# Topics on the History of Tibetan Astronomy

With a Focus on Background Knowledge of Eclipse Calculations in the 18th Century

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Topics on the History of Tibetan Astronomy
with a Focus on Background Knowledge of Eclipse Calculations in the 18th Century

A dissertation presented

by

Sokhyo Jo

to

The Committee on Inner Asian and Altaic Studies

in partial fulfillment of the requirements
for the degree of
Doctor of Philosophy
in the subject of
Inner Asian and Altaic Studies

Harvard University
Cambridge, Massachusetts

May 2016
Topics on the History of Tibetan Astronomy
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ABSTRACT

The eclipse calculations in Tibet feature religious implications. One religious issue is Buddhist chronology (bstan rtsis). With Kālacakra calculational bases, Tibetan Kālacakra astronomers have tried to synchronize with the Buddhist texts, stating that the Buddha’s enlightenment occurred during a lunar eclipse of the full moon. The concept is called “backward calculation” (yar log gi rtsis).

Another religious issue is the rite of poṣadha (gso sbyong). At some point in Tibet, the idea of ūnarātra (zhag mi thub) in the Abhidharma literature was used to argue the accuracy of the weekday (gza’) value of the skar rtsis for the performance of gso sbyong. However, the decision of the accurate day for the gso sbyong during the 18th century Amdo became an issue. At stake was the conjunction with the occurrence of the solar eclipses, whose dates occasionally matched up with the Qing Chinese calendar, not with the skar rtsis calendar. Upon these cases, one of the possible solutions was to perform gso sbyong in conformity with region (yul bstun gso sbyong) according to the Chinese date.
Under the situation that an eclipse is closely tied to the religious chronology and practice, Tibetan astronomers made great efforts to produce the eclipse calculation results which were in accordance with direct experience (*mngon sum*). However, they have been confronted with the incongruity between their calculations and the real phenomena of an eclipse. Inevitably, the non-*Kālacakra* methods and knowledge, including observation, empirical data, debates, criticism, research into other traditions, etc. have been incorporated into the *skar rtsis* system based upon the *Kālacakra*.

Technically, adding a correction (*nur ster*), the correction of residual (*rtsis ’phro*), the correction of a Great Conjunction at the zero point (*stong chen ’das lo*), etc., within the conceptual and methodological framework of the *Kālacakra*, have been used to tally calculations with the real phenomena of an eclipse. Also, the non-*Kālacakra* Chinese *Lixiang kaocheng* system (later known as *Mā yang rgya rtsis*), which was based upon modern geometric and trigonometric knowledge, was used.
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To my mother and father,

Kang Heeja 강희자 and Jo Kyeonghwan 조경환
ACKNOWLEDGEMENTS

In terms of my dissertation writing, my foremost gratitude goes to my Doktorvater Prof. Leonard W. J. van der Kuijp, who kindly spent a lot of time and energy in correcting errors and mistakes in my manuscript. When I confronted difficulties, he also provided me with solutions. Without his knowledge, this thesis could not have emerged. I am also indebted to him for my scholarly growth throughout my PhD studies. He is a pañḍita type of scholar with whom I could ask questions about any topic and field in Tibetology. He likes to study and has hunger for knowledge, which has been a stimulus to my studies. I am grateful to Yum pa at Bod ljongs sman rtsis khang gnam rig skar rtsis zhib 'jug khang in Lhasa. When I went to Lhasa in 2013 for the purpose of learning Tibetan astronomy, he provided me with many astronomical texts and imparted important astronomical knowledge. After coming back to Harvard, I asked many questions thru Wechat. His knowledge has been incorporated into my dissertation. I am grateful to a young Tibetan astronomer, Blo bzang bstan ’dzin, at Kye rdor grwa tshang in Bla brang bkra shis ’khyil, with whom I discussed many topics in Tibetan astronomy and some of my curiosities were alleviated. My deep gratitude and appreciation go to Mr. Edward Henning who is a Kālacakra astronomy specialist. He read my manuscript and made sharp comments and pointed out errors in it. His rigorous questioning of my arguments and ideas was simply superb. Since his criticisms were pointed and sound, I was happy to accept them. My thanks should be also given to Dr. Ōhashi Yukio, who kindly sent me his articles upon my request around the time I began to study Tibetan
astronomy, Dr. Kitagawa Tomoko 北川智子 (University of California, Berkeley) who kindly helped me with my general exams, Dr. Lee Eunhee 이은희 (Independent scholar) who gave me valuable information regarding ancient Asian astronomy, and Dr. Ku Yunhee 구윤희 (LG Electronics) who provided me with knowledge of trigonometry. Also, my special gratitude extends to Prof. Michael Witzel, who kindly allowed me to add him to my dissertation committee and who conjured up essential issues in my defense, and to Prof. James Robson, whom I had as a general exam examiner. I am grateful to Google. It is simply great. A variety of information was found just by Wylie transliterations. It made my research much easier and convenient. I would like to express my gratitude to past, current and would-be researchers of Indo-Tibetan astronomy, whose books and articles I used in this thesis. At present, I propose that around five scholars functioning in the field of Tibetology may be interested in reading this. Therefore, I will happily enjoy the privilege of becoming an author who has around five readers in the world. If someone criticizes me with a reasonable argument that is supported by evidence, I am poised to express my sincere thanks. Also, I may have a chance to add some issues and points to this writing in the future. Also, this may be more helpful to later scholars who will work on this field. I would like to pay my tribute of praise to those who will take up the slack to study this field. We are responsible for broadening and deepening the scope of Tibetology.

Next, I would like to express my gratitude to the following people for their linguistic help. In the case of Tibetan, my special thanks are given to Professor Rdo rje
snying lcags (alias Nyingcha Duoji) at Zhongyang minzu daxue, who used to be a PhD student at Harvard. We spent significant time together at Harvard. I asked him tons of Tibetan questions. Everytime, he kindly spared his time and energy and gave me solutions. Aside from his linguistic help, his knowledge of Tibetan religion and culture was an immense help for my studies. Furthermore, he provided me with some rgya rtsis texts which would not have been secured anywhere else. He also kindly offered me convenience during my time in Beijing. I stayed at his home in the spring of 2015 for my personal research. Without his enthusiastic help, my studies at Harvard and this thesis would not have borne fruit. My special thanks also go to my fellow student and friend Ian MacCormack, who kindly checked the English translations in below Appendices 2 and 3 and provided quality advice. May his scholarly career blossom! My thanks also go to my friend Snying 'jam tshe ring (Zhongyang minzu daxue), Stag bhe (Zhongyang minzu daxue), Bsod nams sgrol ma (Renmin daxue), and Sha bo don grub (Zhongyang minzu daxue). In the case of Mongolian, I express my gratitude to Öljeibayar, a former Professor at Zhongyang minzu daxue, from whom I initially learned Mongolian and to Qasčilayu (aka Haschuluuu) (Zhongyang minzu daxue) to whom I asked Mongolian questions I could not figure out, both at Harvard and in a cafe near Zhongyang minzu daxue. His knowledge of Tibetan was a great help to understand Mongolian texts. Special thanks should also be given to Čelmeg (Minzu chubanshe, Beijing). I benefited from her knowledge of Mongolian literature. Without her sincere help, I would not have used Mongolian texts. My thanks also go to my friend Dayula (Kökeqota), Prof. Erdem-tü (Renmin daxue), Erdenchuluu Khohchahar (Kyoto University), etc. Last, but not least, I
express my special thanks to my old friend Muzäppär Abdurusul (Zhongguo shehui kexueyuan) from whom I learned Uyghur. I cherish his support and friendship. I should also express my thanks to those who secured texts and articles: especially TBRC (Tibetan Buddhist Resource Center), which is simply amazing. I express my gratitude to Professors Erdenibayar (Inner Mongolia University), Ü Naranbatu (Inner Mongolia Normal University), Dong Jie 董杰 (Inner Mongolia Normal University) and Tü Öljei (Inner Mongolia Normal University). For secondary literature in Japanese, I express my gratitude to Choi Kyeongjin 최경진 (Tokyo University) and Park Hyunjin 박현진 (Tokyo University). For Chinese and Tibetan texts, my thanks go to Han Jiyeon 한지연 (Busan University of Foreign Studies). I also express my thanks to 'Jam dbyangs tshe ring at Bod ljongs sman rtsis khang gnam rig skar rtsis zhib 'jug khang, who kindly helped me with many things for my studies and stay at Lhasa in 2013.

Next, emotional stability is a big part for my studies. I would like to express my utmost gratitude and love to my family members who are sources of my happiness: my devoted parents, father Jo Kyeonghwan 조경환, mother Kang Heeja 강희자, who show unconditional love and affection to me and fully supported me mentally and financially. Without their support and buttressing, I could not have finished my degree. My special thanks go to my thoughtful elder sister Jo Yunhoe 조윤희, who supported me mentally and financially, and to her eleven year old son Won Chaemoon 원채문 for whom I have a xi
deep affection and love. Further, my deepest thanks go to my younger brother Jo Sungyoung 조성영, his wife Kim Soim 김소임, their son and daughter, Jo Eunhyuk 조은혁 and Jo Eunchae 조은채. My brother has kept supporting my studies mentally and financially since his university years. His support was crucial for me to keep going forward. My nephew and niece are thirty-two month old twins. Their occasional big smiles engender my smiles. I am thankful for the small town named Ungcheon 웅천, where I spent my childhood. I have Heimat feelings and attachment to her. My basic sentiment is “accablé par la morne journée et la perspective d'un triste lendemain” like that of Marcel in Marcel Proust’s Du Côté de chez Swann, À la Recherche du Temps Perdu. Ungcheon is like “les petites madeleines” to me. When a feeling of dread uncertainty seizes me, she gives me consolation. I have a similar feeling to what Marcel expresses this way: “... Il m'avait aussitôt rendu les vicissitudes de la vie indifférentes, ses désastres inoffensifs, sa brièveté illusoire, de la même façon qu'opère l'amour, en me remplissant d'une essence précieuse : ou plutôt cette essence n'était pas en moi, elle était moi.” The Heimat feeling associated with Ungcheon may be a subconscious essence which remains under water and it may be myself. I am also thankful for coffee. Writing accompanies pain. It is a process of creation which needs not only intellectual and linguistic skills, but also emotional control and perseverance. Drinking my favorite coffee from Cerrado, Brazil helps me have less negative emotions and feel more emotionally relaxed.
Next, I would express my warmest gratitude to my teacher Prof. Cho Sungtaek 조성택 (Korea University), with whom I consulted on personal issues at critical moments in my life and studies after I met with him in 2002 during his class. I have benefited from his teaching, experience, encouragement, good humor, etc. I should also express my gratitude to those who provided me with help in time of need: Prof. Vesna Wallace (UC Santa Barbara), who kindly provided me with warm words and advice everytime I contacted her and Prof. Ulrich Timme Kragh (University of Copenhagen), who helped me to recover confidence and to increase my capacity to appreciate studies and life. I spent a year together with the latter at Geumgang University in Nonsan, Korea. Also, I convey my great thanks to my best friends in college, whose support and friendship are a crucial part in my mental and emotional stability and maturity: Lee Jaejung 이재정 (Nexen Tire, Frankfurt am Main), who understands me the most and supports me unconditionally, Jeon Ilhwan 전일환 (SK Telecom, Seoul), who is warmhearted and is very supportive of me, Jeon Jaepil 전재필 (CPA), who is circumspect and a good listener, Lee Sangwon 이상원 (CPA. HEC Paris), who always approaches challenges to improve his career and studies, which is an inspiration to me, Kang Deukhon 강덕훈 (LG International Corporation, Beijing), who is warmhearted, very caring, and responsible, Choi Wonjung 최원중 (Korean Reinsurance Company), who is a meticulous, polished, and sensible, and Baek Woongjo 백웅조 (Korea Development Bank), who is disciplined, focused and
dedicated. Also, my warm thanks go to my good friend Lee Genseok 이근석 (Chungnam National University), who helped me in many aspects of my M.A. study in Beijing, and Ku Soyoung 구소영 (Kyungpook National University), who is one of my greatest sources of support. My thanks also go to O Jiyun 오지윤, who is Ku Wonmo’s 구원모 (Ku Soyoung’s younger sister) adorable fifteen month old daughter. The pictures and videos that Jiyun used to make me smile and relax during my hectic writing dissertation were wonderful. Also, my thanks go to Lee Namgil 이남길 (Renmin University), with whom I used to hang out often during my M.A. studies in Beijing. He kindly provided me with a room in Beijing to stay in during my research for this dissertation. My thanks also go to my classmates at Harvard: Dr. Huang Chunyuan 黃春元 and his wife Wang Yihua 王宜華, with whom I have good memories of Boston and Cambridge. I am grateful for their friendship. Andy Francis, who is full of constructive criticism and arguments, is reasonably minded, and knows how to accept criticism. Hur Wonjae 허원재, who is full of positive energy. I am grateful to him for listening to my complaints about studying and life at Harvard, and for presenting his opinions on them. Sun Penghao 孫鵬浩 and his wife Liang Jue 梁珏 with whom I discussed many topics of Tibetan Studies. Their enthusiasm for acquiring new knowledge was an inspiration to me. My distress caused by writing this dissertation was lessened by chatting while eating together. I benefited from their emotional and mental support. My warm thanks also go to my good friend Max Oidtmann (Georgetown University), who offered me his sincere friendship. Also, I express my thanks to Liu Cuilan
刘翠兰 (aka Nyi ma), who provided me with advice for a successful life at Harvard, and also to Heather Edgerly, Asha Kaufman, Elizabeth Angowski, and Jetsun Deleplanque, with whom I happily hang out. Also, I should express my sincere thanks to my fellow Korean PhD students I met at Harvard: Park Hyunsung 박현성, Jeong Sukeun 정수근, Tak Hyungsuk 탁형석, Choi Jiho 최지호 and his wife Park Seonmi 박선미, Lee Dongwoo 이동우, Shim Soyoun 심소연, Chae Eunmi 채은미, with whom I hang out the most often and from whom I received a lot of help and learned information. Their camaraderie buttressed my life and studies at Harvard. My special thanks go to Prof. Tien Ning, Prof. van der Kuijp’s wife, who is a cellist with a sense of equilibrium and balanced perspective. Whenever I converse with her, I feel like she uses string techniques, legato and sul tasto. Conversations were smoothly connected to the next topic with mellow emotions, such as sensitivity. The most memorable conversation took place one day in April 2016, when I was struggling to finish up my thesis at their home. She encouraged me to have a broader and balanced perspective on my studies and life. Also, she prepared kimchi for me, which was a big surprise. In addition, I convey my sincere thanks for the support by the following people: Dr. Cha Sangyeob 차상엽 (Geumgang University), who is comfortable to talk with about many issues of Tibetology, Prof. Ahn Sungdoo 안성두 (Seoul National University), who is ready to help those who are willing to study Indo-Tibetan Buddhism, Prof. Park Changhwan 박창환 (Geumgang University), who is a young talented
Abhidharma specialist suffering from a stroke. I wish him a quick recovery. My thanks also go to Professors Woo Jeson 우제선 (Dongguk University) and Ko Youngseop 고영섭 (Dongguk University), whom I met at Harvard and who treated me to meals many times and gave me helpful advice. Last, but not least, I should like to express my gratitude to Harvard University. It is an expensive school and prices in Cambridge are not cheap. The five year full ride scholarship given by Harvard Graduate School of Art and Science covered the minimum expense for my living and studying in Cambridge. Nevertheless, it has three of the best things: 1) world-class professors, 2) excellent libraries. I used their quality materials, many of which would be difficult to secure in other places. In conjunction with that, I express my thanks to Mr. Abe Nobuhiko 阿部信彦 working in Yenching Library, to Walter Ross-O’Connor and Ellen Harris in Widner Library, and to the Harvard Interlibrary Loan Team. Most of all, 3) the friendly and thorough staff in the Committee on Inner Asian and Altaic Studies: specifically, Mrs. Rose Cortese and Mrs. Georgette Maynard. Their assistance was perfect. Occasionally, they also provided me with emotional support that will be remembered as the best part of my memories at Harvard.
INTRODUCTION

CLASSIFICATION OF TIBETAN ASTRONomy

Roughly two different lineages of rtsis (astronomy/ astrology) have been developed in Tibet: skar rtsis, dbyangs ’char (S. svarodaya) of Indic origin and rgya rtsis (nag rtsis, ’byung rtsis), Mā yang rgya rtsis of Chinese origin.¹

First, skar rtsis. Esoteric Buddhist Kālacakra texts such as Laghukālacakra, Vimalaprabhā, Kālacakrāvatāra, Kālacakra gaṇanopadeśa, etc. play a significant role in the development of astronomy in Tibet. However, not much is known to us about the early

¹ There is no clear-cut division between astronomy and astrology in Tibet such as in other ancient civilizations. Nevertheless, the following rough division may be possible:

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<th>Chinese Origin</th>
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<td>astronomy</td>
<td>skar rtsis</td>
<td>Mā yang rgya rtsis</td>
</tr>
<tr>
<td>astrology</td>
<td>dbyangs ’char</td>
<td>rgya rtsis (nag rtsis, ’byung rtsis)</td>
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In the case of skar rtsis, see Schuh’s analysis and hypothesis for the terms, skar rtsis, dkar rtsis, and dus ’khor rtsis (See Schuh, 1973a: 13-9). In conjunction with it, the term dus ’khor skar rtsis is seen in the works of Kah thog Rig ’dzin Tshe dbang nor bu (1698–1755) and Sum pa Mkhan po Ye shes dpal ’byor (1704–1788). — odun-u jiruqai, the Mongolian rendering for skar rtsis, simply shows that Mongolians take the “skar” in “skar rtsis” as skar ma (M. odun). — Dbyangs ’char is an astrological system that relates different vowels of Sanskrit alphabet to the days of the month for the purpose of telling the fortunes of various human activities. For Mā yang rgya rtsis, see chapters 3 and 4. Being contrary to the claims made by Huang and Chen throughout their writings, the first text of this tradition (= Rgya rtsis snying bsdus) appeared in Beijing in the 18th century and then began by Mā yang Bzod pa rgyal mtshan in Amdo who was possibly active in the early 19th century, and the text has no relation to the Rgya rtsis chen mo. Rather, it is a duplicate of the eclipse calculation algorithm displayed in a Chinese text called the Lixiang kaocheng. In other words, the Mā yang rgya rtsis is not an astronomical system but an astronomical technique for eclipse calculation. For rgya rtsis in the lower-right cell, see the following pages in this introduction in which Schuh’s articles on rgya rtsis / nag rtsis are introduced. It should be noted that rgya rtsis may include all kinds of astronomy and astrology from China in a broader sense, but rgya rtsis as an astrology denotes nag rtsis or ’byung rtsis.
history of the skar rtsis. Let me use Schuh to briefly give an introduction of the earlier history of astronomy in Tibet. According to Schuh, some Kālacakra methods exploited by Slob dpon Bsod nams rtse mo (1142–1182) and Rje btsun Grags pa rgyal mtshan (1147–1216) show that a complete assimilation to the Kālacakra system did not take place until 'Phags pa Blo gros rgyal mtshan’s (1235–1280) time.\(^2\) In other words, the Kālacakra calendar became the official Tibetan calendar by 'Phags pa in the second half of the 13\(^{th}\) century.\(^3\) Along with 'Phags pa, Bu ston Rin chen grub (1290–1364) is one of the most eminent astronomers in the early period.\(^4\) In the 15\(^{th}\) century, remarkable achievements in Tibetan astronomy were made by such Phug pa scholars as Grwa phug pa Lhun grub rgya mtsho (15\(^{th}\) c.), Mkhas grub Nor bzang rgya mtsho (1423–1513), etc. Further, Mtshur phu 'Jam dbyangs don grub 'od zer (1424–1482) developed the byed rtsis calculation

\(^2\) Schuh (1973a: 4-5) and Schuh (1974: 558-9).


of 'Phags pa. The climax was reached by the Phug pa scholar Sde srid Sangs rgyas rgya mtsho (1653-1705).

Second, rgya rtsis, which represents all kinds of astrological and astronomical traditions from China in a broader sense and includes the astrological nag rtsis (Sino-tibetan divinational calculations), 'byung rtsis (elemental calculation), etc. Various types of rgya rtsis can be assumed according to different time periods. In the early period, Schuh mentions 'Phags pa's Rtsis kyi gtsug lag dang mthun par nges pa in which criticism toward rgya rtsis pa (Schuh (1973a: 7): “die in Tibet bekannten chinesischen Astronomen”) is found. In a later period, the division between new and old rgya rtsis (T. Rgya rtsis gsar

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6 Unfortunately, the modern research into Tibetan astronomy and astrology still remains in Schuh’s correct but terse sketch. In fact, some giants in the field of astronomy and astrology should be studied to clarify the formation and development of skar rtsis in the earlier period within a skar rtsis frame and within a broader Kālacakra frame. For example, the following important scholars may be listed: Karma pa III Rang byung rdo rje (1284–1339), G.yung ston Rdo rje dpal (1284–1365), Dol po Shes rab rgyal mtshan (1292–1361), Mnga’ ris Chos rje Jo nang Phyogs las rnam rgyal (1306–1386), Mkhhas grub rje Dge legs dpal bzang po (1385–1438), Byang bdag Rnam rgyal grags bzang (1395–1475), Karma ‘Phrin las pa (1456–1539), Dpa’ bo Gtsug lag phreng ba (1504–1566), Karma pa VIII Mi bskyod rdo rje (1507–1554), etc. In the same vein, Henning’s research into ’Gos Lo tsā ba Gzhon nu dpal (1392–1481) deserves praise. For his research, see Henning (2007: 307-21).

7 Schuh’s definition of rgya rtsis is as follows: Schuh (1973a: 15): “... dass dem Kompositum Rgya rtsis eine Mehrdeutigkeit zukommt und dass es insbesondere auch die chinesischen Divinationskalkulationen (Nag rtsis) mitbezeichnet kann.” Also see Schuh (1973a: 17): “Zusammenfassend formuliert bezeichnet also Rgya rtsis die chinesischen Kalkulationswissenschaften schlechthin und insbesondere terminologisch die chinesische rechnende Astronomie und Astrologie.”

8 For relevant information, see the synopsis of Schuh (2004) in this introduction.

9 For the introduction of the criticism, see Schuh (1973a: 6-7). For an etymological explanation of “rgya rtsis pa,” see Schuh (1973a: 15): “Allerdings erwähnt schon 'Phags pa die Rgya rtsis pa, und meint damit die chinesischen Astronomen und Astrologen, und die gesamte hier berücksichtigte Rtsis Literatur bezeichnet
rnying) emerges according to lo 'go, and Mā yang rgya rtsis, which is the astronomical tradition from Qing China (Man. Daicing gurun / M. Čing ulus. Manchu dynasty), appears. The term ser rtsis is also seen in later Tibetan texts. It may mean “Qing imperial calendar.”

im allgemeinen mit Rgya rtsis die chinesische Astronomie und Astrologie.” I raise three points at this juncture. First, as van der Kuijp (2004) joins Schuh (1973a), it should be noted that Schuh’s (1973a) explanation lacks information of whether rgya rtsis pa was (were) active in Tibet or in China. See van der Kuijp (2004: 14, n. 40): “The term rgya rtsis pa is ethnically ambiguous, for it can refer to such an individual who is Chinese (rgya [mi]), or to a Tibetan who does Chinese (rgya [nag gi]) astrology.” Second, regarding ’Phags pa’s real use of the rgya rtsis calendar in his writing and the level of understanding of the contemporary Chinese astronomy, Chen2 (2006: especially 368-9) may be nice to be mentioned together with Schuh (1973a). Chen2 (2006) worked on ’Phags pa (1992-1993), which is composed of 24 letters of new year’s greetings to Qubilai Qaγan, the prince, and the queen written from 1255 C.E. (T. shing mo yos) to 1279 C.E. (T. sa mo yos): ’Phags pa understands that there is a difference between Tibetan and Chinese calendar in terms of lo ’go. Chen2 (2006) suggests that, meanwhile the first month of Shoushili (授時歷), the official calendar of Yuwan ulus (Yuan dynasty), is equivalent to mchu zla ba (1st month according to the currently used Tibetan Kālacakra system), — Schuh (1973a: 6-8, 32, 102) is clear on that point by his research into ’Phags pa’s Rtsis kyi gtsug lag dang mthun par nges pa. — that of the Tibetan Kālacakra calendar, which was being used at that time in Tibet, may be smal po’i zla ba (= ngo zla. the 11th month), given the 12th letter indicating sa pho ’brug gi lo smal po’i zla ba la (See ’Phags pa [1992–1993: 794-5]). His explanation is as follows: the letter was intended to greet the Chinese new year sa pho ’brug (Ch. wuchennian 五辰年) but the Tibetan sa pho ’brug (1268 C.E.) is already there in the phrase. If it is understood as “in the eleventh month of 1268 C.E.,” there is no way to understand it. Therefore, he suggests that if smal zla is the beginning month of the year according to ’Phags pa’s system—more accurately, the first day of the smal zla is taken as the first day of the year— the sentence will be understood as “in the first month of the year of sa pho ’brug,” and the problem will be solved. Because of not much remaining textual evidence, it is difficult to refute his claim, but we should keep an eye on this issue. — Of course, Schuh (1973a: 8) would not agree with his claim. Then, how to understand the sentence? — Also for the issue of lo ’go, see Bsam ’grub rgya mtsho (2011: 61-3) [= Bod rgya tshig mdzod chen mo (2000: 2806-7) = Tshul khrims rgyal mtshan (2009: 368-9)]; according to Bsam ’grub rgya mtsho’s (2011) classification, one more possibility used by Sa skya pa may be raised: hor zla bcu ba’i mar ngs (the 16th day of the tenth hor zla) is taken as the first day of the year. However, I have never encountered the case in Tibetan literature, which means that I do not know from when Sa skya pa scholars began to use the system in Bsam ’grub rgya mtsho (2011: 62). Third, as Schuh (1977: 170) and van der Kuijp (2004: 15) argue, 13th–14th century Tibetan imperial preceptors (Ch. dishi 帝师) in Yuwan ulus use Chinese calendar in edicts and decrees (Ch. fazhi 法旨).
Several scholars have attempted to reveal the nature and features of Tibetan astronomy. Let me briefly introduce them under a broader frame of skar rtsis and rgya rtsis.

I should first mention Schuh, who, in a bona fide sense, first began research into Tibetan skar rtsis and nag rtsis. Let me first deal with his research into skar rtsis. He produced a monumental work titled Untersuchungen zur Geschichte der tibetischen Kalenderrechnung (1973a), showing mastery of tibetan rtsis literature and calculations, through which the features and characteristics of skar rtsis have been clarified. In it, he combines philological and historical concerns with mathematics to do calendrical research from the chronological perspective. The tables included in the second part of the book epitomize his main concern, i.e., how to match Tibetan calendar dates of different traditions with Gregorian and Julian dates. Within these calendars, the dates, according to the New (m = 1A in his notation) and the Old (m = 1B) Phug system (both grub rtsis), the byed rtsis calendar based upon the Kālacakra (m = 3), and the byed rtsis calendar of 'Phags pa (m = 4) are given with the Gregorian date from 1027 C.E. to 1973 C.E. Schuh (1973a), meanwhile, places significant emphasis on the 15th century; thus, later

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11 His works on skar rtsis include Schuh (1970), (1973), (1973a), (1974), (2008), (2012), (2012a), etc. All of them will be mentioned.

12 For table instructions, see Schuh (1973a: 131-41). For the significance of Tibetan calendar in relation to Tibetan history, see Schuh (1974: 554) who emphasizes that the conversion of the Tibetan dates with the Gregorian dates is critical in historical research.
period astronomical achievements are tersely described. Recently, he published a four volume compendium in which he included a useful glossary and technical vocabulary (Schuh (2012)) and his most up-to-date writing (Schuh (2012a)). The basic frame is not different from that of Schuh’s (1973a), and articles are continuously published online on his website. Some information has been added, but mostly not much progress has been made from his seminal work (Schuh (1973a)). His glossary on Tibetan astronomical and astrological terms (Schuh (2012)) is a contribution to the modern research into Tibetan astronomy.

Because I will continuously use his research into skar rtsis, I, in this section, confine myself to briefly summarizing his works on nag rtsis. On the general history of nag rtsis from the earlier period to the 5th Dalai lama Ngag dbang blo bzang rgya mtsho (1617–1682), Schuh (2004) must be first mentioned. It deals with the transmission and systemization of nag rtsis in terms of politics. His explanation is as follows: the 5th Dalai

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lama’s introduction of the *nag rtsis* after his visit to the Manchu court in 1653 is a great historical event which demonstrates the relationship between politics and astronomy in Tibet as seen in the 5th Dalai lama’s seals: “... Wie sollte sich der 5. Dalai Lama als Herr der buddhistischen Welt vor diesem Hintergrund gegenüber dem mehrheitlich nicht-buddhistischen, machtpolitisch aber aufstrebenden China und seinem nicht-buddhistischen Kaiserhaus positionieren? Den Schlüssel zu dieser Frage liefert uns möglicherweise eine Wissenschaft, die bei den tibetischen Geistlichen der führenden neuren Schulen des tibetischen Mittelalters praktisch keine Bedeutung hatte, nämlich der *Nag rtsis*, die auch *Byung rtsis* "Kalkulation der Elemente" genannt wird und die wir hier als sino-tibetische Divinationskalkulationen bezeichnen.”

Thus, Schuh traces an earlier history of the Sino-Tibetan traditions in Tibet. He argues from the philological viewpoint that *nag rtsis* dates back to the Yar klungs Dynasty (7th c. – 9th c.) and played an important role in the daily lives of mediavel Tibetans, being mostly transmitted by the Rnying ma pa. The *Blon po bka’i thang yig*, which was rediscovered by the 14th century Gter ston O rgyan gling pa (1323–?), states that the *nag rtsis* was transmitted by Mañjuśrī in Wutai Mountain in China and that it is a field of science that does not lead sentient beings to the enlightenment. Therefore, Tibetan Buddhist sects began to regard the *nag*
rtsis as a non-Buddhist path: “Im Unterschied zu den Rnying ma pa ... die neueren Schulen zwar den astronomischen Darlegungen der Astronomie des Kālacakra-tantra große Bedeutung zumaßen, die Lehren der Nag rtsis aber konsequent ignorierten.” However, this situation began to change upon the 5th Dalai Lama’s visit to Qing China in 1653. Five years after his visit to Qing China, he completed the nag rtsis text titled Nyin byed dbang po'i snang ba in which he includes Qing China as the land tamed by Mañjuśrī especially in the field of the nag rtsis. Thus, the Sde srid also states in the G.ya’ sel that the nag rtsis is a field of study blessed by the Buddha. In this way, it was incorporated into the Buddhist world of the Dge lugs pa order. Of course, there existed internal criticism towards nag

17 Schuh (2004: 12-3).


19 Schuh (2004: 14-5). However, his argumentation may be countered. Nag rtsis’s strong ties to the Rnying ma pa and rejection by Dge lugs pa are still unproven. And it may not have been revived by the 5th Dalai lama. Rather, it may have been transmitted without being attached to the religious sects and may have been being researched continuously and sporadically even before the 17th century. For example, see Byang bdag’s letter to Mkhas grub, Byang bdag (2) (n.d.: 10a): “This nag rtsis emerged during the time when human life span did not decrease, (when they lived) 100 years. ... If you have knowledge of Chinese chronology of teaching, please send me an answer to the questions of where is the rotation of sme ba currently and how many have passed up to the present since nag rtsis appeared,” (nag rtsis ’di / mi rnams tsha lo ma ’gribs (sic. read ’grib) pa / brya pa’i dus su byung ba yin / ... rgya (sic.) pa’i bstan rtsis shes pa yod na / ding sang sme ba bskor res / gang la yod / nag rtsis byung nas ding sang yan la ’das lo du song / dris pa’i lan kyang bskur mdzod / ). This quotation may reveal that the nag rtsis was regarded as a field to be studied in the 15th century in which Byang bdag was active. Further, it should be noted that both Byang bdag and Mkhas grub have no ties to Rnying ma pa. In conjunction with this issue, Schuh (2013) presents an instance that counters his previous claim made in Schuh (2004) about the revival of nag rtsis by the 5th Dalai lama. Interestingly, there may have existed a parallel history in Mongolia in terms of the continuity of Mongolian divination, see Ho (2012-2013: 137): he regards the divination documents found in the Xarbuxyn Bargas and researched by Elisabetta Chiado as evidence of an unbroken transmission of Chinese divination in the Mongolian region between the collapse of Yuwan ulus and the beginning of Qing China.
rtsis. For example, in the divination, Kong tse (Confucius. Ch. Kongfu zi 五(夫子. 551–479 B.C.E.) is described as one of the major disciples of Mañjuśrī who transmitted the divination, thus comprehending the gto and dpyad rituals. The nonsensical association was disputed by Thu’u bkwan III Blo bzang chos kyi nyi ma (1737–1802) in the Grub mtha’ shel gyi me long. His other study of nag rtsis (Schuh (1972)) was inspired by Macdonald (1963). He examines Dharmaśrī’s (1654–1717/8) Zla ba’i ’od zer, a work on nag rtsis written in 1684, with a focus on the calculation method of the sme ba dgu. In it, he points out that Macdonald wrongly placed the system of sme ba dgu used in the Rgya bod yig tshang by Stag tshang pa Dpal ’byor bzang po, alias Śrībhūtibhadra (15th c.) in the 60 year cycle, and argues that it should be placed in the 180 year cycle (bringa dang bringad cu skor). He holds that the ignorance of the sme ba dgu brought about the difficulty in deciding the year in which the chapter of the Chinese royal lineage in the text was written.

20 For more information, see Lin (2005) and Lin (2007).


22 For the term, see ’Gyur med rdo rje (2001: 417): “sme ba dgu (Ch. jiugong 九宮); the nine numeric squares that comprise White One, Black Two, Blue Three, Green Four, Yellow Five, White Six, Red Seven, White Eight, and Red Nine. ... Through the sme ba dgu, the Tibetan sexagenary cycle is actually extended to one of 180 years (sme phreng gsum).” According to Macdonald’s research, the introduction of sme ba dgu in Tibet dates back to the early 8th century according to the Sde srid. See Macdonald (1963: 73). For the principle and divinational methods of the term with a background of the Tang dynasty divination, see Sun (2007)

23 See Schuh (1972: 487ff.). Dharmaśrī (1654-1717) introduces the term bregyad cu skor (lit. 80 year cycle) for the 180 year cycle (brgya dang bregyad cu skor). It may be misleading without background knowledge on the depiction in Dharmaśrī’s Zla ba’i ’od zer. See Dharmaśrī (1999: 7a). Also, see Fifth Dalai Lama (2009: 448).

24 For Macdonald’s doubt, see Macdonald (1963: 78ff.). Especially, Macdonald (1963: 79): “« ... Si l’on calcule
According to him, because of her misunderstanding of the *sme ba dgu*, 60 years increased in calculations: the actual year *shing pho stag* where the *srog sme* White Eight is in the center is 1434 according to the 180-year cycle of the *sme ba*. Thus, he concludes that the chapter of the Chinese royal lineage was also written in 1434, not in 1494, and that, given the *Rgya bod yig tshang*, the 180-year cycle of the *sme ba* was used in 15th century Tibet.\(^{25}\) Schuh (1973c) also may be read together with his previous article Schuh (1972) in which he explains: the 5th Dalai lama states in the *Rtsis skar nag las brtsams pa’i dris lan nyin byed dbang po’i snang ba* that, before the 17th century where the 180-year cycle of the *sme ba* was well-established, the two ways of allocation of the *sme ba* to the year, i.e., the *drug bcu skor*

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(60 year cycle of the sme ba) and the brgya dang brgyad bcu skor, existed simultaneously: Some texts like the the Rin chen gsal sgron are based upon the drug bcu skor; meanwhile, the Phag mo gru rulers adopted the brgyad bcu skor in the 15th century. Therefore, special attention needs to be given in order to calculate the year on the basis of the sme ba. In the next writing, Schuh (1973d) tackles 'byung rtsis in which Chinese elemental relations of friend (Ch. xiangsheng 相生) and enemy (Ch. xiangke 相剋) become the fundamental principles. The nag rtsis is an indicator of Tibetan customs and rituals. Schuh notably emphasizes that the nag rtsis is characterized by cultural syncretism between China and Tibet. In the same vein, he deals with the rgya nag rdel skor, which is well described as the last calculation method of the keg rtsis in Blo bzang tshul khrims rgya mtsho’s (alias Lha mo tshul khrims (1889–1958)) Rgya rtsis dge ldan mkhas pa'i phyag rgyun du bstar ba'i rdel 'grem dpag bsam ljion shing written in 1921 C.E.. The rgya nag rdel skor, whether it is circle or cross, is given according to the elemental relations whose


28 For a detailed explanation, see Tseng (2005: 28-30).

29 'Gyur med rdo rje (2001: 414): “rdel skor (stone circle); divinatory pebbles: Pebbles were deployed in charts representing the diverse relationships formed by the elements, whether in the context of natal horoscope or of divinations concerning marriage, obstacle years, ill health or death. … In the schematic
origin is Chinese astrology. Thus, Schuh argues that E. Schlagintweit (1835–1904) and L. A. Waddell’s (1854–1938) researches on the *nag rtsis* do not illuminate its religious meaning, which is related to rituals such as marriage, funeral, burial, etc.\(^{30}\)

All in all, Schuh, being equipped with the best philology and astrological and astronomical knowledge, has pioneered the new territories of *skar rtsis* and *nag rtsis*. His marvellous scholarship has been, is, and will be an inspiration for the research of the Tibetan *rtsis*.

Huang Mingxin has produced books and articles on Tibetan astronomy, with the collaboration of Chinese ancient astronomy specialist Chen Jiujin, since the 1980s. Both authors learned from Bsam ’grub rgya mtsho (1923–2006), one of the greatest astronomers of the 20th century at Bla brang bkra shis ’khyil. The quality work *Zangli de yuanli yu shijian* is a joint work by the two. It is a textual research on the two crucial astronomical texts, one from *skar rtsis*: Phyag mdzod Gsung rab’s *Rigs ldan snying gi thig le,*\(^{31}\) the other from the *Mā yang rgya rtsis*\(^{32}\): *Rgyal khab chen po pe cing gnas pa’i yul gru gtsos*

charters or grids that are employed today, the white pebbles are represented by circles and the black pebbles by crosses.”

\(^{30}\) Schuh (1973b) is also based upon this criticism.

\(^{31}\) The author Phyag mdzod Gsung rab (active in early 19th c.) is Shing bza’ Blo bzang dar rgyas rgya mtsho’s (1752-1824) *phyag mdzod*. He mainly functioned at the monastery of Rwa rgya and his *Rigs ldan snying gi thig le*, which was edited and translated in Huang and Chen (1987), is known to be stored at this very monastery. The epoch of the text is 1827 C.E. and then changed into 1927 C.E. by Mkhyen rab nor bu (1883–1962) at Bod ljongs sman rtsis khang. Since Phyag mdzod (1976) whose epoch was changed by Mkhyen rab nor bu does not indicate any sign of the original authorship, both Schuh and Henning (2007) are ignorant of the existence of the original work by Phyag mdzod. Schuh (1973a: 43): “Bstan bcos Vaidūrya dkar po dang nyin byed snang ba’i dgyongs don gsal bar ston pa rtsis gzhi’i man ngag rigs ldan snying gi thig le. Der Verfasser ist der circa 1882 geborene Mkhyen rab nor bu.” Schuh (1973: 287-90): *Rigs ldan snying gi thig le*: No. 305/ Hs. sim. or.
It is an ideal textbook for anyone who is interested in knowing Tibetan rtsis calculations. The book clearly presents Tibetan astronomical concepts and theories. Most of all, the best combination between the Tibetologist and specialists on ancient Chinese astronomy works greatly for the explanation of the Tibetan Mā yang rgya rtsis tradition, which is derived from the Qing China calendrical astronomy.

Yum pa (alias Yum skyabs rgyal), director of Bod ljongs sman rtsis khang gnam rig skar rtsis zhib 'jug khang, is a primary disciple of the aforementioned Bsam 'grub rgya mtsho. He also worked together with Na lendra'i mkhan po Tshul khrims rgyal mtshan (1933-2002) and Byams pa 'phrin las (1929-2011) in Lhasa. Based on my personal experience, he is the only Tibetan rtsis professional among Tibetans in this century. His contributions are as follows: first, he has excavated and published new astronomical texts. For example, he recently edited and published Sum pa mkhan po Ye shes dpal 'byor's

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32 The Mā yang rgya rtsis is a Tibetan duplication of the part of eclipse algorithm in the Lixiang kaocheng, which is the sinicized Western astronomy in Qing China. For the information, see chapter 4. The appellation is not common in Tibetan text. It is usually just denoted as rgya rtsis. As seen above, rgya rtsis may mean all kinds of astronomy and astrology of Chinese origin in a broader sense. Thus, I use the term Mā yang rgya rtsis to tell it from the broader and encompassing term, rgya rtsis.

33 Among Tibetan astronomers and scholars, this text whose epoch is 1744 is simply known as Rgya rtsis snying po bsdus pa (= Rgya rtsis snying bsdus), and its authorship has been attributed to Mā yang Bzod pa rgyal mtshan, which is problematic. See chapter 4.
(1704-1788) astronomical texts, including the *Dga’ ldan rtsis gsar/ Dge ldan rtsis gsar* and Gser tog Blo bzang tshul khrims rgya mtsho’s (1845–1915) astronomical texts. Thus, he has found new astronomical literature. For example, he found the Sde srid’s *bu yig, Bstan bcos chen po bai dur dkar po'i cha rkyen du gtogs pa'i legs par bshad pa bu dpe por gcig*, which has been mentioned in some Tibetan *rtsis* literature, but its existence had not been known until he discovered it. Further, he digitalized the so-called *Rgya rtsis chen mo* stored in the Potala palace. Second, he has developed software for calendrical calculation, named *Bod kyi gnam rig skar rtsis rig pa'i brtsi byed ma lag* (not publicized yet), by using Visual Basic, C++, and Fortran. *Lnga bdsus, Rāhu, spyi zhag, sgos zhag*, etc. of each day in the *grub rtsis* 

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34 I believe that his edition has been published as of 2015 by Si khron mi rigs dpe skrun khang, but I have never seen the hard copy. I use its pdf which Yum pa personally gave me. He used following four versions for the *ma* and *bu* each: two xylographs: one from TBRC and the other from Se ra monastery (originally Potala *par ma*) and two manuscripts: one from Amdo scholar Dam chos, the other from the Library of Nor bu gling ga (Nor bu gling ga’i dpe mdzod khang). Even if the manuscripts are relatively clearer, they are later copies with many typographical and scribal errors. Thus, he primarily used the xylographs to present the modern editions. At any rate, it is intriguing for me to learn that there exists the clearer xylographs of Sum pa mkhan po’s writings than the well-known xylograph from Usu-tu Monastery in Kökeqota, Inner Mongolia. However, it is not known that Sum pa Mkhan po’s *gsung ’bum* exists as a clearer xylograph format in its entirety.


36 See van der Kuijp (2012: 2). The *bu yig* text for the *Vaidūrya dkar po* was found by Yum pa in the old Sman rtsis khang in front of the Jo khang, Lhasa.

37 See van der Kuijp (unpublished (2): 2-5), which is the only English article with the general introduction to this text and its Mongolian original *Tngri-yin udq-a*.

(m = 1A in Schuh’s notation with correct leap month)\textsuperscript{30}, byed rtsis (m = 2 in Schuh’s notation), and Dga’ ldan rtsis gsar (m = 10 in Schuh’s notation) are easily output with it. Tibetan astronomical calculations are based upon four fundamental arithmetic operations, although they are not simple in some cases. The simple and repetitive calculations may be a waste of time because a computer can save us a lot of time and energy. Furthermore, calculational tables in Tibetan astronomical texts, which are used for real calculations, are subject to errors due to handwriting, calculational errors, etc. In that sense, he has made a significant contribution to enhancing the accuracy of calculations.

Edward Henning has worked on Tibetan astronomy for decades. His monograph Kālacakra and the Tibetan Calendar, which is an excellent work from the perspective of modern mathematics, is the most updated research that includes the Tibetan calendar and ephemeris. Throughout the book, he tries to clarify theory and the rationale for the main calculations of Tibetan astronomy. With a tenacious and inquiring mind, he probes and tries to make sense of numbers given in astronomical texts and tries to explain possible theories hidden behind the numbers and formulars. The reading of the main verses of the first chapter of the Laghukālacakra and Vimalaprabhā, which is presented in chapter 5, in the monograph and the thorough exposition on the relationship between the Kālacakra texts and later interpretations of them in Tibetan astronomical writings,

\textsuperscript{30} This can compensate for the defects in the intercalation in the tables (1973a: *1*-*239*) in Schuh (1973a), although these correctly output lhag chad. For the problem in Schuh’s tables, see below no. 432.
which penetrate the monograph, are extraordinary. Nevertheless, it should be cautiously used because Tibetan rationale and astronomical background knowledge and context may be different from the modern astronomical rationale on which the monograph is based. His explanation will be able to be reinforced after confirming with real Tibetan astronomical texts. Further, contrary to the fact that he is equipped with a mathematical background, he may lack in the philological strictness Tibetology requires. His use of Tibetan materials is loosely tied to the Tibetan original text. His other contribution is software comparable with the aforementioned Yum pa’s software: he created software that enables us to easily obtain the values of Inga bdsus, Rāhu, spyi zhag, sgos zhag, etc. of a specific date. His software is designed to calculate the values by Generalized Phug system (from −1000 (= 1001 B.C.E.). m = 1A in Schuh’s notation), Generalized Mtshur phu (from -1000. based upon Kong sprul Blo gros mtha’ yas’s (1813-1899) Rtsis kyi bstan bcos nyer mkho bum bzang las skar rtsis kyi lag len ’jug bder bsdebs pa legs bshad kun ‘dus), Generalized Error Correction (from -2000. ’Gos Lo tsā ba Gzhon nu dpal’s

40 Several modern scholars worked on the arcane chapter I. For example, Toganoo Shoga translated the D. edition Laghukālacakra and Vimalaprabhā in the 1940s, and his note was published posthumously in Toganoo (1989). He translated the most part of chapter I. But, because he has no knowledge on astronomy, the translation is not reliable. Then, Banerjee (1959) presented the translation of the first chapter of the Laghukālacakra on the basis of the Sanskrit manuscripts from Cambridge University Library, Royal Asiatic Society of Great Britain and Ireland in London, and K. P. Jayaswal Research Institute in Patna, but it is not a great addition to the research into the Kālacakra astronomy. Newman (1987) translated Laghukālacakra chapter I, verses 1-27, and verses 128-170 together with some verses of Vimalaprabhā chapter I. He did not work on the essential verses for the astronomical theory and practice. So, no substantial contribution to the understanding of the Kālacakra astronomy has been made before Henning (2007), which is the only work worth being referenced.

41 For the instruction and explanation of the software, see Henning’s web page http://www.kalacakra.org/calendar/os_tib.htm.
Rtsis la 'khrul pa sel ba), Mkhas pa'i snying nor (from 1796. Thu'u bkwan III's Mkhas pa'i snying nor)\textsuperscript{42}, Sum pa Mkhan po's Dga’ ldan rtsis gsar (from 1747. m = 10 in Schuh's notation).\textsuperscript{43} This software surely saves us from spending simple repetitive arithmetic operations such as Yum pa's software does.

Last but not least, research into nag rtsis, astronomy of Chinese pedigree, includes 'Gyur med rdo rje,\textsuperscript{44} Tseng Teming (aka Zeng Deming), etc.\textsuperscript{45} The former

\textsuperscript{42} The authorship is problematic. See the Mkhas pa'i snying nor included in Thu'u bkwan III's gsung 'bum Vol. 9 (ta) (Zhol par ma) (2000: 35b-36a): According to the colophon of the text, a monk who calls himself Btsun gzugs snyoms las pa 'Jam dbyangs dgyes pa'i gzhon nu composed it and made his disciples such as Gtsang ston Bstan pa dar rgyas, etc, who are experts in real practice, calculate and write the values. ... Then, 'Jam dbyangs dgyes pa'i gzhon nu is Thu'u bkwan III's another name? In Thu'u bkwan III's gsung 'bum, Mi pham zla ba's (1767-1807) dkar chag of Mkhas pa'i snying nor, Rtsis kyi bstan bcos mkhas pa'i snying nor gyi dkar chag legs par bshad pa chos dung g.yas 'khyil, is also included but there is no information verifying the authorship of Mkhas pa'i snying nor. Mi pham (2012a: 277) delivers some information on the authorship: "Rtsis kyi bstan bcos mkhas pa'i snying nor; it is said that monk (T. btsun gzugs pa) 'Jam dbyangs dgyes pa'i gzhon nu composed. ... It is said that Thu'u bkwan III Vajradhara summarized its catalogue written by Mi pham zla ba (= Mi pham dbyangs can dga' ba'i blo gro), and wrote." (rtsis kyi bstan bcos mkhas pa'i snying nor zhes /.../ btsun gzugs pa 'jam dbyangs dgyes pa'i gzhon nu mzdad gsungs / .../ de'i dkar chag .../ mi pham zla ba'am / mi pham dbyangs can dga' ba'i blo gros kyis ... bris pa / thu'u kwan rdo rje 'chang gis bsdus zhi ... brtsam zhes so / ). Given the above passage, the original author is the unidentified 'Jam dbyangs dgyes pa'i gzhon nu and 'Jam dbyangs dgyes pa'i gzhon nu is a different one from Thu'u bkwan III Blo bzang chos kyi nyi ma. After browsing TBRC, I found that the unidentified 'Jam dbyangs dgyes pa'i gzhon nu appears again in a blo sbyong text named Blo sbyong tshigs brgyad ma'i 'khrid yig included in Thu'u bkwan III's gsung 'bum Vol. 3 (qa) (zhol par ma). The colophon reads as follows: "Monk (btsun pa) 'Jam dbyangs dgyes pa'i gzhon nu 'Jigs bral smra ba'i nyi ma who is devoted to the teachings of old and new Bka' gdamgs pa composed it." (... bka' gdamgs gsar rnying gi bstan pa la mos pa'i btsun pa 'jam dbyangs dgyes pa'i gzhon nu 'jigs bral smra ba'i nyi ma zhes bya bas ... sbyar ba'o /). Is he Blo bzang chos kyi nyi ma? To decide it, reading his biography may work. Let me leave the issue aside for future research. It has been commonly believed that Mkhas pa'i snying nor is a Thu'u bkwan III's work, but there remains the uncertainty on the authorship. Nevertheless, for convenience's sake, I take it as a work of Thu'u bkwan III.

\textsuperscript{43} His explanation of the term “generalized” is not found on it, but according to him, “generalised” means that it uses no textbook epoch value, but an epoch of year -1000. This is so that all epochs and events such as in the Buddha's lifetime can be calculated. The two traditions out of the five, i.e., Dga’ ldan rtsis gsar and Mkhas pa'i snying nor, which are not addressed “generalized,” adhere to their real epochs, 1747 C.E. and 1796 C.E., respectively.

\textsuperscript{44} 'Gyur med rdo rje (2001).
worked on the nag rtsis parts of the Sde srid’s Vaiḍūrya dkar po⁴⁶ and Dharmasrī’s ‘Byung rtsis man ngag zla ba’i ‘od zer; the latter worked on Blo bzang tshul khrims rgya mtsho’s nag rtsis text Dpag bsam ljon shing.

Overall, not many brilliant works have been intermittently publicized, and the time-honored Tibetan rtsis tradition remains understudied. It is also true that, in spite of the many valuable intellectual texts that have been produced in the field of rtsis, the abstrusity and expertise hinder modern researchers from studying it.

CHAPTER OUTLINE

Among many topics in rtsis, I focus on the Tibetan way of understanding and interpretation of eclipse calculations, especially with a focus on the 18th century.⁴⁷ Then,

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⁴⁵ Tseng (2005).

⁴⁶ For a detailed analysis of the contents of the Vaiḍūrya dkar po, see Schuh (1973: 266-77).

⁴⁷ The early period may not appropriate for the research into Tibetan eclipse calculation. Simply, not many materials exist and the knowledge on eclipse is also meager. For example, Śākyāśrībhadra’s (1127-1225) short text on eclipse calculation Nyi zla ’dzin pa’i rtsis (P. Bstan ’gyur, No. 2100 under the title of Dpal dus kyi ’khor lo’i rtsis kyi man ngag; D. Bstan ’gyur, No. 1385) exists. As for his eclipse calculation, there exists an interesting anecdote between him and Rje btsun included in Sa skya’i gdung rabs ngo mtshar bang mdzod. See Ngag dbang kun dga’ bsod nams (1986: 79-80); for the Chinese translation, see Chen, Gao, and Zhou (2002: 52). It gives us a feeling that he is not learned in astronomy at all. It seems that his disciple Vibhūticandra is also not a master in astronomy. Vogel (2002) evidences that Vibhūticandra has very limited knowledge on eclipse calculation. For the life and works of Vibhūticandra, see Stearns (1996). Nearly no materials showing the systematic eclipse calculation remain in Tibet, even before 15th to 16th century, as far as I know. In that sense, the later period, for example, the 18th century, in which observational data and empirical knowledge kept accumulating, and Tibetan astronomers were able to absorb new elements from other traditions, may be a good topic for the study of the Tibetan eclipse calculation.
why eclipse calculation with a focus on the 18th century? First, within the boundary of astronomical calculations, eclipse calculation is a big part of skar rtsis astronomy, while being related to various issues in skar rtsis. In other words, eclipse is a nice tool to explain overall issues in Tibetan astronomical research. For that purpose, rather than presenting simply the process or sequence to produce eclipse results, I take the following approach: I explain the context and background of why skar rtsis presents certain calculational methods and what Tibetan astronomers’ astronomical thoughts and ideas are based upon, how skar rtsis evolved by interacting with various knowledge sources. With that line of thinking, I further focused on explaining the background knowledge for eclipse calculation. Second, within the religious frame, I focus on explaining the Tibetan rationale for eclipse calculation. Little study on Tibetan skar rtsis has been made thus far from the perspective of religious history. Ultimately, I attempt an interdisciplinary research, which connects astronomy and religion. I present criticism, along with different concepts and ideas for the calculation methods of eclipse and mathematical techniques in the 18th century. I incorporate the mathematical and astronomical knowledge into intellectual and religious context in order to consider the inextricable link and dynamics between Tibetan eclipse calculations and Buddhism as well as to provide understanding of the fundamentals of Tibetan eclipse calculation itself.

My writing is composed of two parts, i.e., part I (chapters 1 and 2) and part II (chapters 3 and 4). Part I concerns religious meaning and the significance of eclipse
calculation in Tibet. For the significance of an eclipse in Tibet, it would not be enough to merely mention that eclipse calculation is made because astronomy is one of the 10 sciences (S. daśavidyā/ T. rig gnas bcu), which are derived from India, because there are Tibetan indigenous interpretations. In chapter 1, first, in terms of Buddhist chronology (bstan rtsis), Tibetan astronomers maintain that the Buddha’s enlightenment during a lunar eclipse recorded in some Indian Buddhist texts such as Vinaya, Abhinīṣkrāmaṇa sūtra, Lalitavistara sūtra, etc. should be accurately calculated by backward calculation (yar log gi rtsis) based upon calculation methods in the Kālacakra. Among many bstan rtsis-s in history, I mainly focus on the conflict between byed rtsis and Phug pa grub rtsis by using Sum pa Mkhan po. The hermeneutics that makes sense of the different Buddhist texts with Kālacakra is as follows: Kālacakra is superior to the other texts, but both the former

48 Rig gnas bcu (ten sciences), which is the traditional Tibetan method for the classification of sciences, includes rig gnas che ba lnga and rig gnas chung ba lnga. The former, or the major five sciences, are bzo rig pa (S. śilpakarmāsthānavidyā, technical science), gso ba rig pa (S. cikitsāvidyā, medicine), sgra rig pa (S. śabdavidyā, Sanskrit grammar), gtan tshigs rig pa (S. hetuvidyā, Buddhist logic and epistemology), and nang don rig pa (S. adhyātmavidyā, Inner science/ Buddhism). The latter, or the minor five sciences are snyan ngag (S. kāvya, Poetry), mngon brjod (S. abhidhāna, synonymics), sdeb sbyor (S. chandas, metrics), zlos gar (S. nāṭaka, drama) and skar rtsis (S. jyotisa, astronomy). For the textual bases on the classification, see Seyfort Ruegg (1995: 93-147), van der Kuijp (2012: 3). Especially for astronomy, see Seyfort Ruegg (1995: 107-8): Dpal khang lo tsā ba Ngag dbang Chos kyi rgya mtsho (active in 16th c.) recognized the skar rtsis as one of the rig gnas chung ba lnga. van der Kuijp (unpublished [2]: 4, no. 18): Vinayavibhaṅga is the locus classicus of the rig gnas chung ba bco brgyad (18 domains of knowledge) in which astronomy/astrology is included.

49 For the use of this term among Phug pa scholars, see van der Kuijp (unpublished [2]: 10-11). He renders it as “reverse engineering” with the presentation of such different terms as “g.yen du log pa’i brtsis/ g.yen log gi brtsis.” My finding on the relevant expression is: Byang bdag (3) (n.d.: passim), which was written in 1440, uses “g.yen log gi rtsis.” Also read Nor bzang rgya mtsho transalted by Kilty (2004) in which Kilty uses “reverse calculation” for the term.

50 This dyadic relationship is safe after the 15th century. See also below note 401.
and latter are affirmed. Tibetan astronomers may have thought that they created the compatible system between them, but they did not provide the reason why they should be compatible and why Buddhist texts being incompatible with the Kālacakra in terms of chronology were ruled out.

In chapter 2, I argue that eclipse, which evidences the accuracy of a certain astronomical system, influences the performance of the religious rite gso sbyong. Tibetan scholars hold that the dates for gso sbyong specified in Indian Mūlasarvāstivāda Vinaya texts, the 14th and the 15th nyin zhag on a fortnightly basis, are basically the 15th tshes zhag in skar rtsis. The logic is called zhag mi thub and works as a way of justifying the accuracy of skar rtsis by means of attuning Vinaya to skar rtsis based upon the Kālacakra. In Tibetan skar rtsis where an eclipse is supposed to occur on the end of the 15th and on the end of the 30th tshes zhag (= 15th tshes zhag on a fortnightly basis) respectively, the fact that the occurrence of solar eclipses occasionally did not match up with skar rtsis dates (tshes zhag) was a challenge on a religious level, specifically for the performance of gso sbyong because it may mean that the tshes zhag is not accurate. Further, it was beyond the explanations justified by the logic of zhag mi thub. Especially in 18th century Amdo, where rgya rtsis was being circulated, the discrepancy between skar rtsis and rgya rtsis dates causes Tibetan astronomers to be confused in deciding the date of gso sbyong: After encountering the occasions on which solar eclipses occurred on the 1st lunar date according to Chinese calendar, not the 30th tshes zhag according to skar rtsis, the local performance of gso sbyong (yul bstun gso sbyong) according to Chinese calendar was added to the time-honored performance based upon skar rtsis. To make sense of Indo-Tibetan Vinaya practices in
Amdo adjacent to han (漢) ethnic China, Sum pa Mkhan po accommodated the Qing China calendar on the basis of the logic of regional difference (yul bstun gso sbyong) by referring to Vinaya again. He still defended the Vinaya. His logic was that the specifications in the Vinaya work greatly in other Tibetan areas including Lhasa, even if it may not work in Amdo near to China. In other words, both Kālacakra and vinaya and Chinese calendar / rgya rtsis are affirmed by labeling the former as “general cases” and labeling the latter as “special cases.” At any rate, I guess that while zhag mi thub is based upon the idea of the accuracy of tshes zhag, yul bstun gso sbyong basically admits the malfunction of the logic of zhag mi thub buttressed by the accuracy of tshes zhag.

As is seen from above, the significance of eclipse calculation in the Tibetan context lies in its religious strata, and the religious meanings have made Tibetans keep striving to get accurate results of eclipse calculation. This religious frame penetrates through the practice of the Tibetan rtsis even when the totally non-religious rgya rtsis was introduced and practiced. Through the research into an eclipse, it is verified that religion is Abgrenzung and Voraussetzung for the development and direction of Tibetan astronomy. Accuracy matters in Tibetan eclipse calculation, but intellectual and religious background of why Tibetans seek after calculational accuracy is also important. Being equipped with such religious background knowledge, our next issue would be Tibetans’ approach to and efforts for the accuracy of eclipse calculation.

Part II is composed of two chapters dealing with 18th century Tibetan astronomical approaches and mathematical methods for the accuracy of eclipse
calculation. Chapter 3 presents a framework that may help in the understanding of how Tibetan astronomers deal with astronomical phenomena, especially an eclipse. I divide textual and non-textual knowledge sources. Further, I present my observation and findings on the Tibetan approach to astronomical phenomena in general and then narrow down to the phenomena of eclipse in particular. Generally, skar rtsis anchoring in Kālacakra religious texts are intermingled and intertwined with non-textual (mostly associated with non-religious) components including observation, empirical knowledge, discussion and debates, and research into other traditions, especially by means of equating and juxtaposing Mongolian and Chinese traditions. Because not much

51 I use the term “textual” to indicate Buddhist texts, especially the Kālacratantra corpus. And the “non-textual” elements are those that are not found in the Buddhist texts, but they are not necessarily non-Buddhist.

52 I borrow the terms “anchoring” and “intertwining” from architect Steven Holl. In his conception, “anchoring” is the building’s integration to land, and “intertwining” is the intermingling of space and time by the interlocking of sound, light, and material, ultimately aiming for the integration of heterogenous and discontinuous spaces. For further understanding, see Holl (2007: 30). To give a context, when building Stretto House in Dallas (completed in 1991), he was inspired by Béla Bartók’s Music for Strings, Percussion and Celeste, Sz. 106. See Holl (2007: 150-5), Holl (2007: 30-43), Holl (1996a). To give a brief introduction to Bartók’s proportion and tonality for the understanding of Holl’s terms, influential but controversial Lendvai’s analysis on Bartók, Lendvai (2009) can be used. First, in the case of proportion, Lendvai argues that the first movement of the Bartók’s piece uses Fibonacci series and golden section (golden mean/golden ratio, \( \approx 0.618 \))—each number in the Fibonacci Series is approximately the golden section of the following number. Second, concerning tonal system, he suggests the three axes system. He analyses that the Bartók’s work is based on harmonic functions of tonic, subdominant, and dominant axes with four poles each. Further, each of the three axes has two branches, i.e., “primary branch” and “secondary branch,” whose members are “pole” and “counterpole” being substitutable. For this, see Lendvai (2009: 3-5). Going back to Holl’s Stretto House, it “anchors” in stretto in a fugue, characterized by golden section, as structural components for the purpose of embodying the overlap of space. It also incorporates heterogenous and discontinuous spaces by means of “intertwining” characterized by infinite but regular tonal substitution in Bartók’s music. Analogically, I use the terms, “anchoring” and “intertwining,” to present the features of skar rtsis: Tibetan skar rtsis texts “anchor” in its locus classicus Kālacakra by claiming the homogeneity of the religious astronomy, but “intertwine” and interlock with observation, empirical data, research into different traditions, political concern, etc. Also, it should be noted here that “anchoring” is not contradictory to “intertwining.” Rather, the former accommodates the latter, making the Tibetan skar rtsis system as an integrated entity. Therefore, the two concepts, “anchoring” and “intertwining,” justify the
information in the *Kālacakratantra* corpus is included in terms of eclipse calculation, the non-textual elements inherently play a significant role in increasing the accuracy of eclipse calculation in *skar rtsis*. Thereby, Tibetan astronomers “saved the phenomena”\(^5\) — not by theory but by practice. Most of all, the non-*Kālacakra* factors do not overturn the basic information in the *Kālacakra*. No oppositional relationship between textual and non-textual components has been posited in Tibetan history of astronomy. For example, even the observations, which look to betray the contents of the *Kālacakra*, are interpreted in a way of being compatible and congruous to the *Kālacakra*. Empirical knowledge and canonical knowledge are not in conflict. “The non-textual sources” are not opposed to the *Kālacakra*. All the information and knowledge from textual/ non-textual and religious/ non-religious sources are arranged and systemized under the religious frame of the *Kālacakra*. Therefore, it is an essential part of research into Tibetan astronomy to point out that the astronomical meaning of *skar rtsis* has been enriched by means of the interface between textual/non-textual and religious/ non-religious elements. Throughout the process of interface, the authority of a religious superior was given to the *Kālacakra* and bilateral or multilateral affirmation of different knowledge sources was

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\(^5\) To save the phenomena (σωζειν τα φαινόμενα), which is an expression coined by Duhem (1861–1916), involves presenting an hypothesis that matches the available evidence without investigating the cause of natural phenomena; see Duhem (1908). For the English translation, see Doland and Maschler (1969).
possible by an unequal and binary relation between the Kālacakra and non-Kālacakra sources.

Chapter 4, I tackle the Tibetan way of getting accurate results of eclipse calculation by means of focusing on real calculation concepts and methods. This chapter is coupled with chapter 3, in which I present the framework to have access to an eclipse calculation in skar rtsis; in this chapter, I focus on the concepts and the ensuing calculations, which are necessary for eclipse prediction. In my conception, they are largely divided into Indo-Tibetan skar rtsis and Chinese rgya rtsis methods. The reason why I focus on real calculation is as follows: Schuh’s stance as a historian, and Henning’s modern astronomical approach have contributed to unveiling the features of skar rtsis astronomy. Nevertheless, real calculation has yet to be presented. Thus, why does calculation matter? I believe that the arcane and abstruse aspects of the Kālacakra corpus may be understood through real use, viz, calculations. I believe that beginning from real calculation in order to understand the esoteric theory and way of depiction in the Kālacakra literature may be a good means of approach. In that sense, throughout this chapter, I attempt to maintain the relation of tension between Kālacakra and real calculations in skar rtsis by means of focusing on the astronomical concepts and ideas and thereby drawing a concrete and tangible picture of skar rtsis in an overall sense. Further, an eclipse is an ideal tool for showing pivotal parts of mathematical calculation as well as concepts and theories in skar rtsis.

Then, which mathematical methods did Tibetan astronomers use to enhance the accuracy of eclipse calculation? It is necessary to investigate the inner tradition (skar rtsis)
and the outer traditions (Tngri-yin udq-a / Rgya rtsis chen mo, Mā yang rgya rtsis) as a whole being interconnected in terms of the accuracy of eclipse calculations in order to draw a picture of eighteenth century Tibetan history of astronomy. Eighteenth century Tibetan eclipse calculation is a good topic for showing a comprehensive picture of Tibetan astronomy.

First, the skar rtsis method: one of the devices to enhance accuracy was to adjust longitude (T. longs spyod) in an arithmetic way, without changing the mean motions (T. rtag longs. constants (= fixed values)). The method is called nur ster (adding a correction). The method is called nur ster (adding a correction).54 Another method taken is the change of rtsis 'phro (calculation remainder) and stong chen 'das lo (elapsed years from a Great Conjunction at the zero point) in an arithmetic means, which helps us to enhance the accuracy of eclipse prediction.55 Within a broader astronomical and religious frame, the change of rtsis 'phro and stong chen 'das lo is a part of a bigger all-embracing cosmological Anschatzung. The values at the beginning of

54 Metaphorically speaking, nur ster is like moving the goalpost to score a goal. For an explanation, see chapter 4.

55 Rtsis 'phro means “the residual from a calculation.” Schuh (1973a) renders the term as “Anfangswerte” (value at the beginning). In the Phug cosmological scheme, the correction of rtsis 'phro values has been made to the planets revolving on their orbits with their own periods. By the correction of rtsis 'phro, the planetary positions were readjusted and consequently, different values of the stong chen 'das lo (= stong chen las 'das lo = years elapsed from a Great Conjunction at the zero point (stong chen = stong chen lo tshogs = great vacuity)) were produced. Metaphorically, the process is like changing runners’ starting points on the running track. Then, what significance and effect does the correction of the stong chen 'das lo have in Tibetan astronomy? Through it, Tibetan astronomers, especially Phug pa scholars, aim for the correspondence between the visible astronomical phenomena such as solstice, equinox, eclipse, etc. verified by mngon sum (direct perception) and their calculation results. Also, the Tibetan peculiarity is that they ultimately aim for the integrity of bstan rtsis which reflects the Buddha’s enlightenment during a lunar eclipse as written in some Buddhist texts. For more explanations of these concepts and methods, see chapters 1 and 4.
calculation (T. _rtsis 'go, epoch) are altered for the correspondence between mathematical calculations and visible phenomena such as eclipse, solstice, equinox, etc. In the process of the change, Tibetan _Phug pa_ astronomers constitute a religious astronomy in which _bstan rtsis_, in which the occurrence of the Buddha's enlightenment during a lunar eclipse is centered, is justified. Thereby, _bstan rtsis_ is not only Buddhist chronology but also the cornerstone on which each astronomical system stands. Continuously, A kya Blo bzang Jam dbyangs rgya mtsho’s (1768-1816) calculation results for the two eclipses in 1785 (_shing sbrul/_12/15 and 1785/12/30 according to _grub rtsis_, _byed rtsis_, and _dga’ ldan rtsis gsar_ are verified by me, which has manifold purposes: I demonstrate that the procedure of eclipse calculation in _skar rtsis_ is based upon _Kālacakra_ methods in terms of vocabulary and mathematics. In addition, I show that the different _rtsis ’phro_ values among the different systems cause different eclipse calculation results. Furthermore, I show that _skar rtsis_ eclipse calculation is relatively simple and thus, has accommodated and has been corrected by empirical data. It is also noted that, from the modern perspective, parallax, semidiameter, etc. are not considered in _skar rtsis_ calculation. This may herald the introduction of the _Mā yang rgya rtsis_ at later period filled with modern astronomical knowledge.

Second, the _rgya rtsis_ method: there are two texts that should be researched in terms of the accuracy of an eclipse, especially a solar eclipse: _Tngri-yin udq-a_ and _Mā yang rgya rtsis_. First, the _Tngri-yin udq-a_, which was created in 1711; some of its chapters are
literal translations of the Chinese original Xiyang xinfa lishu (1645),\textsuperscript{56} which is based upon Western Jesuit astronomy. Thus, it is filled with modern astronomy, trigonometry, geometry, geography, etc. Especially for the calculation of an eclipse, knowledge on coordinate systems, refraction, parallax, semi-diameter of the sun and moon, the distance between the moon and the Earth, etc., which are unprecedented in the Tibetan and Mongolian skar rtsis system, were newly introduced in Mongolian. Ensuingly in 1715/1716, its Tibetan translation Rgya rtsis chen mo was made by Mongolian Lamas on the basis of it. Straightforwardly speaking, the Rgya rtsis chen mo has never been understood or used by Tibetan astronomers. Nevertheless, the reason why I mention it is that it has been wrongly regarded as a forefather of the Mā yang rgya rtsis among Tibetan astronomers.\textsuperscript{57} In other words, the Rgya rtsis chen mo has an astronomical meaning in so far as it is dealt with together with the Mā yang rgya rtsis, which will be mentioned below. Second, another rgya rtsis: Mā yang rgya rtsis,\textsuperscript{58} which is a duplication of the procedure of eclipse calculation included in the Lixiang kaocheng (歷象考成, published in 1723) with some

\textsuperscript{56} For a brief history of Western astronomical writings in Qing China, see Sivin (1973: 89-92). Also see Hashimoto and Jami (2001: 271-4).

\textsuperscript{57} For this, see chapters 3 and 4.

\textsuperscript{58} There is no evidence that the founder of the Mā yang rgya rtsis tradition was a Tibetan. He may have been a Mongolian Lama, who functioned in Beijing, possibly in the 18\textsuperscript{th} century and knew both Tibetan and Chinese. In chapter 4, I argue that the Rgya rtsis snying bsdus, the first work of the tradition presented by Huang and Chen (1987a) was composed in Beijing in the 18\textsuperscript{th} century around its epoch (1744) or during the 13\textsuperscript{th} rab byung (1747-1806) for the purpose of enhancing the accuracy of eclipse prediction by means of accommodating the Kālacakra and skar rtsis knowledge and which then spread to the Amdo area possibly early in the 19\textsuperscript{th} century. Thus, it came to be known as the Mā yang rgya rtsis, because it was initiated by Mā yang Bzod pa rgyal mtshan in Amdo. For my argument and evidence, see chapter 4.
mathematical simplifications. Although it is based upon the new concepts, terms, and methods of the Lixiang kaocheng such as geographical knowledge about latitude, longitude (time difference), geometric knowledge about semi-diameter of the sun and moon, parallax for solar eclipse calculation, they are not based upon theoretical understanding or real calculations of modern trigonometry. Rather, the calculational tables from the Lixiang kaocheng / Lixang kaocheng houbian (歷象考成後編) were copied and used without theoretical basis, given the calculational algorithm for eclipse calculation. And while basically standing on the shoulders of giants of skar rtsis, Tibetan astronomers tried to assimilate the Chinese (fundamentally Western) method into the well-established skar rtsis tradition buttressed by the authority of the Kālacakra for the accuracy of eclipse calculation. In other words, skar rtsis based upon the Kālacakra is the only dominant and superior system through which Tibetan astronomers could interpret other traditions. Still, bilateral affirmation of skar rtsis and rgya rtsis is found in Tibetan rtsis literature along with the paradox, which does affirm the difference and even the contradiction has formed and shaped the current Tibetan astronomy.

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59 This means that it is not a Tibetan development from the Rgya rtsis chen mo. Because the Lixiang kaocheng — for the information on this astronomical text, see below note 325. — is the continuation of the Xiyang xinha lishu of Qing China astronomy, the mathematics that the Rgya rtsis chen mo and Mā yang rgya rtsis are based upon are basically the same. Of course, there are slight corrections and adjustments in the Mā yang rgya rtsis. However, this does not mean that the Mā yang rgya rtsis developed from the Rgya rtsis chen mo. Straightforwardly, the Mā yang rgya rtsis is not an offspring of the Rgya rtsis chen mo.

60 For the information on the Lixang kaocheng houbian, see also below note 325.
ARGUMENT

Throughout these chapters, I raise the issue of the paradox that the skar rtsis approaches and methods may evince. In chapters 1 and 2, I explain how Tibetan astronomers make sense of bstan rtsis and gso sbyong in conjunction with an eclipse. In chapter 1, I discuss concerns regarding the conflicts between the Kālacakra and the Buddhist texts that are incompatible with the Kālacakra, in terms of bstan rtsis, and in chapter 2, I discern the fact that the zhag mi thub is incompatible with the yul bstun gso sbyong. In this work, I point out that Tibetan astronomers selectively chose possible grounds for justifying the relationship between Buddhism and astronomy, but thereby brought about the affirmation of contesting two or more concepts, texts, traditions, etc. It is a paradox of affirmation in a Deleuzian sense. In chapter 3, I tackle discussing the ways in which different knowledge sources are melted for an explanation of astronomical phenomena in general and for eclipse calculation in particular. The dgongs pa (S. abhiprāya. intention) was applied to the knowledge sources within the boundary of the Kālacakra/skar rtsis. The limited information in the Kālacakra and skar rtsis texts is not a defect, but meant that they require further explanation (= dgongs pa can). Also, the limitation of the Kālacakra essentially left a certain scope for non-Kālacakra sources. Confronting such a situation, Tibetan astronomers affirmed both the Kālacakra and non-Kālacakra sources for the explanation of astronomical phenomena, including eclipses. Interpretation of all the knowledge sources was attempted in a compatible way under the
roof of the *Kālacakra*. It is again a paradox of affirmation. In particular, the two different systems, *skar rtsis* and *rgya rtsis*, were believed to be compatible (T. *mthun pa*). Tibetan astronomers affirmed both sides without probing the essential differences, in terms of theory and mathematics. The belief that both can be reconciled brought about the creation of the unique *Mā yang rgya rtsis*, which adjusted the *rtsis ’phro* values of the *skar rtsis* to those of *rgya rtsis*, which will be described in chapter 4 by showing the mathematical methods. Most of all, all the approaches and methods taken by Tibetan astronomers boil down to the fact that they were able to figure out the discrepancy, seemingly logical conflicts and contradictions, etc., by being centered upon the supreme and ultimate *Kālacakra*.

I indicated in the above that I use the term “paradox” in a Deleuzian sense. Therefore, in what sense does Deleuze use the term? He uses the concept of “series” (“séries”) to explain two or more different concepts that are not irrelevant to and are not reduced to each other. He presents the three conditions of the “serialization” (“la mise en séries”) as “1) There must be at least two heterogeneous series, one of which shall be determined as “signifying” and the other as signified (a single series never suffices to form a structure). 2) Each of these series is constituted by terms which exist only through the relations they maintain with one another. ... 3) The two heterogeneous series

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61 Explanations on the meaning of “series” in Deleuze (1973) are found in many works of modern research. Because this writing does not aim at commenting on the concept, let me be restricted to introducing the following work: Poxon and Stivale (2011: especially, 70-2). Deleuze’s basic idea is that events, things, etc. have no “sense” (meaning) *per se*, and their “sense” is generated by “serialization,” when being included in a “series” and thereby being related to other events, things, etc, in a different “series.”
converge toward a paradoxical element, which is their differentiator.” His unique terms and concepts are understood this way: one “series” is superior to the other. So, the two “series” continue to be in a nonequilibrium state and dispersion. The terms of each “series” are in continuous deplacement and shift with respect to other “series”. In other words, there exists an essential sliding between the “series”, without being reduced to one another. The crucial concept “a paradoxical element” in his scheme is the stratum enabling a “series” to have superiority and enabling the relative deplacement of the two (or more) “series.” It belongs to both and neither at the same time. It is called by him “quelconque (aliquid),” “fundamental blank,” “lack,” etc., which transforms the structure to “devenir” (becoming).

His scheme can be applied in the interpretation of the various aspects regarding the development of skar rtsis in Tibet. To take the relationship between the skar rtsis and rgya rtsis as an example, 1) there exist a religious “series” (Kālacakra and skar rtsis) and a non-religious “series” (rgya rtsis). The former is superior to the latter. 2) The disperse relation is constituted between the two “series” in terms of astronomical concepts and calculation methods, but there is no reduction to a single concept between them. 3) There exists a paradoxical element, “aliquid,” which is a fundamental stratum, a undivided whole, or pre-existence enabling the interaction and interface between the religious and non-religious “series”. This means that “a paradoxical element” in the Kālacakra makes possible the bifurcation of “sense (“sense,” meaning.” Ultimately,

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62 See Deleuze (1973: 70-1) [= Deleuze (1990: 50-1)].
“sensation,” the generation of “sens,” is in the process of the “becoming.” The scheme of paradox is also applicable to the following different “series”: Kālacakra/non-Kālacakra buddhist texts, grub rtsis/byed rtsis, skar rtsis/non-Kālacakra elements, such as observation, empirical evidences, etc. The astronomical “sens” is being made by the reciprocal relationships between the different “series,” i.e. the “serialization” of the individual “series.” The part and parcel of the paradox in the Tibetan astronomical “serialization” is that there exists an unequal “series” in making sense of different and seemingly conflicting “series.” Importantly, it is the “series” of the Kālacakra. Its superiority is presupposed and postulated for the “sense” making.

How is the superiority of the Kālacakra posited? We may need a holistic perspective that regards the Kālacakra as a complete and self-sufficient whole. Let me use Quine’s (1908–2000) holistic approach to science: because there are multiple hypotheses and theories accounting for certain phenomena, even if a hypothesis or theory looks refuted by counter-hypotheses, it can be sustained with newly added auxiliary hypotheses. Therefore, the hypothesis or theory is not disproved. \(^{63}\) If his argument is applied to the Kālacakra, it can be assumed that counter-observations and counter-instances (from our perspective, not from Tibetans’ perspective), in whatever forms, do not overturn the Kālacakra, which is the complete whole on which Tibetan astronomers

\(^{63}\) According to Quine (1951: 38-9) and Quine (1975: 313-4), scientific hypothesis or theory cannot be proved or disproved by empirical observations. In order for a theory to be verified, it should be proved that there is no other way to explain that the same phenomena would occur in a different way, but this is impossible. Because there are multiple hypotheses and theories for a phenomenon, even if a hypothesis or theory looks refuted by empirical data, it can be sustained by adding new subsidiary hypotheses. For this well-known “Duhem/Quine thesis (paradox),” see Cuonzo (2014: 66-73).
rely. In other words, Tibetan astronomers have found solutions to make sense of the Kalacakra under any circumstances that are contradictory to or incompatible with its explanations because it is a holistic integrity system, the components of which reinforce and strengthen one another. Regarding this approach, Wittgenstein might have said this: “In the game of the Kalacakra language, the meaning and use of each term is decided by the whole system of Kalacakra. The use of the language is circumstantial. The paradox in the skar rtsis, based upon the Kalacakra, is that multiple interpretations are possible in every case, including apparent discrepancy, seemingly conflicts, and contradictions between rtsis calculations and real astronomical phenomena. Being based upon the paradox, Tibetan astronomers choose a possible interpretation or explanation to make sense of the Kalacakra and skar rtsis systems.”

Skar rtsis is an indigenous astronomy, which has evolved in the Tibetan soil on the basis of the Indic Kalacakra. In it, “paradox” is explicitly and implicitly assumed for the explanations of astronomical phenomena, including eclipse calculations. Accordingly, a

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64 In a similar context with Quine’s holistic approach to science, Wittgenstein’s (1889-1951) holistic view of languages in use may be mentioned. Let me first cite his famous passages in Wittgenstein (1999: 81, 81e): “Unser Paradox war dies: eine Regel konnte keine Handlungsweise bestimmen, da jede Handlungsweise mit der Regel in Übereinstimmung zu bringen sei. Die Antwort war: ist jede mit der Regel in Übereinstimmung zu bringen, dann auch zum Widerspruch. Daher gäbe es hier weder Übereinstimmung noch Widerspruch.” “This was our paradox: no course of action could be determined by a rule, because every course of action can be made out to be in accordance with the rule. The answer was: if everything can be made out to agree with the rule, then it can also be made out to conflict with it. So there would be neither accord nor conflict here.” Here, he means the paradox that it is impossible to decide which use of language is correct. His nonessentialist approach to language is well embodied in the introduction of the concept of “language game” from a holist viewpoint; Wittgenstein (1999: 5, 5e): “Ich werde auch das Ganze: die Sprache und der Tätigkeiten, mit denen sie verwoben ist, das ‘Sprachspiel’ nennen.” “I shall also call the whole, consisting of language and the actions into which it is woven, the ‘language game’.” He argues that the meaning of a word is not fixed, but it varies according to the whole system of language.
crucial question for the skar rtsis is how it created the “sense” of “nonsense” while being centered upon the Kālacakra. It is another way of asking how “paradox” developed through “serialization” in the context of the Kālacakra.” From such a standpoint, I attempt to show the fundamental features of the development of the Tibetan Kālacakra astronomy by using 18th century eclipse calculations.
Part I.

RELIGIOUS REASONS FOR ECLIPSE CALCULATION
CHAPTER ONE

BUDDHIST CHRONOLOGY (T. *Bstan rtsis*)

1. BACKWARD CALCULATION (T. *Yar log gi rtsis*)

THE YEAR OF THE BUDDHA’S *Kālacakra* TEACHING

Buddhist chronology has been one of main concerns for modern scholars who study the history of Buddhism. In spite of their efforts to figure out the date of the Buddha, the different Buddha’s dates presented by different regional traditions are frustrating in nature. In the Tibetan scenery, it is complicated indeed because of mass

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65 I use date number 0. This is simply for the convenience for calculation. There is no date 0 in the actual Tibetan calendar. For example, 1785 (year)/3 (month)/0 (date) (according to *grub rtsis*) is the transition point between 1785/2/30 (= April 9, 1785) and 1785/3/1 (= April 10, 1785). The 3(nag zla)/0 is usually set as epoch in Tibetan calendar. The Tibetan year may span two Western years. For example, 1785/12/1 in the case of *grub rtsis* = January 1, 1786 C.E. The Tibetan year begins with the third month (nag zla) and ends with the second month (dbo zla). So, 1785/2/30 means the last day of the dbo zla in the wood-dragon year (*shing brug*. 1784-1785) during the 13th *rab byung*. Also, 1785/3/1 means the first day of the nag zla in the wood-snake year (*shing sbrul*. 1785-1786.) in the same *rab byung*. At this point, in order to avoid the audience’s misunderstanding, I should also indicate that I use a slash to indicate unit. For example, the numbers and slashes in the parenthesis in the case of 195395485567 (27/60/60/6/67) mean each *gnas ‘khor grangs* (= dkyil ‘khor).

66 The articles in *The Dating of the Historical Buddha* (3 volumes) published during 1991-1997 under the leadership of H. Bechert embrace many chronological exegeses of regionally different Buddhist traditions. In spite of them, we should admit that the historic date of the Buddha is difficult to be pinpointed.
of different years suggested by individual scholars. The complexity has been revealed by some modern researches.  

One of the main exegeses in Buddhist chronology in Tibet is based upon the *Laghukālacakra* and *Vimalaprabhā* in which the Buddha's year of *Kālacakra* teaching is given. However, they do not give a full information of the Buddha's life. Without pinpointing the Buddha's year of *Kālacakra* teaching, they merely state “after this year, 600 years,” (*T. lo 'di nas ni drug brgya'i lo yis*), Mañjuśrī Yaśas will appear. “This year”

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67 As will be described below, the Tibetan chronology whose relationship to Indic one may be posited is more complex and diverse. For example, there are many different opinions even among the *Kālacakra* adherents whose exegeses are based upon *Kālacakra*, *Vinaya* texts, etc. For a brief understanding of Indic chronology, see Lamotte translated in Webb-Boin (1988: 13-23). I focus on Tibetan *Kālacakra* chronology.

68 The following works are listed: Vostrikov translated in Gupta (1970: 101-37), Macdonald (1963: especially 64-71), Grönbold (1991), Seyfort Ruegg (1992), van der Kuijp (2011). However, no research has been made about the astronomical meaning of the Buddha's enlightenment during a lunar eclipse in terms of *bstan rtsis* which has been a serious issue to Tibetan astronomers.

69 Grönbold (1994: 11) classifies the year of Buddha's *Kālacramūlatantra* teaching into four: “there are four theories: 1) Buddha preached in the year of enlightenment, 2) one year after enlightenment, 3) one year before *nirvāṇa*, 4) in the year of *nirvāṇa*.” Mkhas grub belongs to 2) and *Phug pa* scholars belong to 4). However, Grönbold (1991: 395-8) [= Grönbold (1996: 322-4)] is misleading. Grönbold (1996: 323): “1. in the year of his enlightenment, 2. one year after his enlightenment, 3. one year before his *nirvāṇa*, 4. in the year of his *nirvāṇa*. ... according to 4, the Buddha and Sucandra died in successive years.” Unfortunately, his explanation excludes *Phug pa*’s opinion. According to the *Phug pa* scholars, Buddha’s year of death is 881 B.C.E. and Sucandra’s year of death is 878 B.C.E.

means “the year when the Buddha taught the Kālacakra” according to the Vimalaprabhā I. 26. Together with the Buddha, Sucandra appears as an important figure in the transmission of the Kālacakra teaching, and the history of Śambhala appears in the verses I. 3 and I. 150-170.\(^{71}\)

By making the best of the meager information, Tibetan astronomers try to figure out which year is “this year” and what time span is “600 years.” Vast opinions have been presented, but the following opinions, which diverge by the difference in the interpretation of Sucandra’s (977 B.C.E. ~ 878 B.C.E.) last four years, i.e., 881 B.C.E. ~ 878 B.C.E. in conjunction with the Buddha’s Kālacakra teaching, may be regarded as those that have had far-reaching repercussions.

<table>
<thead>
<tr>
<th>Table 1.</th>
<th>Byed rtsis: Bu ston</th>
<th>Byed rtsis: Mkhas grub / Sum pa Mkhan po(^{72})</th>
<th>Grub rtsis: Phug system(^{73})</th>
</tr>
</thead>
<tbody>
<tr>
<td>881 B.C.E. (lcags 'brug)</td>
<td>The Buddha preached Kālacramilatāntara (rtsa rgyud) and then entered into the nirvāṇa in the month of sa ga/ vaisākha.</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

\(^{71}\) For this information, see Newman (1987: 74-5).

\(^{72}\) As seen in the table, there is a one year difference between Bu ston and Mkhas grub/ Sum pa Mkhan po. Modern research has clarified the point: for the brief introduction of their bstan rtsis, Vostrikov (1970: 108-9), Grönhold (1991: 396) [= Grönhold (1996: 322)], Seyfort Ruegg (1992: 278-9). Thu’u bkwan III also belongs to this group; see Thu’u bkwan III translated in Geshe Lhundub Sopa (2009: 382). Unfortunately, some years are misunderstood: chu rta sna tshogs (citrabhānu = water-horse year) is 879 B.C.E., not 878 B.C.E. Thus, Sucandra’s last year should be given as 878 B.C.E., not 877 B.C.E. in Thu’u bkwan III (2009: 381).

\(^{73}\) The textual basis is as follows: Grwa phug pa (2002: 78-92, especially 85-8), then Nor bzang rgya mtsho as translated in Kilty (2004: 29-31), and ’Phrin las dge ba’i dbang po (2002: 596-599). See also below pp. 50-1.
### Table 1 (continued)

<table>
<thead>
<tr>
<th>Year</th>
<th>Event</th>
<th>Year</th>
<th>Event</th>
</tr>
</thead>
<tbody>
<tr>
<td>880 B.C.E.</td>
<td>The Buddha attained enlightenment.</td>
<td>Sucandra wrote</td>
<td>the Mūlatantra down from this year for two years.</td>
</tr>
<tr>
<td>(lcags sbrul)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>879 B.C.E.</td>
<td><strong>The Buddha preached the Kālacakra Mūlatantra.</strong></td>
<td>The Buddha</td>
<td>attained enlightenment.</td>
</tr>
<tr>
<td>(chu rta)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>878 B.C.E.</td>
<td>Sucandra wrote the Mūlatantra down, built the manḍala and passed away.</td>
<td><strong>The Buddha preached the</strong> Kālacakra Mūlatantra.</td>
<td>Sucandra passed away.</td>
</tr>
<tr>
<td>(chu lug)</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

| “600 years”     | counted from the Buddha’s enlightenment (878 B.C.E.).                 | counted from the Buddha’s nirvāṇa (881 B.C.E.). But, Sucandra’s 3 years (880 B.C.E. ~ 878 B.C.E.) are excluded from the “600 years.” |

The issue of how to insert the Buddha’s years in a way of being compatible with Sucandra’s years specified in the *Vimalaprabhā* has been a bone of contention. Both byed rtsis and Phug pa grub rtsis present the year of the Buddha’s Kālacakra teaching respectively in the following way: byed rtsis: 879/878 B.C.E.; Phug system: 881 B.C.E. However, the main difference is that in the case of Mkhas grub and his adherent Sum pa Mkhan po’s byed rtsis, the Buddha taught the Kālacakra Mūlatantra one year after the year of his enlightenment. Meanwhile, in the case of the Phug system, the year of nirvāṇa is the same with that of the Kālacakra teaching. Concerning the “600 years,” both show

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74 Kilty (2004: 28): “King Sucandra compiled the *Root tantra* and composed a commentary. This would have involved one or two years.” Also see Henning (2007: 367). Nor bzang rgya mtsho (2004: 612).

75 Kilty (2004: 29): “the three years of Sucandra and the year the Buddha taught the *Root tantra* account for four years not included in the six hundred.”
discrepancy: In the former, “600 years” are counted from the Buddha’s enlightenment and in the latter, “600 years” are counted from the Buddha’s nirvāṇa. The division is commonplace in Tibetan rtsis texts. For example, Kaṭṭhog Rig ’dzin Tshe dbang nor bu (1698–1755), who did one of the most comprehensive overarching research into bstan rtsis during the 18th century,\textsuperscript{76} classified the bstan rtsis-s based upon the Kālacakra system into two categories and presented 13 different interpretations. In the following table, the years counted from the Buddha’s enlightenment by different scholars are given in the left cell, and the years counted from the Buddha’s nirvāṇa in the right cell according to Kaṭṭhog Rig ’dzin’s research.\textsuperscript{77} It should be noted that he presented rarely mentioned astronomers, thus filling in the blank in the intellectual history.

Table 2.

| Elapsed years from the year of the Buddha’s nirvāṇa. (In this case, Buddha taught the Kālacakra after his enlightenment). | Elapsed years from the year of the Buddha’s nirvāṇa. (In this case, the Buddha taught the Kālacakra prior to his nirvāṇa). |

\textsuperscript{76} See Kaṭṭhog Rig ’dzin (1976-1977: 111-5) [= (2006: 40-1)].

\textsuperscript{77} The two groups of ’das lo calculated from 1742 C.E. are presented. For the year 1742 C.E., see Kaṭṭhog Rig ’dzin (1976-1977: 115) [= (2006: 41)]. For the same kind of division, read also Tshe tan zhab s drung (2007: 10-4): He classifies dus ’khor ba into two, ’das lo mang ba’i phyogs including three rgya mtshos in the Phug system (Gtsang chung Chos grags rgya mtsho, Phug pa Lhun grub rgya mtsho, Mkhas grub Nor bzang rgya mtsho), etc. and ’das lo nyung ba’i phyogs including Bu ston, Mkhas grub, etc. Also, see Tshe tan Zhab s drung (2007: 27): Phug pa scholars’ shing rta and Tshe tan Zhab s drung (2007: 30): Mkhas grub’s chu rta for the year of the Buddha’s enlightenment. See also Seyfort Ruegg (1992: 278, especially no. 73).
<table>
<thead>
<tr>
<th>Year</th>
<th>Event</th>
</tr>
</thead>
<tbody>
<tr>
<td>1308 B.C.E.</td>
<td>Birth of Buddha (nirvāṇa)</td>
</tr>
<tr>
<td>834 B.C.E.</td>
<td>Birth of Buddha (nirvāṇa)</td>
</tr>
<tr>
<td>881 B.C.E.</td>
<td>Birth of Buddha (nirvāṇa)</td>
</tr>
<tr>
<td>878 B.C.E.</td>
<td>Birth of Buddha (nirvāṇa)</td>
</tr>
<tr>
<td>876 B.C.E.</td>
<td>Birth of Buddha (nirvāṇa)</td>
</tr>
<tr>
<td>694 B.C.E.</td>
<td>Birth of Buddha (nirvāṇa)</td>
</tr>
<tr>
<td>627 B.C.E.</td>
<td>Birth of Buddha (nirvāṇa)</td>
</tr>
<tr>
<td>574 B.C.E.</td>
<td>Birth of Buddha (nirvāṇa)</td>
</tr>
</tbody>
</table>


79 Lha dbang blo gros’s (S. Sureśamatibhadra) Bstan rtis ’dod sbyin gter bum was studied by Schlagintweit (1897). Kaḥ thog Rig ’dzin (2006: 40) addresses “gdan dus kyi rtis gzhi mkhan po” before his name. For the tradition, gdan dus (occasionally appears as gdan du) in Bhutan, see Martin (1997: 95-6).

80 For this unidentified rtis pa, see Dharmaśrī (1999a: 150b): “the writings of ’Phrin las pa’s direct disciples such as the documents of Kong po ’Bum rams pa, etc.” (kong po ’bum rams pa’i yig cha sogs phrin (sic.) las pa’i dngos slob rnam kyi yi ge ... ). But we do not know the identity of (Chos rje) ’Phrin las pa. He is introduced as the author of ’Khrul med mdzub tshugs (Dharmaśrī (1999a: 149b). According to van der Kuijp, it is highly probable that he is Karma ’Phrin las pa (1456–1539) who wrote a commentary on Karma pa III’s Kālacakra text, which has been mentioned in Dpa’ bo (n.d. (1): 293a).

81 He has been mentioned by many scholars. See Schlagintweit (1897: 630), Macdonald (1963: 68), Seyfort Ruegg (1992: 276, 278).

82 He seems to be Karma ’Phrin las pa. See above note 80.
As seen from above, there are many possible years even in the separate two categories. Let me focus on the two interpretations: 1) in the case of 2575 elapsed years (‘das lo) in the left cell, the year of nirvāṇa is 834 B.C.E. As previously seen, the year of the Buddha’s Kālacakra teaching is either in or one year after the year of enlightenment, i.e., 879 B.C.E. or 878 B.C.E. according to byed rtsis. 2) in the case of 2622 elapsed years in the right cell, the year of the Buddha’s nirvāṇa is 881 B.C.E. This is also the year of the Buddha’s Kālacakra teaching. Then, why byed rtsis scholars, who belong to the first category [= 2575 elapsed years in this case = ‘das lo nyung ba’i phyogs according to Tshe tan Zhabdrung (2007)], and Phug pa scholars, who belong to the second [= 2622 elapsed years in this case = ‘das lo mang ba’i phyogs according to Tshe tan Zhabdrung (2007)], suggest the Buddha’s years differently? What are their rationale?

THE BUDDHA’S ENLIGHTENMENT AND THE LUNAR ECLIPSE: YAR LOG GI RTSIS

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Rong pa Ngag dbang grags pa is unidentified, but his tradition has been mentioned briefly in Bsod nams rin chen (2009: vol. 2, 188): “If 406 is subtracted [from the Phug tradition], [it is] the tradition of Rong pa Ngag dbang grags pa.” (… bzhi brgya dang drug phri na rong pa ngag dbang grags pa’i lugs so /). This is also verified in the above table: 2622 – 2216 = 406. The difference of ‘das lo between him and the Phug tradition is 406 years.
As seen above, the Buddha’s year of the Kālacakra teaching and Sucandra’s year of writing a commentary to it are specified in the Vimalaprabhā, but the information such as the year of the Buddha’s birth, life span, etc., is not specified. Under such situation, Tibetan Kālacakra proponents selectively chose some Buddhist texts to compensate for the meager chronological information. In doing so, they paid attention to and made sense of the Buddha’s enlightenment during a lunar eclipse recorded in such Buddhist texts as the Vinaya sūtra, the Abhinīṣkramaṇa sūtra, the Lalitavistara sūtra, etc.:84 Their strategy was

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84 A modern calculation based upon Samyutta nikāya stating that the lunar and solar eclipses occurred during Buddha’s stay at Śrāvastī has been made by Sengupta (1956: 124-8), Sengupta (1947: 217-21). Basically, his line of thinking is the same as that of the Tibetan astronomers. Also read Hartmann’s summary and criticism made from the philologist’s viewpoint in Hartmann (1991: 35-6). The Tibetan logic based upon reconciliation between Kālacakra and some Buddhist sūtras is seen passim. To take some examples: Nor bzung rgya mtsho as translated in Kilty (2004: 30-1). Lha dang blo gros (2007: 263-5). For German translation, see Schlagintweit (1897: 600-1). However, it is easily known that, if we broaden our vision to the other texts Phug pa scholars do not use, there is collision among different canons in terms of bstan rtṣis. The following counterarguments have been raised sporadically by Tibetan scholars. For example, Pan chen Bde legs nyi ma’s (16th c.) explanation of dus chen finds this quotation. Bde legs nyi ma (2011: 143): “According to the Kālacakra tradition, [the Buddha] attained enlightenment at the age of 37, on the full moon day of the month of sa ga in water-male-horse year (879 B.C.E.). [According to] the Vinaya tradition, [the Buddha attained enlightenment] at the age of 35, on the full moon day of the month of sa ga in iron-male-dragon year (881 B.C.E.). ...” (dus ’khor ba’i lugs la lo sum cu rtṣa bdun pa chu pho rta’i lo sa ga’i nyan la mnong par byang chub / ’dul ba’i lugs dgyung lo sum cu rtṣa bngo pa lcaq po’ brug gi sa ra la ba’i nyan la mnong par byang chub pa yin te / ...). In the first case, the Kālacakra proponents (dus ’khor ba) include Mnga’ ris Chos rje, Mkhas grub, etc. (according to them, 915 B.C.E. is the year of the Buddha’s birth. 915 − 879 = 36. 36 + 1 = 37 = the Buddha’s age). Bde legs nyi ma claims that it does not accord with the Vinaya tradition stating that the Buddha attained enlightenment in 881 B.C.E. The claim may be based upon Bde legs nyi ma’s real calculation based upon the records of the lunar eclipse at the Buddha’s enlightenment in Vinaya, although he did not mention it. To take another example, Kaḥ thog Rīg ’dzin’s calculation asserts that in the case of Lalitavistara sūtra, the Buddha’s enlightenment is placed in 881 B.C.E. (lcaq po’ brug). Kah thog Rīg ’dzin (1976-1977: 118-22) [= Kaḥ thog Rīg ’dzin (2006: 43-4)]: “In the Lalitavistara sūtra ... [the Buddha] attained enlightenment at the age of 35, on the full moon day of the month of sa ga in the iron-dragon year (881 B.C.E.) called vikrama (dpa’ bo). ... Furthermore, in the dḥru ba (root quantity) of this sa ga month: gza’ dḥru 3/30/54 [= 3’30’54’ in my notation], ril bo/ cha shas 20/34, nγi dḥru 1/16/33 [= 1’16’33’], on the 15th day: gza’ dḥag 4/50 [= 4’50’], nγi dḥag 2/31 [= 2’31’], tshes ’khyud laa skar 16/1 [= 16’1’], res’ grogs laa skar 15/11 [= 15’11’], sgra gcana rtsa 23/18 [= 23’18’], sgra gcana gdong 3/41 [= 3’41’], dus me (= sgra gcana nγu) 17/11 [= 17’11’]. Because 0/38 [= 0’38’], the remainder of the subtraction, arises according to man nγag (S. upadeśa), 1/4 is eclipsed according to myong rtsis (calculation based on empirical data). Moreover, [ ] need to know the
opinions that [the Buddha] attained the enlightenment on the eighth day of the month of sa ga in accordance with the Mahāpārīnīvāṇa sūtra, Bka’ brgyad rdzong ’phrang of Tibetan ancient mantra, and Chinese monk (= Ch. heshang 和尚 Chan (禪) masters (T. bsam gtan mkhan (po) rnam), and the assertion made by mother tantra proponents such as Indian master Dārika and others that [the Buddha] attained the enlightenment on the tenth day of the waning moon. ... Moreover, it is stated in the chapter of Empowerment (S. Abhiṣekapatala/ T. Dbang le’u. Chapter III) in the Vimalaprabhā that, here in the holy land, Bhagavān Śākyamuni attained the enlightenment at the time of the rise of dawn on the full moon day of the month of sa ga, [at the moment of] entering into the first day of the kṣṇapaśa, at the end of the 15 parts (cha. here means tshes zhag) such as the first day (tshes zhag), etc. [= from the first day to the fifteenth day] of the śuklapaśa and [it is] also written in some other texts such as the particular snga gzhung.” (... mdo rgya che rol pa nas ... dngung lo sum rtsa lnga bzhes pa dpa’ bo zhes lcags “brug sa ga’i nya la byang chub shing ... de yang sa ga zla ba ’di yi dhrur bar gza’ gnas gsum chu tshod sum cu / sran g nga bzhī / rīl bor n yī shu cha chas sō bzhī / nī yī dhrur skar gnas gcīg / chu tshod bcu drug / chu sran g so gsum / de yi tshes bco lnga’i gza’ dag gza’ gnas la bzhī / chu tshod lha gcīg / nyi dag skar mar gnyis / dbya gur so gcīg / tshes ’khyud skar mar bcu drug / dbyu gur gcīg / res ’grogs skar mar bco lnga / dbyu gur gcīg / snga gcīn bul bar skar gnas nyer gsum chu tshod bco bgyad / gcōng gsum / chu tshod zhe gcīg / dus me’i skar mar bcu bdun / chu tshod bco gcīg ste man ngag bzhīn sbyangs dor gyi lhag skar gcīg thig dang chu tshod so bgyad shar bas myong rtsis ltar bzhī cha gcīg ’dzin pa yin no / gzhan mdo sde mya nghan ’das pa cen po dang / bod snga gzs mnyi pa’i bka’ brgyad rdzong ’phrang dang raya nag hā shang bsam gtan mkhan rnam mthun par sa ga zla ba’i tshes bgyad la sangs rgyas par bzhed pa dang / raya drk gyi slob dpun dā rī kā sogs ma rgyud smra bā pos ni mar nyo’i tshes bcur sangs rgyas par ’dod pa dag kyang shes par bya dgos la / ... / de yang dri med ’od kyi dbang le’u yi skabs su / ’phags pa’i yul ’dir dkar po’i tshes gcīg la sos pa cha bco lnga’i mthar pa’i tshes gcīg ’jug pa sa ga nya’i skyā renɡs ’char ba’i tshi bcom ldan ’das šākhyā thub pa mong po rdo zogs par sangs rgyas te zhes dang / snga gzs gzhung khyad par can gzhan nas kyang ’byung ltar ro / ). Explanations on some terms are necessary for the understanding of the above quotation: About the term dpa’ bo (S. vikrama), see Newman (1998: 344), my Appdendix I. About bka’ brgyad rdzong ’phrang, Martin’s rendering is as follows: “breach of the citadel”; a class of sams sde teachings; bon tradition maintains a parallel group of teachings by the same name; described in tibetan as rgya bod mkhas pa mi bzhī’i dgyongs nyams gcīg tu dril po bka’ brgyad rdzong ’phrang du grags pa.” (http://www.tbrc.org/#!rid=T003JR4759). As Kah thog Rig ’dzin clearly shows, with vue étendue in the above passage, if we broaden our vision, we may encounter different Buddhist texts, which specify different Buddha chronologies. For example, as is scribed  as an interlinear note  in the above passage, if we broaden our vision , we may encounter different Buddhist teachings; sems sde. Chin (Ch. shan) fishermen (T. bshad dkar po), the same name; described in tibetan as ’breach of the citadel’; a class of teachings; sems sde. The term ’baka’ brgyad rdzong ’phrang du grags po’i dngung lo sum cu’i tshes bgyad ma rdo rje’i thog rigs po ma’i don pa’i tshes gcig la (interlinear note: phyi’i rt’en ’brel gyi rta’gs su nī yī zla’ dzin tshul ’jig rten du snaṅ bā’i dbang du byas te dus ’khor ba nams kyi bzhī pa’i nya la sangs rgyas par ’dod kyang / mdo myang ’das kyi seng ge sgra’i le’u las / bcom ldan ’das kyi sku btams pa dang / mong po par ’byung ba dang / mong po par rdo zogs par sangs rgyas pa dang / chos kyi’ khor lo bskor ba nams yar tshes bgyad khor na laṅs na / ci’i phyir sgrag med mya nyan las ’das pa’i tshul gcig bu tshes bco lnga dang sbyar zhes pa’i dri tshig lan dang bcas pa bshad pa yod do’). For the Tibetan text of the Mahāpārīnīvāṇa sūtra, see Bka’ ’gyur dpe bsdur ma (TBRC accession number W1PD96682), Vol. 53: Myan nyan las ’das pa’i mdo, 335ff. For the Chinese text of Mahāpārīnīvāṇa sūtra, see Taisho Tripiṭaka (Taishō shinshū daizōkyō 大正新修大藏經), vol. T12, No. 374: Daban niepan jing (大般涅槃經), chapter 30 Shizihou pusa pin (獅子吼菩薩品). The electronic version is found in CBETA (www.cbeta.org), T12n0374_p0545a21(10) ff. English translation is found in Yamamoto (1973: 430). Taken
to calculate values reconciling the record of the lunar eclipse at the Buddha’s enlightenment in the aforementioned Buddhist texts with the year of the Buddha’s Kālacakra teaching in the Kālacakratantra. More in-depth research is needed about when such line of thinking was formed first, but it seems to date back to Mnga’ ris Chos rje at the latest.  

If his student Rtogs ldan’s writing is based upon Mnga’ ris Chos rje’s teaching, it is verified that Mnga’ ris Chos rje used the aforementioned Buddhist texts in a way of being compatible with the Kālacakra.

Together, under such situation that other texts presenting Buddhist chronology exist, the reason why Kālacakra adherents use Vinaya texts, Lalitavistara sūtra, etc. to support their bstan rtsis is not known. It is possibly related to the records of the lunar eclipse at the Buddha’s enlightenment in them. In other words, their astronomical concerns may have had an influence on the decision of the textual bases.

For Mnga’ ris Chos rje’s idea, See Kilty (2004: 34). In the case of Bu ston, I did not find textual evidence that he calculated the values of the lunar eclipse at the Buddha’s enlightenment. Byang bdag (3) (n.d.: 2b-3a) indicates that Bla ma dam pa Bsod nams rgyal mtshan (1312-1375) uses the Abhinīkramanā śāstra and the Vinaya sūtra to date the Buddha’s life, but does not indicate whether he tried to reconcile between the Kālacakra calculations with these texts. I speculate that since he is contemporary with Mnga’ ris Chos rje, there may have been discussions on the issue of bstan rtsis and its textual bases among scholars in the 14th century.

Rtogs ldan (2010: 352-3). See also Nor bzang rgya mtsho (2004: 31-2).
Furthermore, section 85 of the *Vinayavastu* (*Dul ba gzhi*) states, \(^{87}\) “When the Bhagavān obtained unsurpassable wisdom, Yaśodharā (Śākyamuni’s wife) gave birth to a baby. The moon was also held by Rāhū.” And “[ ] gives Yaśodharā’s son a name, the retinue of the queen said, ‘because when [you] gave a birth, the moon was held by Rāhū, therefore, this baby will be also called Rāhula.’” And the *Abhiniskramaṇa sūtra* states, \(^{88}\) “After that, his people said to king Śuddhodana (Buddha’s father), ‘Please delight gods! The youth obtained the unsurpassable wisdom. On the very day, Yaśodharā also gave birth to a baby. A baby was also born to Amṛtodana (the uncle of Śākyamuni). In the evening, the moon was held by Rāhū.” And “[ ] gives Yaśodharā’s son a name and the retinue of the queen said, ‘because when [you] gave a birth, the moon was held by Rāhū, therefore, this baby was given the name Rāhula.’”

Since the above passage appeared for the first time possibly by Mnga’ ris Chos rje, it has been an all-time conundrum for Tibetan astronomers. They thought that they should accurately calculate the values of the lunar eclipse in accordance with the aforementioned Buddhist texts while reconciling with the *Kālacakra*. One of possible solutions was also given by Rtogs ldan (possibly Mnga’ ris Chos rje also) arguing that the lunar eclipse at the Buddha’s enlightenment occurred in 879 B.C.E.

\(^{87}\) For the location of the passage in *D. Bka’ gyur*, see Kilty (2004: 619, no. 29).

\(^{88}\) For the location of the passage in *D. Bka’ gyur*, see Kilty (2004: 619, no. 30).

\(^{89}\) Rtogs ldan (2010: 353).
On the day, when the Bhagavān attained full enlightenment, the moon was held by Rāhu\(^90\) and furthermore, the occurrence of the eclipse is established by tshad ma\(^91\) from the arithmetic carried out after having sought the rtsis ’phro in that which counts Sucandra’s one year (878 B.C.E.) separately, and if that year is not counted additionally after having included it under 600 years, the eclipse does not occur at that time in the case of byed rtsis, and also because the error that an eclipse does not occur exists in the case of byed rtsis in the calculation made after having inserted two years [from] the year of Kālacakra teaching up to 600 years, [it] does not accord with the texts. It is very reasonable to count the one year (878 B.C.E.) in which Sucandra built the maṇḍala, etc. separately.

Rtogs ldan (possibly Mnga’ ris Chos rje also), possibly being based upon his calculations, argued that if only 878 B.C.E. is additionally calculated and is not included in the “600

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\(^90\) The gza’ here is Sgra gcan. In general, the Tibetan planetary system is composed of the 10 planets, one of which Sgra gcan. For example, see the terminological dictionary of the Tibetan ten sciences, Dag yiğ mkhas pa’i byung gnas [= Merged yanbu-yin oron] (1742); Lcang skya III et al. (1982: 49), Lcang skya III et al. (2002: 1169-70). However, it should be noted here that there exist multiple systems. See Bsam ‘grub rgya mtsho (2011: 95). For example, Ishihama and Fukuda (1989: 161-2) shows a system composed of nine planets in [ML] (S. Mahāvyutpatti / T. Bye brag tu rtogs par byed pa / M. Ilyal-i ilete uqayulun üledügüči-yin jerge delgeregülün sudur. Manuscript no. 25147 in the library of the Oriental department of the St. Petersburg State University) and [MT] (included in Danǰuur. "Mongol yanjur danjur-un yarcay"-un nayirayulqu jöblel (2002: 783-4). No. 4891 numbered from yanjur: Ilyal-i onyulyuyči): gza’ dgu’i ming [ML] yisün gray-un ner-e [MT] yisün gray-un ner-e. Also see Särközi and Szerb (1995: 235). The following table is created on the basis of Lcang skya III et al. (1982), Lcang skya III et al. (2002) and Ishihama and Fukuda (1989).

<table>
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<tbody>
<tr>
<td>T.</td>
<td>M. (S.)</td>
</tr>
<tr>
<td>Nyi ma</td>
<td>Naran (Āditya)</td>
</tr>
<tr>
<td>Zla ba</td>
<td>Saran (Soma)</td>
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<tr>
<td>Me drar</td>
<td>Angryana (Āṅgāraka)</td>
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<tr>
<td>Lhag pa</td>
<td>Budi (Budha)</td>
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<tr>
<td>Phur bu</td>
<td>Barqasbadi (Brhaspati)</td>
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<td>Pa sangs</td>
<td>Sugir-a (Sukra)</td>
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<tr>
<td>Spen pa</td>
<td>Saničar (Sānaiscarā)</td>
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<tr>
<td>Sgra gcan</td>
<td>Raqu (Rāhu)</td>
</tr>
<tr>
<td>Sgra gcan gdong</td>
<td>Raqu-yin terigün</td>
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<tr>
<td>Sgra gcan mjug</td>
<td>Raqu-yin segül</td>
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\(^91\) mgon sum gyi tshad ma. See below note 126.
years,” the lunar eclipse occurred in 879 B.C.E. during the Buddha’s enlightenment according to byed rtsis.\footnote{His argument that the Buddha’s enlightenment occurs in 879 B.C.E. is verified by Mnga’ ris Chos rje (2008: 11). Rtos ldan (2010: 354): “2255 years have passed since the Mūlatantra was preached up to now (me mo sbrul: 1377 C.E.) and 753 years have passed since mleccha invaded, and 571 years have passed since Kalkī Aja clarified nyung ngu’i byed pa (smaller karaṇa).” (rtsa rgyud gsungs nas da lta’i bar la lo nyis stong nyis braya lnga bcu rtsa lnga ’das shing / kla klo zhus nas bdun braya dang nga gsam / rigs ldan rgyal dkas nyung ngu’i byed pa gsal bar mdzad nas Inga brgya don gcig song ba yin no / )}. The Tibetan rational presented in the above passage is called yar log gi rtsis (backward calculation). The key idea of the concept is as follows: If a calculational system is accurate, it must accurately calculate the time of the lunar eclipse at the Buddha’s enlightenment as described in the aforementioned Buddhist texts by means of the Kālacakra calculation methods.

After having been publicized, the idea of the yar log gi rtsis has been regarded by Tibetan astronomers as a sine qua non for an astronomical system to be accurate.\footnote{To take some examples to trace how the idea of yar log gi rtsis was accepted in the earlier period (before around 16th c.): Byang bdag (3) (n.d.); throughout the text, he examines the accuracy of individual scholars’ systems by gyen log gi rtsis [= yar log gi rtsis]. For example, Byang bdag (3) (n.d.: 5b-7a) is critical of the byed rtsis systems of Bu ston and Mnga’ ris Chos rje, who are main concerns, in the following reasons: According to Bu ston’s year counting, Byang bdag (3) (n.d.: 6a): “It would be the case that the Buddha was born in viśvāvasu the wood-snake year (916 B.C.E.) and if so, [ ] does not agree with the calculation results, ...”. (thub dbang sna tshogs dbyig zhes pa shing sbrul la bitams par ’gyur la / de ltar na brtsis ‘bras dang mi mthun te / ... ) But, it is generally known that Bu ston presents the Buddha’s year of birth as me rta (915 B.C.E). See below p. 53. Byang bdag (3) (n.d.: 6b): “Because it should be said that the Buddha was born in the lunar mansion (skar ma. rgyu skar) skag (S. asleṣā) or mchu (S. maghā), but contradicts [Bu ston’s] statement that [the Buddha] was born in the lunar mansion rgyal (S. puṣya), this (Bu ston’s) teaching is also unacceptable” (thub dbang skar ma skag gam mchu la bitams par byed dyos na’ang skar ma rgyal la bitams par gsungs pa dang ’gal bas lung ‘di yang ’thad pa ma yin no / ). In the case of Mnga’ ris Chos rje, Byang bdag (3) (n.d.: 7a): “ ... because the values [showing] that the moon was eaten by the Rāhu when the Buddha attained the enlightenment do not arise, this tradition is not true.” (... mngon par rdzogs par sangs rgyas pa’i dus / zla ba gzas bzng ba’i ri mo yang mi ‘char bas lugs ‘di yang dag pa ma yin no / )}. Lha dbang blo gros (16th century ‘Brug pa bka’ brgyud pa) is also...}
Astronomers such as Grwa phug pa, Nor bzang rgya mtsho, etc. of the Phug system, whose system has been used extensively in Tibet since the 15th century, also presented their ideas according to the logic. They reconciled the same texts, i.e., Vinaya sūtra, Abhinīskramaṇa sūtra, Lalitavistara sūtra, etc. with their calculations. For example, their values for the lunar eclipse at the Buddha’s enlightenment are given in Grwa phug pa’s Pad dkar zhal lung in this way.94

... rgyal ba zhes pa shing pho rta la mngon par rdzogs par sangs rgyas pa yin no / ... / ... ruya cher rol pa las / skar ma sa ga la bab pa na mngon par rdzogs par sangs rgyas par gsungs pa ni gong du bshad pa'i rigs pa ltar zla ba'i nya dang sbyar ba'i skar ma tsam la dgongs pa yin gyi / zhib mor byas nas 'tshang raya bzhin pa'i dus kyi skar ma ni lha mtshams dang / tshes kyang bcu drug pa

dominantly under the influence of the idea, as seen in Schlagintweit (1897). Throughout his writing, he calculates and presents the figures of lnga bsdus, sgra gcan, etc. of some bstan rtsis traditions to check the possibility of the lunar eclipse at the Buddha’s enlightenment given by each system. In conjunction with it, Singh (1991: 124-5): “various scholars (14 scholars) determined the year of the birth of the Buddha according to their own viewpoints. It is, however, accepted by all of them that there was a moon eclipse according to the Vinayāgama sūtra at the time of the full-moon day of vaiśākha when the Buddha was born.” This is not correct: We have no textual bases to prove that all of them tried to accommodate the Vinaya to prove the occurrence of the lunar eclipse at the Buddha’s enlightenment. Most of all, the lunar eclipse occurred not at the Buddha’s birth but at the Buddha’s enlightenment.

94 The grub rtsis values are given passim in Phug pa texts. For example, for Nor bzang rgya mtsho, see Kilty (2004: 31), Henning, “Siddhānta Calculation Systems Grub rtsis,” [2015]. In the case of Phyag mdzod, see Huang and Chen (1987: 12, 149); Henning (2007: 328); Henning, http://www.kalacakra.org/calendar/os_tib.htm : gza’ dag: 1;38 [= 1'38’], zla skar: 16:0 [= 16°0’], nyi dag: 2:30 [= 2°30’], Rāhu (Sgra gcan gdong): 16:29 [= 16°29’]. It is verified from the values of zla skar and Sgra gcan gdong that the lunar eclipse is possible. Also in Henning’s software version 1.06, choose “generalised Phug pa” -> choose “Calendar cycle” -> input 15 (date)/ 4 (month)/ - 926 (year). (Julian day: 1382912. Western date: March, 17, −926 (= 927 B.C.E.)). gza’ dag: 1:38:39:0:306 (7;60:60:6:707) [= 1'38'39''364'0'0’ (7/60/60/6/707)], zla skar: 15:59:53:1:47 (27:60:60:6:67) [= 15'59'53''1''47’’ (27/60/60/6/67)], nyi dag: 2:29:53:1:47 (27:60:60:6:707) [= 2°29'53''1''47’’ (27/60/60/6/67)], sgra gcan gdong: 16:29:36:3:3 (27:60:60:6:23) [= 16°29'36''33'’ (27/60/60/6/23)]. To see the byed rtsis values of 927 B.C.E. (shing rta)/4/15 [= the date given by Phug pa as that of the lunar eclipse at the Buddha’s enlightenment], see Sum pa Mkhan po’s calculation included in the Dpag bsam ljon bzang: See below p. 68. In that case, too, sgra gcan gdong [= 16°29'36''33'’ (27/60/60/6/23)] is very close to tshes khyud zla skar [16°27'46''9’’(27/60/60/6/13)], which means the lunar eclipse is not possible. For Sum pa Mkhan po’s interpretation of the values, see below page 69 and note 152.
[Buddha] attained enlightenment in the year called rgyal ba (S. jaya), wood-male-horse year (927 B.C.E.). ... The statement in Lalitavistara sūtra that [Buddha] attained enlightenment when the constellation arrived at sa ga (S. vaiśākhā) merely intends the constellation connected to the full moon day according to the mentioned previously logic, but, if done in a detailed way, it is because the constellation of the time of attaining enlightenment is lha mtshams (S. anurādhā) and the date is also the 16th whose nyin rtsis\(^97\) appears as follows\(^98\): gza’ 1’38\(°\), tshes ’khyud zla skar 16’0\(°\), nyi ma 2’30\(°\), sgra gcan rtsa 10’30\(°\), sgra gcan gdong 16’29\(°\).

The figures (T. ri mo), which were presented above to indicate the lunar eclipse at the Buddha’s enlightenment, are those of 927 (shing rta year)/4 (sa ga month)/15 (tshes zhag).

After presenting the values as such, Grwa phug pa presents the same Buddhist texts that Rtogs ldan had used. He maintains that his calculation tallies with the aforementioned Buddhist sūtras stating that when the Buddha attained the unsurpassable wisdom, the moon was held by Rāhu.


\(^{96}\) For this system, see my appendix I.

\(^{97}\) The nyin rtsis is a daily calculation. Therefore, the term cannot be applied to gza’ dhru, nyi dhru, etc. because they are the same during a month. The calculations of gza’ dag, nyi dag, lnga bsdus, etc. are called nyin rtsis.

\(^{98}\) By 927 B.C.E./4/16, he means the transition moment between the 15th day and the 16th day, which is set as the time of lunar eclipse according to the Tibetan skar rtsis system. Given the value of tshes ’khyud zla skar 16’0\(°\) and that of sgra gcan gdong 16’29\(°\), it is possible that the lunar eclipse happens on 927 B.C.E./4/15. In other words, the moon was held by the head of the Rāhu (sgra gcan gdong).
A later scholar 'Ju Mi pham (1846-1912) summarizes the Phug pa’s ideas on the

tshes rtsis\(^99\) at the Buddha’s enlightenment and the occurrence of the lunar eclipse on the
basis of the Vaiḍūrya dkar po of the Sde srid, another Phug pa scholar.

**phug pa’i pad dkar zhal lung gi rjes ’brangs baidur dkar po dang / rtsis gzhung nyin byed snang ba’i
bzhed pa ltar na ston pa shākya’i rgyal po nyid / ... shing rta sa ga zla ba’i tshes bcо lnga’i tho rangs
kya (sic. skya) rongs ’char ba’i dus su mgon par rdzogs par sangs rgyas / de nyin ayi tshes rtsis
dang gza’ dang gza’ / dzin ri mo btab pas gdong ’dzin yod pas sangs rgyas tshe zla ba gzas bzung bar
gsungs pa dang ’grigs /\(^{100}\)**

According to the assertion of Vaiḍūrya dkar po, which follows Phug pa’s Pad dkar zhal lung and Rtsis gzhung nyin byed snang ba, teacher Śākyamuni ... attained enlightenment at the time of tho rangs/ skya rangs\(^{101}\) of the 15th day in the month of sa ga of the wood-horse year (927 B.C.E.). Because there occurs gdong ’dzin\(^{102}\) by calculating tshes rtsis, gza’ dag, and eclipse value of the day, [it] accords with the statement that the moon was held by Rāhu at the time of the enlightenment.

Next, the following table is presented on the basis of Tibetan texts and modern research. In it, there is a remarkable discrepancy between byed rtsis scholars as Bu ston, Mnga’ris Chos rje, and Mkhas grub and Phug pa. Albeit the two groups use the same Buddhist texts, which were mentioned above, the Buddha’s dates bifurcate.

\(^{99}\) For tshes rtsis, see nyin rtsis in note 96. Both are basically the same.

\(^{100}\) Mi pham (2012: 1012-3).


\(^{102}\) For gdong ’dzin, see Bsam ḡrub rgya mtsho (2011: 94).
Table 3.

<table>
<thead>
<tr>
<th></th>
<th>Year of birth</th>
<th>Year of enlightenment</th>
<th>Year of Buddha’s Kālacakra Teaching</th>
<th>Year of nirvāṇa¹⁰³</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bu ston¹⁰⁴</td>
<td>915 B.C.E.</td>
<td>880 B.C.E.</td>
<td>879 B.C.E.</td>
<td>835 B.C.E.</td>
</tr>
<tr>
<td></td>
<td>(me rta)</td>
<td>(lcags sbrul)</td>
<td>(chu rta)</td>
<td>(me stag)</td>
</tr>
<tr>
<td>Mnga’ ris Chos rje¹⁰⁵</td>
<td>915 B.C.E.</td>
<td>879 B.C.E.</td>
<td>878 B.C.E.</td>
<td>834 B.C.E.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>(chu lug)</td>
<td>(me yos)</td>
<td></td>
</tr>
<tr>
<td>Mkhas grub¹⁰⁶</td>
<td>915 B.C.E.</td>
<td>879 B.C.E.</td>
<td>878 B.C.E.</td>
<td>835 B.C.E.</td>
</tr>
<tr>
<td>Grwa phug pa and others (15th c.)¹⁰⁷</td>
<td>961 B.C.E.</td>
<td>927 B.C.E.</td>
<td>881 B.C.E.</td>
<td>881 B.C.E.</td>
</tr>
<tr>
<td></td>
<td>(lcags sprel)</td>
<td>(shing rta)</td>
<td>(lcags ‘brug)</td>
<td></td>
</tr>
</tbody>
</table>

¹⁰³ Macdonald’s minor mistake is seen in Macdonald (1963: 122, no. 59): She holds that the Buddha’s nirvāṇa falls on 877 B.C.E. in the case of Bu ston and 876 B.C.E. in the case of Mkhas grub. But it is not true. First, the years are not those of nirvāṇa but those of the Buddha’s Kālacakra teaching. Second, both of them are identical in terms of the Buddha’s year of Kālacakra teaching: Bu ston: 1786 − 2664 = − 878 (= 878 B.C.E.), Mkhas grub: 1434 − 2312 = − 878 (= 878 B.C.E.). And then we are not puzzled at the understanding of ‘Gos Lo tsā ba’s chronology described by Lha dbang blo gros in Macdonald (1963: 68): She holds that according to ‘Gos Lo tsā ba’s chronology cited by Lha dbang blo ‘gros, Mnga’ ris Chos rje places the Buddha’s nirvāṇa in 835 B.C.E. [1592 − (2427 + 1) = − 836 (836 B.C.E.) may be better]. In the case of Bu ston, she maintains that 878 B.C.E. falls on the Buddha’s year of the Kālacakra teaching. [B.C.E. 1592 − (2470 + 1) = − 879 (879 B.C.E.) may be better]. For relevant remarks, see Vostrikov (1970: 108-9, no. 337), Seyfort Ruegg (1992: 277-9). There may be the difference of one year or so in the Tibetan bstan rtsis. For example, in the case of byed rtsis scholars, the year of the Buddha’s nirvāṇa shows various years because it has nothing to do with the Kālacakra teaching, unlike Phug pa.

¹⁰⁴ Bu ston (1986: 185): 1326 (the year in which Mkhas pa dga’ byed was written) − (2204 + 1) = 879 B.C.E. (the Buddha’s Kālacakra Teaching). However, the year of the Buddha’s Kālacakra teaching in his Chos ’byung is problematic. Obermiller (1931–1932: 108): 1322 − (2198 + 1) = 877 B.C.E. (the Buddha’s Kālacakra Teaching). Something is wrong here. For this year, see also Vogel (1991: 411, no. 90), and Seyfort Ruegg (1992: 278).


As seen above, when deciding the year in which the Buddha taught the *Kālacakramūlatantra*, both groups commonly used the lunar eclipse at the time of Buddha’s enlightenment as stated in the aforementioned Buddhist texts, but they presented the following different years: 879 B.C.E. (*chu rta*) in the case of Mhas grub; 927 B.C.E. (*shing rta*) in the case of Phug pa scholars. The reason why their presentations of the years are different is that the possibility of the lunar eclipse is calculated differently: In the former, the lunar eclipse occurred in 879 B.C.E., but, in the latter, it occurred in 927 B.C.E.. Simply, the common rationale for the decision of the different Buddha dates is *yar log gi rtsis*. As a result, the former holds that the *Mūlatantra* was taught after the Buddha’s enlightenment, and the latter maintains that it was taught before the Buddha’s *nirvāṇa*.

In the following, let me tackle Sum pa Mkhan po, who was most vigilant of the astronomical phenomena and traditions among 18th century astronomers, to see the relationship between the logic of *yar log gi rtsis* centering around eclipse calculation and the accuracy of an astronomical system.

2. A SURVEY OF LATER PERIOD BSTANRTSIS WITH RESPECT TO AN ECLIPSE

SUM PA MKHAN PO: REAPPRAISAL FOR BYEDRTSIS AND THE ECLIPSE CALCULATION

In the 18th century astronomical context, Sum pa Mkhan po is an important scholar who has a sense of the diverse traditions, including Mongolia and China, although he
mainly stands on the shoulders of the Tibetan giants of the previous centuries. The reason why he should be mentioned is that, through him, we can read that the previous tradition was well digested and rejuvenated, and we can also understand what astronomical ideas and thoughts were dominant in his period.

About the eclipse calculation at the Buddha’s enlightenment, he adhered to the time-honored skar rtsis exegesis. He shared the same ideas with his predecessors.

All of them (the different opinion holders on the bstan rtsis) put forth the individual year of the enlightenment, which accords with individual opinion whatever it is, and alleged that they accord with the Vinaya śūtra stating that the lunar eclipse occurred at the daybreak of the full moon day of the month of sa ga such and such, but, because given the figure by backward calculation, the occurrence of the lunar eclipse does not appear except for a few, internal contradiction occurs to most of their own texts.

Intriguingly, he, as a Phug pa scholar, did not follow Phug pa predecessors’ exegesis in terms of the calculation of the lunar eclipse at the Buddha’s enlightenment. Instead, he followed Mkhas grub, who is a byed rtsis scholar, as is clearly seen below.109

108 Sum pa Mkhan po (1979: 287b) [= (1992: 917)].

Table 4.

<table>
<thead>
<tr>
<th></th>
<th>Year of birth</th>
<th>Year of enlightenment</th>
<th>Year of Buddha’s Kālacakra Teaching</th>
<th>Year of nirvāṇa</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mkhas grub</td>
<td>915 B.C.E.</td>
<td>879 B.C.E. (chu rta)</td>
<td>878 B.C.E.</td>
<td>835 B.C.E.</td>
</tr>
<tr>
<td>Sum pa Mkhan po</td>
<td>915 B.C.E.</td>
<td>879 B.C.E.</td>
<td>878 B.C.E.</td>
<td>834 B.C.E.</td>
</tr>
</tbody>
</table>

110 See Sum pa Mkhan po (1979d: 292b) [= (2001: 758)]: “From the water-female-sheep year (878 B.C.E.) in which Bhagavān spoke in the Kālacakra, King of Tantra,” (bcom ldan ’das kyi rayud kyi ryal po dus kyi ’khor lo las gsungs pa’i chu mo lug lo nas ...). Also, see Nishioka (2007: 448). However, there is something wrong in the statements on the year of the Buddha’s Kālacakra teaching in Sum pa Mkhan po’s autobiography. For example, Sum pa Mkhan po (1979d: 166b) [= (2001: 430)]: “on the 14th day of the śuklapakṣa in the third month ... of the year in which 2655 years passed from the year Jina (Buddha) preached Kālacakra, [which is] called manmatha in Sanskrit, myos byed according to the Bde mchog stod ’grel in the Laghutantraṭīkā, yiwei (Ch. 乙末) in great China’s language, kögečin qoni in Mongolian (hor), and the wood-female-sheep year in Tibetan.” (rgyal bas dus ’khor gsungs lo nas nyis stong drug brgya nya lnga ’das pa’i gnam lo sam skrī ta’i skad du mar (ma ra ?) dang stod ’grel la myos byed dang ma hā tsi na’i skad du yi wa’i dang hor aya skad du khu khug chin ho ni dang bod skad du shing mo lug lor ’bod pa’i ... ming gzugs kyi yar ngo’i yar tshes stong ba gsum pa’i nyin ... ). The date is 1775/3/14. For stong ba gsum pa, see the following table.

For the textual basis of this table, see Phyag mdzod, Huang and Chen (1987: 27, 175-6), Bsam ’grub rgya mtsho (2011: 86-7). For the equation of each year according to see Tibetan, Mongolian and Chinese methods, see Appendix I. Especially, for the Tibetan method in the Bde mchog stod ’grel seen in Vajrapāṇi’s (T. Phyag na rdo rje. circa 10th ~ 11th c.) Laghutantraṭīkā, see Cicuzza (2001: 33): “We do not know the origin of 18 stanzas and six astronomic stanzas (in which the name of the Jupiter sexagenary cycle is mentioned). Also read Newman (1998: 344). And for the ming gzugs, see Lcang skya III et al. (2002: 1174-5): one of the synonyms of the zla ba gsum pa (yutayar-asa) is ming gzugs zla (M. ner-e üngge-yin sar-a). Also see Bsam ’grub rgya mtsho (2011: 156). Going back to my point, 1775 - (2655 + 1) = 881 B.C.E. is calculated as the year of the Buddha’s teaching Kālacakra was placed in the year of 878 B.C.E. according to his exegesis. Another example in the same text: Sum pa Mkhan po (1979d: 74b) [= (2001: 193)]: “on the sixth day of the śuklapakṣa in the sixth month according to skar rtsis tradition in the chu stod (the 6th month) month of the [year in which] 2600 [years] passed after Bhagavān’s having preached the Dus ’khor rayud kyi ryal po, the year (T. zla ba’i ’phreng can) in the 12th rab byung, which is called rākṣasa in Sanskrit, srin po according to the Bde mchog stod ’grel, yimao (乙卯) in great China’s language, the wood-female-hare in Tibet.” — I do not translate lo’i mdzod which means month. If translated, it would be redundant. — (bcom ldan ’das kyi rayud kyi ryal po dus kyi ’khor lo las gsungs pa’i chu mo lug lo nas ... nyis stong drug brgya ’das pa rab byung bcu gnyis pa’i nang tshan gyi gnam lo sam skrī ta’i skad du raksha sa dang...
His response to Pañchen Blo bzang dpal ldan ye shes’s (1738–1780) 1777’s (T. me bya) questions in 1778 C.E. (sa khyi) shows his reappraisal of byed rtsis.

... bcom ldan ’das sanks rgyas pa’i sa ga’i nya’i tho rangs la gza’ ’dzin ri mo’i lam nas nges par e ’char / ... lan thal mo sbyar te qsol ba ni / ... mdo na rgyal po (sic. read bu) don kun grub pa gsar du sanks rgyas tshul ston pa’i sa ga’i nya de mtshan mo sgra gcan ’dzin ’khrungs pa dang zla ba sgra gcan gyes zin par gsungs pa dang mthun par byed ched du / mkhas pa so sos rang lugs kyis bcom ldan ’das sanks rgyas lo re bzhag ste de’i sa ga’i nya la de lta’i ri mo re ’grig par mdzad kyang dngos gzhil gang yin kha tshan good dka’ la / ’on kyang mkhas pa la las de la grub rtsis nges la byed rtsis la ri mo de lta bu shar yang mi nges zhes pa’i lan ’debs phyir du / bu ston rin po che dang mkhas grub thams cad mkhyen pa dang chos mgon rnam kyi lugs kyi byed rtsis zhib pa ltar ’thad pa sgrub phyir du khong rnam kyis bzhes pa’i lo lza de’i nyin zhaq gi tho rangs gza’ ’dzin yod pa rtsis gsar la’ang ’grig par byas pa’i ri mo ni zla bshol zhig dang nye yang de kho dag par yod lags /’

... With my hands folded in devotion, replying to [your] questions, “does Bhagavân’s attainment of enlightenment at the daybreak of the full moon day in the month of sa ga certainly occur by the value of eclipse?” is as follows: ... In order to make it agree with the statement in the sūtras that Rāhula was born at the night of the full moon day of the month of sa ga when prince Siddhârtha newly showed the way of enlightenment and the moon was held by Râhu, individual learned scholars put forth the respective year of Bhagavân’s enlightenment by their own traditions and accorded with each value like that on the full moon day of the month of sa ga, but it is difficult to decide the actual basis, nonetheless. However, the values of the occurrence of the eclipse at daybreak of the

stod ’grel ltar na srin po dang / ma hâ tsi na’i skad du yi ma’u dang bod du shing mo yos su ’bod pa’i zla ba’i ’phreng can gyi ... chu stod zla ba’i lo’i mdzod gyi ... skar rtsis lugs kyi zla ba drag pa’i dkar cha’i tshes drug ... ). The date is 1735/6/6. For the chu stod zla ba, see Lcang skyâ III et al. (2002: 1174-8). For the synonyms of the year, see Appendix I. Going back to my point, this is also strange: 1735 – (2600 + 1) = 866 B.C.E. is given as the year of the Buddha’s Kālacakra teaching. It is not 878 B.C.E. most probably because of a miscalculation of the duodenary cycle into the sexagenary one.

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112 Sum pa Mkhan po (1979c: 5a).

113 They include Vinaya sūtra, Abhinîkramaṇa sūtra, Lalitavistara sūtra, etc.
month in the year asserted by Bu ston, all knowing Mkhas grub, and 'Jam dbyangs chos kyi mgon po\textsuperscript{114} in order to reply to some scholars' statements regarding that grub rtsis is certain but [byed rtsis] is not, even if the values occur in byed rtsis; in order to prove the agreement according to the accurate byed rtsis of their traditions, which are also in accordance with Dga’ ldan rtsis gsar, are close to intercalation and correct.\textsuperscript{115}

He defends the byed rtsis of Bu ston and Mkhas grub. The ground is the accuracy of eclipse calculations. He explains that the lunar eclipse at the Buddha’s enlightenment occurred on 879/4/15 according to their byed rtsis system. Therefore, the accuracy of his own system Dga’ ldan rtsis gsar is also justified.

In the section on Mkhas grub in his Dpag bsam ljon bzang, through which we can learn of Sum pa Mkhan po’s ideas and reasoning concerning the relationship between bstan rtsis and eclipse calculation, the motivation to create the Dga’ ldan rtsis gsar, the assessment of the existing systems, and his siding with byed rtsis. First, he cites Mkhas grub’s statements in the Great Commentary that was criticized by Grwa phug pa, and Grwa phug pa’s criticism of Mkhas grub in the Pad dkar zhal lung. Then, he defends Mkhas grub.\textsuperscript{116}

\textsuperscript{114} Tentatively, I adopt the research by Kaḥ thog Rig ’dzin (1976-1977) (2006) for the identity of this man, for which see above p. 42.

\textsuperscript{115} Sum pa Mkhan po (1979c: 5a-5b).

\textsuperscript{116} Van der Kuijp (2013: 142, n. 60). Mkhas grub’s Buddhist chronology, which places the Buddha’s enlightenment in 879 B.C.E. (chu rta), has been understood to be problematic among Tibetan scholars. But Sum pa Mkhan po defends Mkhas grub’s chronology based upon byed rtsis. Sum pa Mkhan po (2001: 309-10): “Also, some learned scholars in calculation say that, although Mkhas grub wrote the Great Commentary on Kālacakra, he has narrow outlook even to Inga bsdus (S. pañcânga), ... the condition that I put some answers to the refusal by some in this [= my] calculation and Chos ’byung is: Sgo mang Bla ma Sems nyid dam chos, having studied calculation, intended to answer, but there was no opportunity. Upon this, when Seng lding zhabs drung came from Dbus to Amdo [= before Seng lding zhabs drung’s coming to Amdo from Dbus], he said, “You ask Sum pa Mkhan po to answer.” Because I could not refuse the statement [made by Sgo mang}
de nang gi dgag pa 'ga' zhig dang mdzad byang sogs mkhas pa lhun 'grub rgya mtsho pas sbyar ba de las bod kyi mkhas pa du ma'i bstan rtis so sor dgag cing / khyad par du mkhas grub rje bka' pa'i thad du dpyad pa byed dka' mod kyang ... mkhas grub rje'i tik chen par ma na / sangs rayas kyi (sic. read kyi) rtsa rgyud gsungs pa'i lo dang de'i rjes su zla bzang gis shambha lar lo gcig gi ring la rtsa rgyud bstan cing 'grel ba brtsams te dus kyi 'khor lo'i gzhal yas khang bzhens nas mya ngan las 'das pa'i lo gcig ste lo gnyis po de ni sngar gyi grangs las logs su lha'h por byrang dgos te / ston pas rtsa rgyud ston pa'i lo 'di nas 'og tu drug brgya'i lo yis zhes pa yin pas / lo drug brgya po de'i sngon ma rtsa rgyud ston pa'i dus de la bzung bas lo gnyis po ni lo 'di nas ni drug brgya zhes pa'i khongs su ma gtags pa'i phyir ro / zhes dang /117 sa gai nya'i tho rongs kyi cha la sangs rayas shing de'i tshe zla ba gzas zin par bshad la / de'i lo de niyid chu pho rta sna tshogs kyi lo yin te / de la sngar bstan rtis kyi skabs su ji skad bshad pa'i 'das lo'i grangs gzhir bzhag pa'i steng nas lugs bzlog gi rtis byas te / lo de'i sa gai zla ba'i zla dag btsal nas de'i nya'i nyin rtis byas pa na ... gaa' dzin dang legs par 'grig par 'gyur ba'i sngar gyi bstan rtis kyi 'das lo 'jog tshul soqs rnam par dag cing yid btsan du rung bar 'grub la / [continued below]

Sum pa Mkhan po's Table A.118

<table>
<thead>
<tr>
<th></th>
<th>1</th>
<th>14</th>
<th>26</th>
<th>0</th>
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</tr>
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<td>0</td>
<td>5</td>
<td>5</td>
<td>5</td>
<td></td>
</tr>
</tbody>
</table>

117 Mkhas grub (1897: 27b): The Zhöl par ma is nearly the same. The difference is underlined in the following: sangs rays kyi (sic. read kyi) rtsa rgyud gsungs pa'i lo dang de'i rjes su zla bzang gis shambha lar lo gcig gi ring la rtsa rgyud bstan cing 'grel ba brtsams te dus kyi 'khor lo'i gzhal yas khang bzhens nas mya ngan las 'das pa'i lo gcig ste lo gnyis po de ni sngar gyi grangs las logs su lha'h por byrang dgos te / ston pas rtsa rgyud ston pa'i lo 'di nas 'og tu drug brgya na lo yis zhes pa yin pas / lo drug brgya po de'i sngon ma rtsa rgyud ston pa'i dus de la bzung bas lo gnyis po ni lo 'di nas ni drug brgya res pa'i khongs su ma gtags pa'i phyir ro / .

118 The value of this table is that of byed rtis at 879 B.C.E. (chu rtas)/4/15. res 'grogs zla skar 14¹2¹5¹0³⁶⁵⁰¹⁰⁰¹⁰, mjug 14¹5⁴⁶⁵¹⁰⁰¹⁰. tshes 'khyud zla skar = res 'grogs zla skar + gza' dag (The gza' gnas is irrelevant to this calculation. i.e. 37⁴³⁵⁵⁰⁵⁰ = 14⁵⁸⁵⁸⁵⁰⁸⁸). The difference between tshes 'khyud zla skar and mjug is around 43³; thus, a lunar eclipse is a possibility. For the term res 'grogs zla skar, see Janson (2014: 29).
### Sum pa Mkhan po’s Table A (continued)

<table>
<thead>
<tr>
<th></th>
<th>5</th>
<th>3</th>
<th>8</th>
<th>3</th>
<th>10</th>
<th>10</th>
</tr>
</thead>
<tbody>
<tr>
<td>gza’</td>
<td>♣zla skar♣</td>
<td>nyi skar</td>
<td>rtsa</td>
<td>gdong</td>
<td>mjug</td>
<td></td>
</tr>
</tbody>
</table>

### Notes

119 gza’ dag.

120 res ’grogs zla skar.

121 nyi dag.

122 Sgra gcan rtsa, gdong, mjug: the unit of cha shas is given as 13.

123 The quotation from sa ga’i nya’i to grub pas is found in Mkhas grub (1897: 390b-391a).

124 Grwa phug pa (2002: 23). This passage from yang ti ka to reg go is from Grwa phug pa (2002: 23-4). Grwa phug pa meant Mkhas grub (1897: 27b) by the quotation from rtsa rgyud gsung ba’i lo phyir ro; Mkhas grub (1897: 390b-391a) by the quotation from lo ’di nas to mngon sum gyis grub pas; Mkhas grub (1897: 390b) by the quotation from bstn pa’i ’das lo’i to la sogs pa’ char.

125 Sum pa Mkhan po (1979: 179b-180a) [= (1992: 541-3)].

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In some criticisms and colophon, etc., in it (Pad dkar zhal lung), which was written by master Grwa phug pa, [he] refused bstn rtsis-s of many learned scholars of Tibet,
respectively, and especially the analysis regarding the refusal of Mkhas grub is difficult but ….. It is stated in the block print of Mkhas grub’s Great Commentary that the year in which Buddha spoke the Mulatantara (878 B.C.E.) and ensuingly the year in which Sucandra taught the Mulatantara and wrote a commentary in Sambhala and passed away after having built Kalacakra celestial palace during one year (878 B.C.E.) is the same year. The two years should be calculated separately, additionally, from the previous numbers because it is stated “by the 600 years onwards from the year Buddha taught the Mulatantara,” the two years before the 600 years do not belong to the quotation “600 years from this year” because the 600 years begin from the time Buddha taught the Mulatantara. It is explained [in Mkhas grub’s Great Commentary] that the Buddha attained enlightenment at the moment of the daybreak of the month of sa ga, and at that time, the moon was held by Rahu, and the year is water-male-horse year citrabhānu (879 B.C.E.). If having reversely calculated from that which was put on the basis of the elapsed years stated in the case of the previous bstan rtis, [ ] calculate nyin rtis of the full moon day for that, after having sought zla dag (true month) in the month of sa ga of the year, … the method of setting ‘das lo (elapsed years), etc. of the previous bstan rtis, which nicely accords with the eclipse, etc. are pure and reliable. If calculated counting the two years, the year in which [Buddha] taught the Mulatantara and the year in which Sucandra taught the dharma, within the 600 years, the value of the eclipse does not arise, but if calculated without counting one year, [ ] established by direct experience (mgon sum)126 in a way that the eclipse occurs.

126 Tibetan scholars and astronomers who have training in Buddhist epistemology (T. tshad ma) use the concept of direct perception (S. pratyakṣa/ T. mgon sum) in a way that whether an astronomical system is accurate or not is verified by direct perception of eclipse, solstice, equinox, etc. This also means that they should produce a system that matches up with the real celestial phenomena. This idea is time-honored. To illustrate some, G.yung ston states in a correspondence between him and Bu ston included in Dharmaśrī (1983: 286-7): “… shouldn’t be afraid when punishing [ ] after having built the court in which the text containing my commentary to the Kalacakratantra, the calculation, i.e. the reason — this is my interim rendering for rgyu mtshan rtis — shown through arithmetic, wisdom on the basis of real things (T. dngos po stobs zhugs. S. vastubalapravṛtta), and non-erroneous direct perception of eye consciousness assemble together?” (… nga’i rgyud ‘grel pa dang bcas pa’i lung dang / sa ris kyi lam nas ston pa’i rgyu mtshan rtis dang / dngos po stobs zhugs kyi rigs pa dang / mig shes ma’ khru’l ba’i mgon sum rnams ‘dzoms pa’i khri’ms ra bcas nas btsa’ (sic. read rta) ra byas dus mi skrag pa e yin /). For this passage, see Tshul khrims chos ’byor (1982: 28) without indicating a proper source of citation. Van der Kuip (2007: 144) indicates the source rightly. In it, G. yung ston clearly states several conditions for being an accurate calculation / astrologer, one of which is “direct perception of eye consciousness.” Another example: Byang bdag’s letter to Mkhas grub, Byang bdag (2) (n.d.: 9b): “Bhadavān also said some byed rtis in calculation, the means to realize it. Even if it is the case, it would not be the case of knowing calculation just by knowing byed rtis a little, and if [you] can show the understanding of reason and the signs of pleasure and pain of the three times by direct perception, it would be the case that [you] know calculation, but not in other cases.” (de rtags par byed pa’i thabs / rtis kyi byed pa’ ja’ yung / bcom ldan ’das kyi’gsungs yod / de lta na yang / byed rtis cung zad tsam shes pas rtis shes par mi ’gyur zhing / rgyu mtshan rtags pa dang / dus gsum gyi bde skad gi mtshan ma mgon sum rnu du ston nus na / rtis shes par ’gyur gyi / gzhag du na ma yin no/). Another example, Sum pa Mkhan po’s second letter to Ngag dbang ngyi ma in 1785/1786, Sum pa Mkhan po (1979c: 91b): “… That being so, because whether my son-text (Zla bsil rtis sbyor dge ldan rtis gsar) is accurate or not is easily known by calculating and checking whether annual solstice, eclipse, etc. accord with their being seen (T. mig mthong), [ ] is the object of direct perception without needing the argument of hidden (T. lkyog gyur) means of knowing and elaborated words, etc. to them.” (… de bas na dbag gi bu gzhung dang mi dag ni lo’ re bzhi’ gyi ngyi ldog gza’ ‘dzin sogs bris nas mig mthong dang ‘grig mi ‘grig bta’ na shes sla pas / de dag la lkyog gyur rtags byed lta’i gyi gan tshigs dang tshig ’phres (sic. possibly ’phres) sogs mi dgos bar mgon gsum gyi yul yin no/). As a matter of fact, it is not difficult to find the concept of mgon sum used in rtis texts. Tibetan astronomers use it passim: an eclipse is manifest by
Grwa phug pa refutes in the *Pad dkar zhal lung* the (Mkhas grub’s) statement of the year of enlightenment saying: Also, the person who wrote the Tikā (= Mkhas grub) wrote that, at the beginning of the explanation of the Tantra, the year of the *Mūlatantra* teaching and the year of Sucandra’s writing a commentary in Śambhala are the same and the two years do not need to be counted separately from the 600 years of Sureśvara, etc. because [they] belong to the 600 years. And then, [he (= Mkhas grub)] wrote below that on the occasion of the rise of lo dag pa of *Laghukālacakra* and *Vimalaprabhā* stating “by six hundred years from this year onwards,” etc., if the two years, i.e., the year in which the *Mūlatantra* was preached [by Buddha] and the year in which Sucandra taught dharma are calculated, being included in six hundred years, the values of of the occurrence of the eclipse do not arise like this, and if [one] calculates without counting one of them, the occurrence of the eclipse is established by mngon sum. And [Mkhas grub] stated that if [one] performs backward calculation by being based on the numbers of the elapsed years stated in the case of the previous bstan rtsis, the eclipse, etc. on the full moon day of the month of the sa ṣa in the year of water-male-horse citrabhānu (879 B.C.E.) appear. And then the values of the eclipse, which were put forth by the previous tradition, were written [in Mkhas grub’s Great Commentary]. Grwa phug pa continuously says that these [= Mkhas grub’s theory] are subject to the three mistakes: (1) the contradiction between earlier and later statements [in Mkhas grub’s Great Commentary]; (2) if put by being based upon the numbers of the years according to the bstan rtsis of the Phug system, the eclipse calculated backward does not arise; (3) the fault that follows, and in addition, merely repeats the previous (Jam dbyangs Chos kyi mgon po, etc.).

Immediately after the introduction of Grwa phug pa’s criticism of Mkhas grub’s bstan rtsis in the above passage, Sum pa Mkhan po’s defense against the three criticisms by Grwa phug pa is as follows. First, for the Grwa phug pa’s first criticism, which is an inner contradiction in Mkhas grub’s Great Commentary that “lo gnyis po” (both years, i.e., the year in which the Buddha taught the Kālacakra and the year in which Sucandra built the maṇḍala. Both indicate 878 B.C.E.) were included and excluded in the “600 years”, he

direct perception / direct experience, and if rtsis (calculations) is compatible with the occurrence of an eclipse in a system, it means that accuracy of the system is verified.

127 The lo dag pa is true elapsed years during a particular period.

128 As a matter of fact, Mkhas grub’s explanation is confusing and misleading. The “two years” seem to mean the same year 878 B.C.E., not 879 and 898 B.C.E.
points out that Grwa phug pa made a wrong citation. Sum pa Mkhan po is right in that the two years do not belong to the “600 years” and should be calculated additionally. Then, why did Mkhas grub say “lo gnyis po,” not “lo gcig po” (one year)? It is still a difficult question, but Sum pa Mkhan po’s following interpretation may be related to the “lo gnyis po”: the difference of the value of ril bo, which is decided by ‘das lo and zla dag, produces different gza’ dhru and nyi dhru. Then, the eclipse will occur in 879 B.C.E. according to Mkhas grub’s yar log gi rtsis calculated according to byed rtsis. All in all, Sum pa Mkhan po agrees with and defends Mkhas grub, arguing if the Buddha’s Kālacakra teaching and Sucandra’s writing a commentary to it occurred in 878 B.C.E., and 878 B.C.E. is not

129 Sum pa Mkhan po (1979: 180a) [= Sum pa Mkhan po (1992: 543)]: “the absence of the quotation cited by Grwa phug pa from it (= the statement in Mkhas grub’s Great commentary), [the two years are] counted being included [within the 600 years] without being counted additionally, ‘is as was cited previously [by me (= Sum pa Mkhan po)].’” (... de las logs su mi bgrang bar de'i khongs su bgrang zhes pa med pa snigar drangs zin ltar yin la ... ). Sum pa Mkhan po shows that Grwa phug pa’s citation of Mkhas grub is groundless. Actually, Grwa phug pa’s citation is the complete opposite to that of Mkhas grub. For the original text of Mkhas grub, see the above Sum pa Mkhan po’s citation of Mkhas grub and Mkhas grub (1897: 27b). Why did this kind of miscitation happen? There may be some possibilities: Grwa phug pa either relied on different manuscripts/block prints or he simply misread Mkhas grub.

130 Sum pa Mkhan po (1979: 180a-180b) [= (1992: 543-4)]: “The statement of counting one year from the previous two years in (Mkhas grub’s) Great Commentary, regarding the lunar eclipse in the night of the enlightenment, is: ... for the values of the eclipse of the night. If you ask how it is so, it is said that it would agree in a way that the eclipse occurs that night if backward calculation is performed after adding 10 months and 15 days, without counting the ril bo of the previous year (879 B.C.E.) after counting the ril bo of the year in which [Sureśvara] built maṇḍala (878 B.C.E.) from the previous two years (879 and 878 B.C.E.) on top of the 600 elapsed years.” (sangs rgyas pa'i nub mo'i zla 'dzin thad du tik chen las lo snja ma gnyis las gcig bgrang gsungs ni ... de nub kyi gza’ 'dzin ri mo'i ched du ste / de ji ltar zhe na lo drug brya sog's 'das lo'i steng du lo snja ma gnyis las blo bslang bzhens s lo ril bo bgrang nas de'i snjan ma'i lo gcig po ril bo mi 'dren par de'i zla ba bco dang zhag bco lnga bsnan nas yar log gi ri mo bris na de nub gza’ 'dzin yod par 'grig 'ong zhes pa'o /). In other words, the use of “two years” and “one year” may be contextual in conjunction with the lunar eclipse at the Buddha’s enlightenment according to Sum pa Mkhan po’s interpretation.
included in the “600 years”, the byed rtsis value for 879 B.C.E./4/15 tallies with the lunar eclipse at the Buddha’s enlightenment.

Next, Sum pa Mkhan po’s defense against the second criticism raised by Grwa phug pa. Grwa phug pa’s criticism was made essentially from the perspective of Phug pa grub rtsis, and Sum pa Mkhan po looks to focus on explicating the accuracy of byed rtsis by using the eclipse at the Buddha’s enlightenment, on the one hand, and focus on explaining the problem of grub rtsis, on the other. His argument is as follows:

ṭik chen gyi lugs gzhir bzhag ste khyed rang dag gis kyang byed rtsis kyi nang nas zhib par bzhed pa ltar gyi yar log gi rtsis byas na chu rta la de’i sa ga’i nga yea la ri mo ’di lta bu shar bas ’dzin dus dang rgya gar dang bod kyi sa tshigs (linear note: sa skya dang rdo rje gdan bar dpag tshad brgyar bshad) bar khyad la man ntag ltar gyi phri snon byas pas ’phags yul dbus su nga’i tho rongs zla ’dzin dang sags rayas tshul gyi mdzad pa ston pa’ grigs la / [continued below]

... If being based on the Great Commentary, you (Phug pa scholars) also perform backward calculation, as is stated exactly within byed rtsis, the values appear like this on the full moon day of the month of the sa ga in the water-horse year (879 B.C.E.). So, by adding and subtracting eclipse timing and the geographical distance between India and Tibet (it has been said that the distance between Sa skya monastery and Vajrāsana is 100 dpag tshad) according to an oral instruction (S. upadeśa), the lunar eclipse in the center of the Holy Land on the daybreak of the full moon day coincide with the way of the Buddha’s enlightenment shown.


132 For dpag tshad, see Bsam ’grub rgya mtsho (2011: 24).
He calculates the value in India on 879/4/15 to defend Mkhas grub’s byed rtsis. He thinks that, because the lunar eclipse at the Buddha’s enlightenment occurred in India,

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133 The basis of the calculation in these tables is not identified at present. Nothing is known how he computed these values. When compared with the previous table, the value of nyi dag is identical, but that of gza’ dag is different. Given the context, the values may be those of byed rtsis chu rta (879 B.C.E.)/4/15 at Rdo rje ldan (Vajrāsana), but the calculation method or man ngag is difficult to know. It seems that a certain correction was applied to the values in the previous table by man ngag. This table clearly evidences that Tibetans were aware of the time difference due to the longitude; better to say the four cardinal points: north, east, south, and west.

134 gza’ dhru.

135 gza’ dag.

136 tshes ’khyud zla skar.

137 Generally, Rāhu’s head is called gdong (sgra gcan gdong).
the values should be those in India, and if the eclipse is possible by the values, the accuracy of byed rtsis is posited. Because tshes ’khyud zla skar\textsuperscript{139} (14°58'58"5'8") and sgra gcana mjag (14°15'46"5'17") are very close in the above table, the lunar eclipse may have occurred (Note that there is no guarantee that an eclipse occurs just by the possibility check). After that, Sum pa Mkhan po uses Phug pa scholar Nor bzang rgya mtsho’s opinion on byed rtsis and divides byed rtsis into two\textsuperscript{140} to defend Mkhas grub’s byed rtsis.

\textsuperscript{138} The way how he produced the byed rtsis values in Vajrāsana is not known. It seems that he embraced a certain man ngag, but it does not appear in his ma (= Skar nag rtsis kyi snying nor nyung ’dus kun gsal me long) and bu (= Zla bsil rtsi sbyor dge ldan rtsis gsar). I hope that someone will be able to clarify this in the future.

\textsuperscript{139} For the term, see Janson (2014: 29): “The (true) longitude of the moon at the end of the lunar day (tshes zhag).”

\textsuperscript{140} According to Sum pa Mkhan po, there are two different byed rtsis: sngon gyi byed rtsis / phyis kyi byed rtsis (= byed rtsis rnam dag). It is difficult to identify them. As far as I know, there is no such thing. In conjunction with the terms, Nor bzang rgya mtsho (2002a: 585-8) mentions that the contemporary byed rtsis is different from the byed rtsis from the Laghukālacakra. However, I think that it is not likely what Sum pa Mkhan po meant because Nor bzang rgya mtsho’s logic is that the contemporary byed rtsis is not correct, being compared with the byed rtsis of the Laghukālacakra.

\textsuperscript{141} I could not identify this in the bu yig (= Nor bzang rgya mtsho’s 11 texts included in Grwa phug pa (2002)). The quotation does not seem to exist in them.

\textsuperscript{142} I cannot identify these contents in Nor bzang rgya mtsho. No such contents exist in his bu yig texts.
Here, the statement made by Nor bzang rgya mtsho in a son-text of the *Pad dkar zhal lung* that if [ ] is calculated by the values from the backward calculation on the basis of *rtsis 'phro* of the 221 years, which is asserted to be accurate on the occasion of previous *byed rtsis*, the lunar eclipse does not occur on the full moon day of the month of the *sa ga* in the water-horse year (879 B.C.E.) during several previous and subsequent years, and although [the eclipse] occurs according to backward calculation by later *byed rtsis*, there is no certainty because errors appear from many years in *byed rtsis* in accordance with the learned scholar Grwa phug pa’s statement in the *Pad dkar zhal lung*; otherwise, because previous *byed rtsis* is a little rough, the values do not occur, but there is no error, and *byed rtsis* calculated by later Bu ston and Mkhas grub and Mañjuśrī Chos kyi mgon po is unmistaken also in the present when [it is] calculated correctly on the basis of the *rtsis 'phro* because the calculation is far more accurate than the previous one in the case that [it is] calculated on the basis of the 221 years, which is [the result of subtracting 182 years from 403 years (*me mkha’ rgya mtsho*), or moreover, because later *rtsis 'phro*, whatever, has the same meaning. Especially, because *byed rtsis* values written here are more accurate than that, it is not only not much different in terms of a rough and subtle level, when being compared with *grub rtsis* in the *Pad dkar zhal lung*, but also is superior to *grub rtsis* in terms of observation and eclipse. Because of that, in the case of the lunar eclipse of the month of the *sa ga* in the water-horse year (879 B.C.E.) calculated backward on the basis of the *byed rtsis*, there is certainly no mistake. ...

Sum pa Mkhan po’s intention is clear, but his use of Nor bzang rgya mtsho’s opinion on *byed rtsis* may be arbitrary. He does not present proper bases to support his opinion on Nor bzang rgya mtsho’s intention. Also, he commits a fallacy of *petitio principii*. (The truth of the conclusion is assumed by the premises): he should prove the accuracy of *byed rtsis*, but it was already presupposed.

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143 *mig skar*: observed star (*skar ma*). In most cases, it looks to be fine to render it as observation.

144 Sum pa Mkhan po (1979: 180b) [= (1992: 544-5)].
Next, he investigates whether or not the lunar eclipse occurs by byed rtsis in the case of 927 B.C.E. (shing rta)/4/15, which was given by Phug pa as the date of the lunar eclipse at the Buddha’s enlightenment.

I think that it is apparently an unestablished proof even if the proper argument of the basis of the investigation when you (Phug pa scholars) say that prince Siddhārta attained enlightenment on the full moon day of the month of sa ga in the wood-horse year (927 B.C.E.) should be said that it is in order to accord with the occurrence of the value of the eclipse that night. The reason is that the eclipse took place according to grub rtsis in the Pad dkar zhal lung,146 but, because the remainder from the subtraction is very small in the case of the accurate byed rtsis, no eclipse occurred that night.

Sum pa Mkhan po’s Table D. 147

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Sum pa Mkhan po (1979: 180b-181a) [= (1992: 545-6)].

For the value, see above note 94.

This table is byed rtsis values of 927 B.C.E. (shing rta)/4/15, which Phug pa scholars claim to be the day of the Buddha’s enlightenment.

146 gza’ dag.
He says that the remainder \(0^k1^s50^2^"5"16""\) is too small for the lunar eclipse to occur in the case of byed rtsis.\(^{152}\) I do not know how to make sense of this, but it is certain that he tries to prove that the lunar eclipse, which occurs according to Phug pa's logic, does not occur in the case of byed rtsis. Ensuingly, he adds a different logic for saving byed rtsis.

\[\text{de ltar na yang gal te byed rtsis la ma shar yang sgrub (sic.) rtsis la gza' 'dzin yod pa'i ri mo shar bas chog zer na / de yang mi 'thad de / de nub byed sgrub (sic.) ci rigs la gza' 'dzin ri mo shar tsam gyis mi chog par nges par zla 'dzin mthong rayu zhiq yod dgos la / de ltar na sgrub rtsis la de ltar 'dzin pa'i ri mo shar yang nges pa med cing byed rtsis rnam dag la de shar na nges par 'dzin pa da ltar yang mngon sum gyis' grub pa dang / der ma zad zhul lung rjes 'brang dpyod idan rtsis rig la byang ba'i ldum po don 'grub dbang rayal dang gnas Inga la mkhas pa'i sangs rgyas rya mtsho so gs kyi kyang zla 'dzin yod med byed rtsis dang dus tshod gtsa bor grub rtsis thig 'ongs zhes pa don la 'ang gnas so}^{153}\]

\(^{149}\) tshes 'khyud zla skar.

\(^{150}\) nyi dag.

\(^{151}\) lhag ma. Here, sgra gcan gdong \(-\) tshes 'khyud zla skar \(= 16^s2^9^3^6^3^"3"\) \((27/60/60/6/23)\) \(-\) \(16^k2^7^4^6^0^"9"\) \((27/60/60/6/13)\) \(= 16^s2^9^3^6^3^"1"6"\) \(-\) \(16^k2^7^4^6^0^"9"\) \(= 0^k1^s50^2^"5"16"\) \((27/60/60/6/13/23)\).

\(^{152}\) The mention of a similar kind is as follows: Ku sri skyabs (1979: 37a): "In general, chu tshod is asserted to be small [for the occurrence of eclipse], but the two (= skar ma and chu tshod) are 0 (= the value of the difference between tshes 'khyud zla skar and sgra gcan gdong or mjug is too small), an eclipse does not occur. The chu tshod value (= the difference between tshes 'khyud zla skar and sgra gcan gdong or mjug) in the case of lunar eclipse is [comparatively] bigger [than the solar eclipse], but if [the value] is more than 58 in the case of gdong 'dzin (eclipse by sgra gcan gdong), and [the value] is over 55 in the case of mjug (mjug 'dzin, eclipse by sgra gcan mjug), an eclipse is not seen." (spyir ni chu tshod nyung bzhex kyang / gnyis ka stongs (sic. read stong) na 'dzin mi 'gyur / zla 'dzin chu tshod mang bzhex kyang / gdong 'dzin klu dbang (58) lhag pa dang / mjug la 'byung mda' (55) bsgral (sic. read bsgril) ba na / mthong bar gyur pa ma yin no / ). Sum pa Mkhan po and Ku sri skyabs's knowledge seems to be (or highly possibly) related to the empirical knowledge accumulated at that time.

\(^{153}\) Sum pa Mkhan po (1979: 181a) [= (1992: 546)].
Nevertheless, if you allege that it is fine because even if [the values of the lunar eclipse] do not appear in byed rtsis, the values of the lunar eclipse rise in grub rtsis, it is also unacceptable. It is not sufficient just by the occurrence of the values of the eclipse in terms of byed rtsis, grub rtsis, whatever, that night. The lunar eclipse should be certainly proved by real observation. If it is the case, even if the values of an eclipse such as those according to grub rtsis, there is no certainty, and surely being an eclipse, if it appears in the accurate byed rtsis, is established by direct perception also in the present. In addition to that, the statements made also by sagacious Ldum po Don 'grub dbang rgyal\(^{154}\) who is skilled in astronomy, the proponent of the Pad dkar zhal lung, and the Sde srid who is versed in five sciences, etc., that, byed rtsis, is accurate for deciding the occurrence of lunar eclipse and in the case of timing, mainly grub rtsis is accurate according with how things are.

His logic, as noted in the above passage, aims at the defense against Grwa phug pa’s second criticism. His aim is twofold as before: explaining the accuracy of byed rtsis and clarifying some problems in grub rtsis in terms of eclipse calculation. For that purpose, he raises the issue of observation. He claims that real observation is crucial and byed rtsis calculation results reflect real phenomena of an eclipse better than those of grub rtsis.\(^{155}\)

\(^{154}\) Ldum bu Don grub dbang rgyal (active in 17\(^{th}\) c.) is one of the excellent Phug pa scholars being contemporary with Dalai lama V. Samten Karmay (2014: 377): “Palgon Trinle had taught them (the instructions taught by the Phug tradition) to Lord Palseng. Lachen Trashi passed on this tradition to Dondrub Wanggyal, the foremost learned man in this field. So I listened to the latter about it in full detail.” Also, see Tshul khrimschos ’byor (1982: 29). Tshul khrimsrgyal mtshan (1986: 361): “Later, many scholars such as Gzhon nu don grub, the father of Zur chen chos dbyings rang grol (1604-1669) at Smin grol gling, Ldum po (bu) Don grub dbang rgyal, expert in astronomy from Lho kha gra nang, and Lu ’go bla mkhyen Ngag dbang, etc. appeared.” (rjes su smin gling zur chen chos dbyings rang grol gyi yab gzhon nu don grub dang / rtsis rig smra dbang lho kha gra nang gi ldum po don grub dbang rgyal dang / lu ’go bla mkhyen ngag dbang sogs phug lugs kyi rjes ’dzin mkhas shing mang ba byon te ...). For Ldum bu (po), see Smith (2001: 243): “There is absolutely no doubt that Ldum bu was the actual author of the Vaiḍārya dkar po and probably several other astrological works assigned to the authorship of the Sde srid.” For van der Kuijp’s legitimate counterview, see van der Kuijp (2013: 135, n. 45). For Lu ’go Ngag dbang, see below note 422.

\(^{155}\) Regardless of the real calculation practice that was being used in Sum pa Mkhan po’s time for the accuracy of eclipse calculation, his logic is not persuasive from the perspective of the lunar eclipse at the Buddha’s enlightenment. How can he observe the lunar eclipse at the Buddha’s eclipse, which happend long time ago? How can he guarantee that byed rtsis also worked better than grub rtsis at the time of the Buddha?
His stance giving credence to byed rtsis in terms of eclipse calculation is also dramatically read in the following.

Furthermore, although grub rtsis pa, based upon the Pad dkar zhal lung, indeed alleges that byed rtsis of others such as Bu ston, Mkhas grub, etc., is not accurate in whatever occasions of sun, moon, Rāhu, five planets are concerned, there are not many cases that are in accordance with observation, and especially, even the eclipse that is to be seen by all people here is far from accurate, according to grub rtsis. For example, as clarified in the previous myong byang (note on personal experience/observation) mentioning (the instance) that no lunar eclipse was predicted in the fifth month, the earth-hare year of the 11th rab byung (rab drag sa yos/1639 C.E.) in byed rtsis, but in the case of grub rtsis of the Pad dkar zhal lung, many grub rtsis scholars calculated according to the two methods, i.e., rough and subtle grub rtsis, predicted that there would be eclipse and put up the sgo yig (posters) at the monasteries of Se ra, 'Bras spungs, etc., in Lhasa, but did not occur, inaccurate occasions happen many times according to grub rtsis nowadays, too.

It is known from the above passage that the reason why Sum pa Mkhan po criticizes Phug pa grub rtsis and defends byed rtsis, including Bu ston, Mkhas grub, etc. is that eclipse calculations based upon the latter is more accurate than those based upon the former.

The fact that eclipse calculations by the former do not match up with real phenomena does not merely mean that the calculation system of the former is flawed. The

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156 Sum pa Mkhan po (1979: 184a) [= (1992: 556)].

157 This way of publicizing the calculation results to check their accuracy was customary in Tibet. See also Bstan ’dzin dpal ’byor (1987: 285) [= Bstan ’dzin dpal ’byor (1988: 238)].
fundamental stratum also lies in bstan rtsis: if an eclipse is not accurately predicted, how can the bstan rtsis based upon the lunar eclipse at the Buddha’s enlightenment be justified?

All in all, it is speculated that the essential reason why Sum pa Mkhan po refuses Phug pa’s bstan rtsis and accepts byed rtsis’s bstan rtsis is due to the correspondence between calculations and real phenomena in the case of the latter. Ultimately, his criticism toward Grwa phug pa is closely tied to the bstan rtsis in the Dga’ ldan rtsis gsar with new rtsis ’phro-s and stong chen’das lo where eclipse calculation is central and pivotal.158

RGYA RTSIS SUBSUMED UNDER RELIGIOUS FRAME

In Tshe tan Zhabs drung (2007b) written in the late winter of 1949 C.E. or early winter of 1950 C.E. (“winter in the earth-female-ox year”. T. sa mo glang gi lo’i dgun), Tshe tan zhabs drung follows the bstan rtsis of the Phug system, not that of byed rtsis. He has the same logic as used by his predecessors: yar (s)log gi rtsis.159

158 For this information, see chapter 4.

159 Tshe tan Zhabs drung (2007: 10): “The root quantity of the Kālacakra tradition established by Phug pa by backward calculation, regarding the lunar eclipse when the Buddha attained enlightenment, is not only unmistaken, it is also because the Buddha’s elapsed years are seen more accurate than others also when I calculated backwardly the root quantity by rgya rtsis (= Mā yang rgya rtsis).” (ston pa sangs rgyas pa’i dus kyi zla ’dzin la dus ’khor lungs kyi dhrur wa yar slog phug pas blood pa de gtsigs par ma zad / bdag gis rgya rtsis steng nas dhru wa yar slog bris pa’ang ston pa’i ’das lo gzhan las gtsigs par mthong ba’i dbang gis yin no / ). My interim rendering for “gtsigs pa” is “unmistaken/ accurate.”
He applied the skar rtsis religious concept and frame of bstan rtsis to the Mā yang rgya rtsis, which derived from Qing Chinese system for eclipse calculation around the 18th/19th century.\textsuperscript{160} By using Ser chen (1861), one of the Mā yang rgya rtsis texts, he verified the lunar eclipse at 927 B.C.E. (shing rta)/4/15, which is the date given by Phug pa. His calculation is as follows: \textit{lo dag pa} = 837 (1027 C.E. ~ 1863 C.E.\textsuperscript{161}) + 403 (tenth and eleventh Rigs ldan-s (S. Kalki) 624 C.E. ~ 1026 C.E.) + 1500 (877 B.C.E. ~ 623 C.E.) + 4 (Sucandra’s years 881 B.C.E ~ 878 B.C.E.) + 46 (927 B.C.E (the year of the Buddha’s enlightenment according to the Phug system) ~ 882 B.C.E.) = 2790 years.\textsuperscript{162} Zla dag = 34510, and \textit{mda’ ro lhag ma} = 20. The calculational results are as follows:\textsuperscript{163} The total eclipse (T. ril ’dzin) occurs. Timing is substracted from the standard Beijing time. The value of half-duration is 1 dus 50 thun 23 srang (24/60/60).\textsuperscript{164} The following table derives from the value.

\textsuperscript{160} For the raya rtsis (Mā yang rgya rtsis) calculation, see Tshe tan Zhabs drung (2007b: 403-13).

\textsuperscript{161} 1863 C.E. is chu phag which is the last (= 60\textsuperscript{th}) year according to Chinese calendar / Rgya rtsis. In “shing bya’i sngar lo chu phag nas” (2007b: 405), shing bya should be shing byi. Also it should be noted that Ser chen (1861)’s epoch is 1863/12/0 according to grub rtsis. It is speculated that Tshe tan Zhab drung used Ser chen (1861), not Mkhyen rab nor bu (1943) [= the version that Mkhyen rab nor bu changed Ser chen (1861)’s epoch (= 1863/12/0) into 1926/12/0].

\textsuperscript{162} Tshe tan Zhab drung (2007b: 405).

\textsuperscript{163} Tshe tan Zhab drung (2007b: 406ff. especially, 410-2).

\textsuperscript{164} Half duration = ‘dzin rdzogs mkho dus − ‘dzin mgo rtsom dus = grol zin dus − ‘dzin rdzogs mkho dus. The incorrect value 1 dus 50 thun 43 srang (for the correct one, see above) is given in Tshe tan Zhab drung (2007b: 410). The ‘dzin gtong yun tshod is given as a term to denote half-duration, but this is incorrect. It means a duration of an eclipse between the beginning (T. ‘dzin ’go / ‘dzin mgo. first contact) and the end
Table 5.

<table>
<thead>
<tr>
<th>Tshe tan Zhabs drung’s term(^{165})</th>
<th>Beijing time</th>
<th>Amdo time</th>
<th>Lhasa time</th>
</tr>
</thead>
<tbody>
<tr>
<td>first contact (’dzin mgo rtsom dus)(^{166})</td>
<td>4 dus 12 thun 18 srang</td>
<td>3 dus 22 thun 18 srang</td>
<td>3 dus 0 thun 8 srang</td>
</tr>
<tr>
<td>second contact (bsgribs ma thag dus)(^{167})</td>
<td>4 dus 17 thun 2 srang(^{168})</td>
<td>4 dus 27 thun 2 srang(^{169})</td>
<td>4 dus 5 thun 2 srang</td>
</tr>
</tbody>
</table>

(T. ’dzin gtong / btang zin. last contact). In this case, it is 3/40/46. The units dus, thun, and srang are the same with modern units: 1 hour (T. dus) = 60 minutes (T. thun / phun < 分), 1 minute = 60 seconds (T. srang).

It is because the Mā yang rgya rtsis is based upon the Chinese Lixiang kaocheng / Lixiang kaocheng houbian system which is / are the Chinese versions of Western Jesuit astronomy. For more information, see chapter 3. There are many typographical errors in the computerized Tshe tan Zhabs drung (2007b), as Tibetan astronomical texts are usually so, regardless of being ancient manuscripts/block prints or modern computer inputed version.

165 Roughly, a total eclipse is composed of five phases: first contact (T. ’dzin ’go / ’dzin mgo. (Mā yang rgya rtsis term). Ch. chukui 初虧), second contact: beginning of total eclipse (T. sgrib ma thag. Ch. shiji 食既), mid-eclipse (mid-totality. T. ’dzin rdozgs. Ch. shishen 食甚), third contact: end of total eclipse (T. mtha’ nas gso. Ch. shengguang 生光), and fourth (last) contact: end of the whole process (T. ’dzin gtong / btang zin. Ch. fuyuan 复圆). A partial eclipse is composed of three contacts: first contact (T. ’dzin ’go / ’dzin mgo. Ch. chukui), mid-eclipse (T. ’dzin rdozgs. Ch. shishen), last contact (T. ’dzin gtong / btang zin. Ch. fuyuan). Mongolian terms were used in Mongolian Shixianli (時憲曆) in Qing China: I could find following terms in jin (1992: 42): first contact: egüsgen γarumui, second contact in total eclipse: bari ğ u ket üremüi, last contact: dakin dügüreng. Because I have not secured the Monolgian Shixianli, I cannot present the terms in their entirety.

166 The Mā yang rgya rtsis term (see chapter 4) is ’dzin ma thag (’dzin ’go) gi dus tshod, which is a different term from Tshe tan Zhabz drung (2007b: 410).

167 The Mā yang rgya rtsis term is sgrib ma thag gi dus tshod which is basically the same. See Tshe tan Zhabz drung (2007b: 411).

168 The incorrect value 5 dus 10 thun 7 srang is given in Tshe tan Zhabz drung (2007b: 411).

169 The incorrect value 4 dus 77 thun 2 srang is given in Tshe tan Zhabz drung (2007b: 411).
Table 5 (continued)

<table>
<thead>
<tr>
<th></th>
<th>mid-eclipse ('dzin rdzogs mkho dus)\textsuperscript{170}</th>
<th>third contact (mtha’ nas gso dus)\textsuperscript{172}</th>
<th>fourth (last) contact (grol zin dus)\textsuperscript{173}</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>6 dus 2 thun 41 srang</td>
<td>6 dus 48 thun 20 srang</td>
<td>7 dus 53 thun 4 srang</td>
</tr>
<tr>
<td></td>
<td></td>
<td>5 dus 12 thun 41 srang</td>
<td>7 dus 3 thun 4 srang</td>
</tr>
<tr>
<td></td>
<td></td>
<td>4 dus 50 thun 41 srang</td>
<td>6 dus 41 thun 4 srang</td>
</tr>
</tbody>
</table>

The time difference between Beijing and Amdo is assumed to be 50 minutes, and that between Amdo and Lhasa 22 minutes (1 hour and 12 minutes in total).\textsuperscript{174}

Taken together, it has been crucial in the Tibetan astronomers’ rationalization of bstan rtsis-s to make the different Indic traditions and texts, i.e. the Kālacakra and some

\textsuperscript{170} The Mā yang rgya rtsis term is 'dzin rdzogs kyi mkho ba'i dus tshod, which is the same with Tshe tan Zhabz drung (2007b: 410).

\textsuperscript{171} The incorrect value 5 dus 14 thun 41 srang is given in Tshe tan Zhabz drung (2007b: 410).

\textsuperscript{172} The Mā yang rgya rtsis term is mtha’ nas gso dus, which is the same with Tshe tan Zhabz drung (2007b: 412).

\textsuperscript{173} The Mā yang rgya rtsis term is btang zin dus tshod, which is a different term from Tshe tan Zhabz drung (2007b: 411).

\textsuperscript{174} In the Mā yang rgya rtsis tradition, the calculated timing accords with Beijing time. Then, subtractions are made to calculate Amdo and Lhasa time as above. It seems that there have existed a few different values applied according to Huang and Chen (1987a). According to Huang and Chen (1987a: 412), the above method accords with that of Drung yig Thub bstan rgya mtsho’s (active in the 19th c.) Ma ha tsi na'i rang lugs 'ba' zhi g las 'ongs pa'i zla n'gyi sgrub rtsis 'jam dbyangs 'dzum zer. This text is not available to me. For the time differences indicated in the Mā yang rgya rtsis, see chapter 4.
Buddhist texts, compatible on the basis of the Kālacakra calculation method. Thereby, the Tibetan chronology based upon Buddhism (bstan rtsis) has acquired the new horizon, which was unprecedented in India. In its apex, eclipse calculation exists. It verifies the accuracy of a system on an astronomical level and simultaneously functions as the most pivotal criterium for the various bstan rtsis-s on a Buddhist level. It is a foundation stone on which skar rtsis, whose essential part is bstan rtsis in that the accuracy of bstan rtsis is a synonym for the accuracy of an astronomical system, stands firm. In that sense, many efforts to produce more accurate eclipse calculations have been made in Tibet. The ideas of and approaches to the issue of eclipse calculation were not restricted to skar rtsis. It is assumed that the Māyang rgya rtsis introduced to Tibet from Qing China can be understood from that perspective, given Tshe tan Zhabs drung (2007b). In other words, in both skar rtsis and the Māyang rgya rtsis, the notions on eclipse calculation are common on the astronomical and religious level.

\[175\] I have no information on whether the historical approach, which is based upon the concept that Buddhist texts have been created and formed during different time periods, has been made by Tibetan astronomers when they try to reconcile the chronologically different texts.
CHAPTER TWO

THE RITE OF CONFESSION (S. *POṢADHA* / T. *GSO SBYONG*)

1. *GSO SBYONG* DATE AND *ZHAG MI THUB* (S. *ÜNARĀTRA*)

Time measurement is closely tied to the observance of *Vinaya*, Buddhist disciplinary regulations. The rite of *poṣadha*¹⁷⁶ (P. *uposatha*, S. *poṣadha* / *upavasatha*, T. *gso sbyong*) epitomizes it. In it, monks confess offenses and chant the *Prātimokṣa sūtra*. The canonical basis of the ceremony is the *Poṣadhavastu* (T. *gso sbyong gi gzhi*) in the *Vinayavastu* (T. *'Dul ba gzhi*).¹⁷⁷ Hu-von Hinüber presents the following three categories in relation to the way of the performance of the *poṣadha*: date, number of participants, and


¹⁷⁷ For a general understanding of Buddhist ritual, see Kieffer-Pülz (2000). Time measurement in *vinaya* texts in general and with a focus on the *'Dul ba gzhung dam pa* (S. *Vinayauttaragrantha*) is found in Schopen (1998: 157-79, especially 176). For the location of the *'Dul ba gzhung dam pa* in the different xylographs of *Bka’*gyur, see Prebish (1994: 98-9).

In this manuscript, the first category, date, is the main concern. The three foundations of Vinaya (‘Dul ba gzhi gsum) are “the ceremony for restoring monastic vows (T. gso sbyong), the rules for the rainy season retreat (S. varṣa, T. dbyar gnas), and the ceremony at its end for lifting these rules (S. pravāraṇā, T. dgag dbye).”

For the second category, following Indian exemplary occasion is seen in a commentary written by Mtsho sna ba Shes rab bzang po (birth: 13th c.). According to Schuh (1973a: 8-9, n. 30), Tshe mchog gling Yongs ’dzin Ye shes rgyal mtshan’s (1713-1793) Rgyal bstan mdzes pa’i rgyan mchog phul byung nor bu’i phreng ba includes a short biography of him. Mtsho sna ba (2013: 72-3): “If it is the 15th lunar day for resident monks (S. āvāsika/ naivāsika. T. gnyug mar gnas pa) and it is the 14th or the 16th lunar day for non-resident monks (S. āgantuka. T. glo bur du lhags pa), one should follow the majority for the timing (of the gso sbyong ritual)...

If the number of resident monks and that of non-resident monks are the same, lam mthun pa (?) such as lunar day numbers is of resident monks. Furthermore, if resident monks performed gso sbyong and then, more non-resident monks say that it is the 15th for the next day the 16th, resident monks should also definitely perform gso sbyong. When the monks, whose one day passed after having performed gso sbyong on the 15th day in other places, suddenly come, the non-resident monks should definitely carry out gso sbyong if the resident monks whose number is the same with or more than the guest monks say that today is the 15th.”

The practice of gso sbyong in Tibet is based upon the Mūlasarvāstivāda Vinaya, which is the only Vinaya translated into Tibetan in the beginning of the 9th century.\footnote{182 For the Tibetan Mūlasarvāstivāda Vinaya, see Willemen, Dessein, and Cox (1998: 85-9), Prebish (1994: 84-113).}

**THE DATE OF GSO SBYONG AND ITS RATIONALE, ZHAG MI THUB**

In the case of gso sbyong, following two issues may be raised in conjunction with astronomy: deciding the date of gso sbyong and its relationship to eclipse. Firstly, as for the date in the gso sbyong, there are two occasions: cāturdayī (S. cāturdaśī) and pañčadasī (S. pañcadasī), i.e. the 14th day (gso sbyong bcu bzhi pa) and the 15th day gso sbyong (gso sbyong bco lnga pa) on a lunar fortnight basis respectively.\footnote{183 Upasak (1975: 53). For the fortnightly 14th or 15th day as the observance day in the Prātimokṣa sūtra of the Mūlasarvāstivādin (Tibetan tradition), see Prebish (1975: 46, 49). Especially, see Vogel (1997: especially 687).} Then, when is it held on the 14th? When the 15th? The following passage by 'Jam dbyangs bzhad pa I (1648–1721/1722) is a good summary of the gso sbyong dates.

\begin{verbatim}
'dir dus 'brel kyi gso sbyong nges can yod de / lo la zla bshol med dus zla ba bcu gnyis yod cing / zla ba re'i yar ngo dang mar ngo la gso sbyong re re yod pa'i phyir te / rtsa bar / zla ba phyed phyed kyi tshes bco lnga la'o / zhes dang\footnote{184 See Gunaprabha's auto-commentary to the 'Dul ba'i mdo (Vinayasūtra), 'Dul ba'i mdo'i 'grel pa mngon par brjod pa rang gi rnam par bshad pa (S. Vinayasūtravytityabhidhānasvavyākhyāna); Bstan 'gyur dpe bsdur ma, vol. 89: 959.} / dge slong gi lo dri bar / gso sbyong du yod / nyi
\end{verbatim}

\footnote{184 See Gunaprabha’s auto-commentary to the ‘Dul ba’i mdo (Vinayasūtra), ‘Dul ba’i mdo’i ‘grel pa mngon par brjod pa rang gi rnam par bshad pa (S. Vinayasūtravytityabhidhānasvavyākhyāna); Bstan ‘gyur dpe bsdur ma, vol. 89: 959.}
The Mongolian terms in the above table may be misleading: first, the Merged yard-yin oron renders _tha chung_ as _aday_; meanwhile, the Mongolian Mahāvyuttpattis render it as _ecīs_, which is not a problem in itself, but the rendering in the latter cause a problem in the following way: for the translation of _dgun smad_, which is one of the seasons based upon the Indian system, the Mongolian Mahāvyuttpattis still use the same terms, _ecīs_ or _aday_, as seen above. As a result, it is difficult to tell the Tibetan system from the Indian system just by the Mongolian renderings. Going back to the statement by Atiśa in the above quotation, the boldic font in the above table indicates the month in which _gso sbyong_ is performed on the 14th day. The dates specified

|-----------------------------------|----------------------------------|
| ra ba                             | S. _phaīguna_ T. _dp'yid zla ra ba_ (T. dhok) | S. _jyeštba_ T. _dbyar zla ra ba_  
[ML] qabur-un ekin sar-a  
[MT] qabur-un ekin utarakalaguni sar-a |
| _bring po_                       | S. _saγadha_ T. _dbyar zla 'bring po_ (T. chu stock) | S. _ašvini_ T. _ston zla 'bring po_  
[ML] jun-u dumda sar-a  
[MT] jun-u dumdadu burinsad sar-a |
| _thang_                          | S. _vaγsaksba_ T. _dp'yid zla thā chung_ (T. sa ga) | S. _kārttika_ T. _ston zla thā chung_ (T. smin drug)  
[ML] qabur-un ecīs sar-a  
[MT] qabur-un ecīs śoṣay sar-a |
| _aday_                           | S. _śrāvana_ T. _dbyar zla thā chung_  
[ML] qabur-un ecīs sar-a  
[MT] qabur-un ecīs śoṣay sar-a | S. _māγha_ T. _dgun zla thā chung_  
[ML] ebūl-un ecīs sar-a  
[MT] ebūl-un ecīs mag sar-a |
|                                   | S. _mrγaśirγa_ T. _dgun zla ra ba_  
[ML] ebūl-un ekin sar-a  
[MT] ebūl-un ekin margasw sar-a |
by Atiśa are identical with Vogel (1997: 687) presenting those of the Indian Mūla sarvāstivāda tradition, which is the only vinaya tradition introduced in Tibet. Also see Klong rdol bla ma Ngag dbang blo bzang’s (1719–1794) following table with a focus on boldic font in Klong rdol bla ma (1985: 50-1).

The way how nag rtsis pa (Tibetan nag rtsis astrologers) placed the beginning of the year before the calculations of Gtsang chung Chos grags rgya mtsho, Phug pa Lhun grub rgya mtsho, and Mkhas grub Nor bzang rgya mtsho, and the Sde srid Sangs rgyas rgya mtsho, etc. spread. (rgya mtsho nam gsum dang sangs rgyas rgya mtsho sogs kyi rtsis ma dar ba’i snga rol nas nag rtsis pas lo mgo ’dzin tshul)

<table>
<thead>
<tr>
<th>season (T. dus bzhi)</th>
<th>three spring months (T. dpyid zla gsum)</th>
<th>three summer months (T. dbyar zla gsum)</th>
<th>three fall months (T. ston zla gsum)</th>
<th>three winter months (T. dgu n zla gsum)</th>
</tr>
</thead>
<tbody>
<tr>
<td>month count (T. zla grangs)</td>
<td>11</td>
<td>12</td>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td>month name (T. zla ba’i ming)</td>
<td>stag</td>
<td>yos</td>
<td>‘brug</td>
<td>sburl</td>
</tr>
<tr>
<td>(T. ngy skar)*</td>
<td>mgo</td>
<td>rgyal</td>
<td>mchu</td>
<td>dbo</td>
</tr>
</tbody>
</table>

The table, which shows the equation between skar rtsis and nag rtsis in terms of month reckoning, looks not to evince any conflicting issues with the above Ishihama and Yumiko’s table. However, things may be more complex. Firstly, let me introduce Yum pa’s excellent research into the month-reckoning system: 1) The Sde srid’s Vaidūrya dkar po / Dharmaśrī’s Zla ba’i od zer present the following table.

Klong rdol bla ma (1985: 50-1) shows this equation. For example, dgu n zla ‘bring po is equated with dbyu gu zla ba (9th month).

2) Nag rtsis utpala sngon po’i do shal lugs kyi zla ba bcu gnyis are as follows:

<table>
<thead>
<tr>
<th>season (T. dus bzhi)</th>
<th>three spring months (T. dpyid zla gsum)</th>
<th>three summer months (T. dbyar zla gsum)</th>
<th>three fall months (T. ston zla gsum)</th>
<th>three winter months (T. dgu n zla gsum)</th>
</tr>
</thead>
</table>

81
pa 'byung dus yod de / dgun stod dang / dgun smad dang / dpyid stod smad dang / dbyar stod
dbyar smad drug la zla ba gnyis gnyis yod pas zla ba phyed gnyis 'das / phyed las pa'i mar ngo drug
la bcu bzhi pa re re ste drug dang lhag ma bco bryad bco lnga pa yin pa'i phyir te / mdzod 'grel las
/ dgun dang dpyid dang dbyar rnams kyi / zla ba phyed dang gnyis 'das shing / zla ba phyed ni lus

<table>
<thead>
<tr>
<th>month count (T. zla grangs)</th>
<th>12</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
<th>7</th>
<th>8</th>
<th>9</th>
<th>10</th>
<th>11</th>
</tr>
</thead>
<tbody>
<tr>
<td>month name (T. zla ba'i ming)</td>
<td>stag</td>
<td>yos</td>
<td>'brug</td>
<td>sbrul</td>
<td>rta</td>
<td>lug</td>
<td>sprel</td>
<td>bya</td>
<td>khyi</td>
<td>phag</td>
<td>byi</td>
<td>glang</td>
</tr>
<tr>
<td>(T. nya skar)</td>
<td>rgyal</td>
<td>mchu</td>
<td>dbo</td>
<td>nag pa</td>
<td>sa ga</td>
<td>snron</td>
<td>chu stod</td>
<td>gro bzhin</td>
<td>khrums stod</td>
<td>dbyu gu</td>
<td>smin drug</td>
<td>mgo</td>
</tr>
</tbody>
</table>

Some Tibetan scholars such as 'Bri gung Chos kyi grags pa (1595-1659), Mkhas mchog Karma Chags med (1613-1678), Dge rtse 'Gyur med bstan pa rgya mtsho (this one is 'Gyur med bstan pa rnam rgyal (1886-1952) who is the author of 'byung rtsis dpyad don rmad byung utpal sngon po'i do shal (TBRC accession number W25167)) are mentioned as those who followed the above method.

3) Nag rtsis nyer mkho bum bzang lugs kyi zla ba bcu gnyis are as follows:

<table>
<thead>
<tr>
<th>seasons (T. dus bzhi)</th>
<th>three spring months (T. dpyid zla gsum)</th>
<th>three sumer months (T. dbyar zla gsum)</th>
<th>three fall months (T. ston zla gsum)</th>
<th>three winter months (T. dgun zla gsum)</th>
</tr>
</thead>
<tbody>
<tr>
<td>month count (T. zla grangs)</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
</tr>
<tr>
<td>month name (T. zla ba'i ming)</td>
<td>stag</td>
<td>yos</td>
<td>'brug</td>
<td>sbrul</td>
</tr>
<tr>
<td>(T. nya skar)</td>
<td>mchu</td>
<td>dbo</td>
<td>nag pa</td>
<td>sa ga</td>
</tr>
</tbody>
</table>

This is Karma Ngads bs tan 'dzins (1700-?) system. — For him, see Sobisch (2002: 274). The nyer mkho bum bzang was written in 1732. See also Schuh (1973: 292). — If we look at the above tables given by Yum pa, we can easily recognize that first (T. ra ba), middle (T. 'bring), and last (T. tha chung) in each season are differently equated with nag rtsis and skar rtsis. For example, there are three possibilities for the dgun zla 'bring po (fixed as byi ba'i zla ba) in the case of skar rtsis: dbyu gu zla ba (9th month), smin drug zla ba (10th month), and mgo zla ba (11th month). Now, it is clear that the above Ishihama and Fukuda (1989), in which dgun zla 'bring po is equated with rgyal (12th month), causes a problem: which system are the Mongolian Mahāvyuttpattis based upon in terms of season? Are they Mongolian variations which accommodate Mongolian seasons? Or, are they based upon different manuscripts or traditions from the three raised by Yum pa? More research is needed. My point is that more broadly, in case that gso sbyong is reckoned just by season, we should be cautious. In that case, we should first investigate which system the author uses. Of course, if is reckoned according to / together with nya skar, the problem would not occur.
Here, there are 24 gso sbyongs at a fixed time (dus 'brel kyi gso sbyong). It is because, in this case, there is no leap month during a year, there are 12 months, and there is gso sbyong each in waxing (S. śuklapakṣa) and waning moon phases (S. kṛṣṇapakṣa) of each month. Because it is stated in the root text, “on the 15th day of half month each” and in the Dge slong gi lo dri ba, “how many gso sbyong?” “twenty-four: gso sbyongs in the waning phases of the middle month of winter (dagun zla 'bring po), the first and third months of spring (dyiyid zla ra ba / tha chung), the middle month of summer (dyiayar zla 'bring po), the first and third month of autumn (ston zla ra ba / tha chung) are gso sbyong on the 14th day. The others are the gso sbyong on the 15th day.” Because it is stated as such, there are times of gso sbyong on the 14th day and gso sbyong on the 15th day. Because there are two months each in the six seasons, i.e., early winter (dqun stod), later winter (dqun smad), early and late spring (dpvaid stod / dpvaid smad), early and late summer (dyiayar stod / dyiayar smad), [gso sbyong falls on], the 14th each in the six waning moon phases in which one and half months passed and the half remains, and the remainder 18 cases are the 15th. Because the Abhidharmakośabhāṣya states that if one and half months of winter, spring, and summer passed and half month remains, scholars omit the zhag mi thub (S. ānarātri / ānarātri) and the Shā tam (= Guṇaprabha’s

186 Vasubandhu (Dbyig gnyen), Chos mngon pa’i mdzod kyi bshad pa (S. Abhidharmakośabhāṣya), Bstan ’gyur dpebsdur ma, vol. 79: 383.


188 Kha che Mkhan po Na ra sa de ba (S. Narasadeva), Dge tshul gyi dang po’i lo (S. Śrāmaṇera varṣāgṛapṛcchā), Bstan ’gyur dpebsdur ma, vol. 93: 908.


190 Vogel (1997: 679) renders it as “a night less,” or “having a night less” with a good explanation of it: “as the lunar month has roughly 29\frac{1}{2} civil days and the civil day is taken in India to run from sunrise to sunrise, ānarātri could originally have been either the night wanting from the last day of the month or the last day of the month lacking a night.” However, his following indication is incorrect: “it [= Mālasarvāśīvāda Vinayavastu] offers the only instance found in Buddhist literature as yet of the term ānarātri serving to designate the missing 15th day.” It also appears when Vasubandhu explains about the synodic month in the Abhidharmarsh states. See de la Vallée Poussin (1869-1938) (1926: troisième chapitre, 180) [= English translation, Pruden (1988-1990: Vol. 2, 475, 541)]. The Chinese original text that de la Vallée Poussin used is as follows: Apidamo jushelun bensong (阿毘達磨俱舍論本頌 (CBETA, T29, no. 1560) translated by Xuanzang (玄奘 (602 ~ 664)). S. Abhidharmakośakārikā. / T. Chos mngon pa’i mdzod kyi tshig le’ur byas pa). The term appears in the

83
Every year, every three years, the difference becomes around 33.81195 days and makes two days shorter. The reason is because in the winter season in which the Earth is near perihelion (the nearest point to the Sun with 30 days). In other words, according to the synodic month, winter season is longer; summer season is shorter. As a result, the length of the synodic month becomes shorter. Thereby, the same phrase appears in T29n1560_p0315c12(00) and 18 cases are zhag on the 15th day, gso sbyong on the 14th day exists in which month: gso sbyong on the 14th occurs in the waning phases of rgyal, dbo, sa ga, chu stod, khrums, and smin drug, and because Dge slong gi lo dri ba states [in] the half month, the black part (S. kṣṇapakṣa) of

following way:
T29n1560_p0315c10(00) 十二月為年
T29n1560_p0315c11(00) 於中半減夜
T29n1560_p0315c12(00) 寒熱雨際中 一月半已度
T29n1560_p0315c13(00) 於所餘半月 智者知夜減

Further, the same phrase appears in T29n1560_p0315c12(00) translates by Xuanzang into Chinese (S. Abhidharmakośabhāṣya (Apidamo jushelun bensong, Chos mngon pa'i mdzod kyi bshad pa). It is the phrase Jam dbyangs bzhad pa I meant in the above passage. Of course, he meant the Tibetan Chos mngon pa'i mdzod kyi bshad pa. Pruden's (1988–1990: vol. 2, 475) translation of the above phrase: “When one month and a half of the cold, hot, rainy season has elapsed, the learned omit one ānarātra in the half-month that remains.” In it, it is verified that zhag mi thub is a rendering of ānarātra. “āna” means “short of the right quantity, fewer.” Its Tibetan rendering mi thub is faithful to the Sanskrit word. “rātra” means “night.” Xuanzang’s rendering ye (夜) is faithful to the Sanskrit word but may not be to Tibetan: “zhag” is “day,” not “night.” The second meaning given by Vogel “the last day of the month lacking a night” may work better for the Tibetan rendering, zhag mi thub. Regarding the etymology of this term, read also Vogel (1997: 679). The term may be literally rendered as “a night that is short of the right quantity.” The above phrase is related to the practice of posadha / gso sbyong inextricably tied to the motion of the moon, as de la Vallée Poussin (1926: troisième chapitre, 180) [Pruden (1988–1990: vol. 2, 541, no. 490)] points out. Let me add two things to reinforce his explanation in Tibetan context: first, the seasonal difference of the practice of gso sbyong. The length of the synodic month is around 29.53059 days (nyin zhag) in the case of Phug pa grub rtvis. On average, during winter season, there are more months with 30 days than those with 29 days; meanwhile, during summer season, there are more months with 29 days than those with 30 days. In other words, according to the synodic month, winter season is longer; summer season is shorter. The reason is because in the winter season in which the Earth is near perihelion (the nearest point (apside)), it revolves faster around the Sun. As a result, the length of the synodic month becomes longer. Meanwhile, in the summer season, in which the Earth is near aphelion (the farthest point), it revolves slower. As a result, the length of the synodic month becomes shorter. Therefore, ānarātra (zhag mi thub) occurs more in the summer season than in the winter season. This may lead to the seasonal frequency of the gso sbyong practice. Second, the close link between the gso sbyong interval and intercalation. The duration of the posadha makes 354 days in total because there are six cātuḍāsīs (6 × 14 = 84 days (T. nyin zhag) and 18 paṇjarasīs (18 × 15 = 270 days). As there are approximately 365.27065 days (nyin zhag) during a year in the case of Phug pa grub rtvis, there is around 11.27065 day difference (= 365.27065 − 354) every year. Every three years, the difference becomes around 33.81195 days and make two paṇjarasīs, with 3.81195 days still remaining. The remainder is also accumulated and becomes another intercalary month. The quantity 354 means the approximate length of the lunar year, i.e., 354 ~ 355 days, 383 ~ 385 days in case that there is an intercalary month (S. adhikamāsa/ adhimāsa).
these rgyal, dbo, sa ga, chu stod, khrums smad, and smin drug\textsuperscript{191} [exists] the gso sbyong on the 14\textsuperscript{th} day ... .

Being based upon the Indic Mūlasarvāstivāda texts, gso sbyong is performed on the 14\textsuperscript{th} day (six times) and on the 15\textsuperscript{th} day (18 times) a year in Tibet. There are 24 times a year in total. As seen above, a rationale Tibetan scholars use for the difference between 14\textsuperscript{th} day and the 15\textsuperscript{th} day for gso sbyong is ūnarātra (zhag mi thub), which appears in the Abhidharma texts.

Using the concept to explain the dates of gso sbyong looks unprecedented in India, albeit it is a relevant concept to gso sbyong in terms of day-reckoning in Indian lunar calendrical system.\textsuperscript{192}

Next, how the concept was used in relation to gso sbyong in Tibetan context is as follows. In Tibet, zhag mi thub\textsuperscript{193} has been understood to be related to the difference

\textsuperscript{191} For this information, see Bod rgya tshig mdzod chen mo (2000: 3029). For the ordinal numbers of the above six months in the Tibetan skar rtis system which fixes the third month as nag zla, see Lcang skya III et al. (1982: 51-2), Lcang skya III et al. (2002: 1174-8): zla ba gnyis pa (qoyaduyar sar-a): dbo zla (udarabalguni sar-a < S. uttaraphālguṇī / phālguṇa), zla ba bzhi pa (dūtīg sar-a): sa ga zla ba (sege / saga sar-a < S. vaśākha), zla ba drug pa (jiyuaduyar sar-a): chu stod can (burwasad < S. pārvāśādhā / āśāḍha), zla ba bragad pa (naimaduyar sar-a): khrums zla (= khrums smad) (burwabradrapad < S. bhāḍrapada), zla ba bcu ba (arbaduyar sar-a): smin drug zla ba (kirdig sar-a < S. kārttika), zla ba bcu gnyis pa (arban qoyaduyar sar-a): rgyal zla (bus / būs sar-a. < S. pusya). See also Schuh (2012: 1647-8).

\textsuperscript{192} Vasubandhu’s original meaning of zhag mi thub is related to the length of the synodic month and lack of day on a yearly/monthly basis. In Tibetan context, the logic has been applied to explaining the gso sbyong, which is practiced on a fortnightly basis. Especially, it has been used to provide a rationale for the gso sbyong bcu bzhi pa (gso sbyong on the 14\textsuperscript{th} day). As Vogel (1997: 678) clearly mentions, “poṣadha always fell on full-moon or new-moon day,” the accuracy of lunar calendar has been proved by the instances of the gso sbyong bcu bzhi pa. The clear-cut recognition of the difference between tshes zhag and nyin zhag in Tibet is also evidenced by them.

\textsuperscript{193} This concept is based upon zhag gsum rnam dbye (the distinctions of three types of day) (see Bsam ’grub rgya mtsho [2011: 52-4]). For easy understanding, in the case of one day, nyin zhag is composed of 60 chu tshod, tshes zhag ranges from around 54 to around 64 chu tshod, and khyim zhag is around 1,015 nyin zhag. For more information, see below pp. 193-4 and note 508. The logic of zhag mi thub concerns the relative length of tshes zhag and nyin zhag: in case that tshes zhag is more than 60 chu tshod [= longer than nyin zhag], it is
between tshes zhag (S. saura dina) and nyin zhag (S. sāvana dina). For example, Dge 'dun grub (1391–1474) explains why the 14th day (nyin zhag) falls on the 15th day (tshes zhag) by citing Dharmamitra (early 9th c.).

By saying the 15th day, the 14th day is also subsumed: it is stated in the Tikā, “because like this, [ ] lacks one day from being suitable whatever day from 1st to 15th [is concerned], generally 14 days exist. Because of that, from the perspective of lay people, Bhagavān also says gso sbyong on the 14th day in the Pratimokṣa sūtra, but actually, it is because lacking a day in whatever day of the phase of the moon is to leave it as empty space, but it does not lack in the day on the day of gso sbyong, the day called gso sbyong on the 14th day is the 15th day.”

Although he relies on the Indic texts (Guṇaprabha’s 'Dul ba'i mdo / Dharmamitra’s 'Dul ba'i mdo'i rgya cher 'grel pa), it is not likely that Guṇaprabha and Dharmamitra explained the different dates and lack of day in relation to gso sbyong. His explanation for the difference called zhag thub; in the case that tshes zhag is less than 60 chu tshod [= shorter than nyin zhag], it is called zhag mi thub.

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194 Dharmamitra (T. Chos kyi bshes gnyen), 'Dul ba'i mdo'i rgya cher 'grel pa, Bstan 'gyur dpe bsdur ma, vol. 91: 267.

between *nyin zhag* and *tshes zhag* as a ground for *zhag mi thub* is more concrete and
definite in the following passage:  

nyin zhag las tshes zhag yud tsam phyed phyed kyis myur bar 'da' bas tshes zhag drug cu song ba na nyin zhag nga dgu yin pas zhab mi thub pa zhes bya'o / tīkkar / nyi ma gcig chad pa de nyid sa stong du dor bar zad ces pa dang / nyi ma de nyid tshes bco lnga pa yin pa'i phyir ro / zhes dang / ...  

Because *tshes zhag* is a little faster than *nyin zhag* by half of half, 59 *nyin zhag* passed in case that 60 *tshes zhag* passed.  

Therefore, it is called *zhag mi thub pa*. It is stated in the *Ṭīkā* that it is because lacking in a day is to leave as empty space and the very day is the 15th.

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196 Dge ’dun grub’s above passage may be the earliest evidence that mentions *zhag mi thub* in terms of *gso sbyong*. The term *ūnarātra* (= *zhag mi thub*) in *Abhidharma* literature was commentated on by Tibetan commentators from early period. However, I think that we should check whether there exist pre-15th century examples that clarify the difference between *tshes zhag* and *nyin zhag* for the explanation of *gso sbyong*. I am skeptical that the Indic term *ūnarātra* had been used in relation to the practice of *posadha*. If my conjecture is justified, the logic of *zhag mi thub* applied to *gso sbyong* may be a good example by which the Tibetan interaction between astronomy and religion is read because the use of the concept may be related to the full-fledged development of the concept of day, *zhag gsum rnam dbye*. For the *zhag gsum rnam dbye* and its development in the 15th century, see above note 13.

197 Dharmamitra, *Dul ba'i mdo'i rgya cher 'grel pa, Bstan 'gyur dpe bsdur ma*, vol. 91: 267.

198 Dharmamitra, *Dul ba'i mdo'i rgya cher 'grel pa, Bstan 'gyur dpe bsdur ma*, vol. 91: 267.

199 Dge ’dun grub (1999: 450).

200 See above note 193.

201 Dge ’dun grub (1999: 450).
In his exegesis, gso sbyong is basically gso sbyong on the 15th day (tshes zhag), and gso sbyong on the 14th day is actually gso sbyong on the 15th day because the 14th day (nyin zhag) is the 15th day (tshes zhag). Taking other examples using the same logic, Blo gros legs bzang (16th c.), who was the 9th khri rabs at the monastery of Bkra shis lhun po and was Legs pa don grub’s (1479-1555) student, writes,

The 14th gso sbyongs are the 14th gso sbyongs because they reached the 15th tshes zhag from the previous 15th day passed, but it did not get out of the 14th nyin zhag (= still the 14th nyin zhag), and it is because a gso sbyong at the time when it reached the 15th nyin zhag from the previous gso sbyong passed is said to be gso sbyong on the 15th day. ... It is because it is said to be gso sbyong of mi thub pa by the reason that it is gso sbyong relying upon not being able to substitute for nyin zhag by tshes zhag. ... However, gso sbyong on the 14th days are gso sbyong on the 15th day in terms of tshes zhag, ... Because Vimalamitra’s So sor thar pa’i rgya cher ’grel pa bam po lnga bcu pa states that all are the 15th day with respect to the accuracy of date, therefore, in the case of gso sbyong on the 15th day, it is necessarily gso sbyong on the 15th day in terms of nyin zhag. The peculiarity of the two gso sbyongs is due to arranging them with respect to nyin zhag.

It is verified again that there are two occasions: gso sbyong on the 14th day (nyin zhag) and gso sbyong on the 15th day (nyin zhag). The day reckoning for the nomenclature of gso
sbyong is according to nyin zhab. If the difference between tshes zhab and nyin zhab is taken into account, all the gso sbyong-s fall on the 15th day (tshes zhab). To take another example, Paṇ chen Bde legs nyi ma (16th c.) explains it in the same manner with Legs pa don grub.

Well, then, if you ask what is the reason why all gso sbyong-s are not 15th or the 14th (also) occurs, there is: it is because gso sbyong on the 14th day occurs because nyin zhab cannot be substituted by tshes zhab, and because the time when gso sbyong on the 14th day occurs is the 15th tshes zhab but is the 14th nyin zhab, ... .

Again, there are two possibilities for gso sbyong: 1) gso sbyong bco bzhi pa: 14th nyin zhab, but 15th tshes zhab, 2) gso sbyong bco lnga pa: 15th nyin zhab and 15th tshes zhab. In both cases, gso sbyong is held on the 15th tshes zhab. In the first case, nyin zhab is longer than tshes zhab.

There are two issues to think about regarding gso sbyong practice in Tibet: First, applying the difference between nyin zhab and tshes zhab to explain the gso sbyong on the 14th day (nyin zhab) apprears to be a Tibetan indigenous interpretation even if Tibetan scholars cited Indic texts. In fact, I have not found the instance in Indic texts directly relating ānarātra to poṣadha. The issue is open to Indologists. Second, in conjunction with the first issue, in the Tibetan interpretation of zhab mi thub, the length of the lunar month according to the planetary movement, which was meant originally in the Indic texts, may

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204 Paṇ chen Bde legs nyi ma (2011: 141).
not be the concern for the observance of gso sbyong in Tibet. Rather, a focus may have been given to the accuracy of tshes zhab: the claim that all the gso sbyong dates fall on the 15th when being counted by tshes zhab is possibly the expression of the confidence in the skar rtsis system. Tibetan scholars have paid attention to the logic of zhab mi thub in order to justify the accuracy of tshes zhab buttressed by the accurate skar rtsis system. Then, why the accuracy of tshes zhab matter? It may be related to the fact that the accurate tshes zhab is a minimum requirement for skar rtsis to be accurate. Also, in the Tibetan religious calendar, the tshes zhab reckoning has religious implication. For example, calculating correct full-moon days according to tshes zhab is crucial for religious life in Tibet.

2. A SURVEY OF LATER PERIOD PRACTICE OF GSO SBYONG WITH RESPECT TO AN ECLIPSE: YUL BSTUN GSO SBYONG (GSO SBYONG IN CONFORMITY WITH REGION)

RGYA RTSIS DATE AND YUL BSTUN GSO SBYONG

Sum pa Mkhan po (1979c) includes letter exchanges three times with an astronomer named Ngag dbang nyi ma. In the letters, local unfolding of vinaya with respect to eclipse in 18th century Amdo is understood. It is also understood that, with the emergence of the Chinese calendar, the practice of gso sbyong took a new turn. The second

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205 In the third letter to Ngag dbang nyi ma in Sum pa Mkhan po (1979c: 95b), Ngag dbang nyi ma is identified as “sku ’bum pa rab byams sde snod ’dzin pa” (“universally learned holder of the tripiṭaka at Sku ’bum”).
exchange of letters in 1785/1786 shows Ngag dbang nyi ma’s questions on gso sbyong date in relation to the Chinese date.

Also, is it possible that the solar eclipse occurs on such a day as the first rgya rtsis day of the seventh hor zla and thereafter, the lunar eclipse occurs on the fifteenth rgya rtsis day due to the absence of the lunar day? If possible, gso sbyong on the fifteenth day is performed at that time? In the same way, if the solar eclipse occurs on the new moon day of the seventh hor zla, is the date new moon day of Vinaya tradition or not? If it is, how to deal with the statement that gso sbyong should not be performed because of zhag mi thub on the thirtieth day in the three basic monastic rites (T. gzhi gsum cho ga)? If not, because nothing is appropriate other than the twenty-ninth, will it be the case that the occurrence of the eclipse on the twenty-ninth becomes possible in Vinaya tradition?

His letter reflects the situation that the different date between skar rtsis and the Chinese calendar causes confusion in the Indian vinaya practice in monasteries in Amdo. The recognition must have derived from the observation that solar eclipses occasionally occurred according to Chinese date, not according to skar rtsis one.

Sum pa Mkhan po’s answer is as follows:

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206 Sum pa Mkhan po (1979c: 90b).

207 Chinese lunar calendar is focused on calculating the new moon day (shuo 朔) (the Sun, Moon, and the Earth are aligned) which falls on the 1st lunar day. A solar eclipse occurs only on that day. The full moon day (wang 望) (the Sun, the Earth, and the Moon are aligned) is not always 15th lunar day, and it may be the 16th or 17th. A lunar eclipse occurs on the full-moon day. Meanwhile, Tibetan lunar calendar is focused on calculating the full moon day which falls on the 15th tshes zhag. Thereby, a lunar eclipse always occurs on the 15th tshes zhag, but a solar eclipse may not always occur on the 30th (tshes zhag). — Of course, timing corrections have been made for eclipse calculations possibly on the basis of empirical data. — For example, a solar eclipse occurred in some areas of East Asia on 1786/1/1 (according to the Qing Chinese lunar
... skar rtsis nyin zhag ltar dang rgya rtsis ltar ni rags la / tshes zhag ltar ni zhib pa dris lan snga mar dang ’og tu’ang smos ltar dang / khyad par du ’dul luangs la’ang rags zhib gnyis mod de / bcom ldan ’das rgya gar du zhal dngos thun mong njor bzhugs dus su/ dge slong rams kyi thog mar zla re’i yar ngo mar ngo’i nyi shu (sic. maybe nyi shu rtsa bzhis) dang zhag mi thub zla bshol ji bzhin brtsi pas gzhan kyi s’hyas pa na lo rer rang sangs rgyas kyi bkas lo drug rer zla bshol bton pa ni rags rtsis yin kyang / de dus su dus ’brel ayi gso sbyong dbyar khas len dgaag dbye yang yang mzdad pa dang / phyis su de dag yul spyi’i zhag zla brtsi tshul dang ma mthun pas kan gyis ’phya pa na / bcom ldan ’das kyi snyid brag bram ze ’phya ba ’i gus te / rgyal po’i gzhung dang skar rtsis ba’i rjes su ‘brang bar bya’o / zhes gzhung dam pa bam po sum bcu pa sogs las gshungs pa ni 209 skar rtsis lta bu zhib rtsis ltar yang rung bar gsung la / de ltar na yul gang du’ang zla zhag brtsi tshul dang ’dul ba’i lag len ni ji ltar grags pa de ltar bya rung njam snyam / des na ... 210 dang mdo kham kyi yul ’dir yang ’dul ba yul dus dang bstun dgos zhes pa ltar bod kyi sgar rtsis la chad lhag ji bzhin bton pa zhib pa ltar deng sang dbus gtsang du de ltar byas pa zhaq (sublinear note : 04 ?) la nor (sublinear note : 15) ’khrul med pas lags la / yang rgya nag dang ’dab ’brel bar nye bas rgya’i rgyal po’i luangs dang ’byung rtsis ni skar rtsis las cung zad rags kyang de dang mthun dgos pa’i a mdo’i yul ’di lta bur de dang bstun nas dugs ’brel gso sbyong bya rung bar khums / 211
calendar). — For the occurrence, see below note 527. — The date also falls on 1786/1/1 according to Phug pa grub rtsis calendar. Because the solar eclipse occurred after nam langs (according to Tibetan time), it was certainly 1/1. — The solar eclipse was calculated by A kya; see Chapter 4. For the religious issues of the solar eclipse on 1786/1/1 pertaining to gso sbyong, see below note 248. — The disagreement between lunar date and an eclipse is related to the fact that the synodic month is around 29.5 days, not 30 days (civil day).

208 Sum pa Mkhan po’s answer is wide off the mark in this letter: he does not specify which skar rtsis (or rgya rtsis) date is appropriate or inappropriate for gso sbyong. It seems that he just has overall sense of the practice of gso sbyong, which accommodates both Indic skar rtsis and Chinese rgya rtsis with a great focus on the former. Of course, we can understand from his answer that he also admits gso sbyong cannot be followed strictly according to skar rtsis, as frequently evidenced by the occurrence of eclipse. As for the answers for the Ngag dbang nyi ma’s questions, we may be able to Sum pa Mkhan po (1979c: 79a-79b) in the first correspondence and Gser tog (1982: 234): they are based upon the same idea, which may mean that their ideas and approaches were widespread at that time. In conjunction with this, it should be stressed that the problems raised by Ngag dbang nyi ma may be also common religious issues at that time in Amdo. We may be able to see more evidence through textual study.

209 The story is seen in the ’Dul ba Gzhung dam pa, Bka’ ‘gyur Dpe bsdur ma, vol. 13: 165-70.

210 illegible.

211 Sum pa Mkhan po (1979c: 93b-94a).
That which [day reckoning] is rough according to nyin zhag of skar rtsis and rgya rtsis and [day reckoning] is accurate according to tshes zhag is as said in the previous reply and (will be said) below, and especially also in Vinaya tradition, there are two, rough and subtle, but the statements in the Gzhung dam pa (S. Uttaragrantha) section 30 (bam po sum bcu pa), etc. that "when Bhagavān stayed in India in person among ordinary people, monks firstly calculated 20 (maybe 24?) waxing/waning phases of each month, zhag mi thub, leap month as they are and then were blamed by others, placing the leap month every six year annually by Pratyekabuddha’s words is the rough calculation (raqs rtsis), but he performed gso sbyong at a fixed time, accepted summer retreat, performed dgag dbye at that time, and when [he] was blamed later by all because those did not accord with the way of calculation of day and month of the region, Bhagavān accommodated the blame by the householders and Brahman, and spoke that Rgyal po'i gzhung (?) and skar rtsis should be followed” is spoken appropriately also according to accurate calculation (zhib rtsis) such as skar rtsis, etc., and if it is the case, I think that it would be appropriate that, in whatever place, reckoning of month, date, and practice of Vinaya should be made according to those known. Then, I think that in ... and in Mdo kham here also, as is said that [the practice of Vinaya] needs to tally with regional time (yul das), it is good because the practice made nowadays in Dbus gtsang according to the fine one, which is that lhag chad is placed according to Tibetan (bod) skar rtsis, is unmistaken in reckoning days and also, although Chinese Emperor’s tradition and 'byung rtsis are a little more rough than skar rtsis, it is suitable to perform gso sbyong at a fixed time by tallying with them in Amdo, etc., where […] need to tally with them due to the proximity to China.

Different dates between skar rtsis and the Chinese calendar and the relevant problems in the performance of gso sbyong caused by them are clearly depicted in the above letter. In response to Ngag dbang nyi ma’s questions on the timing of gso sbyong caused by the Chinese calendar, which was being used in Amdo, Sum pa Mkhan po provides a solution based upon the Indian Buddhist Vinaya text Uttaragrantha: with it, he justifies his suggestion of yul bstun gso sbyong (gso byong in conformity with region). It should be also noted that, even if he argues for the idea of yul bstun gso sbyong, he does not argue that

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212 Another evidence that the Qing Chinese day-reckoning system different from that of Tibetan calendar was being used in determining the date of gso sbyong in the 18th century Amdo is seen in the biography of Thu’u bkwan III. Thu’u bkwan III’s activity in Dgon Gsar thar pa gling in Amdo one time at the age of 47 (1783 C.E.) conveys the following information. Gung thang Bstan pa’i sgron me (1992: 383): “... [For] eighteen gso sbyong on the 15th days and six gso sbyong on the 14th days during a year, the unmistaken and unbroken counting method of the number of nyin zhag after tallying with rgyas rtsis of the regional tradition (T. yul lugs) is needed and ... ” (lo gcig la dus ’brei gyi gso sbyong bco lnga bco bragad dang bcu bzhi ba drug mnams yul lugs kyi rgya rtsis dang bstun nas nyin zhag gi grangs rtsi tshul ma nor zhing ma chad pa dgos pa dang /.... ).
skar rtsis is problematic. Rather, he holds that skar rtsis is more accurate than Chinese calendar in terms of day reckoning in Dbus gtsang, and the fact that skar rtsis does not accurately reflect date in Amdo is due to regional difference. Here again, it is verified that Tibetan astronomers find whatever possible rationale for conflicting and contesting sources in a way of being compatible with skar rtsis / the Kālacakra.

RELIGIOUS RITUAL AND LUNAR AND SOLAR ECLIPSES

Before tackling the relationship between gso sbyong and eclipse, let me tackle the religious meaning of eclipse with a focus on the 18th century context. Eclipse is a crucial part of religious practice in Tibet, and the observance of Buddhist ritual has been made according to an eclipse. It may be due to Tibetans’ belief in the increase of merit in the case of religious practices performed during an eclipse.

The ideas are found in Tibetan texts including rtsis, lo rgyus, rnam thar, etc. As an example, Dalai lama V performed the following religious ritual upon the lunar eclipse in 1656: “On the 15th, there was an eclipse, and I intended to practise the violent rite of Mashi (Mashin) from the 11th by entering into a strict retreat and beginning to recite the mantra of Jamkar (T. 'Jam dbyangs dkar po).”213 Another example: Gung thang Bstan pa’i

sgron me records Thu'u bkwan III’s performance of the sādhana at the age of 57 (water-female-ox year (chu mo glang 1793 C.E.)/7/15) at Mchod rten thang bkra shis dar rgyas gling (Ch. Tiantangsi 天堂寺) upon the occurrence of the lunar eclipse in the following way.

Upon the occurrence of the eclipse at night, although he constantly performed special sādhana, the existence of diligently performing special sādhana whenever each eclipse occurs is: as is stated by Rang byung rdo rje’s inner meaning that if white and red life sustaining winds (T. srog rlung) are connected, the lunar and solar eclipses occur, [eclipse is] the way of agreeing with external and internal dependent origination and the appearance of the multiplication of virtue due to that, i.e., the intended meaning of many unsurpassable Tantra sections such as the Kālacakra and others, and as is also stated in Gsang ba spyi rgyud (*Sāmānyaguhyatrantra) that the sun and moon was held by Rāhu, the great wondrous sign occurred and [...] should write maṇḍala with great concentration in the miraculous moon, Thu'u bkwan said that [the occurrence of eclipse] is the extraordinary time of great progress.

Another example is seen in Phyag mdzod. Also, Rdo ring pa Bstan 'dzin dpal 'byor (1760 ~ ?) dramatically shows the meaning and significance of an

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214 ‘gyur / bsgyur’ means ‘times, multiple.’ ‘khyad’ means ‘difference, uniqueness.’ So, ‘dge ba’i ‘gyur khyad’ means ‘the uniqueness of multiplication of virtue’. Simply, Tibetans believe that when one practices on the occasion of an eclipse, the virtue is multiplied.


216 Huang and Chen (1987: 37).
eclipse in Tibet on a religious and technical level. He calculated the values of the lunar eclipse in 1776.

Because the value of total eclipse by the head of Rāhu to the moon arises in the feast dpal lha'i ri rab kyi dus ston (= a religious festival) at night on the 15th day of the 10th month, I drew the steps of the shapes (the picture of the moon and Rāhu) and the 3 (?) on the poster of the moon and Rāhu. Upon my posting the poster with an extensive explanation regarding the way the moon was eaten by Rāhu which agrees with the intended meanings of the lustrous Kālacakra through the outer, inner, and other realms (phyi nang gzhan gsum) in a profound and vast way [by means of] such as poems of snyan ngag, etc. and vividly [by the picture] on a narrow point of the main gate of the yard of the Jo khang, Lhasa, everything such as earlier (?) timing of the occurrence of the eclipse, magnitude, size, direction, etc. occurred very accurately like the unmistaken poster, and in this occasion, Phur lcog sprul sku rin po che (Phur bu lcog 2 Blo bzang byams pa (1763–825)) and I, together in Rdo ring, [the tantric practice] related to the self generation of the physical form of white Mañjuśrī of Ma ti tradition/ method (tantric practice ?), in reciting

217 The chu shel dbang po refers to the moon. And seng ge mo'i bu (M. ülügčin arslan-u kübegün) refers to Rāhu. See Lcang skya III et al. (2002: 1195).


219 gdong ’dzin.

220 The sentence is not understandable in some respects. I have no idea what “gsum” here means. Something may be missing.
mantra, visualizing, and nurturing by relying upon the practice of pea from the beginning of the lunar eclipse before the termination of it, ... 

The lunar eclipse (1776/10/15 = November 25, 1776) was successfully predicted, and the tantric practice was arranged. In the same manner with the case of Dalai Lama V, the mantra of white Mañjuśrī was recited and white Mañjuśrī was visualized. The description for a solar eclipse which he predicted to occur in 1776 reads as follows:

\[
\text{de rjes gnam stong la yang nyi 'dzin gyi ri mo zhiq 'char gyi 'dug stabs / nyi mar sgra gcans mjug 'dzin yong tshul gyi sgo yig zhiq bris par dge rgan 'gyur med rnam rgyal lags}^{221} \text{ nas / zla 'dzin gyi ri mo las nyi 'dzin 'di lta bus ma thiss tsam yong gi 'dug pas brtan po gyis zhes gsungs byung 'phral la blo the tshom du gyur kyang / ...}^{222}
\]

After that, because the value of solar eclipse appears also on the new moon day, upon my posting the poster which describes the occurrence by Rāhu's tail to the sun (mjug 'dzin), my teacher 'Gyur med rnam rgyal said, “do carefully because the value of solar eclipse is more inaccurate than that of lunar eclipse” I immediately became doubtful.

As doubted by him, no eclipse occurred.\(^{223}\) And then,

\(^{221}\) His teacher 'Gyur med rnam rgyal is the teacher of Lha rigs dga' ldan dbang phyug dpal 'ba, the father of the present head of the monk at Smin grol gling, Rgya ri ba'i Zhabdrung Khri Rinpoche. For the information, see Bstan 'dzin dpal 'byor (1987: 284) [ = Bstan 'dzin dpal 'byor (1988: 237)].


On that day, everyone opened mouth and looked over the sky. Although I pretended (humble way of saying) to calculate accurately without a mistake, (by using) the method of nur ster for Rāhu, east and west, height of mountain, the sun of summer and winter, territorial peculiarity, the tradition of spor thang rtsis, etc, whatever, errors in the value occurred by hands, or because the young man (= I) wrote in the manner of boasting knowledge without calculating by pure motivation to exhort sentient beings to act virtuously, in order for some Yogis who know the mind of other people and attained mastery over prāṇa-mind to conquer my arrogance of bragging about knowledge, [they] hooked yellow downward-clearing wind (S. apana vāyu / T. thur sel gyi rlung), the nature of the sun, and white upward life sustaining wind (S. prāṇa vāyu / T. srog dzin rlung), the nature of the moon, together in the central channel (S. avidhūti / T. rtsa dbu ma) in the way of two vases being jointed together, etc. in whatever case.

The relationship between eclipse and religious practice within a broader frame is seen again. An eclipse has a close tie with tantric practice.

The religious aspect and concern on the occasion of an eclipse is also related to the practice of gso sbyong, which is one of the religious rituals in Tibet. Most of all, due to that, eclipse calculation and prediction were necessary for religious practice. Next, let me

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224 For spor thang rtsis, see Macdonald (1963: 74) introduces Thu’u bkwan III’s opinion on spor thang rtsis; Geshe Lhundub Sopa (2009: 334): “Chinese divination translated into Tibetan during the Tang dynasty.”


226 The above considerations look common at that time. This will be also mentioned below in chapter 4. In essense, they are those that can be devised within the Kālacakra astronomy. When being juxtaposed with the Mā yang rgya rtsis (see chapter 4) which is based upon modern trigonometry, it is easily known that they cannot be fundemental solutions for the increase in the accuracy of solar eclipse calculations.
narrow down to \textit{gso sbyong} with a focus on eclipse in the following section. I will illustrate the emergence of the Chinese calendar in Amdo and its influence on the traditional concept of \textit{zhag mi thub}.

\section*{Relationship between \\ \textit{gso sbyong} and solar and lunar eclipses and the Chinese date}

In \textit{skar rtsis}, the date of a lunar eclipse is fixed as the end of the 15\textsuperscript{th} \textit{tshes zhag} and that of solar eclipse is fixed as the end of 30\textsuperscript{th} \textit{tshes zhag}. Further, eclipses occur nearly on the same day with \textit{gso sbyong}. Therefore, if an eclipse occurs on a different date, it may cause a problem with the integrity of the \textit{skar rtsis} system and ultimately, a threat to the cooperative system between \textit{Kālacakra} and \textit{Vinaya} because \textit{gso sbyong} is buttressed by \textit{Kālacakra}-based calculational \textit{skar rtsis} and the Buddhist texts of disciplines, and ritual practice according to \textit{Vinaya} will not be performed properly in that case. The point will be mentioned in the following.

First, let me begin with the situation in which eclipse timing (\textit{gza'} value) was not calculated accurately in Amdo in the 18\textsuperscript{th} century by using Sum pa Mkhan po.

\ldots zla gling ni mtshan mo zla 'dzin dus su lta byed dang / nyi gling ni nyin mo nyi ma 'dzin dus su lta byed yin pas / ... shing 'brug lo'i drug pa'i stong gi nyi 'dzin ... nyin de'i re (sic.) gza'i chu tshod ni tshes (15) bsres pas nyer gcig byung bas tho gling dbus mar 'dzin par shar ltar ro / \'on kyang
Because the moon (T. *zla gling*) is used in the observation in lunar eclipse at night and the sun (T. *nyi gling*) is used in the observation in solar eclipse during daytime,... the solar eclipse on the thirtieth day in the sixth month of wood-dragon year (1784 C.E.)... the eclipse occurs in the center of the southern continent since twenty-one \([chu tshod]\) occurred by adding fifteen to the *chu tshod* of the *res gza’* of the day. However, the solar eclipse should occur on the new moon day, ... but was seen in this continent in the morning of the first lunar day... .

To understand the above quotation, the following context should be understood: the lunar eclipse, which occurred on the 15\(^{th}\) *tshes zhag*, was tallied with by adding 15 *chu tshod*, which derived possibly from empirical data, but, then again, the solar eclipse on the 30\(^{th}\) day was not tallied with by using the same corrections as with the occasion of the lunar eclipse. The problem is not merely astronomical, it also causes a serious religious

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227 Sum pa Mkhan po (1979c: 81a).

228 My renderings for *nyi gling* and *zla gling* are tentative. They look to be special terms used in the *Dga’ ldan rtsis gsar*. I did not find other reference except for these examples.

229 For the meaning of *res gza’*, see Henning (2007: 11).

230 This part is Sum pa Mkhan po’s answer to Ngag dbang nyi ma’s questions in the first correspondence. It is known from the questions and this answer that 15 *chu tshod*, the *gza’* value (*nur ster* value), has been added to the *gza’ dag* calculated in 18\(^{th}\) century Amdo in order to justify the *Kālacakra* world system. To briefly cite the relevant passages in the Ngag dbang nyi ma’s questions in Sum pa Mkhan po (1979c: 80a): "... if 20 arises by adding fifteen to *tshes longs* (*tshes kyi longs spyod*) of this place, eclipse will be in the center of the southern continent, ... the practice of adding fifteen to *gza’ dbyug* is just under the power of this continent." (... *grub sa’ di tshes longs la / tshes (15) byin pas mkha’ mig (20) shar ba na lho gling dbus mar ’dzin par ’byung la / ... gza’ dbyug la tshes (15) byin gyi cho ga byas pa’ang gling ’di kho na’i dbang du ’gyur ro / ’). The *tshes longs* is *tshes kyi longs spyod* (daily motion). The *gza’ dbyug* is the value of *dbyug gu* in the value of *gza’*. The *dbyug gu* (S. *ghatikā* (or *daṇḍa*)) is *chu tshod*. 

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problem. For example, the inaccuracy of weekday (gza’) value verified from eclipse phenomena creates confusion in deciding a day for gso sbyong.

Then, what would happen in case the Chinese calendar, not Tibetan calendar, showed the correspondence between the date and the occurrence of a solar eclipse? In the first exchange of letters, the Sku ’bum monk Ngag dbang nyi ma asked Sum pa Mkhan po twenty-seven questions on Buddhist texts and sciences (T. rig gnas). The issues of the occurrence of eclipses and different dates according to different calendars with respect to the performance of gso sbyong are also included in them.

dri ba bcu gsum ni / ... bco lnga lta bur gso sbyong byed pa brjed nas bcu drug gi nyi ma ma shar gong du byas chog pa’i dmigs bsal gsungs pas / de’i tshe dus go ji ltar brjes laqs / zhes pa ’di dogs gnas zhig yin pas lan ni / ... ’dul ba’i skabs ’dir gtsos bor nyin zhag ltar byed la / ... / ... bcu drug gi skya rangs (sic. rengs) dang po ma shar yan bco lnga dang de shar tshun chad bco drug du gto (sic. gtogs) go / ...’dul gzhung du bco lnga la brjod sogs kyi de ma grub na bco drug gi nyi ma ma shar gong du bya rung gsungs pa ni / ... gal te phyi nyin rgya rtsis kyi gcig la nyi ’dzin byung na der gso sbyong bya dgos pa dmigs bsal dang ces pa’o / ... / nyi ma ma shar gong gi ’char kha’i dus de bco lnga’i mtsan mo’i cha la gto gsungs pas de’i gso sbyong la bco lnga’i zhes brjod na bde’am snyam / ... 232

The 13th question: ... because a special case is stated that having forgotten performing gso sbyong on the 15th, it would be fine to perform [gso sbyong] before the 16th sun rises, how to change the date and time? Since there is a doubt as such, my answer is: ... The occasions of Vinaya here are mainly based according to nyin zhag, ... [The date] belongs to the 15th up until the first dawn of the 16th, belongs to the 16th after it rises. 233 ... As for the statement

231 See Sum pa Mkhan po (1979c: 70b).

232 Sum pa Mkhan po (1979c: 79a–79b).

233 In the skar rtsis, one day (nyin zhag) is defined as follows: Bod ljongs gnams rig skar rtsis rig gzhung tshogs pa (1985: 88): “from a dawn when the lines of palm are visible to the next dawn when the lines of palm are visible.” (nam langs lag ris mthong ba nas / rjes ma’i lag ris mthong gi bar /). Bsam ’grub rgya mtsho (2011: 53). In Chinese lunar calendar, midnight (Ch. zizheng 子正) is the beginning point of time measurement: One day is divided into 12 subsections of time called shi’er shichen (十二時辰) in which each subsection has two, chu (初) and zheng (正) and thereby makes 24 in total. For example, the time of mouse (zi 子) is divided into zichu (子初) and zizheng (子正). The following table is presented in the same manner.
in Vinaya that if by the explanation of the 15th, etc. it was not established, it would be fine to do [gso sbyong] before the sun of the 16th day rises: ... if the solar eclipse occurs next day on the first day according to rgya rtsis, it is stated as a special case that gso sbyong should be done on that day. ... I think that since the time immediately before [the sun’s] rise belongs to the part of the night of the 15th day, it would be fine if [we] call the gso sbyong the gso sbyong on the 15th day... .

As seen above, Sum pa Mkhan po admits an exception that gso sbyong should be performed on the first day in case that a solar eclipse occurred according to the Chinese calendar. The suggestion is combined with the logic of yul bstun gso sbyong. 234

dbus gtsang du skar rtsis ltar byas ba ni ‘grii la / a modo’i yul rgya rtsis dang bstun pa la mi ‘grii pa mang du yod pa’i rgyu mshdan ni skar rtsis kyi zla re’i chad lhag rang rang thad du bton pas lo re’i dus gzer bzhis dang zla re’i tshe brgyad nyer gsum la zla dkyil phyed pa dang bco lnga la nyla gang sosgs mig mtshon dang ji bzhin ‘grii cing / gling’ di’i nnyi ‘dzin yin na nnyin zhi gzhi nam stong dang zla ‘dzin rkyang ba yin na nnyin zhag gi bco lnga ’ong bas khyab pa med kyang phal cher de dang der ‘ong ba dang / tshes zhag ltar na yar ngo mar ngo’i mshdams su ‘dzin sosgs dus ’khor las gsungs pa dang yin ‘grii sosgs zhib la / ... / khyad par du nnyi ‘dzin phal cher rgya nang gi rang lungs kyi zla phyi’i tshes gcig dang zla ‘dzin bco drug la ’ong ba’ang mang ngo’ 235

<table>
<thead>
<tr>
<th>shier shichen</th>
<th>zi (子)</th>
<th>chou (丑)</th>
<th>yin (寅)</th>
<th>mao (卯)</th>
<th>chen (辰)</th>
<th>si (巳)</th>
</tr>
</thead>
<tbody>
<tr>
<td>现代时辰</td>
<td>23~24</td>
<td>24~1</td>
<td>1~2</td>
<td>2~3</td>
<td>3~4</td>
<td>4~5</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>shier shichen</th>
<th>wu (午)</th>
<th>wei (未)</th>
<th>shen (申)</th>
<th>you (酉)</th>
<th>xu (戌)</th>
<th>hai (亥)</th>
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<tbody>
<tr>
<td>现代时辰</td>
<td>11~</td>
<td>12~</td>
<td>13~</td>
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<td>15~</td>
<td>16~</td>
</tr>
</tbody>
</table>

In skar rtsis, the hours from midnight to nam langs belong to the previous day; in the Chinese lunar calendar, they belong to the very day.

234 As a matter of fact, yul bstun gso sbyong is an exception of the principle of zhag mi thub in the practice of gso sbyong. Both of them are incompatible. For my explanation, see below pp. 108 ff and especially note 248.

235 Sum pa Mkhan po (1979c: 79b).
It is appropriate if done according to skar rtsis in Dbus and Gtsang, but the reason why it is not appropriate in many cases [according to skar rtsis] in Amdo with respect to tallying with rgya rtsis is that [skar rtsis] is accurate [in the following reasons]: because the lhag chad of each month is placed individually in the case of skar rtsis, it conforms with observation of such things as 4 seasonal points of each year, distinguishing the middle of the month in the 8th and 23rd day of each month, full moon day on the 15th, etc, and since if solar eclipse occurs in this land, it is new moon day according to nyin zhag and if only lunar eclipse occurs, it falls on the 15th day according to nyin zhag, there is no pervasion, but [they] mostly occurs on the days, and tally with the statement in Kalacakra such as being eclipsed at the border of waning and waning phases according to tshes zhag, etc., ... especially, there are many occasions that solar eclipse occur on the 1st day of half month of the Chinese tradition and lunar eclipses occur on the 16th day.

Sum pa Mkhan po is well aware of the difference between skar rtsis calendar and Qing Chinese calendar (Ch. shixianli) in terms of the day reckoning. The evidence was an eclipse: a lunar eclipse occurred on the 15th tshes zhag according to skar rtsis calendar. Meanwhile, a solar eclipse occasionally occurred on the 1st lunar day according to Qing Chinese calendar, not on the 30th tshes zhag according to skar rtsis, in Amdo. 236 Nevertheless, he emphasizes that skar rtsis works greatly in Dbus gtsang. Then, he goes back to his topic, i.e., the timing of gso sbyong in Amdo in the following way:

... dus 'brel gso sbyong yul dus dbang btsan nas rgya rtsis ltar byed dgos na / yar ngo'i gso sbyong bco lnga pa kun rgya mthun bco lnga la byas nas / mar ngo'i bzu bzhii bco lnga pa gang yin kyang bzu drug nas zhag grangs brtsis na cung zad bde yang / de yang skabs 'gar mi 'grig pa 'ong bar snang ngo /

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236 The differences of lunar dates between Tibet and China are as follows: Tibetan full moon day is on the 15th. However, a synodic month is 29.5 days long. The average length from new moon to full moon is about $14\frac{3}{4}$ days long (not 15 days). Therefore, Tibetan new moon day is not necessarily the first day. However, in the case of Chinese lunar calendar, the new moon day (shuo 朔) is always the first day; meanwhile, the full moon day may not be on the 15th. Sum pa Mkhan po is well aware of the difference as seen in the above quotation.

237 Sum pa Mkhan po (1979c: 79b).
... if gso sbyong at a fixed time should be performed according to Chinese calendar due to the power of regional time, it would be a little convenient that after having performed all gso sbyongs on the 15th days (gso sbyong bco lnga pa) of the waxing phase on the 15th days in accordance with China (Chinese calendar)238, [we perform] 14th and 15th of the waning phase, whatever, being counted from the 16th (=1st day of the waning phase), but even so, it is not right on some occasions.

He basically embraces the Chinese calendar and maintains the logic of yul bstun gso sbyong. However, given the context, he seems to adhere to the day-reckoning of skar rtsis without actively receiving the Chinese tradition. His basic stance is as follows: Because the 15th day (tshes zhag) is accurate in skar rtsis, gso sbyong bco lnga pa at the end of the waxing phase is performed without a problem according to skar rtsis. The gso sbyong bcu bzhi pa / bco lnga pa at the end of the waning phase can be occasionally decided by referring to the Chinese calendar. It may be that because he has no understanding of the day-reckoning system of the Chinese calendar, he cannot present an essential solution for the confusion of gso sbyong date caused by the emergence of the Chinese calendar in Amdo. Therefore, the following statement based upon Indian Buddhist concepts and ideas is made by him.

... yang zla 'dzin yod dus su yul der graqs pa'i bco lnga'i nyin gso sbyong bco lnga pa byas zin kyang phyi nyin la zla 'dzin byung ba mthong na de'i dus su slar gso sbyong skyar dgos la / de yang 'dul bar mthong na mthong na zhes gsungs kyang rtsis (sic. read rtsi) pas zla 'dzin yod nges ri mos mthong na de'i nyin mo der byas chog la de nyi 'dzin la'ang 'dra bo / de dag gis mtshon pa'i 'dul ba'i bcas bkag gnang gsum sogs kyi phyag len la lar spyi (sic. read spyir) btang dmiags bsal yod kyang / gtsos cher sangs rgyas kyiis gsungs litar bya dgos te /... sbrul lo 'di'i rgyal zla'i rgya rtsis nya (supralinear note: 15) la zla sgrib byung ba'i phyi nyin nas bgrangs pa'i bcu drug pa tshes gcig la nyi 'dzin byung pas gso sbyong bya dgos kyang bco lnga las bcu drug pa zer mi 'os sam239

238 “rgya” looks to be “rgya rtsis” or “rgya nag.” It is my interim reading, but I do not understand why “China” or “Chinese calendar” appears here. I think deciding gso sbyong bco lnga pa of the waxing phase cannot be a big issue in the skar rtsis system. Of course, rgya rtsis calendar can be also referred to together with skar rtsis calendar. He may have meant it by the term “rgya.”

239 Sum pa Mkhan po (1979c: 79b).
... Also, although gso sbyong was completed on the 15th day as known in the region at the time of lunar eclipse, if lunar eclipse is seen the next day, gso sbyong should be performed again at that time. Furthermore, although “when a sign is seen” is stated in Vinaya, it would be fine to do during the day if the certainty of the occurrence of lunar eclipse is seen by values by calculation, and it is also applied in the case of solar eclipse. Even if there are general and special cases in some practices of (making of) rules, prohibitions, and permissions of Vinaya represented by them, but fundamentally, they should be done according to the Buddha’s teaching. ... Because the solar eclipse occurred on the 1st day, the 16th day counted from the next day of the lunar eclipse on the full moon day according to rgya rtsis, rgyal zla (12th month), snake year (1786 C.E.) 240, gso sbyong should be performed, but isn’t it inappropriate to call (it) the (gso sbyong) 16th other than the (gso sbyong) 15th?

240 This eclipse has been calculated by A kya. For the calculations, see chapter 4. The date of the 12th month in the year shing sbrul (1786 C.E.) according to grub rtsis, byed rtsis, and Qing Chinese calendar is as follows:

<table>
<thead>
<tr>
<th>Gregorian date</th>
<th>Jan, 1786</th>
<th>1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15</th>
</tr>
</thead>
<tbody>
<tr>
<td>grub rtsis</td>
<td>1785/12/1</td>
<td>2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16</td>
</tr>
<tr>
<td>byed rtsis</td>
<td>12/1</td>
<td>2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16</td>
</tr>
<tr>
<td>Chinese date</td>
<td>12/2</td>
<td>3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16</td>
</tr>
</tbody>
</table>


We see here that there is a problem for the calculation of the solar eclipse: there is no 30th day in grub rtsis, and this must have caused a problem in performing gso sbyong as mentioned by Sum pa Mkhan po. In conjunction with this, the following may be raised: it seems that the Mā yang rgya rtsis (see chapter 4) was not used for eclipse calculation up to the 1780s in Amdo. The discrepancy between rgya rtsis and skar rtsis dates was perceived, but if Mā yang rgya rtsis was ever used or existed, Sum pa Mkhan po and Ngag dbang nyi ma could have mentioned that there is no problem in terms of date and eclipse occurrence when the eclipse is calculated by Mā yang rgya rtsis. But they just mention the difference between the dates. I guess that this may mean that eclipse calculations according to skar rtsis were exclusively used at that time when they exchanged the letters.
He presents a “paradoxical” idea (according to Deleuze’s sense) that affirms both the performance of Indo-Tibetan vinaya and that of gso sbyong according to Chinese calendrical date by placing the former under the category of general cases (= zhag mi thub) and the latter under the category of special cases (= yul bstun gso sbyong). Of course, as expected from Tibetan scholars, the superiority was given to the former. His interpretation is quite a common approach observed in making sense of different astronomical knowledge sources.

Another example, which is based upon the same dyadic relationship between zhag mi thub and yul bstun gso sbyong and which also shows the relationship between gso sbyong and an eclipse in Amdo is as follows: Gser tog clearly says that an eclipse influences deciding the performance of gso sbyong in the following way:

\[ \ldots \text{zla re bzhin gyi nya dang zhag thub mi thub kyi gnam gang ngam nyer dgu la dus 'brel gyi gso sbyong / de la 'dul ba las / spyir btang dmigs bsal du ma gsungs shing / khyad par zla bshol ni ryal po'i rjes su 'brang bar bya'o / zhes dang / mtsphan ma byung na gso sbyong bskyar bar bya'o / zhes gsungs pa la brten nas / a mdo tsong kha'i yul 'dir rgya nag ser rtsis kyi zhan bshu' ste ri thu}^{241} \text{litar zla ba che chung dus mtshands nyer bzhis sogs de la bstun pa'i phyir / sgong gai phyag srol gai rayun ni dper na hor zla dang po'i tshes gcig nas drug pa'i bco lnga'i bar dang / de nas zla ba bcu gnyis pa'i gnam gang bar / nyin zhag grangs kyi thub mi thub brtsis nas gso sbyong mzdad cing / de'i tshes nyin zhag dang tshes zhaq sna ma mnyam pa'i dbang gis / gza 'dzin nam ngyi 'dzin byung na snga nyin gso sbyong byas yod na nyin 'dir slar yang bskyar ba dang / byas med na nyin 'dir gso sbyong byas te phyi nyin nas zhaq grangs bgrang zhing / gal srid mtsphan ma ma byung na / drug pa'i bco lnga dang / bcu gnyis pa'i gnam gang ngam nyer dgu la zhaq bco lnga long ma long (sic. read longs ma longs) gang yin yang dmigs bsal dbang btsan par byas te gso sbyong bco lnga pa mzdad pas lo zla khyud 'khor la thub mi thub kyi gso sbyong nyin zhaq grangs bzhin mzdad pa yin / 'on khyang deng sang gso sbyong deitar mzdad kyin med par bshad mkhan mang yang/...}^{242} \]

\[ \text{It seems to mean almanac / calendar (T. li tho / lo tho) given the previous term 'zhan bshu'. Guo’s (1986: 186) rendering litu (歷圖) looks to be correct.} \]

Regarding the gso sbyong at a fixed time on the full moon day and on the new moon or on the 29th by zhag thub or zhag mi thub every month, relying upon the Vinaya stating many special cases in general and [stating] that as for leap month, specifically, rgyal po\textsuperscript{243} should be followed and [stating that] gso sbyong should be repeated if a sign occurs, in order to accord with such as big and small month (30 day month and 29 day month respectively) and 24 jieqis (節氣).\textsuperscript{244} etc. according to the shixianshu (T. shixianli / Ch. shixianshu (時憲書))\textsuperscript{245} almanac of Chinese ser rtsis here in Tsong kha district, Amdo, the continuity of the previous system, for example, is as follows: gso sbyong is performed after calculating thub or mi thub\textsuperscript{246} by the numbers of nyin zhag from the first day of the first hor zla\textsuperscript{247} to the 15th day of the sixth hor zla, and then, up to the new moon day of the 12th hor zla, and at that time, because of the imbalance between the nyin zhag and tshes zhag, in case that a solar eclipse occurs: if gso sbyong was performed on the previous day, it is repeated again, and if it was not performed, it is performed on that day and the day numbers are counted from the following day, and if a sign does not occur, gso sbyong is performed on the 15th day (T. gso sbyong bco lnga pa) on the 15th day of the sixth hor zla and on the new moon or on the 29th day of the 12th hor zla by the power of the special case, regardless of whether it is sufficient to be the 15th day or not. In doing so, in the entire year month, gso sbyong of

\textsuperscript{243} This seems to be Rgyal po'i.gzhung mentioned in Sum pa Mkhan po (1979c: 94a). Or, rgyal po = 16, the 16th day? This does not make sense.

\textsuperscript{244} The 24 jieqi (節氣, seasonal points. T. dus mshams nyer bzhi / dus tshigs nyer bzhi) denotes Chinese 12 jieqi (jieqi (T. dbugs) and 12 zhongqi (T. sgang). See Tshe tan phabs grags (2007a: 341–6), Henning (2007: 354–6). For a general understanding of the Chinese system, see Sivin (2009: 79–81). In current lho tho, there are two sgang-s and two dbugs-s. Firstly, the rgya sgang and rgya dbugs are either the same with or very close to the Chinese 24 jieqi, which date back to Mtshur phu Rgyal tshab Chos dpal bzang po's (1766-1820) rgya rtsis gsar 'gyur (new translations of Chinese calculations / rgya rtsis) according to Chos kyi rgyal mtshan (1985: 144a) [= (1986: 125a) = (2004: 140a)]. For the calculation method, see Chos kyi rgyal mtshan (1985: 96b-101b) [= (1986: 82b-87a) = (2004: 88b-93b)]; it is verified that the method which has been adopted in current lho tho published by Lha sa sman rtsis khang (see Bod ljongs gnam rig rtsis rig gzhung tshogs pa (1985: 153-5)) is based upon Chos dpal bzang po's values and methods. Secondly, the bod sgang and bod dbugs are not related to the Chinese jieqi but to the Tibetan intercalation. Their positions are closely tied to the intercalation method in which mda' ro lhag ma 48 and 49 indicate leap month in the Phug system. It is safely assumed that the change of the values of the mda' ro lhag ma into 48 and 49 possibly in the middle / late 17th century is tied to the introduction of the concept sgang and dbugs. See Janson (2014: 57, n. 68).

\textsuperscript{245} Shixianshu is an almanac based upon shixianli which is Qing Chinese calendrical astronomy of Western origin. For more information, see chapter 4. Sivin's (2009) rendered it the ‘temporal pattern system.’

\textsuperscript{246} Thub mi thub means zhang thub / zhang mi thub.

\textsuperscript{247} For hor zla, see Schuh (2008: 216 ff), Schuh (2012: 1647–8).
thub or mi thub is performed according to the numbers of nyin zhag. However, nowadays, there are many who speak that gso sbyong is not performed as such, but ....

The issue of the performance of gso sbyong on the 29th day of the 12th month was mentioned in the above passage. Concretely speaking, if the 29th day is the 14th nyin zhag, not the 15th on a fortnightly basis, it contradicts the gso sbyong bco lnga pa. The problem may not be simple because it means a serious threat to the logic of zhag mi thub, which was interpreted to buttress the performance of gso sbyong as specified in vinaya texts. The solution looks as follows according to the above paragraph from Gser tog: the logic of zhag mi thub is still effective, but an exception should be included: the gso sbyong is fine to be performed on the 29th (= 14th nyin zhag) in the case of the 12th month. As a matter of fact, the exception is a fatal counter-example that ruins the concept of zhag mi thub. Nevertheless, Gser tog’s idea is to strengthen and solidify the religious practice of gso sbyong based upon skar rtsis day-reckoning system by setting up an exception as Sum pa Mkhan po did. Because Tibetans’ priority concern in the performance of gso sbyong is essentially the descriptions in Vinaya texts, the exceptions were interpreted to be compatible with them.

Another aspect which threatens the accuracy of tshes zhag in skar rtsis was that solar eclipses occasionally occurred on the 1st tshes zhag (= on the 1st lunar date as in Chinese lunar calendar), not on the 15th tshes zhag on a fortnightly basis (= 30th tshes zhag) as in Tibetan calendar. For example, a solar eclipse was predicted to occur on 1786/1/1 according to Chinese calendar. The date also falls on 1786/1/1 according to Phug pa grub rtsis calendar. Such examples must have been a threat to the performance of gso sbyong
because they mean that the *zhag mi thub* based upon the accuracy of *tshes zhag* is not always rigorously applied.

Given the aforementioned Sum pa Mkhan po and Gser tog, the following fundamental points regarding the performance of *gso sbyong* may be raised in conjunction with eclipse phenomena: In the case of the Chinese calendar, the new moon day is more accurate, while in the Tibetan lunar calendar, the full moon day is more accurate. Thereby, the former is more accurate than the latter in terms of the correlation between the date of a solar eclipse (= the first lunar day (= new moon day) in the Chinese calendar) and its real occurrence. By the observation of the occurrence of a solar eclipse according to the Chinese calendar, it was easily recognized that *skar rtsis* occasionally disclosed a limitation in day reckoning. However, it is not likely that the fact simply implied the accuracy of the Chinese system because, in the case of a lunar eclipse, the date according to *skar rtsis* must have been more accurate than the Chinese one (see also Sum pa Mkhan po above (1979c: 93b-94a)) in terms of the correspondence between the *tshes zhag* and real occurrence of a lunar eclipse. Under such circumstance, Tibetan scholars figured out a solution by accommodating both the Indian Vinaya texts and the Chinese calendar for the performance of *gso sbyong*. Given Sum pa Mkhan po (1979c: 90b), it is certain that

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248 See again Ngag dbang nyi ma’s questions in Sum pa Mkhan po (1979c: 90b) translated on above page 91. Further, see A kya’s calculation in chapter 4. Even if there is no textual basis, the reason why A kya calculated the solar eclipse at 1785/12/30 may be related to the performance of *gso sbyong* on the same date. Let me use A kya’s calculation to explain the above Gser tog’s passage. In the *Phug pa grub rtsis* calendar, 1785/12/7 and 1785/12/30 do not exist (*chad*) and 1785/12/28 is doubled (= *lhag*). 1785/12/1 to 1785/12/16 are 15 *nyin zhag*-s and 1785/12/17 to 1785/12/29 are 14 *nyin zhag*-s. There are 29 *nyin zhag* in total. It follows then that the *gso sbyong bco lnga pa* on a fortnightly basis is jeopardized in that month. Should *gso sbyong* be done on 1785/12/29? The date falls on the 14th *nyin zhag* on a fortnightly basis, which means that the *gso sbyong bco lnga pa* cannot be followed. In addition, a solar eclipse was predicted on 1786/1/1.
the emergence of the Chinese calendar in Amdo and the verification of its accuracy by the date (= new moon day) of solar eclipses influenced Tibetan interpretation of the performance of gso sbyong. However, it is also certain that they still adhered to Buddhist concepts and interpretations such as vinaya specifications, the difference between tshes zhag and nyin zhag, zhab mi thub, etc. From a different angle, eclipse phenomena played a pivotal and crucial role for the religious practice of gso sbyong in Amdo, being combined with the Chinese calendar which showed coherency in terms of the correspondence between date and the occurrence of a solar eclipse. Lastly, the following fact needs to be indicated: it is verified from the above passages from Sum pa Mkhan po and Gser tog that gso sbyong was practiced upon the occurrence of eclipses in the 18th century Amdo. — This tradition does not exist any more as far as I know. The last line in the above passage from Gser tog (see above pages 106-8) may mean that it already vanished. — As a result, accurate predictions and calculations of eclipse combined with observation of real eclipse

according to Qing Chinese shixianli calendar (the date also falls on 1786/1/1 according to Phug pa grub rtsis calendar). Gso sbyong is supposed to be performed when an eclipse occurs. — The accuracy of tshes zhag for the timing of the solar eclipse was proven to be problematic in this case. It should be stressed again that 15th and 30th tshes zhag are tied to the occurrence of an eclipse as well as to the performance of gso sbyong. — Then, when to perform gso sbyong? Only on 1786/1/1? In contrast with their serious frame of thinking and religious concern, their answers look simple. For example, both Sum pa Mkhan po and Gser tog suggested that the gso sbyong should be performed on both day by setting up a special case for 12/29 (according to Phug pa grub rtsis calendar. See below table). The solutions given by them may reflect the general approach at that time in Amdo. Let us keep eyes open wide and correct materials which substantiate or invalidate my conjecture.

<table>
<thead>
<tr>
<th>Gregorian date</th>
<th>Jan 29, 1786</th>
<th>Jan 30, 1786</th>
<th>Jan 31, 1786</th>
</tr>
</thead>
<tbody>
<tr>
<td>grub rtsis</td>
<td>1785/12/29</td>
<td>1786/1/1</td>
<td>1786/1/2</td>
</tr>
<tr>
<td>byed rtsis</td>
<td>1785/12/30</td>
<td>1786/1/1</td>
<td>1786/1/2</td>
</tr>
<tr>
<td>Chinese date</td>
<td>1785/12/30</td>
<td>1786/1/1</td>
<td>1786/1/2</td>
</tr>
</tbody>
</table>
phenomena and research into a neighboring tradition must have been an indispenpensable part for the practice of gso sbyong.

More research is needed, but given the above passages from Sum pa Mkhan po and Gser tog, the following scenario may be suggested regarding the religious meanings of an eclipse in conjunction with gso sbyong: firstly, an eclipse was accompanied by religious practice in Tibet. Buddhist rituals including gso sbyong were performed when eclipses occurred. Secondly, in the local unfolding of the buddhist practice gso sbyong in the 18th century Amdo, there existed the mismatch between the logic of zhag mi thub and the Chinese calendrical system, and eclipse phenomena were manifest evidence of the discord. As a result, Tibetan astronomers set up exceptions by the logic of yul bstun gso sbyong, which is an example to show that an eclipse influenced the decision of the religious performance. Essentially, the whole process was tied to the issue of the accuracy of tshes zhag/ gza’ values in skar rtsis.

Let me recapitulate the second religious meaning due to its gravity in the religious practice and the accuracy of skar rtsis. First, for the gso sbyong date in accordance with skar rtsis, the Tibetan traditional justification is zhag mi thub based upon the imbalance between tshes zhag and nyin zhag whose textual basis is the Indic Abhidharma texts. In the exegesis, the accuracy of tshes zhag in the skar rtsis system is a central idea. Second, however, upon the emergence of the Chinese calendar in Amdo, the different dates between skar rtsis and the Chinese calendar, especially in the case of new moon, were occasionally witnessed together with the occurrence of solar eclipses in accordance with
the Chinese date. Third, under such situation, the following issues became critical for the practice of gso sbyong: how to make sense of the Indian vinaya in the district of Amdo near to China where the Chinese date looked more accurate as seen from the occurrence of solar eclipses? Can the Chinese date be embraced for the performance of the religious rite of gso sbyong? A solution was presented in the writings of Sum pa Mkhan po, Gser tog, etc.. As expected, Sum pa Mkhan po first defended the time-honored Tibetan tradition of skar rtsis. He stressed that the gza’ value of skar rtsis is accurate in Dbus gtsang (mainland Tibet), even if it may be less accurate than the Chinese calendar in Amdo. Of course, he did not simply ignore the Chinese calendar evidenced by the occurrence of solar eclipses. For a solution to accommodate both skar rtsis and the Chinese calendar, he set up an exception for the cases which are beyond the boundary of the logic of zhag mi thub, suggesting a special case of yul bstun gso sbyong. In other words, he embraced the Chinese calendar for the performance of gso sbyong. The relationship between an eclipse and gso sbyong is dramatically witnessed in the coordination between the religious practice in the Indian Vinaya texts and the calendrical viewpoints seen in his suggestions: an eclipse proves the accuracy of an astronomical system and thereby influenced the religious practice. Of course, no antithetical relation between astronomy and vinaya was established. Also, vinaya assumes the superior position, being combined with skar rtsis calculations supported by the Kālacakra. Later, Gser tog follows Sum pa Mkhan po’s suggestions. The former may have read the letter exchanges between the latter and Ngag dbang nyi ma, given the similarity of the ideas unfolded by the former (See above pages 106 ff). Or, it is highly possible that the ideas were common among the scholars in Amdo
at that time. In other words, Sum pa Mkhan po probably followed the contemporary wide-spread opinions for the observance of gso sbyong in Amdo.

Before ending this chapter, let me go back to the issue of paradox: while zhag mi thub is based upon belief in the accuracy of tshes zhag in skar rtsis, yul bstun gso sbyong is a counter-example showing that zhag mi thub is not always true. The yul bstun gso sbyong is a corollary from the observation of eclipse phenomena in accordance with the Chinese calendar. I suggest that the affirmation of zhag mi thub and yul bstun gso sbyong is a paradox in a Deleuzian sense. The association and equation between the Indo-Tibetan calendar and the Chinese calendar and the clear sense of the malfunction of the zhag mi thub and the ensuing establishment of the exceptions embracing the Chinese calendar may mean that Tibetan astronomers tacitly or overtly have accepted the confictions and contradictions when making sense of their astronomical calculations. Further, by the affirmation and approval of both, they have made sense of the different traditions and methods while still mainly adhering to their own tradition. With the superiority of Indic Vinaya and skar rtsis calculations based upon the Kālacakra, the Chinese methods and calculations worked auxiliarily.
PART II.

AN INCREASE IN THE ACCURACY OF ECLIPSE CALCULATIONS
CHAPTER THREE

THE KĀLACAKRA APPROACHES TO KNOWLEDGE

INTRODUCTION

Solar and lunar eclipses have religious significance in Tibetan society, as seen in chapters 1 and 2. Thus, it was necessary for Tibetans to accurately predict them. In the following section, I will focus on the approaches and methods that Tibetans employed to predict eclipses. Textual and non-textual sources have contributed to the accuracy of eclipse prediction. Due to the religious authority of the Kālacakra, eclipse prediction is arranged in a religious context despite its scientific premise. The approaches in this chapter are inextricably tied to eclipse-calculational techniques, which will be tackled in chapter 4.

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249 I divide knowledge sources in skar rtsis into “textual” and “non-textual.” “Textual” refers to Buddhist texts. In the conception of Kālacakra adherents, the major textual source is the Kālacakra to which the utmost authority is given. The other Buddhist texts may be regarded as not as authoritative as the Kālacakra. I use the term “non-textual” to denote knowledge obtained from astronomical observations, empirical data, discussions and debates, other traditions such as Chinese astronomy/astrology, etc. The “non-textual” sources may have nothing to do with Buddhism, but they are not necessarily non-Buddhist. Moreover, it should be noted that the “textual” and “non-textual” sources are not opposed, because both are simultaneously affirmed through the superiority assigned to the textual Kālacakra. The hermeneutics will be clarified throughout this chapter.
1. KNOWLEDGE DEPICTED IN BUDDHIST TEXTS

KNOWLEDGE IN BUDDHIST TEXTS FOR ECLIPSE CALCULATION

The most basic step in eclipse calculation is to judge eclipse possibility. True/apparent position (longitude) of the sun and the moon and the position of the nodes are necessary.\textsuperscript{250} The \textit{Kālacakra} indicates basic techniques for eclipse calculation such as true longitude of the sun and moon, nodes (\textit{sgra gcan}), etc.\textsuperscript{251} Geometric and geographical knowledge make the calculations accurate, but the \textit{skar rtsis} calculations are far from geometric.\textsuperscript{252} Although it is certain that the \textit{Kālacakra} is somewhat based upon Indic

\textsuperscript{250} As described by Sivin, the position of apparent conjunctions, i.e. proximity to the lunar nodes, are pivotal for accurate eclipse calculation. See Sivin (2009: 312): "Accurate prediction of time and magnitude depend on successfully incorporating a number of factors into an eclipse theory. One is the position of apparent conjunction. This is in turn based on knowledge of the apparent lunar and solar motions: solar equation of center, and lunar equation of center. Another important variable is proximity to the lunar nodes. The nodes are the intersections of the ecliptic and the lunar orbit, where the right ascensions and declinations of the sun and moon are equal." The nodes are the two points (the ascending node and the descending node) where the moon’s orbit and the ecliptic intersect. In order for an eclipse to occur, the distance between the moon and the nodes at new moon and full moon should be close enough. Concretely, the lunar eclipse occurs: 1) at full moon and 2) when the moon near one of the nodes. The solar eclipse occurs: 1) at new moon and 2) when the moon is near one of the nodes.

\textsuperscript{251} See Henning (2007: chapter 5).

\textsuperscript{252} For example, knowledge on parallax, which diminishes the altitude of a celestial body, is crucial for solar eclipse calculations. They concern lunar horizontal parallax (diurnal parallax; horizontal parallax is a special case of diurnal parallax), i.e. the angular difference between the observation from the center of the earth and that from the surface of the earth at the observer’s position. It is maximal when the moon is on the observer’s horizon. Nearly all astronomical books describe this. To illustrate some, see Evans (1998: 253-4); for the Ptolemaic approach, see Pedersen (1974: 203-35) in ancient astronomy. For basic explanations, see Schmeidler (1994: 24-5), and Duffett-Smith and Zwart (2011: 83-8, 176-7). Parallax calculation is pivotal for a solar eclipse is because it influences the possibility of an eclipse. Simply put, eclipse limit is
geometric knowledge, it is difficult to determine which geometric bases were adopted in the system. Rather, the expressions in it are arithmetic in nature. Concretely, the *Kālacakra* specifies the calculation method of the position of the sun and moon in the *Laghukālacakra* and the *Vimalaprabhā* I. 29-38. Based on this, Tibetans formulated the algorithm for the sun’s true motion. As for the apparent position, understanding of parallax is necessary, but the *Kālacakra* is not a good textbook for this. Moreover, there is no clear division between ecliptic motion and the orbit of the moon in the *Kālacakra*. In determined by apparent latitude of the moon, which changes via different parallax values. It also influences the time of mid-eclipse, magnitude, etc. Mid-eclipse timing by calculation does not agree with apparent conjunction because of parallax. In the case of magnitude, it is influenced by the apparent semi-diameter of the moon, which changes according to the distance between the moon and earth, refraction, etc. Taken together, parallax is one of the most important factors that should be incorporated into real calculations of solar eclipses. However, in the case of skar rtsis, there is no evidence that parallax was understood and used. For example, the timing of the occurrence of eclipses is fixed; empirical corrections, not parallax based upon geometry, have been applied. Of course, there is a Tibetan method in which parallax was applied for solar eclipse calculation. See chapter 4 for my preliminary study on parallax applied in the *Mā yang rgya rtsis* (= the duplication of the eclipse algorithm included in the *Lixiang kaocheng*). Another example: in modern astronomy, the calculation of times of sunrise and sunset, which is related to decide the time of eclipse occurrence, requires the declination of the sun and celestial latitude of the observer. Although there have been studies into times of sunrise and sunset in *skar rtsis* astronomy, they are not based upon geometric knowledge of such kind. They are mostly conjectured to be based upon empirical knowledge according to each region. This topic may require systematic research. Moreover, the points I raise here are connected to the criticism in the preface of *Tngri-yin udq-a*. See my Appendix II.

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253 Ōhashi (1986: 635-7), (1991), (2000: 354-60) points out that the equation of the center of the sun and moon and the epicyclic correction of planets, are close to the Indian *Ārdharātrika* school by comparing Indian works with Bu ston’s *Mkhas pa dga’ byed*. However, things may be more complex. Regarding errors in the *Lāghukālacakra* in terms of the equation of the center of the sun within a bigger frame of Indian astronomy, see Pingree (2001: 659-60).

other words, there is no acknowledgement of the fact that the sun and moon travel nearly on the same path. Therefore, the implication is that an eclipse is not caused by the occultation of the earth and moon respectively, but by the motion of Rāhu. In other words, the virtual planet of Rāhu (T. sgra gcan. ascending node (sgra gcan gdong) and descending node (sgra gcan mjug)) are used to judge the distance between themselves (sgra gcan gdong and sgra gcan mjug) and the sun and moon, to explain the occurrence of an eclipse.\(^{256}\) See verses Laghukālacakra and Vimalaprabhā I. 39, I. 52. The period of Rāhu is 230 lunar months (tshes zla = 6900 tshes zhag). It means 0.234782608 yul gyi chu tshod (= \(0^\circ0^\prime14^\prime0^\prime12^\prime (23)\)) per tshes zhag.\(^{258}\)

In the textual “series,” the Kālacakra is a theoretical basis. Chapter I in the Laghukālacakra is intimately connected to the other chapters—converging toward religious practice while showing a clear sense of the period of planets under the scheme of outer – inner – other (T. phyi nang gzhan gsum)\(^{259}\). Since it is basically a religious text

\(^{256}\) The use of the term Sgra gcan (Rāhu) in ancient Asian astronomy—including India, central Asia, China, etc.—is complex. To briefly describe it in the Tibetan context: In Indian astronomy, generally, the ascending node is called Rāhu; the descending node is Ketu. For example, Yabuuchi’s research into the huihuili in China, van Dalen tr. (1997: 26): “As far as the points of intersection of the ecliptic and the inclined lunar orbit are concerned, following terminology of Indian astronomy, it was customary to distinguish between Rāhu (Ch. Luohou 羅睺) as the ascending node and Ketu (Ch. Jidu 計都) as the descending node.” But in Tibetan astronomy/astrology, the ascending node is called Sgra gcan gdong (head of Rāhu) and the descending node is called Sgra gcan mjug (tail of Rāhu). Another planet—in Tibetan conception—Mjug ring (comet) is Ketu. In other words, Ketu has nothing to do with node or eclipse.

\(^{258}\) \(1620^\circ \div 6900 = 0.234782608\). The equivalent value \(0^\circ0^\prime14^\prime0^\prime12^\prime (23)\) is everywhere in skar rtsis texts. For example, see Huang and Chen (1987: 228), Henning (2007: 96, 271–3).

\(^{259}\) The Kālacakratantra is composed of the following interrelated three parts: phyi (phyi'i dus 'khor), which means outer time cycle of the cosmos; nang (nang gi dus 'khor), which means inner time cycle of a person;
that uses astronomical phenomena for the explanation of tantric practice in an arcane and esoteric way, concrete details and methods for astronomical calculations may not be a major concern. Aside from the Kālacakra, even if we extend the scope of investigation on astronomical knowledge to Buddhist texts, there may exist no remarkable difference. It is difficult to find theoretical and calculational expositions for astronomical calculations in general, and eclipse calculations in particular, in other Buddhist texts. Even if relevant information is found, religious interpretations are dominant.

Next, by using Ku sri skyabs’s (?) religious hermeneutics on the virtual planet sgra gcan, let us see how Tibetan astronomers read astronomical phenomena from a Buddhist perspective. He presents three classifications in terms of buddhavacana: five neyartha (drang don) texts, two thun mong ba texts, and three nīśārtha (nges don) expositions. Firstly, mythical accounts on sgra gcan in the following texts are classified as drang don: (1) Dran pa nye bar bzhag pa (S. Smṛtyupasthāna), (2) Thar pa Lo tsā ba Nyi ma rgyal mtshan’s (13th c. ~ 14th c.) later translation of the Nyi zla’i mdo, (3) Myang ’das mdo (S. and gzhan (gzhan gi dus ’khor), which is associated with the stage of generation (T. bskyed rim) and that of perfection (T. rdzogs rim).

260 Thun mong ba and thun mong ma yin pa are generally seen in Tibetan Buddhist exegeses on the interpretation of sūtras and tantras. For example, Kapstein (1988: 151) explains the differentiation between thun mong ba and thun mong ma yin pa; their subdivisions, drang don and nges don, are used as a hermeneutic tool in Kong sprul’s Shes bya kun khyab. In Ku sri skyabs’s case, I do not know what the middle thun mong ba has in relation with the first drang don and third nges don. At any rate, he uses the Buddhist hermeneutics for making sense of and justifying the supreme authority of the Kālacakra.

261 It means the Nyi ma’i mdo (S. Sūryasūtra) and the Zla ba’i mdo (S. Candrasūtra). See Bka’ gyur Dpe bsdur ma, vol. 34: 832-3 and vol. 34: 836-7 respectively. For the latter, see the Sde srid (2010: 64).
Mahāparinirvāṇa sūtra, (4) Rgyud bla ma, and (5) Dgongs can bya rgyud gra lnga (Gzungs gra lnga ?). They are “the way of explanation of being related to kun rdzob bden pa (S. samvṛtisatya. conventional truth).” (kun rdzob bden sbyar bshad tshul).262 Next, two thun mong ba texts include: (6) phyi rol rig byed gtam rgyud, and (7) Yan lag brgyad pa.263 They are “... we don’t consider the external world as true, which is explained in the texts, which has been refuted in the Tshad ma nmam ’grel, etc.” (... phyi rol gzhung bshad bden pa ru / mi ’dzin tshad ma nmam ’grel sogs nas bkag / ). Lastly, the three nges don expositions are as follows: (8) “according to outer, ... ultimate truth” (phyi ltar ... ... gnas lugs), (9) “when combined with inner ... explained under the category of rtsa dkar = zla ba, rtsa nag po = nyi ma, and rlung rgyu (wind channel; moving wind) = sgra gcan.” (nang dang sbyar na ... rtsa dkar zla ba nag po nyi ma dang / rlung rgyu sgra gcan rigs su bshad pa yin / ), and (10) “... connected with yoga of the developing stage (bskyed rim) and the perfection stage (rdzogs rim)” (bskyed rdzogs rnal ’byor dang sbyar ...).264 They are “the way of apprehending by

262 Buddhism differentiates two levels of truth, i.e. samvṛtisatya (kun rdzob bden pa. conventional truth) and paramārthasatya (don dam bden pa. ultimate truth).

263 It means Vāgbhaṭa’s (7th c.) Aṣṭāṅgahṛdayasamhitā (T. Yan lag brgyad pa’i snying po bsdus pa).

264 Ku sri skyabs (1979: 33b-35a). For a similar description of Rāhu which appears in Tibetan literature, see also the Sde srid (2010: 52-64). Ku sri skyabs must have read the Sde srid (2010). Ku sri skyabs (1979) is included together with Brag dkar rta so Chos kyi dbang phyug’s (1775-1837) text Chos kyi dbang phyug (1979: 75-89) under the modern title, Tibetan Rtsis Texts. The editor writes in the preface that the writing in it “is apparently from Western Tibet and represents a tradition that passed through Brag dkar rta so Chos kyi dbang phyug.” Even if this is the case, we do not know who predates who between Ku sri skyabs and Chos kyi dbang phyug. For future researchers, let me briefly mention the colophon in Chos kyi dbang phyug (1979: 88-9): Chos kyi dbang phyug (1979) was written in 1824/3/15 at Le’u dgon nges don dar rgyas gling in Mang yul (Mnga’ ris) at the request of Bag dro, who was called “astronomer, a nephew of the throneholder of the monastery of Dpal sding, Mdo chen po (?))” (dpal sding gdan sa pa mdo chen po’i gdung dbon rtsis rig ’dzin pa ).
combining the three, i.e. outer, inner and other in the great secret Kālacakra, the essence of niṭārtha." (nges don snying po gsang chen dus 'khor lor / phyi nang gzhan gsum sbyar 'dzin tshul). In other words, the phyi nang gzhan gsum of the Kālacakra are niṭārtha. Ku sri skyabs (1979), which is a skar rtsis text based upon the Sde srid in many respects, is filled with religious content. It is also clear that such information is not of service for real eclipse calculation. These types of religious orientations and contexts in the Kālacakra and Buddhist texts have been described and may be presupposed. However, in real calculations, Tibetan astronomers have no choice but to go beyond them.

2. KNOWLEDGE FROM NON-TEXTUAL SOURCES

Religion-based, and thereby meager, interpretations for real eclipse calculation in the Buddhist texts have been inevitably followed by the adoption of non-textual elements. In most cases, no theoretical aspects such as the movement of the sun and moon, sgra gcan, etc are considered. Instead, the focus is on the improvement of the accuracy of eclipse calculation within the given frame of the Kālacakra calculations. My following observations on them, albeit periodically broad in the beginning of each source, will narrow each down to the 18th century eclipse calculation when possible.
2.1. MYONG BYANG (A NOTE BASED UPON OBSERVATION): ASTRONOMICAL OBSERVATION AND CRITICISM

Firstly, corrections through astronomical observations have been made. As mentioned by Petri and Schuh, astronomical observation may have not been active in Tibet. Schuh argues that since the Kālacakra system was officially established in the 13th century in Tibet, the Tibetan system has not been combined with real observations and criticism. I only partly agree with Schuh’s point.265

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265 For the modern appraisal of the Tibetan astronomical observations, see Schuh (1974: 559-60, 562-3). Also see Schuh (1973a: 20): “... konkrete, systematische Beobachtungen des Sternhimmels und der Planetenbewegungen von Seiten tibetischer Astronomen nur in geringem Maße durchgeführt worden sind und dass solche Beobachtungen für die Entwicklung der Astronomie in Tibet nicht von großer Bedeutung gewesen sein können.” Before him, Petri also made similar comments. See Petri (1967: 161): “Geometry is never made use of; nor do we read about actual observations except some very simple eclipse phenomena and one interesting remark about a comet ...” Petri should be used cautiously. He is a specialist in modern astronomy, indeed, but he is not a specialist in the field of Indotibetan astronomy. He relied upon very limited, contemporary, translated materials on Indian astronomy and made arbitrary decisions. Information in his writings is outdated and is historically too simplified and untenable. Also, some of his arguments remain as hypotheses. For example, he presents hypotheses on precession in this way: Petri (1966: 105): “Für das Kālacakra gilt festzuhalten, dass neben einer “solaren” Periode von 21600 (LaghuKālacakra 22/23) eine “planetare” von 24000 (LaghuKālacakra 87; Bhukti des Planetenjahres) vorkommt, die beide in der zeitgenössischen indischen Astronomie für die Präzession auftreten. Die Erscheinung der Präzession selbst ist nirgends explicite dargestellt.” The reason why I mention Schuh and Petri is as follows: They may be right, but should be stressed that the observations of eclipse, equinox and solstice have been made continuously. Firstly, regarding eclipses, see Schuh (1973a: 20, n. 83): “Abgesehen von der Bestimmung der Sonnenwendenden anhand des Gnomon ... liegt nur ein einziger Hinweis über systematische Beobachtung der Mondbahn im Zusammenhang mit der Berechnung von Sonnen- und Mondfinsternissen vor.” As Schuh himself says, eclipse observation is a big part of Tibetan astronomy. I also present some examples I found. Secondly, regarding the observation of equinoctial and solstitial points, see below note 553. In particular, Henning (2007: 315–6) presents ‘Gos Lo tsā ba’s observation on the length of day and night, and summer and winter solstices, and says that it contributes to the creation of the accurate longitude of the sun in his system. Moreover, we can obtain more information on Tibetan observations through the brief modern research made by Tshul khrims chos 'byor et al. (1983), Zhou et al. (1995). Thus, I think we do not need to jump to the conclusion that Tibetan astronomical observation was not significant in the development of the field. We can collect as many case studies as possible. Another point I raise is the role of observation. For example, we should ask why Tibetans were so eager to accurately predict eclipses.
In fact, observations have been made continuously and have been recorded as myong byang.\textsuperscript{266} For example, Sum pa Mkhan po’s (1979c) letters show astronomical observations accumulated from his predecessors.\textsuperscript{267} Among them, his correspondence with the Paṇ chen lama in 1779 C.E. presents his opinions on the correct rtsis ‘phro of comets (du ba mjüg ring gi rtsis ‘phro nam dag) in the following way.

\begin{quote}
drang srong du ba can kho bos ’ga’ zhig mthong ba ni / sngar rab drag lcags stag la mjüg ring du phod ring po can mnya’ ris su shar zhes pa dang mtshungs par / a mdor yang rab nyi’i chu phag la du ba shin tu ring po can sa sros nas shar ba mthong na yang zla tshes brjed (supralinear note: 15) ’dag / rab nyi’i sa stag gi mjüg gi hor zla gnyis pa’i smad la tho rangs shar du du ba chung ba can byung / de’i rgyun sa yos gsum pa’i yar ngos (sic. read ngo) tho rangs la pa wa sangs kyi byang
\end{quote}

It guided the development of Tibetan astronomy. Some answers are given in chapters 1 and 2. I believe that even if eclipses cannot explain all aspects of Tibetan astronomy, given their religious significance in Tibetan Buddhism, astronomical observations are to some degree linked to the increase in the accuracy of eclipse calculation. In the same vein, we could ask the following questions: Why does astronomical observation matter? What compelled Tibetan astronomers to observe the sky? What significance do observations have in Tibetan astronomy? In what aspects did they make a contribution? Another aspect of Tibetan astronomy in conjunction with observation is that it does not remain merely observation. Since Tibetan astronomers do not cast doubt upon the authority of the Kālacakra, observations which may contradict the Kālacakra were re-interpreted in order to reconcile them with the Kālacakra. The Kālacakra’s meager information on astronomy may evince limitations (from a modern perspective), but its essential and supreme status has never been questioned. In Tibetans’ conception, the Kālacakra is the fount of all possible solutions and explications. It also means that no antithetical relation between canonical/religious knowledge and empirical/observational knowledge is posited in the Tibetan skar rtsis astronomy based upon the Kālacakra.

\textsuperscript{266} The genre of myong byang (including the genre of nyams yig in medicine) is important in Tibetan intellectual history because it contains empirical and observational knowledge on the practices of astronomy and medicine. For example, Dharmashri (1999a: 149b ff.) contains the myong byangs and man ngags passed down before and around Dharmashri for eclipse calculation. In it, we can read Dharmashri’s criticism of the ellipse calculation based upon his previous myong byang-s. Regardless of its apparent importance in Tibetan intellectual history, it is unfortunately difficult to pinpoint the writers and the texts that appear in it—mostly because it does not give full-scale information, and our modern accumulated knowledge on Tibetan rtsis research is too meager for us to speculate them. Most importantly, it seems that no texts remains among those it mentions.

\textsuperscript{267} De Jong (1967: 208-16) is one of the earliest research efforts, but unfortunately, it does not mention the astronomical content.
ngos su rtse mo lho nub bstan pa chung ba mthong / yang de’i qsum pa’i nyer gsum nyer bzhi nas bzung ste bzhi pa’i bcu gcig bcu gnyis bar du srod la me bzhi’i mdun dbo’i thad du skar chen ‘dra ba zhig las du ba rtse mo shar bstan dang / phyis su (supralinear note: lnga par) skar chung ‘dra ba du bas g.yogs pa lta las rtse mo cung zad thon pa byung / (sublinear note: bdun par 28 ‘od dmar byung) yang sa yos de’i zla ba bcu gcig pa’i bcu drug bcu bdun soqs nas srod la lho rgyal gyi rgyab ngos su rtse mo shar bstan zhig shar ba phyis su smin drug thad du slep nas yal song / sa glang (supralinear note: 1) lo’i bdun pa’i nyer bzhi nyer lnga soqs nas tho rangs smig (sic. smin) drug gi rgyab tu rtse mo nub btlas du ba cung zad ring tsam shar te yal nas phyis su dgu pa bcu pa’i mtshams su sa sros la yang shar / de’i phyi lo lcags stag gi lnga pa’i yar tshes lnga drug nas sa sros la shar drang thad du chu stod kyi g.yas su skar chung ‘dra ba du bas g.yogs pa nya zla ‘dra ba zhag ‘ga’ la shar nas / bcu nas byang ngos sme bdun thad du song nas zhag ‘ga’ zhig nas yal ba / mthong / de nas bzung ste sa phag lo’di’i bar (supralinear note: 10) du ‘dir ma mthong / ‘on kyang gong smos de dag gi tshes grangs snga phyi cung zad re nor pa yod dam snyam lags /268

I saw, a few times, drang srong (S. ṛṣi) du ba can. It was comparable to the statement that a long comet appeared in Mnga’ ris in the iron-tiger year of the previous 11th rab byung (rab drag) (lcags stag lo / 1650 C.E. ~ 1651 C.E.); a very long comet that appeared in the dusk was observed also in Amdo in the water-pig year (chu phag lo / 1743 C.E. ~ 1744 C.E.) of the 12th rab byung (rab nyi’l), but I forgot the date (15). A small comet appeared in the east in the 2nd hor zla, the last hor zla of the earth-tiger year (T. sa stag lo (= 1699 C.E. in this case)) of the 12th rab byung. Continuously, a small comet whose small peak was shown in the southwest, was observed to the north of Venus at daybreak of the waxing phase of the 3rd hor zla of the earth-hare year (sa yos lo / 1699 C.E.). Also a comet with a peak appeared from something like a big star, facing the uttaraphālgunī in front of hasta at dusk from 23rd/24th of the 3rd hor zla of the year to 11th/12th of the 4th hor zla, and later (supralinear note: in the 5th hor zla) [the comet’s] peak emerged a little from something like a small star, which is covered by the comet. (sublinear note: 28 red light emerged in the 7th hor zla). Also, there was one whose peak appeared in the dusk on the 16th/17th of the 11th hor zla in the earth-hare year (T. sa yos lo (= 1700 C.E. in this case) at the back of the southern continent faded away towards the kr̃ttikā later. A comet whose peak was towards the west at the back of the kr̃ttikā at daybreak appeared for some time and then disappeared on the 24th/25th of the 7th hor zla in the earth-ox year (sa glang lo / 1709 C.E. (supralinear note: 1)), and later appeared again at dusk on the border between 9th and 10th. One disappeared on the 10th towards the Big Dipper in the north and faded away some days after. Something like a small star covered by the comet, which is something like a full moon, appeared a few days directly on the right of the pārvāsādāḥ at dusk on the 5th/ 6th of the waxing moon of the 5th hor zla of the following year iron-tiger year (lcag stag lo / 1710 C.E.). Thereafter, it was not observed from that year to this year, earth-pig year (T. sa phag (1779 C.E. ~ 1780 C.E.) (supralinear note: 10)), However, I think that there may be a small error back and forth in the aforementioned dates.

268 Sum pa Mkhan po (1979c: 13a-13b).
The above passage clearly demonstrates comet-observational data coming down to Sum pa Mkhan po, and observations made also by Sum pa Mkhan po himself. My guess is that observations, records and relevant content that have been hitherto ignored may exist somewhere in Tibetan writings.

The example of an eclipse that I could identify is as follows: Phu klung Dge slong Blo bzang yon tan’s (17th c.) Nyi zla gza’ ’dzin gyi ri mo myong byang (1387 C.E. ~ 1687 C.E.) is mentioned by the Sde srid. “phu klung par g.yu (sic.) lo nas kyi rab bdun nas da lta’i bar gyi ri mo dang byung ba’i myong byang gi dpe ’dag par .../.” The translation “[I (= the Sde srid) witnessed] Phu klung Dge slong Blo bzang yon tan has the figures and the experience notes (myong byang gi dpe) from the seventh rab byung (beginning from 1387) up to now (around 1685 in which the Vaiḍūrya dkar po was completed) given by G.yu lo pa.” It is verified from the passage that the observations were made continuously over a long

269 For Sum pa Mkhan po’s observations of du ba mjug ring, see also note 576. We should begin to accumulate data and knowledge that enable us to assess the role of observation in the development of Tibetan astronomy in general, and in eclipse calculation in particular.

270 Dalai lama V conveys some information on this G.yu lo pa. See Dalai Lama V (2009: 22-4) and Dalai Lama V (2009a: 437): The lineage of the teaching heard is as follows: Dpal mgon 'phrin las pa - Phug pa Dpal seng pa (Dpal gyi seng ge) - Sngags 'chang G.yu lo pa (= Bla mkhyen G.yu lo pa) - Gnyag(s) ban Nang ra ba Bla mkhyen Ngag dbang 'jam dpal blo gros who is contemporary with Dalai lama V. Dpal mgon 'phrin las pa and Dpal gyi seng ge, who are important figures in the transmission of the Phug tradition, were active in the 16th century. See below note 285. And given the fact that Gnyag(s) ban is a contemporary of Dalai lama V, it is safely assumed that G.yu lo pa lived in the 16th or 17th century.

271 Sde srid (1996: 68). The 7th rab byung (rab bdun) ranges from 1387 to 1446. Since Blo bzang yon tan is a contemporary of the Sde srid, it is not likely that he observed and calculated the eclipses before the 17th century. Because Blo bzang yon tan received the myong byang from G.yu lo pa, it is possible that the latter also received it from his predecessors. It records the observations made in the 14th century. Tshul khrims rgyal mtshan (1986: 362) and Tshul khrims chos 'byor et al. (1982: 29) also mentions the myong byang without textual evidence.
period of time, from 1387 to around 1685. In particular, the Blo bzang yon tan’s two myong byangs 272 include his own calculation results together with observations. It is known from the notes in their kha byang (written by someone else, possibly by the Sde srid) that, rather than blind acceptance of observations made by Blo bzang yon tan and previous scholars and astronomers, a critical appraisal has been made of their observations and calculations. One of the kha byang of the two myong byangs reads as follows:

phu klung dge slong blo bzang yon tan gyi gza’dzin skor myong ba’i lab rigs /

“Humble view273 of the section on the eclipse experienced by Phu klung Dge slong Blo bzang yon tan.”

And right below it, there is the following note in red ink.

phu klung pa gza’dzin la brtson pa che ba nas chu phag lo dri (sic. possibly bris) ba byas pa la lar rgyud grel soqs yig cha dang ri mo rtsa ba ma phigs pa’i rtags mang bar mchan btab cing la lar yas mas ‘gal rgyab lhur274 myong byang la dga’g pa kyang yod do /

272 These texts contain Blo bzang yon tan’s observations and calculations of the eclipses which occurred during the 11th rab byung (roughly 1630s-1680s). This means that Blo bzang yon tan lived in the 17th century. They merit detailed research. It would fill in the gap in Tibetan history of astronomical observations in the context of ancient astronomy. Together with them, there is another myong byang composed of 38 folios. The kha byang reads as follows: “A clear note [written] with vermilion red color on the eclipses which occurred in the wood-mouse year (1684 C.E. ~ 1685 C.E.) in the 11th rab byung according to the treatise Vaidūrya dkar po and visual phenomena on the way back home.” (rab byung bcu gcig pa’i shing byi nas brtsams nyi zlar sgra gcan rim byung bstan bcos bai dkar nang bzhiin dang / yul lam du mthong snang rnams mthal skag soqs kyi mchan gsal bcas bkod pa ). In it, the observations of the eclipses during the 11th rab byung and the 12th rab byung are included together with skar rtsis calculations. All the three texts provide evidence that long-term observations of eclipses have been made, combined with criticism generated by real calculations of the values reflecting empirical corrections on time, node, etc.

273 The “lab” means chat. It is a humble way of expressing his speech and writing. The “rigs” means thought”, “thinking”, “view”. That is why the “lab rigs” is rendered as such by me.

274 The “rgyab lhur” is a tentative reading. The dbu med letters are not clear at all. The “rgyab” may be “rgyab ‘gal”. It may be given in this text as “‘gal rgyab”. The “lhur” may mean “lhur len” / “lhur blangs”. Since the two words are not clear, my rendering may be awkward.
“This note (T. mchan) has been made with many signs without understanding the fundamental values and the texts, such as Kālacakra commentary and others, in some calculations in the water-pig year (1683 C.E.) by Phu klung Dge slong Blo bzang yon tan with great devotion to eclipses. There exists denial of the experience note (myong byang) in which there are self-contradictory statements in some places above and below.”

The kha byang of another Blo bzang yon tan’s 10-folio text reads as follows:

\[
\text{rab byung bcu gcig pa'i nang gi nyo zlar sgra gcen 'jug tshul ri mo dang rjes rtags kyi mthong myong bkod pa bzhiugs/}
\]

“Herein exists the writing of the values of the way of Rāhu’s entering to the sun and moon and the experience [note or calculation] of the following sign (T. rjes rtags) within the 11th Rab byung.”

The following note exists right below the kha byang in red ink.

\[
\text{phu klung dge slong blo bzang yon tan gyi myong byang ri mo sogs la 'di gar rtsis shes 'dra ri mor zhus bskyar byed bcu pa la rang gi'ang nges pa'i yid ches tsam dang la lar dogs gnas zhal lung gi thun mong ba skar mda' me mig tu bzung ba dang thig le bzhi lnga brtsegs pa sogs ri mo yig cha'i rtsa ba ma phigs pa'i rtags kyang mang yang gza' 'dzin rang la re mkhor (maybe res 'khor) sā ra mngon/}
\]

“[I (possibly the Sde srid)] let someone who seems to know calculations repeatedly edit the values in Phu klung Dge slong Blo bzang yon tan’s myong byang, and [I] also have a confidence in understanding it with certainty. However, in some places, [I have two] doubts, i.e. that which [Blo bzang yon tan] apprehended the general method of the Pad dkar zhal lung as $5^23^9$ (T. skar mda’ me mig) and piled four 0-s or five 0-s. [As such,] there are many signs without [his] understanding the fundamentals of the text, ... ,”

\[275\] The myong byang is a note based upon experience and observation. The myong rtsis is a calculation based upon experience and observation. Both may be appropriate in this context.

\[276\] The “zhal lung gi thun mong ba skar mda’ me mig tu bzung ba” is not understandable. My translation is tentative. More research into the Pad dkar zhal lung and the myong byang is needed.

\[277\] The “thig le bzhi lnga brtsegs pa sogs” is not understandable. More research is needed.

\[278\] The part “yang gza’ ‘dzin rang la re mkhor sā ra mngon” is not understandable. So, I could not translate it. The sā ra (= rgya mtsho) seems to designate the Sde srid Sangs rgya rgya mtsho. More research is needed to understand this part.
It is not certain who (possibly the Sde srid?) wrote the criticism down. As criticism is a major part of Tibetan intellectual history, so is it a major factor in the research into rtsis. Of course, the criticism does not go beyond the boundary of the Kālacakra. The foundation and reasoning of the criticism is and remains within the Kālacakra.

Tibetans’ observations may not be restricted to eclipses, solstitial points, comets, etc. It is possible they recorded celestial phenomena observed via their naked eyes and instruments. It is speculated that besides the above examples, many examples await us in some unknown or known texts. If some data are accumulated, we could tackle the issue of how the observations have been reflected in real calculations through traditional and modern methods. Then, we could obtain a more detailed and broader perspective of Tibetan astronomy.
2.2. **MAN NGAG (ORAL INSTRUCTION): THE TRANSMISSION OF EMPIRICAL KNOWLEDGE**

Information regarding eclipse calculation in the *Kālacakra* is limited. Tibetan astronomers compare observations with real calculations through which empirical knowledge has been accumulated. In real eclipse calculations, empirical corrections have been applied to the eclipse limit, timing correction, duration, magnitude, direction, color, etc., for which relevant information is not found in the *Kālacakra*. It may be assumed that the process has contributed to the accuracy of eclipse calculation with the formation of the unique Tibetan *skar rtsis* astronomy.

Here, I focus on the development of empirical knowledge for eclipse calculation, passed down to later generations in the form of *man ngag*. It was combined with the *guruśīya* (master-disciple. T. *bla ma brgyud pa*) relationship within a school or tradition. There is no remarkable difference among different schools and traditions in terms of the process of eclipse calculation. However, minor differences are seen, which are partly related to the fact that each tradition has combined individual observations and empirical data. As a matter of fact, no uniform numbers and quantities in terms of the eclipse limit, timing, duration, magnitude, direction, color, etc. are seen in Tibet—even

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279 Empirical knowledge is the accumulated and non-theoretical knowledge formed by experience, observation, experiment, etc. Therefore, it is closely tied to 2.1. Nevertheless, the reason why I separate this part from 2.1 is that I focus on the media through which knowledge is transmitted: 2.1 is a record note (*myong byang*) combined with observation. 2.2. is oral instruction (*man ngag*) combined with sectarian transmission.
if all the methods in skar rtsis generally follow the same algorithm.\textsuperscript{280} For example, 'Bri gung Dkon mchog ’phrin las bzang po’s (1656-1718) Byed grub thun mongs (sic. read thun mong) kyi rtsis kyi bstan bcos khol bur ston pa mkhas pa dagyes pa’i spyod yul, written in 1678, seems to be a fundamental text for the development of the 'Bri gung tradition of eclipse calculation.\textsuperscript{281} He conveys the empirical knowledge he inherited for the calculation of eclipses. The empirical data date back to Dus zhabs Shākya dbang phyug (active. 15\textsuperscript{th} c.)\textsuperscript{282} at the latest. I am not sure of the exact location where he mentions this in his text, but at least some explanation for the direction is Dus zhabs’s knowledge transmitted by means of man ngag.\textsuperscript{283} In later periods, the knowledge transmitted to and described by Dkon mchog ’phrin las bzang po keeps finding its way continuously into the 'Bri gung tradition. For example, an unknown author in the sect, which is based upon byed rtsis (this is an influence from the Sde srid), combines man ngag and myong rtsis that was transmitted to him. It gives more credence to Dharmaśrī’s Nyin byed snang ba (1990) with a grub rtsis

\textsuperscript{280} For an understanding of the Tibetan algorithm of eclipse calculation, see Henning (2007: chapter 3).

\textsuperscript{281} Dkon mchog ’phrin las bzang po (1975: 54a) was written during the day of the waxing moon on the fifth month of 1678 C.E. (= dus kyi pho nya yi snron zla ba’i yan tshes). He was the 24\textsuperscript{th} abbot of 'Bri gung monastery ('Bri gung che tshang 02, 1656-1718). For him, see 'Bri gung Bstan 'dzin Pad ma’i rgyal mtshan (1770-1826) (1989: 289-303). For the Chinese translation, see Kezhu qunpei (1995: 226-36).

\textsuperscript{282} He is known as a kālacakra scholar of the lineage of the snye mo sku zhang. For a brief overview of the lineage, see http://www.tbrc.org/#!rid=G4397: “This seat of the zhwa lu sku zhang of snye mo is meant a monastery of the Bu ston lugs of the kālacakra located in Phu gsum shang founded in the 11\textsuperscript{th} century by Zhwa lu sku zhang Bkra shis rgyal mtshan.”

\textsuperscript{283} Dkon mchog ’phrin las bzang po (1975: especially, 51b).
stance in terms of the practice of nur ster (nur byin) As seen from this, Tibetans attempted to make sense of rtsis (calculations) on the basis of all the possible sources available.

Each sect, which quite possibly incorporated the observations and empirical data available in each region, continuously absorbed and embraced empirical results. The accumulated empirical knowledge has been transmitted as man ngag within each sect. In particular, before the methods in the Sde srid’s Vaiḍūrya dkar po, Dharmaśrī’s Nyin byed snang ba and Gser gyi shing rta took deep roots in Tibet, it is highly possible that each sect transmitted different values and methods reflecting regional differences, even if the method and procedure were already fixed. We need more knowledge regarding this; if data are accumulated, we may be able to clarify the meaning of the numbers by means of modern and traditional methods. It should be also noted that although the Sde srid’s Vaiḍūrya dkar po and Dharmaśrī’s Nyin byed snang ba, Gser gyi shing rta have taken deep

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284 Anonymous1 (1985: 295). We can obtain a little information on this text in Anonymous1 (1985: 302): “Written by the one entitled khri chen as is spoken by Khri sprul rin po che Chung tshang,” (khri sprul rin po ches chung tshang gsung ltar / khri chen ming gis lags so /). We do not know who the author is, but it is certain that he is a contemporary of Dharmaśrī at the earliest and possibly later than Dharmaśrī. He uses the byed rtsis method and is well aware of Dharmaśrī’s grub rtsis method. Anonymous1 (1985: 301): “This is nothing but byed rtsis: if compatible with grub rtsis, sgra gcan nur ster 0°31'41''10(23) (i.e. correcting the longitude of sgra gcan mjug or sgra gcan gdong by subtracting the value 0°31'41''10), and the nur ster of chu tshod (adding some chu tshod) to time, etc. the Nyin byed snga ba is more profound.” (’di ni byed pa kho na ste / grub pa’i rtsis dang bstun pa na / sgra can (sic. gcan) nur te bya ba dang / (0 31 41 4 10) dus la chu tshod nur ster sogs / nyin byed snang ba zab par ’dug / ). And Anonymous1 (1985: 299-301): Solar eclipse condition adopts Phyag mdzod’s value: sun – sgra gcan gdong < 50°, sgra gcan gdong – sun < 5°, sun – sgra gcan < 8°, sgra gcan ’jug (sic. read mjug) – sun < 40°. See Henning (2007: 129). There is an intriguing man ngag in it: Anonymous1 (1985: 301): “Furthermore, it is said that [when the sun] is close to Mercury and Venus, solar and lunar eclipses are difficult [to occur] and even if they occur, the size is small and the length is short.” (gzhan yang lha’ag pa pa sangs gnyis / nye ba nyt zla ’dzin dka’ zhing / ’dzin kyang cha (sic.) chung yun thung gsung / ). Observations have been made continuously and the empirical knowledge and data accumulated have been transmitted by means of the guruṣīya.
roots since they were publicized, the values and methods accumulated prior to them were not simply ignored. Rather, they remained as a possible explanation. This may cause a hermeneutical issue, which will be mentioned below. No definite answer or solution is given in the text.

Thus, we may read the traces of the different numbers and quantities and methods in later rtsis texts. That could mean that later texts may be the confluence of the earlier and lingering traditions, which show evidence of the indigenous sectarian methods. Again, we need more research into the transmission of astronomical data in individual sects. Through experiences (myong rtsis) and observations, which have been transmitted in the form of man ngag and possibly with sectarian differences, Tibetans have filled a gap of knowledge which does not exist in the Kālacakra. Experiences and observations have been regarded as sources of reliable knowledge in the case of rtsis.

In another example showing that the accumulated empirical knowledge has been transmitted in the form of man ngag, or a certain method of transmission, Ku sri skyabs—who appears to belong to Chos kyi dbang phyug’s tradition in the west (Brag dkar rta so in the region of Mang yul)—introduces empirical knowledge transmitted from such Phug scholars as Mkhas dbang 'Chi med bde ba and Mang thos Shākya rgyal mtshan.

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285 'Chi med bde ba (16th c.) appears passim in the Sde srid’s G.ya’ sel. For example, see the Sde srid (2002: Vol. 1, 162): “the existence of the ‘Od zer brgya pa of Dus rams pa ‘Chi med bde ba.” (dus rams pa ‘chi med bde ba’i ‘od zer brgya par yod pa). The Sde srid (2002: Vol. 1, 279) indicates that he is one of the disciples of the well-known Phug pa scholar Dpal mgon ‘phrin las pa (15th c.-16th c.): “Dus rams pa ‘Chi med bde ba heard skar rtsis and nag rtsis well from Dpal mgon ‘phrin las pa.” (... dpal mgon ‘phrin las par dus rams pa ‘chi med bde bas legs par rtsis dkar nag gsan). Ngag dbang (2002: Vol. 2, 341) [= the Sde srid (2002: Vol. 2, 341)]: “From the key teaching of the ‘Od zer brgya pa, a commentary on Dbyangs ‘char, which is an extremely profound tradition transmitted from only Dus rams pa ‘Chi med bde ba.” (... dus rams pa ‘chi med bde ba nas brgyud pa’i ches zab pa chig brgyud ma’i dbyangs ‘char gyi ’grel ba ‘od zer brgya pa’i bka’ gnad las ...). The “chig brgyud ma” means a
had no chance to read any short pieces collected in a disorderly manner. Hitherto-unknown astronomers are personally.

Drukpa Kargyud Institute, 1985), is another work by the.

The subsequent garland of the zla ba'i 'od zer / nor bu bde ba chen po'i 'dra dpe'o /

Mang thos Rdo rje, but I had no chance to read personally.
being mostly based upon the Sde srid’s byed rtsis for eclipse calculation. 287 Since I have not found the methods used by the two elsewhere, this is a valuable source to show both their methods and how previous methods were incorporated into the later text without simply being dismissed.

Furthermore, in case that the remainder of the difference [between] tshes ’khyud zla skar of the byed rtsis and grub rtsis [in accordance with] the tradition of the linear transmission of

286 If Ku sri skyabs belongs to Chos kyi dbang phyug’s tradition, it leaves room for questions regarding how the knowledge of ’Chi med bde ba and Shākya rgyal mtshan survived in the West. In fact, we have no knowledge about the author. Once he is identified, we will be able to go further. Ku sri skyabs (1979) conveys much information and simultaneously asks many questions in terms of the transmission of astronomical knowledge after the Sde srid. It is surely an important text in rtsis studies.

287 Ku sri skyabs follows the Sde srid’s eclipse calculation method based upon the byed rtsis. For example, Ku sri skyabs (1979: 36b-37a)’s judgement of the possibility of eclipse is based upon the Sde srid’s byed rtsis method. He presents the distance between Rāhu and the moon (sgra gcan zla ba’i bar khyad): the moon – gdong < 57, gdong – the moon < 50, dus me (= sgra gcan mjug) – the moon < 50, the moon – dus me < 45. The conditions are the same with the Sde srid’s value. See Henning (2007: 104-5). For the Sde srid’s defense of byed rtsis for eclipse calculation because of empirical reason, see the Sde srid (1996: 69). The Sde srid defends byed rtsis, but he does not present an explanation of why byed rtsis is right or should be used. For more information on the Sde srid’s menthod for eclipse calculation, see Henning (2007: chapter 3).

288 phud = khyer = divide.

Mkhas dbang 'Chi med bde ba and Mang thos Shākya rgyal mtshan and Rāhu’s head or tail whatever [the value] is close [to the tshes 'khyud zla skar], which subtracts the smaller one from the bigger one [among the two values] is 0 skar gnas / 52 ghaṭikā (or daṇḍa) below, there will be a [lunar] eclipse in byed rtsis and if the difference is 0/15 below, there will be a [lunar] eclipse in grub rtsis. If there is an eclipse in byed rtsis, but there is not in grub rtsis, then 30 are added to the tshes 'khyud zla skar of the grub rtsis and [the result] is subtracted from the value where the quotient after being divided by 60 is added to the skar gnas. If the difference is 46 below, there will be an eclipse. If eclipse value agrees without adding the difference of chu tshod in the grub rtsis, [ ] is obscured being bigger than byed rtsis. If there is an eclipse in the grub rtsis, but there is not in the byed rtsis, then, there will not be an eclipse, due to being mainly based upon the Bsdus rgyud (S. Laṅghukālacakra). As for the size, divide the chu tshod of the difference [between tshes 'khyud zla skar and the Rāhu value] by 5. In the case that the quotient is 0 ~ 4, [there will be] a total lunar eclipse. [However,] in the case that the remainder after the division is 1 ~ 3, light will remain a little at the rim (= not completely obscured). In the case of the quotient 5 ~ 10, each obscured each. In the case that the remainder after the division is 4 ~ 5, there will be a lunar eclipse. [The information] was stated by [Mkhas dbang 'Chi med bde ba and Mang thos Shākya rgyal mtshan].

Whether all the values and methods in the above passage were given by 'Chi med bde ba and Shākya rgyal mtshan are not clear. Actually, Ku sri skyabs relies more on byed rtsis than on grub rtsis regarding the judgement of eclipse possibility. It may be the influence of the Sde srid. Or, ‘Chi med bde ba and Shākya rgyal mtshan may have also based more upon byed rtsis.

Next, let us think about how Ku sri skyabs deals with the conflicts, contradictions and uncertainty that may occur in the transmission and expansion of knowledge by means of man ngag, emergence of advanced texts, mutual interactions, etc.

\[\text{gnyis pa nying \textquotesingle dzin ri mo cung khag kyang / ... che chung sbyang lhag ... shākya rgyal mtshan lugs / sbyangs lhag mes (3) bsgyur dus (6) bges thob nor la / gzugs (1) shar drug cha me shar sum cha dang / mda (5) shar sum gnyis ri (7) shar ril bor sgrib / bcu bdun (17) phyed sgrib nyer gnyis (22) sum cha sgrib / gsun kyang mkhas pa'i gsung rnaams cha sdur rtsi / sgrub par sbyang lhag bcu (10) tshun 'dzin pa dang / lhag na mi 'dzin byed par 'dzin pa shar / sgrub par ma shar nyan dag chu tshod}\]

\[\text{He means the following: 5: } \frac{5}{6}, \frac{4}{6}, \frac{7}{6}, \frac{2}{6}, \frac{3}{6}, \frac{8}{6}, \frac{2}{6}, \frac{9}{6}, \frac{1}{6}, \frac{10}{6} \text{ obscured each.}\]
Secondly, solar eclipse values are a little difficult, but ... size, the difference (T. sbyang lhag.
remainder after subtraction) ... the tradition of Shākya rgyal mtshan says that the
quotient obtained from multiplying the difference by 3 and dividing by 6: 1 rises: \(
\frac{1}{6}
\), 3
arises: \(
\frac{2}{3}
\), 5 arises: \(
\frac{3}{5}
\) arises : total eclipse, 17: \(
\frac{1}{2}
\) obscured, but [ ] compare the
statements of other learned scholars and calculate. If the difference is 10 below in grub rtis,
there is an eclipse; if [the difference] is 10 above, there is no eclipse, but there is an eclipse
in byed rtis [in the latter case]. In the case of no eclipse in the grub rtis, if [the result]
reaches 60 [by] adding 30 to the chu tshod of the value of nyi dag, there is an eclipse. If the
difference between the result and Rāhu, whatever is close, is 40 below, there is an eclipse,
and if an eclipse occurs without adding the difference in grub rtis, [ ] take the grub rtis as
a basis. Timing is as follows: in the byed rtis, [the sun is] obscured at that point of the
completion, i.e. [at the time of] adding 10 to the tshes long of the byed rtis in the case of
gdong 'dzin (eclipse by sgra gcan gdong), and [at the time of] adding 14 to the tshes long in
the case of 'jug 'dzin (eclipse by sgra gcan mjag). In grub rtis, [the sun is] obscured [at the
time of] the tshes long at the point of the completion ... This is chapter seven of the Rtsis zhi
(sic. gzhii) rin chen 'phreng ba, which derives from the intended meaning of the Vaiḍūrya dkar
po, that wrote the values of the way of the moon and sun’s being obscured by Rāhu,
including myong rtis phran bu written by Mkhas dbang Grwa phug pa, 'Chi med bde ba,
Mang thos Shākya rgyal mtshan, etc. on top of leaving the intended meaning (T. dgongs
don) of the uncertain (T. mngon med) treatise Vaiḍūrya dkar po untouched.

This passage begins with the famous phrase seen in the explanation of solar eclipses in
Tibetan rtis texts, i.e. “solar eclipse calculation is difficult.” It is mostly based upon myong
rtis of Grwa phug pa, 'Chi med bde ba, and Shākya rgyal mtshan each of who seems to
have written Myong rtis phran bu.292 This may mean that man ngag is not the medium of


292 It is difficult to pinpoint which solar eclipses each scholar witnessed. It would be a huge and difficult
project to investigate all solar eclipses during their lifetimes. Modern technology may give some answers
for the venue and time when the solar eclipses were observed and some rationale for why the values were
given as such.
the transmission of their knowledge based upon observations. From the above passage, it is not difficult to imagine that eclipses were observed, recorded, compared and contrasted with real calculations, and that some empirical values were formed during the period the Phug scholars. Of course, it would be better to say that such observations, calculations and recordings must have occurred from the beginning of the Tibetan skar rtsis or earlier. Unfortunately, not many materials have been found yet. I hope more materials emerge. Ku sri skyabs (1979) is a rare instance that manifests the eclipse calculation method by early Phug scholars.

Going back to my topic, I focus on hermeneutical issues that can be approached from the following two issues: conflict and uncertainty. In the first case, Ku sri skyabs attempts to make sense of the longitudinal difference between grub rtsis and byed rtsis, which caused serious problems in Tibetan eclipse calculations. He also asks other scholars to compare and contrast multiple sources with criticism regarding the emergence of no correspondence between rtsis and eclipse phenomena. However, even if a system is contradictory to real phenomena, he does not repudiate it. It remains as a possible method and keeps being compared and contrasted with other methods. This is because many parts of Tibetan eclipse calculations are justified by empirical knowledge. It may be that it aims at “saving the phenomena” in a situation where theoretical approaches are inherently limited—since the Kālacakra corpus, the only locus through which Tibetans could learn astronomical theory, does not work.
For the second case, Ku sri skyabs is based upon Buddhist hermeneutics. In the above passage, he mentions “intended meaning (dgongs don) of the uncertain (mngon med) treatise Vaidūrya dkar po.” Regarding the solar eclipse calculation, he says:

'khrul med bsdus rgyud dgongs don gtso / ... mkhas dbang mi rje sangs rgyas rgya mtsho'i bka’ rtsom 'bai dkar dgongs don 'khrul med yin / . 293

[take] the unmistaken bsdus rgyud as a main intended meaning (T. dgongs don). ... The intended meaning (T. dgongs don) of the Vaidūrya dkar po, the writing of the Sde srid, king of learned ones, lord of men, is unmistaken.

The “unclear” part in the Sde srid is dgongs don. In other words, it was intended by the Sde srid. Moreover, in the following, the dgongs don is applied very vaguely and comprehensively in terms of solar eclipse condition, size, time, etc.:

padma dkar po'i zhal lung phugs (sic.) lugs thams cad mi mda' (sic. read gda') ba'i dgongs pa'i don / gsal por ston pa'i 'jam dbangs mi'i rje sa ri'i bka' rtsoms mngon med bai dkar ma bu'i dgongs don chu thigs tsam zhig ri mo'i lam nas phyin phyi (sic. read ci) ma log par mkhas dbang brgyud pa'i phyag rgyun ltar lhur blangs nas / ... . 294

... having made efforts regarding the intended meaning (T. dgongs don) of the uncertain (T. mngon med) compositions, Vaidūrya dkar po, the mother-text, and the son-text (T. ma bu)295 of Mañjuśrīghoṣa lord of men Sa ri (= the Sde srid) which clearly show the non-existent intended meaning (T. dgongs pa'i don / dgongs don) of all Phug traditions [including/represented by] the Pad dkar zhal lung, by means of the values of a mere drop of water, unmistakenly according to the lineage of the learned scholars ...

293 Ku sri skyabs (1979: 44a-47a).

294 Ku sri skyabs (1979: 72b).

295 The ma is the Vaidūrya dkar po; the bu is Nor bzang rgya mtsho’s texts.
According to Ku sri skyab s, the unclear part in the Pad dkar zhal lung is elucidated by the Sde srid’s Vaiḍūrya dkar po. This means that the former has dgongs pa. Ku sri skyab s himself explained the unclear part in the Sde srid’s Vaiḍūrya dkar po by referring to different traditions that preceded him; they possibly include writings and man ngag in his traditions. Therefore, the Sde srid’s text is regarded as dgongs pa can (= require further explanations). Ku sri skyab s strikes a compromise between his research and the Sde srid by assuming that his writing is exactly what the latter intends (T. sor bzhag. “put as it is”). We do not know how he can make this assumption.

The hermeneutical tool dgongs pa is not merely related to the justification of experiences and observations as noted above, but also may be related to making sense of astronomy in general. For example, if the Kālacakra is “not clear but unmistaken”, then it needs further explanations (= dgongs pa can). From a different perspective, it may be said that the abstraction and esoterism in the Kālacakra leads to skar rtsis, which may be regarded as that which elucidates the “unclear” points according to the “unmistaken” Kālacakra, being based upon concrete observations, experiences, empirical knowledge, even different traditions, etc.

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296 For the division between neyartha and nīṭārtha in Buddhist hermeneutics and the four criteria for neyartha in the Tibetan hermeneutics, dgongs pa (S. abhiprāya), dgongs gzhi, dgos pa (S. prayojana), and dngos la gnod byed (S. mukhyārthādha), see Seyfort Ruegg (1985: 309): “dgongs pa “intention, intended meaning, purport” and dgongs pa can “pertaining to intention, intentional,” said of a sūtra text the surface meaning of which does not reflect the ultimate and definitive intention of the Buddha.” See also Seyfort Ruegg (1988: 1-4), and Lopez (1988: 55-6).
Does this make sense? We might conjure up a simple response: The reason why *dgongs don* is raised in Tibetan astronomy is that information in the *Kālacakra* or *skar rtsis* texts is lacking or is wrong/different. In other words, the information in it is not “unclear and unmistaken.” Moreover, the hermeneutic strategy may raise some obscure points: It seems difficult to demarcate between 1) and 2). The “uncertain” includes “wrong?” By which criteria is a certain opinion or argument embraced or rejected? Considering the conflicting situation among knowledge sources, can the term *dgongs pa* be used? And can the *dgongs pa* be applied to the interpretation of the texts/methods which had existed even before certain knowledge was formed? Can this situation be regarded as “uncertain”? It may be intriguing to answer these questions by using astronomical texts based upon Buddhist hermeneutics. However, the final and ultimate answer looks to be fixed as far as my observations are concerned. In other words, it is a paradox.

At some point, some observations, data, arguments, etc., may appear contradictory or “uncertain”, but will be compromised and interpreted under the bigger scheme of the *Kālacakra*. The seemingly conflicting different knowledge sources including experience, text, canon, etc., will be applied in individual cases without being discarded, thereby strengthening the extant system. Every single source for eclipse calculation is partly true and partly wrong if not written in the *Kālacakra*. There must not exist contesting sources in the Tibetan conception.

In Tibet, transmitted knowledge was not simply discarded by later scholars. Rather, making sense of and reconciling it with various later sources were made not only in eclipse calculations but also in astronomy in general. In the course of doing so,
Buddhist hermeneutics based upon the concept of *dgongs pa* became a solution when scholars were confronted by “unclear” points.

The *man ngag* is inherently combined with observations, empirical analyses, and so on, some of which has been identified in *rtsis* texts. It is also assumed to have interacted with the textual traditions, and it comprises a significant part of the transmission of astronomical knowledge. Inevitably, it is involved in the Buddhist hermeneutics, about which we may find more textual evidence in the future. In fact, Buddhist hermeneutics may penetrate every single aspect of the interpretation of religio-astronomical phenomena. In other words, we may be able to find more evidence regarding how it has been applied also in *myong byang*, *dris lan*, *skar rtsis* commentaries, and even *rgya rtsis* exegeses.

2.3. **DRIS LAN** (LETTERS): CRITICISM, DEBATES AND DISCUSSION AMONG SCHOLARS

One of the non-textual knowledge sources consists of interactions among intellectuals. Many topics related to observations, empirical data, discussion on astronomical texts, different opinions and traditions that either strengthen or decline astronomical ideas were discussed and debated. Examples are found in such texts as *chos ’byung*, *rtsis*, *dris lan*, etc.

In this work, I attempted to present some astronomical ideas seen in letters. Repeated interactions among scholars facilitated sharing and exchange of information as
well as criticism. Many productive and fruitful words and ideas must have disappeared, but the genre of *dris lan* fortunately offers a wide range of topics and issues such as theories, calculations, religious/ philosophical viewpoints, different traditions, etc., regarding astronomy. Scholastic concerns not seen in treatises or commentaries are described vividly and concretely in this genre. It has contributed to strengthening the *skar rtsis / Kālacakra* system.

For example, the letters that contain astronomical contents include Byang bdag versus Mkhās grūb, Dharmaśrī’s letter to the Sde srid in the *Dri lan skor rmongs pa’i mun sel legs bshad nyi ma’i snying po las skar nag rtsis kyi dri lan skor phyogs bsdus.* Ngag dbang to the Sde srid is included in the Sde srid’s *G.ya’ sel.* Sum pa Mkhan po versus the Paṇchen lama is included in Sum pa Mkhan po (1979c). Sum pa Mkhan po versus Ngag dbang nyi ma is included in Sum pa Mkhan po (1979c). Aside from these, there must be many *dris lan* that mark important moments of Tibetan history of astronomy. So far they have been ignored by modern scholars, and they await research.

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297 For the texts in which the letters are included, see below note 590.

298 See *van der Kuijp* (2012: 2).


It is certain that *dris lan* offer a wealth of information on astronomy, but reading *dris lan* has its limits. Some letters were replied to, but some were not. Also, some replies may have disappeared. Moreover, answers may deviate from the original questions partly because they are not given during face-to-face discussion or debate. Most of all, it is difficult to concentrate on solving a certain topic or issue consistently. It is highly possible to end as a letter of Einmaligkeit.

There may exist more methods and approaches for the accuracy of eclipse calculations in *skar rtsis*, but the above three appear typically. Next, we will look into the Tibetan response to Chinese astronomical systems, which may be one of the most salient features in the 18th century.

### 2.4. THE MĀ YANG RGYA RTSIS: RESEARCH INTO DIFFERENT TRADITIONS

The Tibetan astronomy has absorbed neighboring traditions on the basis of the Indic *Kālacakra* tradition since the beginning. One of the most important external traditions in the 18th century is Qing Chinese astronomy. In this section, I focus on how

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* The *Kālacakra* is regarded as the text of the last phase of Indian esoteric buddhism. It means that after the transmission of the text into Tibet, the transmission of astronomical knowledge from Indian Buddhism lessened. Of course, some techniques from the west seems to have been transmitted sporadically. For example, Phyag mdzod conveys a tradition from Nepal named *kar myang gi rtsis*. It is a tradition related to precipitation. Its epoch is 78 C.E. We have no idea when it was introduced. For more information, see Huang and Chen (1987: 232). In later periods, especially after the 17th century, interests in Chinese astronomy/astrology/almanac were active. Because my research focuses on the 18th century, I have no choice but to tackle the Qing Chinese astronomy/astrology introduced to Tibet. It should be noted that later periods are not the only periods where we can witness Tibetan attention to Chinese astronomy. On the contrary, it was
the Tibetan skar rtsis astronomy absorbed the different traditions and methods in eclipse calculations. In that respect, the first Mā yang rgya rtsis text, the Rgya rtsis snying bsdus, reproduced in Huang and Chen (1987a) and the Rgya rtsis chen mo (see the section of political concern following this section) are important. — the Rgya rtsis chen mo predates Rgya rtsis snying bsdus. But the former has no real significance for the history of Tibetan astronomy. — In this chapter, I will introduce the historical background of these two texts and the mathematical and calculational background in the fourth and last chapter.

THE TRADITION OF THE MĀ YANG RGYA RTSIS

ubiquitous since the Tibetan Empire. Such records are easily found in some texts. If we find textual evidence in Chos ’byung text, for example, Bsod nams rgyal mtshan (1993: 74) writes the following during the time of Thon mi sambho ta (7th c.): shar gya dang / mi nyag gi yul nas bzo dang rtsis kyi dpe blangs / For the English translation, see Sørensen (1986: 180). A similar account is found in Dpa’ bo (2006: 100) for the same period: “[ ] received books of technology and astrology from China and Mi nyag (possibly Tangut) in the east”. (shar phyogs rgya dang mi nyag nas / bzo dang rtsis kyi dpe rnam blangs /). And except for the Kālacakra, Tibetans have never conducted full-scale research into different astronomical systems. Later period Mā yang rgya rtsis is also just the introduction of eclipse calculation algorithm included in the Lixang kaocheng. In other words, under the situation that the Kālacakra astronomy and cosmology is dominant, only the adoption of eclipse calculation methods was made.

It is known that the tradition in Amdo began from Mā yang Bzod pa rgyal mtshan. Texts belonging to this tradition are not plentiful. The Bla brang bkra shis ’khyil Catalogue edited by Grags pa (1985: 42-7) lists several important texts such as Drung yig (2006), Dpa’ ris Sngo kho tshang’s Bsam ’phel dbang gi rgyal po, etc. The text title indicates that of Ser chen Zhabs drung (1861). I have no idea of the relationship between the two. Future researchers may have gain access to ’Jam dbyangs bzhad pa’s library at Bla brang bkra shis ’khyil in which the texts in the Catalogue are stored. Dme shul Chos ’phel’s Pad dkar chun po rgyas pa, — See Schuh (1973: 309) : No. 324/ Hs. sim. or. JS 626. Mā ha cina’i rtsis la nye bar mkho ba dbugs sgang gi ri mo bsgrub tshul dang tshes grangs kyi re’u mig nam mka’ mig dbang lag pa’i grangs su spel ba padma dkar po’i chun po bcas (Epoch: 1900). — Pad dkar chun po bsdus pa, Bṛtag thabs shes rab ral gri and its re’u mig. Recently, Ahua Awanghuadan (2013: 324) confirms that Guojia tushuguan in Beijing has ’Ul gyi ba thu’s (possibly < M. Öljelbatu) Ma hà cì na’i lugs kyi nyl zla gza’ dzin gyi mo ’bri tshul 34 folios. See also Huang (2002: 216). Bzod pa rgyal mtshan, the founder of the so-called Mā yang rgya rtsis in Amdo, is difficult to identify, but the date and area of the aforementioned astronomers are mostly identified. Except for ’Ul gyi ba thu, who was active in Beijing in the late 19th century, they appeared in Amdo after the 19th century. Among them, Ser chen Zhabs drung and Drung yig are earlier Mā yang rgya rtsis writers. Ser chen Zhabs drung’s writings give some information on the dissemination of the tradition in Amdo. For example, Ser chen Zhabs drung (1861: 20b), which is a nearly unreadable dbu med writing: “May the practice of rgya rtsis be clarified like daytime by this
one that Khri rin po che Sngo khyo Spyan snga Ngag dbang legs bshad nyi ma at Mchod rten thang bkra shis dar rgyas gling gave big presents such as silk scarf, three sku-ś (statues), and ... , received the insistent speech [made by him] that there is a need to compose a complete and elaborate rgya rtṣis section, with great reverence, and Ser chen sprul sku named Ki rti shā sa na rda rā (~ S. Kīrtiśāsanadhara > T. Grags pa bsthan ’dzin) wrote at the age of 43, at the time of the completion of the 15th day of the third month (nag zla) in the 14th rab byung iron-chicken year (1861 C.E.) at Zhwa dmar bkra shis chos gling dgon!” (~ mchod rten thang bkra shis dar rgyas gling gi khri rin po che sngo khyo spanya snga nas nrog dbang legs bshad nyi ma lha dar sku gsum dang / dam chos x (illegible) ljid mo soṣ gšol ras rgya chen po gnang ste ’di skor cha tshang rgyas pa zhig brtсанs dgos zhes bka’anal chen po gnang ba spyi bos blangs te / zhwa dmar bkra shis chos gling dgon gyi ser chen sprul ming ba ki rti shā sa na rda rā sras rang lo tse gsum pa rab yid lcags bya’i lo nag pa zla ba’i tshes bco lnga’i nyin rdzogs par sug bris byiṣ pa’ ’dis kyang rgya rtṣis kyi lag len nyin mo litar gṣar bar gyur cig / ). For research into Sngo khyo Ngag dbang legs bshad nyi ma (19th c.) him, see http://www.tbrc.org/#/rid=P368: He is a teacher of Brag dgon Zhabs drung. For Mchod rten thang bkra shis dar rgyas gling (Ch. Tiantsangsi (天堂寺)), see Pu (1990: 554-6), Smith1 (2013: 299, 435): it is located at Dpa’ris (Ch. Tianzhu 天祝). The colophon of Ser chen Zhabs drung’s other writing (n.d.: 20a), which is the appendix to Ser chen Zhabs drung (1861): “The appendix for establishing bskal li.” (bskal li bsgrub tshul zur du bkod pa / ). Ser chen Zhabs drung (n.d.: 21a): “in the sa ga month of the water-dog year in the 14th rab byung (1862 C.E.) in the method/tradition of...”. (... lugs su rab yid chu khyi’i lo sa ga’i zla la ...). This part is mostly illegible. And Ser chen Zhabs drung (n.d.: 20a-20b): “After Mkhas dbang Drung yig Thub bstan rgya mṣṭho at Bla brang bkra shis ‘khyil heard that there are a few rgya rtṣis sections which accord with the current hwang li (~ Ch. huangli 黃歷 / huangli 黃歷), the letter sent out requesting to send whatever rgya rtṣis sections exist to me, together with a silk scarf, arrived, but ... Sngo khyo Sprul sku Rin po che (I have no idea who this is) says “please compose an entire section of this!” to me, [gave] gifts of white silk scarves and [I] kept the words, with a golden head ornament, in mind (= never forgot the words) changelessly, and Drung yig Thub bstan rgya mṣṭho also via letter gza’ skar, nyi khams (Ch. ganzi 干支), intercalation method, big and small month (30 day month/ 29 day month in the Chinese lunar calendar), dus gzer (Ch. jieqi 节气), eclipse, sa glang, etc., ... .” ( kho bos da lta’i hwang li dang mthun pa’i rgya rtṣis skor re gnyis byiṣ yod pa bkra shis ‘khyil gyi mkhas dbang drung yig thub bstan rgya mṣṭhos gsaṅ nas / bsdag la rgya rtṣis skor gang yod bskar dgos tshul gyi yi ge lha rdzas rten bcas gnaṅ ba lag tu ‘byor yang ... sngo khyo sprul sku rin po ches bsdag la ’di skor cha tshang zhig rtṣomsh sgsi ces lha dar dkar b’i x (illegible) legs skyes dang / bka’la γyur med gser gyi cod paṅ sgtṣug tu bcings pa dang / drung yig thub bstan rgya mṣṭhos sgar yang yi ge’i lam nas nyin re’i gza’ skar / nyi khams / bshol dang / zla ba che chung / dus gzer / gza’ ’dzin / sa glang sogs x (unclear) ci rigs la brtsans pa dang / ... ). The condition of the dbu med of Ser chen Zhabs drung (n.d.) is poor. The typed Tibetan of the colophon has been also given in Huang (1987: 242). For sa glang, see Henning (2007: 176-80). Taken together, Ser chen Zhabs drung is a sprul sku at Zhwa dmar bkra shis chos gling dgon (~ Ch. Xiamasi 夏玛寺). — For the monastery, see Wang Qian and Dan qu (2000: 177): it was founded in the 17th century and is located in present-day Dpa’ris. For its location, see Smith1 (2013: 300, 436). — And he is a contemporary of Drung yig and Brag dgon Zhabs drung Dkon mchog bstan pa rab rgyas. Drung yig is verified to be a secretary at Bla brang bkra shis ‘khyil. A little more information on him is confirmed in Brag dgon Zhabs drung (1987a: 93a) [= Brag dgon Zhabs drung (2006: 1367)] whose original epoch is 1867. The original print is not available to me. In both of these (both 1987a and 2006), the rtsis ‘go has been changed into 1987/3/0 by the lamas who are responsible for the creation of an annual almanac in the Dus ’khor grwa tshang at Bla brang bkra shis ‘khyil (T. dus ’khor grwa tshang gi ri thu’ gan ’khor ba rnam) and was carved by the lamas named Blo bzang sbyin pa and Bstan pa at Bla brang bkra shis ‘khyil (They possibly also belong to the Dus ’khor grwa tshang). Brag dgon Zhabs drung (1987a: 92b-93a) [= (2006: 1367)]: “Drung yig Thub bstan rgya mtsho placed the summary of the necessary section as it is in the form of appendix as the great throneholder (T. khri chen) Vajradhara Dbal mang Paṇḍita Dkon mchog rgyal mtshan was diligent in the way correct values must exist in the rgya rtṣis section. Drung yig Thub bstan rgya mtsho, who has knowledge of the five sciences, and his disciple Rgyal mtshan bstan pa did multiplication and division of (calculated the values and editing, etc. ... .” (rgya rtṣis skor kyi ri mo rnam dag zhig dgos tshul khri chen rdo
The *Rgya rtsis snying bsdus* is divided into three sections: calculation of true conjunctions (T. *dag pa’i nya* / *dag pa’i tshes*), method of calculating a lunar eclipse, and method of calculating a solar eclipse.\(^{303}\) Let us first discuss the authorship together with its origin and provenance. Its authorship is problematic.\(^{304}\) After investigating some *Mā yang rgya rje*’s sources, I estimate that the *Rgya rtsis snying bsdus* tradition did not fully blossom even in the 19th century. Rather, the tradition looks to be in the beginning phase, as evidenced by the curiosity about and interests in the tradition from contemporaries of the two writers.

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\(^{303}\) For a understanding of this tradition, see the excellent research of Huang and Chen (1987a). Since the original manuscript of the *Rgya rtsis snying bsdus* reproduced by it is not available, I follow the computerized text and the numbering in Huang and Chen (1987a).

\(^{304}\) Huang and Chen (1987a) insists that *Mā yang Bzod pa* rgyal mtshan, who was active around 1744 (the epoch of the *Rgya rtsis snying bsdus*), is the founder. However, there are several issues to think about regarding this claim: First, the manuscript of the text has not yet been published yet. Huang and Sun (2012: 216) presents the three manuscripts of the text: 1) The first manuscript is composed of 16 folio. Its epoch is 1744. Where it has been stored is not indicated. The computer input is found in Huang and Chen (1987a). 2) It is a 27 folio manuscript. Its epoch is 1842. Where it has been stored is also not indicated. 3) The epoch has been changed into 1876 by Blo bzang 'od zer (?-?). According to Huang and Sun (2012: 215-6), the second text states: “The one written by *Mā yang Bzod pa* rgyal mtshan.” (ma yang bzod pa rgyal mtshan gyis sbyar ba). Then, we have a problem: Does it mean that the epoch was changed from the first one written by the same author? Or, was *Mā yang Bzod pa* rgyal mtshan active in the 19th century? Secondly, Huang and Chen (1987a) does not present the 18th century calculational tables. Because most of the *Mā yang rgya rtsis* text indicate how to use calculational tables, the text is useless without the tables. Huang and Chen (1987a) presents Dme shul Chos 'phel’s (late 19th ~ early 20th c.) tables. Thirdly, there is the issue of identifying the alleged founder Bzod pa rgyal mtshan. It is worth mentioning van der Kuijp’s research into the colophon of the *Mā yang sman yig gces btus* and an account of the Dalai Lama VI (1988). See van der Kuijp (2015: 460-1). For information about the Ti thung Rdo rje ’chhang, see Pu (1990: 560-2), and Smith1 (2013: 299, 437). However, it is probable that the colophon in which *Mā yang Bzod pa* rgyal mtshan appears was attached later. The printing blocks were carved during the period...
rtsis texts, written after the Rgya rtsis snying bsdus, my findings on the tradition are as follows: the Rgya rtsis snying bsdus was written by a lama in Beijing in the 18th century. Then Mā yang Bzod pa rgyal mtshan encountered the text and first disseminated the method in Amdo. Let me present my evidence. Mi pham (2012a), written in 1912, explains the differences between many astronomical traditions with a focus on later-period eclipse calculations. In it, Mi pham also conveys some information on Mā yang rgya rtsis.

of Gubci elgiyengge Xianfeng (咸豐; r. 1851-1861) Emperor. Another factor pertaining to the identification of Mā yang Bzod pa rgyal mtshan presented by van der Kuijp (2015: 460) is Brag dgon Zhab drung (1987: 575-6) [= Chinese translation, Wu Jun et al. (1989: 542)]: Mā yang rtsis pa, a Mā yang rgya rtsis astronomer who taught 'Jam dpal bstan pa'i sgron me (1802-?) who was born in the water-dog year (1802) appears in Brag dgon Zhab drung’s Mdo smad chos ’byung (written in 1865). Given this information, it is certain that Mā yang rgya rtsis was being taught in Mā yang dgon after 1802 in the early 19th century. For the introduction of Mā yang dgon, which was established in the ninth year of Abkai wehihe Gnam skyong Qianlong (1744 C.E.), see Brag dgon Zhab drung (1987: 111-2). For the Chinese translation, see Wu Jun et al. (1989: 111). Huang and Chen (1984) shows that it was founded in 1740 on the basis of Dalai Lama VI and Ngag dbang lhun grub dar rgyas (1981: 143). For the Chinese translation, see Zhuang (1981: 101). Also see Pu (1990: 63): “Mā yang dgon Bkra shis chos gling (Ch. Mayingsi 馬營寺): located in Mayinggou (馬營溝) in Dpa’ ris and is a sub-temple of Dgon lung byams pa gling (Ch. Youningsi 佑寧寺).” Also see Smith 1 (2013: 286, 435). All in all, through the points mentioned in this note in terms of manuscripts, the calculational tables, and the identification of Bzod pa rgyal mtshan, it is doubtful that he created the text in the 18th century. As will be clarified below, I think he is the founder of the Mā yang rgya rtsis tradition in Amdo in the early 19th century, and the actual founder of the tradition may be a Beijing lama who lived in the 18th century.

Ser chen Zhabs drung claims in his text, written in 1861, that Bzod pa rgyal mtshan is a key figure in the dissemination of the tradition. Ser chen Zhabs drung (1861: 20a): “Mā yang Bzod pa rgyal mtshan extensively spread the calculation method of this tradition in this region ...” (phyogs ’dir mā yang bzod pa rgyal mtshan gyis / lugs ’di’i brtsi srol rgya chen phe zin ...). He is the founder of the tradition in Amdo.

Mi pham is well aware of the Mā yang rgya rtsis. In fact, it was pointed out by Henning’s (2007: 99) loose translation: “In his Great Commentary on the Kālacakra Tantra, “The Illumination of the Vajra Sun,” Mipham’s frustration at the state of Tibetan eclipse prediction is made clear... discusses the need to take into consideration geographical location when examining solar eclipses. He makes the point that Chinese methods are often superior to those in use in Tibet ...” For Tibetan, see Mi pham (2012: 1030-1). Mi pham’s level of understanding of the Mā yang rgya rtsis is well displayed in Mi pham (2012a).
As seen above, the tradition in Amdo dates back to Bzod pa rgyal mtshan. Mi pham introduces Mdzod ban Bstan pa rgyal mtshan's (birth: 19th century) Rtsis kyi man ngag dpag bsam yongs 'du'i snye ma as witnessed by him.

rtsis kyi man ngag dpag bsam yongs 'du'i snye ma zhes pa /... rab yid mdzes byed chu yos la lo 'go bzung ba 'dug /.


308 Chinese calendrical calculations begin from the year of mouse (Ch. zi  jiazhi). The exact epoch date is 1863/12/0 (grub rtsis). 12/0 according to grub rtsis is the epoch in the Mā yang raya rtsis tradition. For the explanation, see below note 682.

309 The 'das zla is also calculated from 12/0. The Mā yang raya rtsis calculates zla dag according to skar rtsis. See below p. 313.

310 Mi pham (2012a: 262-77) introduces this text written by Mdzod ban Bstan pa rgyal mtshan (birth: 19th century) in 1859 in Bla brang dbang ldan phyug mo (possibly Bla brang bkra shis 'khyil ?) and Mi pham (2012a: 277) indicates his other name was Dbyangs can dga' ba'i lang tsho. Zhongguo shaoshuminzu guji zongmu tiyao, Zangzu juan, Xining fenjuan (2010: vol. 3, 1142-50, especially 1150) indicates that a three-volume gsung 'bum of Tsha bo Bstan pa rgyal mtshan (= Mdzod ban Bstan pa rgyal mtshan) is extant in Sku 'bum. It also indicates that Rtsis kyi man ngag dpag bsam yongs 'du'i snye ma is included in volume ga.

311 Mi pham (2012a: 262-3).
I (= Mi pham) witnessed that there is Rtsis kyi man ngag dpgam yongs 'du'i snye ma, whose epoch is the water-hare year (T. mdzes byed / S. śobhana. the 37th year, 1843 C.E.) in the 14th rab byung.

Mi pham explains that in it, the tradition of the Mā yang rgya rtsis was mentioned in the following way:

... rig pa'i dbang phyug kun dga' chos dbyings rgya mtsho yi / rayud dang 'grel las dngos shuqs kyis / legs bstan rtsis kyi bstan bcos der / ... khyad par gong ma'i them mi mda' (sic. read 'du) ba'i rgya rtsis de / drang srong mngon shes can zhig gis 'phro bzhag zer ba / rtsis 'phro dngos rnyed pa yin nam / dus 'khor rgyud ltar nyi longs shin tu dag snyam pa dang / nyi ldog gza' 'dzin sogs gang yang / 'khrul bral yin zhes kho bo'i (sic. read kho bos) zla ba dkar (sic.) nag rtsis rig la 'khrul pa'i dri med bchod pa rgyal mtshan pa las zhal gdams yang yang thos zhes 'dug / .

In the astronomical treatise (= Rtsis kyi man ngag dpgam yongs 'du'i snye ma) well said directly and indirectly by the transmission and the commentary of the lord of knowledge, Kun dga' Chos dbyings rgya mtsho (? -?) ... especially, the rgya rtsis which cannot cross the doorway (= should be at the place where it is), and it is said that a sage (T. drang srong / S. rṣi) with higher perceptions placed the rtsis 'phro values,313 there are [Mdzod ban's] passages [which was witnessed by Mi pham. Mi pham read the manuscript]: “I (= Mdzod ban) think that [its] rtsis 'phro was actually calculated or the longitude of the sun is extremely accurate as in the Kālacakra.” “Solstices, eclipse, etc, whatever, are also unmistaken.” “I (= Mdzod ban) repeatedly heard from Bzod pa rgyal mtshan, the immaculate one in the astronomy of skar rtsis / nag rtsis.”

Mdzod ban mentions that a sage with higher perceptions (T. drang srong mngon shes can) is the original author. We do not know who he is. Moreover, Bzod pa rgyal mtshan is the transmitter of the tradition founded by the sage. It should be stressed that Mdzod ban, who was active (born (?)) in the 19th century,314 is a contemporary of Bzod pa rgyal

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312 Mi pham (2012a: 267-8).

313 This is to adjust the Chinese yingshu (應數 = equivalent to Tibetan rtsis 'phro) values to the rtsis 'phro values in the skar rtsis system. For the information, see chapter 4.

314 Mdzod ban was was active in the middle 19th century. See above note 310.
mtshan, according to the above passage. The relationship between the sage and Bzod pa rgyal mtshan is not mentioned, but I speculate that the above passage alludes to the fact that there is a remarkable time difference between the two. It is odd that Bzod pa rgyal mtshan would not know the name of the sage if he had learned from him personally. At any rate, Mi pham does not identify the origin of the Mā yang rgya rtsis or who Bzod pa rgyal mtshan is. We have limited materials available for identifying Bzod pa rgyal mtshan. Nevertheless, the above quotation is powerful evidence that Bzod pa rgyal mtshan was active in the 19th century. Another compelling piece of evidence is a calendar (T. lo tho) reported by Huang at Bla brang bkra shis 'khyil. The colophon says: “In the Doro Eldengge Daoguang (Ch. 道光) 8th year (1828 C.E. r. 1821-1850) of the 14th rab byung, Mā yang Bzod pa rgyal mtshan and Ser chen Zhabs drung (possibly Ser chen Zhabs drung Grags pa bstan ’dzin) changed the rtsis ’phro from the previous one.” (rdo bkwang brgyad pa rab yid la mā yang bzod pa rgyal mtshan dang / ser chen zhabs drung rnam gnyis sogs kyis sngar las rtsis ’phro spo ba mdzad / . 315). In other words, the change of epoch was made in the early 19th century and Mā yang Bzod pa rgyal mtshan lived in the same century.

The colophon of the Rgya rtsis snying bsdus clearly states that Bzod pa rgyal mtshan learned the rgya rtsis method via oral transmission and created his own interpretation316,

315 See Huang (1987: 235). Nevertheless, Huang (1987) maintains the claim that the Mā yang rgya rtsis tradition began from Bzod pa rgyal mtshan who lived around 1744 (= the epoch of the Rgya rtsis snying bsdus). At this point, let me use Huang and Sun (2002: 216) again: the second text’s epoch has been changed to 1842. The text may be also the work of Bzod pa rgyal mtshan, who participated in the creation of the above almanac in 1828. Of course, at present, it is difficult to comment further because the original manuscript of the second text has not been publicized yet.

but another colophon attached in the *Rgya rtsis snying bsdus*\(^{317}\) states that a Beijing *rtsis rams pa* is the founder of the tradition.\(^{318}\) What relationship exists between the *rtsis rams pa* and Bzod pa rgyal mtshan? What role does Bzod pa rgyal mtshan play in the transmission of the *Mā yang rgya rtsis*? It may be a pivotal question to resolve the issue of authorship. In this case, the 20\(^{th}\)-century astronomer Smad Sog\(^{319}\) Badzra’s (d. 1918) testimony may be helpful.

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\(^{317}\) See van der Kuijp (2015: 462).

\(^{318}\) The *Rgya rtsis snying bsdus* itself says that it was created in Beijing. See Huang and Chen (1987a: 367, 377): read [104], [105], and [196]. Then, there are at least two possibilities: A Tibetan in Beijing wrote it or Bzod pa rgyal mtshan visited Beijing in the 18\(^{th}\) century. According to the above colophon, I side with the first possibility. See also van der Kuijp (2015: 462): “Its attribution to Bzod pa rgyal mtshan may be mistaken after all!” I do not agree with Huang and Chen (1987a), which says that the tradition was founded by Mā yang Bzod pa rgyal mtshan. He is the founder of the tradition in Amdo!

\(^{319}\) The *smad sog* means inner Mongolia. Badzra derives from Sanskrit *vajra*.

\(^{320}\) This part was written by Badzra in Drung yig (2003a: 417-8) [= appendix to Drung yig (2003)]. It does not exist in its original text, Drung yig (2006a) [= appendix to Drung yig (2006)].
learned Beijing astronomer took the wood-mouse year (= 1744 C.E.) of the 12th rab byung as the epoch for the previous Raya rtsis chen mo, and determined the values in a way of being compatible with Kālacakra-based skar rtsis. [It] was known as the Summary of the Essence of Rgya rtsis (T. Rgya rtsis snying po bsdus pa / Rgya rtsis snying bsdus = Huang and Chen (1987a)). ... Doro Eldengge Daoguang 8th year (1828 C.E.) in the 14th rab byung, Mā yang Bzod pa rgyal mtshan and Ser chen Zhabs drung changed the epoch from the previous one (= the above whose epoch is 1744 C.E. = the Rgya rtsis snying bsdus). 321

I surmise that his opinion may be based upon a general conception or belief among Tibetans, possibly transmitted orally: He says that a Beijing lama created the Rgya rtsis snying bsdus from the Rgya rtsis chen mo. I think he is partly right but also partly wrong—the lama created it, but from the Lixiang kaocheng, not from the Rgya rtsis chen mo. No continuation from the Rgya rtsis chen mo is posited. 322

Taken together, I suggest that the tradition later known as Mā yang rgya rtsis was created in Beijing in the 18th century (around the epoch 1744 of the first work, the Rgya rtsis snying bsdus) and was not transmitted into the Amdo area until the early 19th century (perhaps it was the late 18th century; I have no evidence to refute this possibility given the evidence presented. However, it does not date back to the middle 18th century). I think Bzod pa rgyal mtshan must have visited Beijing or contacted someone who knows the Chinese method very well. Without sufficient knowledge or background, the Chinese method may seem arcane and esoteric. In any case, there is a possibility that he probably added his colophon in the Rgya rtsis snying bsdus without changing the epoch 1744. Since I

321 See above p. 150. This must be the same almanac Huang (1987) mentioned. Badzra also must have seen the text in Bla brang bkra shis ’khyil. The epoch is 1828 = earth-mouse (T. sa byi) year.

322 For more information, see Chapter 4.
have not seen the manuscript of the Rgya rtsis snying bsdus, I am not sure about this. However, it may have happened in Tibet.  

Some may raise more possibilities regarding the authorship of the Rgya rtsis snying bsdus. It could be surmised that Bzod pa rgyal mtshan, who was possibly active during the 13th rab byung (1747-1806) [i.e. in the late 18th or early 19th century], may have visited Beijing and created the Mā yang rgya rtsis with epoch 1744 (Ch. jiazi, the first year of the Chinese calendar) in order to adjust the epoch values of the 13th rab byung (1747-1806). Then, the created calendar is useful and effective during the 13th rab byung. This then is also a possible scenario, but we cannot explain the existence of the Beijing lama/drang srong mngon shes can. Some may say that Bzod pa rgyal mtshan could have created the text in the 19th century, for example in the 1820s, in order to adjust the Chinese epoch data to his own new system. He might have then changed epoch again to 1828 as specified in Huang (1987) and Badzra (2003a). This may be also possible because the latter calendar

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323 For example, the reason why Schuh (1973) and Henning (2007) did not identify the original author of the Rigs ldan snying thig is that Mkhyen rab nor bu does not convey any information on Phyag mdzod in Phyag mdzod (1976). Even if its author looks like Mkhyen rab nor bu, it is actually not. In other words, it is possible that Bzod pa rgyal mtshan copied the original text and wrote his name down or forgot to cite the original author (or, did not know the name of the original author).

324 Mkhyen rab nor bu (1943: 19a): “Because the palace established a law, Chinese masters (= astronomers) strictly kept everything secret, but being based upon various means of faith and action, the translations evolved gradually in the Amdo area from the 13th rab byung (1747-1806 C.E.).” (rgyal khab kys khrims su bcas pas rgya’i slob dpon nas bka’ rgya dam bsgrags shin tu che yang / rab ’dod nang tsam nas dad sbyor gyi thabs sna tshogs la brten a mdo khul du rim bzhin ’gyur ’dug pa ... / ). Mkhyen rab nor bu does not say that Bzod pa rgyal mtshan is the author, but the Mā yang rgya rtsis text came into being in Amdo during the 13th rab byung. I should point out two things: It may be a commonly believed idea among Tibetans. And Mkhyen rab nor bu, who mostly functioned in the 20th century, is the first one who introduces the Mā yang rgya rtsis method to Lhasa. His understanding of the history of the Mā yang rgya rtsis may not be reliable.
(epoch 1828) is effective in the 19th century, when Bzod pa rgyal mtshan may have lived. But, in this case, we have no choice but to admit that Bzod pa rgyal mtshan is the first author of the tradition. There is no room for the Beijing lama/drang srong mgon shes can in this case, too. I prefer the first opinion, given my textual research. As our research progresses, we may be able to find more evidence to come to a final conclusion.

THE RGYA RTSIS SNYING BSDUS AND THE CHINESE ORIGINAL TEXT LIXIANG KAOCHENG

Given the epoch, it is highly possible that the Mā yang rgya rtsis is related to the two Chinese astronomical systems, the Lixiang kaocheng and the Lixiang kaocheng houbian. It is not likely that the earlier Chongzhen lishu or Xiyang xinfa suanshu was a consideration. Let me investigate whether or not this predisposition can be justified.

325 Here, I briefly give a context of the two. Firstly, the Lixiang kaocheng is the astronomical system adopted in Qing China after the Xiyang xinfa lishu. Since its epoch is 1684 (the year of jiazhi 甲子), it is called Jiazhiyuan (= Kangxi jiaziyuan 康熙 甲子元). It was used from 1726 (Hūwaliyasun tob Yongzheng 雍正) 4th year to 1741. It is composed of three parts: 1) shangbian (上編) 16 chapters – lili (歷理 calendrical theory), 2) xiabian (下編) 10 chapters – lifa (歷法 calendrical methods), 3) biao (表 tables) 16 chapters. Putting aside complex and difficult theories and calculations in the astronomical system, I point out the following: the system features the Sinocization of western Jesuit astronomy. Roughly speaking, the Chongzhenlishu and the Xiyang xinfa lishu, which predate it, were compiled by Jesuits in Beijing. But, when compiling the Lixiang kaocheng, Chinese astronomers had some confidence in the principles and methods of the western Tychonic (Ch. Digu 第谷 < Tycho Brahe) astronomy, which enabled them to combine their traditional concepts and methods with Western astronomy. For this information, see Hashimoto (1970: 49-92, especially, 68). I mention it because it may mean that, as Chinese astronomers in Beijing began to make sense of the western astronomical methods within their framework of Chinese astronomy, the western methods became more accessible to general Chinese astronomers—and even to Tibetan/Mongolian lamas in Beijing. This situation may have caused the genesis of the tradition later known as the Mā yang rgya rtsis in Amdo. In fact, the Mā yang rgya rtsis is totally based upon Chinese understanding of Western astronomical methods and mathematics, and Tychonic astronomy on which it is based is not explicit, as will be clarified below. Tibetans had no sense of what differentiates Tychonic astronomy from the other Western astronomies. The
Mā yang rgya rtsis is a mere Tibetan translation of the algorithm part of eclipse calculation in the Lixiang kaocheng. For the information, see below note 654. In other words, it is surely based upon Tycho's values and models, but it merely introduces the eclipse calculation skills understood and created by Chinese astronomers. Ultimately, it has nothing to do with the Tychoic astronomical theory. Going back to the Lixiang kaocheng, it revealed limitations in the solar eclipse prediction of 1730/8/1 [according to Qing Chinese lunar calendar]. As a result, Ignatius Kögler (1680-1746) and André Pereira (1690-1743) were ordered to revise the Lixiang kaocheng, and the revision, i.e. the Lixiang kaocheng houbian, was completed in 1742. Its epoch is 1723 (guimao 壬卯 year). So, it is called Guimaoyuan (= Yongzheng guimaoyuan 雍正癸卯元). It was used from Abkai wehiyeh Qianlong 7th year (1742) up until the end of the Manchu dynasty. For general research on the Lixiang kaocheng houbian with a focus on the difference from the Lixiang kaocheng, see Hashimoto (1971: 245-72), Shi (1993a: 959-63), Shi (2008): Kepler’s elliptical orbit was applied to the calculations of the sun’s motion (richan 日躔) and the moon’s motion (yueli 月離). Improvements from the Lixiang kaocheng include the introduction of the new values of tāiyáng dībàn jīngchā (Ch. 太陽地半徑差, or diurnal parallax of the sun, difference of diameter between the sun and moon as seen from the earth), qīngmēng qīchā (Ch. 清蒙氣差), or atmospheric refraction, the deviation of light as it passes through the atmosphere) based upon the observation values by Giovanni Domenico Cassini (> Ch. Kaxini 噶西尼.1625-1712) and John Flamsteed (> Ch. Falande 法蘭德.1646-1719). My point is as follows: As evidenced by the reason why the Lixiang kaocheng houbian was compiled and by the changes of the values of dībàn jīngchā and qīngmēng qīchā in it, eclipse calculation is one of the major astronomical concerns in Qing China as with previous dynasties in China. The Emperor, who is a son of Heaven, should know and accurately predict the celestial phenomena. The theory of Western astronomy was not a crucial issue in Qing China, and just “saving the phenomena” mattered. It goes without saying that the Mā yang rgya rtsis, which introduces the tiny part of the Lixiang kaocheng, has nothing to do with theory and practice of Tychoic astronomy. It is related to Tychoic astronomy in its origin, but it does not mean that it is based upon any understanding of Tychoic astronomy.

326 Chen Jiujin and Huang Mingxin unveiled the origin of the Mā yang rgya rtsis in conjunction with the Lixiang kaocheng and the Lixiang kaocheng houbian. For example, it has been pointed out by Huang and Chen (1987: 366, 383, 400) that the same eclipse limit for the judgement of an eclipse with that of the Lixiang kaocheng houbian is used in the Mā yang rgya rtsis. Since an eclipse occurs near the intersection point between the ecliptic and lunar paths, calculating the position of the intersection point and the distance of the sun and moon from the intersection point are pivotal for the judgement of the possibility of an eclipse. So, it can be a determinant showing the relationship of influencing and being influenced. However, strangely enough, Huang and Chen (1984: 68) (1987a: 561) conjecture that the first Mā yang rgya rtsis text, i.e. the Rgya rtsis snying bsdus, is a selective translation from the Xiyang xinfa lishi on which the Lixiang kaocheng is based. The claim is untenable. There may exist some possibilities; they did not peruse the Lixiang kaocheng; Huang and Chen (1987a) uses Qingshigao zhì (志) shixianzhì (時憲志) (simply 時憲志 Shixianzhi), in which the algorithms of eclipse calculation based upon the Lixiang kaocheng and the Lixiang kaocheng houbian are included respectively, to explain the algorithm of the eclipse calculation in Mā yang rgya rtsis. That may be the reason why they could not pinpoint the parallel part between the Lixiang kaocheng and the Mā yang rgya rtsis. As a matter of fact, the Qingshigao was compiled in 1927. It means that even if it can enhance understanding of the algorithm in Mā yang rgya rtsis, but is not a good method to explain some of Mā yang rgya rtsis’s issues such as its origin.
Firstly, I will compare basic constants among the *Lixiang kaocheng*, the *Lixiang kaocheng houbian* and the *Mā yang rgya rtsis*. Since astronomical constants have lots of digits, it is difficult for independent astronomical systems to have the same figures without influencing and being influenced.\(^{327}\) The table of the comparison among the constants in the three systems is as follows:

Table 6.

<table>
<thead>
<tr>
<th></th>
<th>Kangxi jiaziyuan (the system of the <em>Lixiang kaocheng</em>). He et al. (1985).</th>
<th>Yongzheng guimaoyuan (the system of the <em>Lixiang kaocheng houbian</em>). Kögl er and Pereira (1985).</th>
<th><em>Mā yang rgya rtsis</em>: epoch 1743/12/0 (according to Tibetan <em>grub rtsis</em> calendar)</th>
</tr>
</thead>
<tbody>
<tr>
<td>length of tropical year (huiguinian 回歸年)</td>
<td>365.2421875 days</td>
<td>365.24233442 days</td>
<td>365 (\frac{60}{247}) = 365.2429149 days (nyin zhag)</td>
</tr>
<tr>
<td>length of synodic month (shuoce 朔策)</td>
<td>29.530593 days</td>
<td>29.53059053 days</td>
<td>(\text{tshes zla'i rtag longs} = 29^d \ 12^h \ 44'3''11'''111'''') (30/24/60/60/60/360) (^{328}) = 29.53059 days</td>
</tr>
</tbody>
</table>


\(^{328}\) (30(day)/24(hour. dus)/60(thun)/60(srang)/60(cha)), 6 measurement units: (30/24/60/60/60/360), and 7 measurement units: (30/24/60/60/60/360/30). It is easily recognized that the temporal values are already transformed in Tibetan notation.
Table 6 (continued)

| mean motion of the sun per synodic month (taiyang pingxing shuoce 太陽平行朔策) | 104784°.304324 329 | nyi ma'i spyi 'gros dhru wa = 29°6'24"15"103" (30/60/60/60/360/) 330 (104784°.2547685) 331 : tshes zla gcig gi longs spyod (angular distance of one tshes zla) |
| argument from the sun’s movement per synodic month (taiyang yinshu shuoce 太陽引數朔策) | 104779°.358865 332 | nyi ma'i rang 'gros dhru wa = 29°6'19"9"242" (30/60/60/60/360/) (= 104779°.1612037) : tshes zla gcig gi longs spyod |
| argument from the moon’s movement per synodic month (taiyin yinshu shuoce 太陰引數朔策) | 92940°.24859 333 | zla ba'i rang 'gros dhru wa 25°49'0"3"317" (12/30/60/60/60/360/) (= 92940°.064675925) : tshes zla gcig gi longs spyod |

329 See He et al. (1985: 644b): the value of taiyang pingxing shuoce (太陽平行朔策) = 104784°.304324 .

330 The units used — the same with the modern unit — are as follows: 1°(zodiac) = 30°, 1° (T. du’u / zhag) (Ch. du 度, 1° = 3600 ″), 1′(arcminute) = 60″ (arcsecond), 1″ = 1 60 , 1″ = 1 21600 , 1 du’u = 4.5 yul gyi chu tshod in skar rtsis. (one khyim = 30° = 135 yul gyi chu tshod). Mi pham (2012a: 280) also presents them; the figures given in it are incorrect. See also Huang (1987a: 523-5). Also compare this table with the table in pp. 318-9.

331 The value is nearly the same as that of the Lixiang kaocheng. The difference between the Chinese one and the Mā yang rgya rtsis one (transformed into decimal numbers in the above cell) derives from the Tibetan notation (see above) of the original Lixiang kaocheng value. In other words, Tibetans are not used to decimal numbers. They probably found the most equivalent numbers in the Tibetan system in order to approximate the Chinese decimal numbers.

332 He et al. (1985: 644b). The shuoce (朔策) is the length of the synodic month. The “lunation factor” is given in Sivin’s rendering. See Sivin (2009: 391-2). The taiyang yinshu shuoce is the sun’s argument during the period of the synodic month. The half-month value is wangce (望策). For wangce, see below note 725.

333 He et al. (1985: 645a): the value of taiyin yinshu shuoce (太陰引數朔策) = 92940°.24859 .
In absorbing the Chinese tradition, the Tibetan calculations still use integers, but do not use fractions. For example, length of tropical year $= 365\frac{60}{247}$, not 365.2421875 days as in the Lixiang kaocheng system nor 365.24233442 days as in the Lixiang kaocheng houbian system. This means that the differences of fractional values caused by the Tibetan interpretation are inevitable, and it is difficult to judge from astronomical constants the similarity between the two Chinese systems. At this point, we have no choice but to postpone a final decision.

Secondly, I present powerful evidence: The astronomical tables of the Lixiang kaocheng and the Lixiang kaocheng houbian are in accord with those of the Mā yang rgya rtsis. The comparisons of the tables are as follows:

<table>
<thead>
<tr>
<th>moon’s distance from the Rāhu per synodic month (taiyin jiao zhou shuoce 太陰交周朔策)</th>
<th>110414”.016574</th>
<th>110413”.92441334</th>
</tr>
</thead>
<tbody>
<tr>
<td>$rwa$ (rā) gdong bar khyad dhru wa = $1°40'13&quot;55&quot;167&quot;''$ (12/30/60/60/60/360/) (= 110413”.924398248)</td>
<td>$tshes$ zla gcig gi longs spyod</td>
<td></td>
</tr>
</tbody>
</table>

334 He et al. (1985: 645a): the value of taiyin jiao zhou shuoce (太陰交周 朔策) = 110414”.016574.

335 It is close to that of the Lixiang kaocheng houbian.
Table 7.

<table>
<thead>
<tr>
<th>Lixiang kaocheng biao (SKQS 791)</th>
<th>Lixiang kaocheng houbian (SKQS 792)</th>
<th>Dme shul Chos 'phel’s table 336</th>
</tr>
</thead>
<tbody>
<tr>
<td>He et al. (1985a)</td>
<td>Kögler and Pereira (1985)</td>
<td></td>
</tr>
<tr>
<td>(1985a: 20-6): taiyang junshu biao 太陽均數表 not the same with Mā yang rgya rtsis.</td>
<td>(1985: 294-303): taiyang junshu biao</td>
<td>{kha} nyi ma'i snon phri'i longs spyod kyi re'u mig : the same with the Lixiang kaocheng houbian with simplifications.</td>
</tr>
<tr>
<td>(1985a: 66-72): taiyin chujun biao 太陰初均表</td>
<td>(1985: 393-412): taiyin chujun biao</td>
<td>{ga} zla ba'i snon phri'i longs spyod kyi re'u mig : the same with the Lixiang kaocheng houbian with simplifications with some wrong copies.</td>
</tr>
<tr>
<td>(1985a: 37-8): shengdu shicha biao 升度時差表</td>
<td>(1985: 312-3): 升度時差表</td>
<td>{cha} mnyam byrod zhag gi dus kyi dman cha'i re'u mig : the same with the Lixiang kaocheng houbian</td>
</tr>
<tr>
<td>(1985a: 299-300): yuejuri shixing biao 月距日實行表</td>
<td></td>
<td>{ja} rā zla'i bar khyad zhag gi re'u mig : The same with the Lixiang kaocheng biao in a simplified format.</td>
</tr>
</tbody>
</table>

336 All the Mā yang rgya rtsis texts use the same tables. It seems that the tables must have been copied after the Lixiang kaocheng houbian was compiled (i.e. 18th century), but I do not know whether they existed or not around when the Rgya rtsis snying bsdus was written. And Dme shul Chos 'phel's tables [= The calculational tables appended to Dme shul Chos 'phel's Snang byed zung gi sgrin yol sogs brtag thabs shes rab ral gri'i 'od zer] included in Huang and Chen (1987a) look to be a later copy, given the physical status of its handwriting.

337 He et al. (1985: 157-8). The table of time difference (Ch. Shichabiao 時差表) is one table (Ch. Richabiao 日差表) in the Chongzhen lishu and the Xiyang xinfa lishu [> M. Tngri-yin udq-a / T. Rgya rtsis chen mo], but it was divided into two tables Shengdushichabiao (升度時差表) and Junshushichabiao (均數時差表) in the Lixiang kaocheng for the purpose of increasing the accuracy. For more information, see Chen1 (2003: 668). The Mā yang rgya rtsis is also based upon the Lixiang kaocheng. Then, it may be safely assumed that the Mā yang rgya rtsis cannot be a continuation or creation of the Rgya rtsis chen mo. It is a mere duplicate of the Lixiang kaocheng in terms of the tables and the method of their use.
### Table 7 (continued)

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>(1985a: 557-68): Dongxinanbeicha biao 東西南北差表</td>
<td>n/a</td>
<td>{tsa} missing</td>
</tr>
</tbody>
</table>

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338 The differences between the Lixiang kaocheng and the Lixiang kaocheng houbian include the values of the apparent diameter of the sun and moon, the earth’s distance to the sun and moon at syzygies with respect to the semi-diameter of the earth, etc. The values of the latter are much more accurate, showing a drastic difference from those of the former and the Xiyang xinfa lishu, and must have contributed to the accuracy of eclipse calculation. For more information, see Hashimoto (1971: 263-4). However, the Ma yang rgya rtsis uses the shibanjing biao in the Lixiang kaocheng, not in the Lixiang kaocheng houbian. I do not know why, but it does seem that although the author of the first Ma yang rgya rtsis (= Rgya rtsis snying bsdus) knew the crucial importance of incorporating the unprecedented factors in Tibet, he probably did not know the astronomical significance of the change or did not seek to be very accurate in eclipse calculation. Or, he may have adopted the widespread method at that time in Beijing. As a matter of fact, it is known that whatever method is used between the Lixiang kaocheng and the Lixiang kaocheng houbian, the results would not make a big difference. It may be a reason, too.

339 The values are different from, but are closer to, the Lixiang kaocheng. Specialists in the field of Qing China astronomy would surely know why.
The bold fonts indicate the original tables of the Mā yang rgya rtsis. My conclusion is that the Mā yang rgya rtsis selectively chose the tables from both Chinese systems.\textsuperscript{340} It also means that the Mā yang rgya rtsis came into being after the Lixiang kaocheng houbian, which is the last calendrical system in Qing China. Moreover, it implies no relevance to the Rgya rtsis chen mo.\textsuperscript{341} It is mostly based upon the Lixiang kaocheng. In addition, I should stress that the two Chinese texts are filled with more complex tables. The Mā yang rgya rtsis singled out the indispensable tables for eclipse calculation, with simplification in some cases. Chinese astronomy specialists would immediately recognize, by merely looking at the above table, how the computation is made in the Mā yang rgya rtsis: Semi-diameter of the sun and moon, semi-diameter of the earth’s shadow, parallax computation through the table of the nonagesimal (the huangpingxiangxian biao) are immediately speculated.

\textsuperscript{340} At this point, the relationship between the Lixiang kaocheng and the Lixiang kaocheng houbian should be noted: the Lixiang kaocheng houbian was used as a supplement to the Lixiang kaocheng in the Manchu dynasty. Regardless of the revolutionary Kepler’s first law (all planets move in elliptical orbits with the sun as one focus) in the Western context, it was understood as a mathematical device to enhance the accuracy of astronomical calculations in the Lixiang kaocheng houbian system. In other words, it was believed that if the elliptical orbit is applied to calculate richan (movement of the sun) and yueli (movement of the moon), the results would be more accurate than the Lixiang kaocheng. And the expositions on the movement of the five planets are not included in the Lixiang kaocheng houbian, which means that it still uses those of the Lixiang kaocheng. Simply put, after 1742 in the Manchu dynasty, calculations of sun, moon, and eclipse are based upon the values of the Lixiang kaocheng houbian system without fundamental differences in calculation methods from the Lixiang kaocheng, and the planetary movement is based upon the system of the Lixiang kaocheng. The main reason is that the Lixiang kaocheng houbian system focuses on the improvement of the Lixiang kaocheng system, which has demonstrated problems in eclipse calculation. The practice in contemporary China may be related to the Mā yang rgya rtsis in terms of the choice of the tables.

\textsuperscript{341} To verify this, I should present the difference of the tables between the Xiyang xinfa lishu (Rgya rtsis chen mo) and the Lixiang kaocheng/ Lixiang kaocheng houbian, but it is beyond my scope. However, I would say that Chinese astronomy specialists would agree with me in terms of the different tables between the Xiyang xinfa lishu and the Lixiang kaocheng/ Lixiang kaocheng houbian. My point is that Huang and Chen (throughout their writings), Badzra (2003a) in which the continuation / creation of the Mā yang rgya rtsis from the Rgya rtsis chen mo cannot be justified.
Thus the tables, not real mathematical calculations or theoretical bases, play a big role in eclipse calculation in the Mā yang rgya rtsis. At any rate, it is evident that the system would be different from the skar rtsis method in terms of eclipse calculation.

I present more evidence: An algorithm. The Rgya rtsis snying bsdus is a duplicate of the algorithm for eclipse calculation in the Lixiang kaocheng.\textsuperscript{342} The algorithm in the Mā yang rgya rtsis is basically identical to that in the Lixiang kaocheng.\textsuperscript{343} This means that the first Mā yang rgya rtsis text, the Rgya rtsis snying bsdus, is not a continuation of the Rgya rtsis chen mo. It uses another Chinese text, the Lixiang kaocheng, which has basically the same mathematical bases as the Xiyang xinfā lishu (the original text of Mā yang rgya rtsis). It is reasonable say that it has no relevance to the Tngri-yin udq-a / Rgya rtsis chen mo.

Whether or not the research into Chinese eclipse calculation methods may be closely tied to religious reasons such as bstan rtsis, gso sbyong is unknown. I have not found any textual evidence yet for such a link.

\footnote{342 See below note 654. Given its algorithm, Mā yang rgya rtsis’s Chinese original text leaves no other option except for the Lixiang kaocheng. For the peculiarities of the Lixiang kaocheng method among the Chinese methods used in Qing China, see below note 654.}

\footnote{343 The simplications in the algorithm and the use of huangpingxiangxian not baipingxiangxian in the Mā yang rgya rtsis should be mentioned. See chapter 4.}
2.5. POLITICAL SUPPORT

According to Schuh, grub rtsis of the Phug system was accepted by the Phag mo gru government for 15th century Tibetan astronomy.\footnote{Schuh (1974: 562-3).} The Rgya rtsis chen mo may be filed under the category of political concern because it came into existence due to Manchu political concerns in the 18th century, especially in conjunction with eclipse calculations.

**TNGRI-YIN UDQ-A/ RGYA RTSIS CHEN MO**

The original text of the Tngri-yin udq-a\footnote{The text has different Mongolian titles. In Mongol undūsütüen-ü bürin toli (2007: 1313), four titles are given: toyan-u uqayan-u oki sain čobural bičig, odun oron čay ularil-i boduqu jingkini nom, engke amuyulang qayan-u jokiyaysan kitad čay ularil-un quriyangui nom-un mongol orčiyula-yin debter, and engke amuyulang qayan-u jokiyaysan kitad čay ularil-un bičig-iin quriyangui. Čeden, Suwadi and Sarantuyay-a (1988: 68) gives the following three titles: Solbičan bariqu-yin bodurul bičig / (Ch. Jiaoshibiao 交食表), jiruqai-yin youl (Ch. Shulijingyi congshu 數理精儀叢書), and Tngri-yin udq-a (Ch. Tianwen yuanli 天文原理). Also see Čeden et al. (1990: oroyulburi (lit. insertion), 1). Each chapter has a title, but the title of the whole text has not been given. Moreover, an incomplete version (for example, just some chapters of it) has been circulated. The whole text was computer-typed by Čeden et al. (1990) after the extant prints were collected and compared. The problem in the appellation of the text continues in its Tibetan translation, the so-called Rgya rtsis chen mo. The Tibetan title of the whole text is not given, even if it has been called as such.} / the Rgya rtsis chen mo is the Xiyang xinfa lishu. There are some chapters which original texts are not identified in the Tngri-yin udq-a / Rgya rtsis chen mo.\footnote{For the Tngri-yin udq-a, see Čeden et al. (1990: oroyulburi, 5). For the Rgya rtsis chen mo, see Huang and Chen (1987: 572-5) and Lobsang Yongdan (2015: 190-6) with some errors: misidentification of the Chinese parallel parts and wrong order of the Tibetan chapters. Huang and Chen (1987) are basically correct. It uses the Xinfa suanshu to present parallel parts in the Rgya rtsis chen mo. But, the following minor fact should be also considered. In 1629 (Chongzhen 2nd year), the Bureau of Astronomy (Ch. liju 歷局) was established for} The translated chapters from the Xiyang xinfa lishu (1645) are not
theoretical but practical for eclipse calculations, containing mostly calculational tables. In other words, *Richanbiao* (日躔表) and *Yuelibiao* (月離表), *Jiaoshibiao* (交食表), which are the calculation tables, were included in the *Tngri-yin udq-a/ Rgya rtsis chen mo* for actual eclipse calculation. However, their individual theoretical parts, i.e. *Richanlizhi* (日躔歷指), *Yuelilizhi* (月離歷指), and *Jiaoshilizhi* (交食歷指) were not translated. The Mongolian translation was designed for practical use, but no evidence exists showing that it has been actually used by Mongolians. The comparison table of the three different language versions (Chinese-Mongolian-Tibetan) is as follows:

Table 8.

<table>
<thead>
<tr>
<th>Chinese Xiyang xinfa lishu [= Xinfa suanshu]</th>
<th>Mongolian Tngri-yin udq-a</th>
<th>Tibetan Rgya rtsis chen mo (1715/1716)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 n/a</td>
<td>1.347 jiruqai-yin orusil (1990: 1-3)</td>
<td>n/a</td>
</tr>
</tbody>
</table>

The revision of the calendar, and the *Chongzhen lishu* composed of 137 juan-s was completed in 1634 (*Chongzhen* 7th year). Unfortunately, they have not been found until now. Therefore, the *Chongzhen lishu* we now have access to is different from the first edition. Moreover, the *Chongzhen lishu* was reedited by Adam Schall von Bell (Ch. Tang Ruowang 湯若望) into the *Xiyang xinfa lishu* and began to be used in 1645. See Hashimoto (1988: especially, 28-52 and 64-8). And then, it was renamed *Xinfa suanshu* when it was included in SKQS in Abkai wehiyehe Qianlong 37th year (1772). For more information, see Hashimoto (1988: 62-4). In other words, rather than the *Xinfa suanshu*, the *Xiyang xinfa lishu* is the Chinese original of the *Tngri-yin udq-a* and the *Rgya rtsis chen mo*.


348 The parallel chapters in the different languages are written in the same row in this table.

349 I followed Čeden et al. (1990) in the numbering.
Table 8 (continued)

<table>
<thead>
<tr>
<th></th>
<th>Richanbiao (日躔表) chapter (Ch. juan (卷)) 1 (2000: vol. (Ch. ce (册)) 4: 57a-94b) [≡ (1983: vol. (Ch. ce (册)) 788: chapter (Ch. juan (卷)) 25, 392a-429a)]</th>
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<tr>
<td>3</td>
<td>Richanbiao chapter 2 (2000: vol. 4: 95a-117b) [≡ (1983: chapter 26, 430a-454a)]</td>
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<td>5</td>
<td>Yuelibiao (月離表) chapter 1 (2000: vol. 4: 200a-216a) [≡ (1983: chapter 32, 560a-576b)]</td>
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<tr>
<td>7</td>
<td>Yuelibiao juan 2 (2000: vol. 4: 216b-229b) [≡ (1983: chapter 33, 577a-589b)]</td>
<td></td>
</tr>
<tr>
<td>9</td>
<td>Yuelibiao juan 3 (2000: vol. 4: 230a-247a) [≡ (1983: chapter 34, 590a-606b)]</td>
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</tbody>
</table>

350 The numbering is based upon the Tibetan print. The Tibetan version is verbatim ac litteratim translation of the Mongolian one, but the order of the former is occasionally different from that of the latter. See the order of the chapters 22, 23, 35, 36, and 37 in the above table! When I perused the Mongolian print in Öbör mongol-un neigem-ün sinjillekü uqayan-u nom-un sang, I saw that each volume (5 volumes in total) is in a book-bound format. If the Mongolian lamas who translated the Tngri-yin uqa into the Rgya rtsis chen mo just followed the Mongolian order, there would not have been such difference. Thus, there may be several possibilities. Perhaps the original Mongolian print was not bound in a book format when it was delivered to the translators. Or, the Tibetan translators were not meticulous. It is certain that they did not or could not meticulously translate the Mongolian text partly because of lack of knowledge. Or, there may exist other possibilities. It is difficult to pinpoint the reason at present.

351 ngos ‘dzin (lit. recognition) is used to render biao (表)/ M. bodurul. It is problematic.

352 It seems that the strange Tibetan alphabets were devised to number 37 chapters —excluding the colophon—. The Tibetan 30 consonants from ka to a are not enough to number 37. It is possible that my reading the Tibetan alphabet may be wrong because there exist strange letters. The Chinese numbers written in the right margin in each folio help to ascertain the exact number of each chapter.
<table>
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<tbody>
<tr>
<td>6. tsa: zla ba brgal ba'i ngos 'dzin / glegs bam bzhi pa / 25 fols.</td>
<td>8. tsha: gza' spen pa'i ngos 'dzin 34 fols.</td>
<td>8. dza': gza' phur bu'i lo nyis brgya yun gyi ngo 'dzin 25 fols.</td>
<td>9. dza': gza' mig dmar gyi lo nyis brgya yun gyi snyoms 'gros kyi ngos 'dzin 33 fols.</td>
<td>10. nya: gza' pa sangs kyi ngos 'dzin 31 fols.</td>
<td>11. tsa: gza' lhag pa'i ngos 'dzin 32 fols.</td>
<td>12. tsha: 'phred pa lnga'i ngos 'dzin 29 fols.</td>
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353 The _kha byang_ was not carved independently. The title is given in the upper margin in the first folio.

354 The _kha byang_ was not carved independently. The title is given in the upper margin in the first folio.
<table>
<thead>
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<th>Table 8 (continued)</th>
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<tbody>
<tr>
<td><strong>Jiaoshibiao juan 1</strong> (交食表卷1) (2000: vol. 2: 38a-64a) [=(1983: chapter 72, 295a-320b)]</td>
</tr>
<tr>
<td><strong>Jiaoshibiao juan 2</strong> (2000: vol. 2: 64b-88a) [=(1983: chapter 73, 321a-343b)]</td>
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</table>

| 15. solbičan bariqu-yin bodurul qoyadügar (1990: 407-34) |
| 16. solbičan bariqu-yin bodurul yurbadügar (1990: 435-509) |
| 17. solbičan bariqu-yin bodurul dörbedügar (1990: 511-85) |
| 18. solbičan bariqu-yin bodurul ğirγudügar (1990: 617-45) |
| 19. solbičan bariqu-yin bodurul ğirγudügar (1990: 617-45) |
| 20. solbičan bariqu-yin bodurul doludügar (1990: 646-62) |
| 21. solbičan bariqu-yin bodurul namadügar (1990: 663-89) |

555 The solbičan bariqu looks to be a literal rendering of the Chinese term jiaoshi. For another expression seen in Tngri-yin udq-a, see below note 362. The mostly-used Mongolian terms are naran bariqu (solar eclipse) and sara bariqu (lunar eclipse). They seems to date back to earlier time. A 14th century use of the terms is found in an Arabic manuscript (Bibliothèque nationale Paris, Fonds Arabe No. 6040) in which solar and lunar eclipse calculation tables are included. The author is Abū Muḥammad 'Aṭā (1290?) during the period of Chagatai Khanate. Franke (1988: 98): “… Hierbei sind in vielen Fällen die arabischen astronomischen Fachworte nicht übersetzt, sondern nur transkribiert, was sicher darauf zurückzuführen ist, dass es im damaligen Mittelmongolisch der Zeit um 1369-1370 dafür keine mongolischen Äquivalente gab.” Nevertheless, the Mongolian expressions were used for eclipses. See Franke (1988: 100): fol. 42b. naran bariqu, fol. 44a: sara bariqu. Modern Mongolian terms are as follows: nara gkirtükü (solar eclipse) and sara gkirtükü (lunar eclipse).
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<th>No.</th>
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<tr>
<td>23</td>
<td>n/a</td>
<td>23. nemeqsen bodural-un uy jayur-un jiruy-un kelelge (1990: 721-36)</td>
<td>22. ba: bsnan pa'i bsnol 'dzin gyi byung 'khungs kyi ri mo'i brjod pa 10 fols.</td>
<td></td>
</tr>
<tr>
<td>24</td>
<td>n/a</td>
<td>24. nemeqsen solbičan bariqu-yin bodural dóčin qoyar qonuy (1990: 737-57)</td>
<td>22. pha: bsnan pa'i bsnol 'dzin gyi ngos 'dzin / zhag zhe gnyis pa / 15 fols.</td>
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<tr>
<td>25</td>
<td>n/a</td>
<td>25. nemeqsen solbičan bariqu-yin bodural dóčin dörben qonuy (1990: 758-74)</td>
<td>24. bha: bsnan pa'i bsnol 'dzin gyi ngos 'dzin / zhag zhe bzhi pa / 12 fols.</td>
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<tr>
<td>26</td>
<td>n/a</td>
<td>26. nemeqsen solbičan bariqu-yin bodural dóčin jiruyyan qonuy (1990: 775-91)</td>
<td>25. ma: bsnan pa'i bsnol 'dzin gyi ngos 'dzin / zhag zhe drug pa / 12 fols.</td>
<td></td>
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<tr>
<td>27</td>
<td>n/a</td>
<td>27. nemeqsen solbičan bariqu-yin bodural dóčin naiman qonuy (1990: 792-808)</td>
<td>26. ya: bsnan pa'i bsnol 'dzin gyi ngos 'dzin / zhag zhe brgyad pa / 12 fols.</td>
<td></td>
</tr>
<tr>
<td>28</td>
<td>n/a</td>
<td>28. nemeqsen solbičan bariqu-yin bodural tabin qonuy (1990: 809-25)</td>
<td>27. ra: bsnan pa'i bsnol 'dzin gyi ngos 'dzin / zhag lnga bcu pa / 12 fols.</td>
<td></td>
</tr>
<tr>
<td>29</td>
<td>n/a</td>
<td>29. nemeqsen solbičan bariqu-yin bodural tabin dörben qonuy (1990: 826-42)</td>
<td>28. la: bsnan pa'i bsnol 'dzin gyi ngos 'dzin / zhag nga bzhi pa / 12 fols.</td>
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</table>

356 The chapters 24-32 in the Tngri-yin udq-a are for Mongolian use. Geographical knowledge is necessary for eclipse (especially solar eclipse) calculation and it seems that they are related to the real measurement of the latitude and longitude of the Mongolian regions made during Elhe Taifin Kangxi’s time. Even if they were also translated into Tibetan (incidentally, they are useless for the Tibetan areas, e.g., latitude in Lhasa is 29°), the latitudes selected (42°, 44°, 46°, 48°, 50°, 54°, 58°, 62°, 66°) explain that the Tngri-yin udq-a was designed to enhance the accuracy of eclipse calculations in Mongolia, where the inaccurate Tibetan skar rtsis method (no geographical consideration) was used. Read the preface of the Tngri-yin udq-a together with these tables! Then, where do the chapters derive from? It may need an investigation into the history of latitude and longitude in Manchu dynasty, which is a huge topic involving cartography and geographical knowledge at that time. It is beyond my scope here. For more information, see Qingting sanda shice quantuji (2007), du Halde (1735: 473-88), Ding, Tan, Luo and Li (1977: 29-45), Foss (1988: 209-51), and Yee (1994: 35-31). For the measurement of the latitude and longitude in Tibetan areas in Manchu dynasty, no professional research has been made as far as I know. Some fragmentary facts are known to us through a classical study by Fuchs (1943), which presents maps such as a map of Lhasa (No. 13), a map of Brahmaputra/ Yar klungs gtsang po (No. 14), a map of Kailāśa/Gangs rin po che (No. 15), etc. And Fuchs (1943: 12) and Lobsang Yongdan (2015: 185-6) mention Chu’erqin zangbu (楚儿沁藏布< T. Tshul khrims bzang po) who was dispatched to Tibet in 1717 for the geographical measurement of Tibet. For the history of the measurement of the latitude and longitude of Mongolia, there are some articles. Especially see Hasibagen (2010: 92-6).
<table>
<thead>
<tr>
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<th>Table 8 (continued)</th>
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</table>
| 30 | n/a | 30. **nemegsen solbičan bariqu-yin bodurul tabin naiman qonuy**  
  (1990: 843-59)  
  29. *wa*: bsnan pa’i bsnol ’dzin gyi ngos ’dzin / zhaṅ nga bryaṅ pa /  
  12 fols. |
| 31 | n/a | 31. **nemegsen solbičan bariqu-yin bodurul jiran qoyar qonuy**  
  (1990: 860-76)  
  30. *sha*: bsnan pa’i bsnol ’dzin gyi ngos ’dzin / zhaṅ re gnyis pa /  
  12 fols. |
| 32 | n/a | 32. **nemegsen solbičan bariqu-yin bodurul jiran jirgyan qonuy**  
  (1990: 877-93)  
  31. *ṣa*: bsnan pa’i bsnol ’dzin gyi ngos ’dzin / re drug pa /  
  12 fols. |
| 33 | n/a | 33. **Tngri-yin udq-a-yin alqum-un domuy-un yarçay**  
  (1990: 895-918)  
  32. *sa*: gnam don gyi tshad bshad pa.357  
  14 fols |
| 34 | *baxianbiao juan shangxia* (八线表 卷上下)  
  (2000: vol. 4: 340a-390a) [=  
  (1983: vol. 789: chapters 81 and 82, 501a-551b)] | 34. **naiman utasun-u bodurul**  
  (1990: 920-)  
  33. *ha*: skud pa brayad kyi ngos ’dzin  
  54 fols. |
| 35 | n/a | 35. **darun odqu galun odqu-yin bodurul**  
  (1990: 1021-)  
  34. *ka*: mnam brnyas kyi ngos ’dzin  
  11 fols. |
| 36 | n/a | 36. **dürim bayidal-un joktyangyui-yin bodurul**  
  (1990: 1035-)  
  37. *kya* (?): rnam pa’i bkod pa mdzad pa’i ngos ’dzin  
  32 fols. |
| 37 | n/a | 37. **doluyan gray-un narin būdūgūbcī**  
  (1990: 1061-)  
  35. *kra* (?): gza’ bdun phra mo’i zin bris  
  11 fols. |
| 38 | n/a | 38. **solbičan bariqu-yin narin būdūgūbcī**  
  (1990: 1076-)  
  36. *kla* (?): bsnol bar ’dzin pa’i phra mo’i zin bris  
  20 fols. |

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357 3 folio Snyoms tshad skor thig gi skar ma thams cad kyi ri mo’i bshad pa is inserted between chapter 32 and chapter 33.

358 *kya / kra / kla*: These appear to be the spellings which combine k / ka with ya / ra / la according to Tibetan alphabetical order. Even if it is the case, a problem exists: the order in Chinese (see roman numbers) does not match up with that in Tibetan.
The differences between the *Tngri-yin udq-a/ Rgya rtsis chen mo* are as follows: The order of some chapters are different, and the *ǰiruqai-yin orusil* (preface) in the *Tngri-yin udq-a* is included only in the *Tngri-yin udq-a*; the printer’s colophon in the *Rgya rtsis chen mo* is included only in the *Rgya rtsis chen mo*.361

CRITICISM OF TIBETAN *SKAR RTSIS* ECLIPSE CALCULATIONS IN THE PREFACE OF THE *TNGRI-YIN UDQ-A*

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359 For the appellation of Elhe taijin Kangxi Emperor in Tibetan, see Tuttle (2011: 194-5): one of the Tibetan equivalent of Elhe taijin Kangxi Emperor is *bde skyid*. Also see Karsten (unpublished: 5): *bde ’jag* is given for the title of Elhe taijin Kangxi Emperor together with *bde skyid*. And in this colophon, *bde ldan* is given as the Tibetan appellation of the Emperor. The *Tngri-yin udq-a* from which the Tibetan *Rgya rtsis chen mo* was translated addresses him as ‘*maṇjuśrī degedü amuγ anγ qa γ an*’ which is reconstructed as ‘*Jam dbyangs gong ma bde ldan rgyal po*’ in Tibetan and which appears later in this colophon. Thus, it is highly possible that the Tibetan appellation *bde ldan* reflects that of the Mongolian original text *Tngri-yin udq-a*. It should be also noted that both *Tngri-yin udq-a* and *Rgya rtsis chen mo* were created by Mongolian lamas.

360 The *rgyal pos mdzad pa* is the rendering of the Chinese *yuzhi* (御製). It does not mean “emperor’s work.” Rather, it means “imperially commissioned/imperially published”. So, ‘*Jam dbyangs bde ldan rgyal pos mdzad pa’i rgya rtsis bod skad du bsgyur ba*’ means “the Tibetan translation of the Chinese astronomy which was imperially commissioned by Maṇjuśrī Kangxi Emperor.”

361 For the translations, see Appendix III.
Much information is included in the preface of the *Tngri-yin udq-a*. The preface begins with an overview of the history of the Tibetan *skar rtsis*. (See appendix II). It also clearly demonstrates criticism of Tibetan *Kālacakra* / *skar rtsis* eclipse calculations:

*Töbed oron-dur ḣadada ḣadu dutu ḣadu yerüngki-yin jiruqai kemekü üile-yin jiruqai kiged, dotuyadu yerii busu-yin jiruqai kemekü siddi-yin jiruqai, qoyar būri erten-ečė delgerebečii, naran saran tiūdkii*362*-yin čay möče terigüten-i yajar oron-u öndür boyuni kiged, naran saran erte orui uryuqai-yin kemjiiyen-dür onuju*363*bodalan*364* taniqü cergeştei kemen nomlaysan atala, yajar oron-u öndür boyuni-yin kemjiiyen-i*365* [Tngri-yin udq-a (1711: 3)] üjeküi yosun-u ar-y-a terigüten inü sudur-tur todurqai ese boluyan-u tulada, jiruqaičin-nuyad-ber čay möče terigüten-i endegürel ügegüy-e onuqu anu berke boluyad,*

In the land of Tibet, each of the two—byed rtsis (M. üile-yin jiruqai), known as the astronomy common to outer and inner [principles], and grub rtsis (M. siddi-yin jiruqai), known as the astronomy that is of inner [principles]—is not universal, but has prospered since ancient times. However, at the same time there are those [texts] which explain that it is necessary to concretely recognize the čay möče (< Ch. *shike*)366, etc. of the solar and lunar eclipses, after one has understood by measurement the height of the place (= altitude) and the rise of the sun and moon in the morning and evening [respectively]. Because the methods and such of observing the level of the height of the place were not clear in the texts, astronomers had difficulty understanding the *shike*, etc., without error.

362 From the context, it appears that “tüdkii” meaning “obstruct” is rarely used for denoting an eclipse. Such expressions as *naran bariqu* for solar eclipse and *saran bariqu* for lunar eclipse are commonly used in Mongolian literature.

363 It looks difficult to translate “kemjiyen” in “kemjiyen-dür onuju”. My suggestion is “measurement.”

364 This word is rarely seen. It may be related to “bodatai” meaning “concrete/substantial.”

365 My suggestion for "kemjiyen" in “kemjiyen-i üjeküi” is “level.”

366 The “čay möče” is a literal rendering of the Chinese *shike* 時刻.
Firstly, the skar rtsis method is ignorant of “the height of place” (= altitude of Polaris (= latitude) in context. This looks to be a rendering of the Chinese gaodu 高度). It highlights that the importance of geographical knowledge in the calculation of solar eclipses was not considered in Tibet. This is a valid criticism. Secondly, the measurement of sunrise and sunset time is not proper from the perspective of modern astronomy. Sunrise and sunset time changes according to solar declination (δ) which changes according to season and φ.367 It is necessary for deciding the time of eclipse, the status of daishi (带食), etc. From that perspective, the prediction of an eclipse is not accurate in Tibet and Mongolia, which use the Tibetan skar rtsis method. All in all, it points out that the Tibetan skar rtsis method is not based upon firm geographical/geometric knowledge from the modern perspective. Although this is true, the above passage may also indicate that there is no deep understanding of Tibetan skar rtsis methods from the outside perspective.369

367 There is no solid concept of φ in skar rtsis. But, there is a concept of different length of day and night according to different region. Albeit very brief and inaccurate, there have been Tibetan considerations for sunrise and sunset time in the case of eclipse calculations. For example, see Sum pa Mkhan po’s eclipse calculation in which the eclipse time was calculated from nam langs (possibly from sunrise time). See below note 536 and p. 259. This issue needs more investigation. However, if the above passage means that the Tibetan skar rtsis method is not based upon modern method, it is true.

368 Sivin uses “carried eclipse” for translating the Chinese term “daishi”. See Sivin (2009: 515): “A carried eclipse is an eclipse which takes place at sunrise or sunset, that is, in which sunrise or sunset falls between first and last contact.” There are two cases: richu daishi (日出带食), the case in which an eclipse already began before sunrise; and rimo daishi (日没带食), the case in which the sun sets during the progress of an eclipse).

369 The understanding of the Tibetan calendrical system by Chinese, Mongolians, and Manchu people during the Manchu dynasty looks to be very limited. For example, see Huang1 (Huang Peiqiao 黄沛翘. active late 19th c.) (1982: 179): He seems ignorant of the Tibetan calendrical system, but is aware of the difference of the intercalation method between Tibet and China. In particular, he states that there are no errors in the calculations of solar and lunar eclipses in Tibet. His statement is groundless. Another example
In the 18th century, there existed a clear demarcation between Tibetan religious astronomy—čāy-un kārdūn (Mongolian Kālacakra)/ odun-u jiruqai (Mongolian skar rtsis)—and non-Tibetan non-religious Western (Chinese) astronomy, including the Tngri-yin udq-a, etc., in Mongolian astronomy. The former was employed by lamas and the latter by Qing court astronomers, respectively. In this context, Mongolian astronomers of the Qing court selectively chose some chapters of the Xiyang xinfa lishu, which are pivotal parts of the Western (Chinese) eclipse calculation based upon geometric and trigonometric methods.

THE SIGNIFICANCE OF THE RGYA RTSIS CHEN MO IN THE TIBETAN ASTRONOMY

The Rgya rtsis chen mo is a verbatim ac litteratim translation of the Tngri-yin udq-a by the Tibetan-literate Mongolian lamas in Kökeqota. Clearly, it was not understood because of the unprecedented number of new mathematical terms, concepts and technical knowledge, which had no common footing in skar rtsis. Most of all, there is no evidence that it was ever used. The translation makes no contribution to the expansion of

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is He (Mongolian official He Ning 和寧 (alias He Ying 和瑛, ? - 1821)) (2013: 173) [= also in Huang1 (1982: 253-4)]. His understanding is better than that of Huang1 although he must have lived earlier than Huang1. He mentions Tibetan auspicious and inauspicious days combined with intercalation; the difference of new moon days between Tibetan and China; the different intercalation methods; Tibetan rabs byung system (his understanding is based upon the equation of it with the Chinese liushi jiazi (六十甲子) system supported by tiangan (天干) and dizhi (地支)), etc. Of course, it is obvious that he has fragmental knowledge and information of Tibetan astrology / astronomy.
astronomical concepts and knowledge in Tibet.  In the Tibetan academy, it seems to have been significant only against the background of the Mā yang rgya rtsis. Although I investigated the Mā yang rgya rtsis in relation to the Lixiang kaocheng, one could ask this question again once more by looking into the relationship between the Mā yang rgya rtsis and the Rgya rtsis chen mo. My conclusion is that the Rgya rtsis chen mo shows no textual relationship to the Mā yang rgya rtsis text, at least given the differences in terminology.  The Rgya rtsis chen mo was compiled at the command of Elhe taifin Kangxi Emperor and instigated by his faith in Western astronomy. But it also means that the text as such has nothing to do with the Tibetan astronomy per se. The criticism in the preface of the Tngri-yin udq-a and the new knowledge found in the text itself aimed to introduce a new method calculating eclipses that were based upon Western / Chinese methods, but the Tibetans had absolutely no way to understand it.

370 For the question and my answer to this, see chapter 4.

371 For my linguistic evidence, see below pp. 307-8. I think the terms listed are a bit technical. So, it would be better for them to be presented in chapter 4, not here. Again, I stress that Badzra (2003a), which argues for the continuation of the Rgya rtsis chen mo to the Mā yang rgya rtsis, is problematic. Another untenable groundless claim is Lobsang Yongdan (2015: 177): “the Jesuits’ works that were translated into Tibetan and Mongolian or on the fact that Tibetans in Amdo reformed their calendar according to the system devised by Danish astronomer, Tycho Brahe (1546–1601).” As clarified in this section, it is true that the Mā yang rgya rtsis is based upon Tychonic astronomy. However, Tibetans did not know the nature of Tychonic astronomy. Most of all, such history that Tibetan astronomers created the Mā yang rgya rtsis on the basis of the knowledge on the Rgya rtsis chen mo does not exist. Simply, the Mā yang rgya rtsis is a system that translated the algorithm part for eclipse calculation included in the Lixiang kaocheng. See below note 654. Tibetan skar rtsis methods and approaches such as rtsis ’phro change, etc. were used to create the system. In other words, Tibetans absorbed the new methods on the basis of time-honored skar rtsis / Kālacakra system. There is no single evidence that they knew modern astronomy. Lobsang Yongdan (2015: 188–9) shows excessive attention to the issue of modernity in his attempt to place Tibet in the context of modern scientific history. Tibetan phrases and passages relevant to the history of the Mā yang rgya rtsis do not say so. Also see chapter 4.
In this chapter, I drew a broad picture without being restricted to a single text. I attempted to read the Tibetan approach to eclipse calculation by setting up the textual and non-textual “series.” The gist is that the skar rtsis has been articulated, formulated, and modulated by the religious Kālacakratantra corpus, but it has not been separate from the non-textual “series.” The method of calculating eclipses epitomizes the problem. In other words, showing the non-textual “series” involved in the eclipse calculation may be a way to elucidate the nature and features of skar rtsis. The solutions presented by the media for the non-textual “series” such as myong byang, dris lan, man ngag, Chinese and Mongolian texts, political support, etc. are essentially scattered, distracted, and fragmented. Using them, Tibetans tinkered with the revealed problems individually and sporadically for the purpose of “saving the phenomena.” As a result, compared with the abundant information presented in the media, no significant impact on the skar rtsis is seen. Astronomical observations, questions and discussions are combined with criticism, empirical knowledge evinces the emergence of challenging knowledge, and the transmission of new astronomical methods from China affects the understanding of the outer tradition in an inclusive way. We may be able to accumulate more information and data in the future, but at present I suggest that the criticism, impacts, and influences did not become a frame or system with fundamental and theoretical solutions for the Tibetan eclipse calculation. Instead, the Kālacakra is always there. The skar rtsis is justified by the Kālacakra.
At this point, it is natural to ask about the hermeneutical concepts *dgongs pa* (intention) and *mthun pa* (compatibility) that have been used in Tibetan astronomy. The former has been used within the frame of *skar rtsis*; the latter within the frame of the relationship between *skar rtsis* and *rgya rtsis*. The common denominator of the two is the *Kālacakra*. Firstly, *dgongs pa*. I have not yet found any textual phrases and sentences, but the following scenario may justify the *Kālacakra*: in the case of clear components in the textual and non-textual “series” against the “unclear” (*mngon med*) *Kālacakra*, the *dgongs pa* will be assumed. In the case of incoherence and conflicts among the components in the textual, non-textual “series,” the *Kālacakra* will be reinforced. The absolute knowledge of the *Kālacakra* as well as its supreme religious authority is postulated.

Furthermore, I think *mthun pa* may be a hermeneutical concept for the *Mā yang rgya rtsis*, in the sense that it derives from a form of Chinese astronomy with a different origin from *Kālacakra*. “Being compatible to *skar rtsis*” (*T. skar rtsis dang mthun pa*) is seen *passim* in the *Mā yang rgya rtsis* corpus. It is not clear why Tibetans think that both are compatible. Of course, I think they surely know that the Chinese system is different from *skar rtsis*, even if Ser chen Zhabs drung (1861) is the only instance clearly stating “*mi mthun*” in the following way.

... 'di yi 'jig rten chags tshul sogs / 'ga' zhiig dus kyi 'khor lo dang / mngon pa sogs dang mi mthun yang / rtsi na'i rang lugs rnam dag go /

Some things such as the way of the arising of the world, etc. of this (*Mā yang rgya rtsis*) do not agree with *Kālacakra* and *Abhidharma*, etc, but the Chinese tradition is impeccable.

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372 Ser chen Zhabs drung (1861: 3b). According to my reading, “*mi mthun*” is not often found to describe the relationship between *skar rtsis* and *rgya rtsis*. 

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The recognition of its difference from the Kālacakra and the Abhidharma is clear. However, Ser chen Zhabs drung has no theoretical background to articulate it. My point is that even if he says “mi mthun”, his understanding is rooted in the Kālacakra. The Kālacakra for skar rtsis and the Mā yang rgya rtsis are assumed to be the common ground for the criteria he uses to judge the different systems. Therefore, the mthun pa is assumed also in the above passage, as is true for all the other Mā yang rgya rtsis texts I have perused.

Mthun pa is a concept or activity to inclusively understand or internalize unfamiliar outer concepts, ideas, thoughts, methods, theories, systems, etc. In that sense, it can be viewed in terms of the increase of new knowledge in skar rtsis, not in the increase of knowledge about Chinese astronomical methods themselves.373 We may think

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373 M. Foucault (1926-1984) may find the “mthun pa” interpretable in his philosophical scheme. To give some context, his academic concerns include knowledge and power. He focused on elaborating on knowledge in the archaeological stage and focused on power in the genealogical stage. Let me confine discussion to the topic of knowledge to explain the term “mthun pa.” Foucault investigates archaeologically how knowledge constitutes human beings as the subject according to historical period. In his The Archaeology of Knowledge (L’Archéologie du Savoir), he presents the concept of the statement (énoncé) in order to elucidate how the discourses (discours), which are the object of his archaeological investigation, are formed. - The statement is the atom of the discourse; the discourse is a set of elements of the statement. - What makes his statement remarkable is that the discourse does not exist independently because it has meaning only if it is related to the other statements and is placed in certain discourses where certain rules dominate. Thus, his archaeological subject is the location of the subject as long as one occupies a certain location among discourses. And by way of his archaeological method, Foucault traces how the subject is formed historically. In his Words and Things (Les Mots et les Choses), archaeology is defined as the method investigating the historical formations and transformations of episteme (épistémè < G. ἐπιστήμη) as the regularity which is hidden but dominant and which underlies discourses and knowledge. The field of the statement, which is the formulation within which the statement appears, forms episteme, which is the transcendental structure and is the condition of possibility underlying the activities of discourses, including propositions and sentences. Peculiarly enough, he argues at this point that episteme is also historical a priori (l’a priori historique) in that it is a regularity that unconsciously dominates certain discourses and knowledge in a certain historical period and in that, it undergoes historical changes itself. According to him, the historical a priori does not exist before history is reified, but is formed through the long-term process of production of knowledge. Therefore, it works as the rule to the production of knowledge and is simultaneously established by the rule. The episteme of resemblance (ressemblance) is dominant during the Renaissance, representation (représentation) during the Classical Period, and the
about the following issues: the transformation of what had been received or different understanding of what had been received. I think that Tibetans transformed some Chinese elements according to skar rtsis.\textsuperscript{374} Generally, Tibetan self-understanding of skar rtsis, not Chinese methods, has expanded. In the same vein, one may ask whether or to what degree the phenomena of eclipse was differently understood after the introduction of Mā yang rgya rtsis. The answer may vary depending on which point we focus, but in terms of the expansion of modern scientific knowledge, I do not think Tibetans disengaged from the Kālacakra / skar rtsis and began to see a different world.\textsuperscript{375} All in all, mthun pa may mean the internalization of other traditions without a clear sense of the difference between the self and others in the context of the Mā yang rgya rtsis.

analytic of finitude (l’analytique de la finitude) during the modern period. All in all, through the episteme, which is fundamentally human thoughts and experiences distributed in the space of knowledge and the immanent structure in the historical process, he deals with formations and transformations of discourses. As a result, he reveals the basis of thoughts of certain periods by excavating the possible conditions enabling cognition in real human history. Going back to the Tibetan concept, “mthun pa,” research into the later period rgya rtsis reveals that the comparison of day- (tshes grangs), year-reckoning (lo mgo), intercalation (zla bshol, sgang method), etc. are the main concerns of Tibetans about the Chinese tradition. The components may have been thought to be the ground of mthun pa, because their parallels are found in skar rtsis. — I have not found any text pinpointing the rationale of the “mthun pa” yet. — Tibetan astronomers have captured the resemblance between the Chinese astronomical elements and Tibetan elements, and skar rtsis-ized the Chinese elements. The episteme of resemblance may fundamentally regulate the way of thinking and approach involved in the adoption of outer tradition.

\textsuperscript{374} See chapter 4.

\textsuperscript{375} See chapter 4.
At this point, let me attempt the fusion of Gadamer's “commonality” and the Galison's linguistics-based concept, “creolization.” Tibetans’ astronomical level and concept and methodology remain in their one and the only dominant system, i.e. Kālacakra. Gadamer may say that Tibetan astronomy is bound to the “commonality” of the Kālacakra. In terms of shared knowledge in a community or society, Amdo, Khams, and Lhasa before 20th century were different from Beijing where western Jesuit astronomy was dominant. The Lama in Beijing, founder of the tradition later known as the Mā yang rgya rtsis, must have witnessed the different scientific climate and maturity.

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376 Gadamer’s (1900-2002) concept, ‘the fusion of horizons’ (Horizontverschmelzung) of two or more different knowledge systems or traditions, may be useful to appraise the Tibetan adoption of the Chinese tradition. Gadamer (1960: 277) [= (2004: 293-4)] explains Martin Heidegger’s (1889-1976) ontological hermeneutics in the sense that human understanding is grounded in “commonality” and “tradition.” — It is related to his criticism of Friedrich Schleiermacher (1768-1834) without considering “concretion of historical consciousness.” — : “Heidegger’s description and existential grounding of the hermeneutic circle, by contrast, constitute a decisive turning point. ... The circle, then, is not formal in nature. It is neither subjective nor objective, but describes understanding as the interplay of the movement of tradition and the movement of the interpreter. The anticipation of meaning that governs our understanding of a text is not an act of subjectivity, but proceeds from the commonality that binds us to the tradition. But this commonality is constantly being formed in our relation to tradition. Tradition is not simply a permanent precondition; rather, we produce it ourselves inasmuch as we understand, participate in the evolution of tradition, and hence further determine it ourselves. Thus the circle of understanding is not a “methodological” circle, but describes an element of the ontological structure of understanding.”

377 Galison’s term, “trading zone,” was devised to explain the communication and interactions among different groups of scientists. He presented the following examples of the “trading zone”: during World War II, physicists and engineers worked jointly to develop radar at MIT’s Radiation Laboratory (Rad Lab), and physicists and mathematicians co-developed the Monte Carlo Simulation. The term, challenging the “incommensurability” raised by Thomas Kuhn (1922-1996), concerns linguistic pidginization and creolization. Galison (1997: 770): The pidgin focuses on “exchange function”. About the creole language, Galison (1997: 783): “cultures in interaction frequently establish contact languages, systems of discourse that can vary from the most function-specific jargons, through semispecific pidgins, to full-fledged creoles rich enough to support activities as complex as poetry and metalinguistic reflection.” Since he focuses on how experiments, instruments etc, function in the communication of different sciences, his theory may not be applicable to east Asian science, which would inevitably involve a possible argument substantiating the understanding of the heterogeneous Western sciences through the import/ adoption of them.
Amdo, in which the Chinese calendar was studied\textsuperscript{378} may be better than Lhasa in terms of the condition for “the creole language”, but Lhasa and Khams were too far away from the han Chinese cultural and scientific areas.\textsuperscript{379} My point is that without the “commonality” of background knowledge and social scientific context, “the fusion of the horizons” might have no choice but to work inclusively, without evolving to “a creole language.” In the Tibetan context, the \textit{Mā yang rgya rtsis} terminology, coined possibly by the Beijing lama, could not go through “the creolization” in the Tibetan areas. Because the \textit{Kālacakra} was a “commonality” and “tradition,” the new calculational method could not be understood. The method of looking up in the tables and using the algorithm in the \textit{Mā yang rgya rtsis} does not advance the Tibetan astronomy further.

I defined \textit{dgongs pa} within the \textit{skar rtsis} tradition, and \textit{mthun pa} from the relationship between \textit{skar rtsis} and the \textit{Mā yang rgya rtsis}. The two hermeneutical concepts have the common ground of \textit{Kālacakra}, which is the only reference system in Tibet. Most of all, as far as the \textit{Mā yang rgya rtsis} is concerned, it is difficult to say whether an essential increase to or change to the frame of the \textit{Kālacakra} has been attempted or achieved by its assimilation into the new method. Simply, the Tibetan way of understanding and assimilating the Chinese eclipse calculation method in the \textit{Mā yang rgya rtsis} is to find

\textsuperscript{378} The Kye rdor grwa tshang at Bla brang bkra shis ’khyil established in 1877 is one of the places where the Qing Chinese calendar was studied.

\textsuperscript{379} It also explains the slow transmission of the \textit{Mā yang rgya rtsis} from Beijing thru Amdo to Khams and Lhasa. During Mkhyen rab nor bu’s time, it was transmitted to Lhasa. For more information, see Yum pa (2008: 269-70). In the case of Khams, I guess that Mi pham (2012a), which was assumed to have been written immediately before his death in 1912, seems to be the first text that evidences a kind of transmission.
possible rationale, centered upon the skar rtsis / Kālacakra. It follows then that the Mā yang rgya rtsis, which is based upon different theory and mathematics, appears compatible (mthun pa) with their own tradition. Skar rtsis expanded the boundary in the course of making sense of the Mā yang rgya rtsis, and ultimately, the Kālacakra astronomy has been solidified.

Lastly, I raise again the essential issue, i.e. the paradox in terms of “sensation” in a Deleuzian sense. The textual (religious) origin/ non-textual (religious or non-religious or both) “series” function together compatibly. The two are not antithetical. No conflicting relationship is posited. It is a paradox. Deleuze says, “The force of paradoxes is that they are not contradictory; they rather allow us to be present at the genesis of the contradiction.” 380 The “series” converge towards and disperse from “paradoxical element” which effects the three syntheses: “the connective synthesis, which bears upon the construction of a single series; the conjunctive series, as a method of constructing convergent series; and the disjunctive series, which distributes the divergent series.” 381

The “connective synthesis” integrates elements constituting a “series”, the “disjunctive synthesis” ramifies and differentiates to create a divergent “series”, and the “conjunctive synthesis” is where different “series” converge toward a point, i.e. “paradoxical

380 Deleuze (1973: 102) [= Lester and Stivale tr. (1990: 74)].

381 Deleuze (1973: 238) [= Lester and Stivale tr. (1990: 174)].
element”/ “aleatory point.” The syntheses are applicable to the two “series”, textual / non-textual, classified by this writer to explain the approaches to eclipse calculation in Tibet: The “connective synthesis” within the textual “series” is based upon the Kālacakra / Buddhist texts. With that, the skar rtsis astronomy is constituted. And the “disjunctive synthesis” is the dispersion and the expansion of communication in an inclusive way within the textual “series” and within the non-textual “series,” respectively and mutually. The “conjunctive synthesis” is produced by the common denominator of the previous two “syntheses.” Two resonating “series” converge towards “the aleatory point,” i.e. the Kālacakra astronomy with more concreteness and more newness. Deleuze says, “As for the conjunctive synthesis, it tends also toward being subordinated to the synthesis of connection, since it organizes the converging series over which it bears as it prolongs them under a condition of continuity.” By the syntheses, he intends that the “structure” (“champ transcendent”/ “transcendental field”) which is composed of such elements as “aleatory point”, plural “series,” etc. are inevitable for the “devenir” (becoming/ genesis). Likewise, the Kālacakra astronomy embodied in skar rtsis is in the

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382 Bogue (1989: 76): “The aleatory point [= paradoxical element] produces structures by effecting three syntheses: a connective synthesis that establishes a single series; a conjunctive synthesis that sets two series in resonance; and a disjunctive synthesis that causes series to branch out in divergent directions. ... The connective synthesis establishes differences between terms within a series, the conjunctive synthesis creates differences between the differences of the two series, and the disjunctive synthesis affirms difference by differentiating itself into two divergent series. Ultimately, the paradoxical element sets all series in resonance and itself traverses all series,...”

383 Deleuze (1973: 239) [= Lester and Stivale tr. (1990: 175)].

384 Deleuze (1973: 88-90) [= Lester and Stivale (1990: 64-5)].
middle of a journey of “devenir.” The generation of meaning in the Tibetan skar rtsis eclipse calculation is in development by the approach and method realized by the textual and non-textual “series.” And the seemingly contradictory values and ideas and theories seen in multi “series” all make sense and are affirmed as sources of knowledge. The incessant formation by syntheses is paradox in the Deleuzian sense. The skar rtsis clarifies the Kālacakra with reality, while making sense of the textual and non-textual “series”; the acquired reality unites the authority of the Kālacakra with esoteric abstraction.
CHAPTER FOUR

METHODS FOR ACCURACY IN ECLIPSE PREDICTION

INTRODUCTION

Chapter 4 represents the continuation of the ideas presented in chapter 3. The approaches mentioned in chapter 3 are tied to real mathematical considerations in chapter 4. In other words, it is possible that observation, empirical knowledge, discussion/ debates/ criticism, etc., influenced mathematical considerations, including *nur ster* applied to the longitude of the sun and moon, *rtsis ′phro / stong chen ′das lo* corrections, which will be mentioned in this chapter. Regarding the issue of different traditions referred to in chapter 3, I will briefly mention mathematics of the *Mā yang rgya rtsis* and the *Rgya rtsis chen mo* from the perspective of their use for the increase of the accuracy of eclipse calculations. Both are based upon different mathematics from *skar rtsis* mathematics, but are understood within the *skar rtsis* mathematical framework supported by the *Kālacakra*. From that point of view, parallax and geographical knowledge based upon Western and Chinese trigonometry will be mentioned, in

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This argument should be demonstrated through textual evidence. I have focused on this concept and presented related proofs in this chapter. However, more evidence should be identified to substantiate it.
conjunction with the arithmetic approach of the skar rtsis. From a macro perspective, the methodological and mathematical unfolding of skar rtsis made by adopting “textual” and “non-textual” sources has been conditioned by the Kālacakra. Whatever mathematical methods were taken, they were restricted by the Kālacakra in the case of skar rtsis or were interpreted in conformity with the the Kālacakra in the case of rgya rtsis. The direction of evolution of the skar rtsis approach and mathematical methods has been determined solely by the Kālacakra. This chapter validates the argument.

1. SKAR RTSIS

1.1. BASIC KNOWLEDGE USED IN CALCULATIONS

Firstly, the bhūtasamkhyā system in Indian astronomy\(^{386}\), which uses some words to represent numbers, must be understood.\(^{387}\) The Dag yig mkhas pa’i byung gnas (M. Merged yarqu-yin oron neretü toytayaysan dagyig)\(^{388}\) nicely provides us with the following list of synonyms for each number.\(^{389}\)

\(^{386}\) See Neugebauer and Pingree (1970: 185): The bhūtasamkhyā system in Varāhamihira’s (505-587) Pañcasiddhāntikā is given.

\(^{387}\) The information is commonplace. For example, Petri (1966: 22-6), Kilty (2004: 605-9), etc. It is essentially Indic.

Table 9.

<table>
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<th>Synonyms (T.(M.))</th>
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164-8), Kanaoka (1987: 195-230), etc.. It was completed by Lcang skya III and others in 1742 (Abbai wehiyehe Qianlong 7th year). See Lcang skya III et al. (1982: 21), Lcang skya III et al. (2002: 1427-8). This work basically represents a dag yig text, but is closer to mgon brjod (S. abhiγđhāna) as far as the section of astronomy (T. bzo ba rγiγ pa'i skor / M. uraγaγu uγayān-u yου) is concerned. At least two Kalacakra specialists participated in the compilation of this section. See Lcang skya III et al. (1982: 20), Lcang skya III et al. (2002: 1422-4): “A proponent of bzo rγig, Se chen Rab ‘byams pa Blo bzang sangs rgyas (M. Lobangsangjalai), who came from Dbus gtsang in Tibet ... A Kalacakra proponent at Sgo mang dam chos gling Amdo, Chos rje Rab ‘byams pa Blo bzang rgyal mtshan Blo bzang rgyal mtshan (M. Lobangsangjalazn).” (töbed buiγang-ača ireγgyen jiruγai-yin uγayay-yi uγiγileγči sečen rabjamba lobangsangjalai, ... amduu-yin yaumang tāmgolling keid-ün doγγqurba bandida čorji rabjamba lobangsangjalanz, ... / bod dbus gtsang nas phebs па’l bzo rγig smra ba se chen rab ‘byams pa blo bzang sangs rgyas ... A mdo sgo mang dam chos gling gi dū’ khor ba pañди ta chos rje rab ‘byams pa blo bzang rgyal mtshan ... ). However, given the colophon, some other scholars in the colophon may have background knowledge on astronomy, aside from these two.

389 Lcang skya III et al. (1982: 58-9). Lcang skya III et al. (2002: 1206-11). The references present a problematic situation. Srid pa means 3 or 14. Note that it is used as 14 in most cases and it is rarely used as 3. A similar problem is also seen in Phyag mdzod reproduced in Huang and Chen (1987: 7).
Table 9 (continued)

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<tr>
<td>24</td>
<td>rgyal ba (ilayuysan), yul (oron).</td>
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<tr>
<td>25</td>
<td>de nyo (ter-e-kü činar).</td>
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<td>27</td>
<td>'khor lo (kûrdün), skar ma (odun).</td>
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<tr>
<td>32</td>
<td>so (sidün), gnyis skyes (qoyar ta törügeči).</td>
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<tr>
<td>0</td>
<td>stong pa (qoyasun), nam mkha’ (øytaryui).</td>
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It is important to note that numbers are read in a reverse order. For example, me (3) mkha’ (0) rgya mtsho (4) is 403, not 304. The technical terms of the four fundamental arithmetic operations are as follows. The operations were developed by sa gzhong.

Table 10.

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<td>add</td>
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<td>ster ba</td>
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<td>phul ba</td>
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<td>sbyin pa</td>
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<td>bson pa</td>
<td>nemerı</td>
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<td></td>
<td>nor da’gyur ba</td>
<td>ed bolyaqu</td>
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<td></td>
<td>idan pa</td>
<td>tegüseku</td>
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<tr>
<td>subtract</td>
<td>'phri ba</td>
<td>qasuqu</td>
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<td></td>
<td>sbyang ba</td>
<td>arilyaqu</td>
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<td></td>
<td>'phrog pa</td>
<td>bulyaqu</td>
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<td></td>
<td>zhu ba</td>
<td>simedgıkü</td>
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<td></td>
<td>'phral ba</td>
<td>qayacaıyulqu</td>
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<td></td>
<td>dor ba</td>
<td>nuyurqu</td>
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<td></td>
<td>'brid pa</td>
<td>bayurayulqu</td>
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<td></td>
<td>dman pa</td>
<td>doruitayulqu</td>
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<td></td>
<td>bu lon’gyur ba</td>
<td>üri bolyaqu</td>
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For further information on the calculations with an Tibetan sand abacus (T. sa gzhong), see Schuh (1970) which describes Mkhas dbang 'dus byung pa'i rde'u rtsis gzhung sarga brayad la daq ther byas pa rab sbyang gser gyi me long, the treatise of the rde'u rtsis was written by 'Dus byung pa (aka Ánanda) during the period of Dalai lama V (1617-1682). Schuh indicates that the calculations made with an abacus were for the conversion of units during taxes calculations after the harvest.
The following phrases are often seen in *rtsis* literature.\(^{392}\)

Table 11.

<table>
<thead>
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<th></th>
<th>T.</th>
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<tr>
<td>erase</td>
<td>physis pa</td>
<td>arčiçu</td>
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<td></td>
<td>dbyi ba</td>
<td>išikā</td>
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<td></td>
<td>bsubs pa</td>
<td>baliçu</td>
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<td>obtain</td>
<td>rnyed pa</td>
<td>olja</td>
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<td>thob pa</td>
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<tr>
<td></td>
<td>nor</td>
<td>ed</td>
</tr>
</tbody>
</table>

The units of time and space must also be understood. Such units as *chu tshod*, *chu srang*, *dbugs*, and *cha shas* are used for temporal and spatial divisions. 1 day equals 60 *chu tshod* (*S. nāḍī, ghaṭī, ghaṭikā, daṇḍa*), 1 *chu tshod* equals 60 *chu srang* (*S. pāṇipala, liptā, vināḍī*), 1 *chu srang* equals 6 *dbugs* (*S. ṣvāsa, prāṇa*). (one day equals 21600 *dbugs* (\(= 60 \times 60 \times 6\))).\(^{393}\) The ecliptic is divided into 27 *rgyu skar\(^{394}\)* counted from *tha skar* (*S. Aśvinī*). 1 *rgyu

---


<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>T.</td>
<td>Ishihama and Fukuda (1989)</td>
</tr>
<tr>
<td>0 tha skar</td>
<td>aśuwanī (ML asuvani)</td>
</tr>
<tr>
<td>1 bra nye</td>
<td>barāni (ML barni tulya)</td>
</tr>
<tr>
<td>2 smin drug</td>
<td>kīrdā (ML kirtik)</td>
</tr>
<tr>
<td>3 snar ma</td>
<td>rūgini (ML rokini)</td>
</tr>
<tr>
<td>4 mgo</td>
<td>mrgesir (ML margasir)</td>
</tr>
<tr>
<td>5 lag</td>
<td>ardīr (ML ardīr)</td>
</tr>
<tr>
<td>6 nabs so</td>
<td>burniwasa (ML bunarvasu)</td>
</tr>
<tr>
<td>7 rayal</td>
<td>bus / bis (ML bus aday)</td>
</tr>
<tr>
<td>8 skag</td>
<td>asāsī (ML askes)</td>
</tr>
<tr>
<td>9 mchu</td>
<td>mig (ML mag)</td>
</tr>
<tr>
<td>10 gre</td>
<td>burwabalgāni (ML burwabalgāni)</td>
</tr>
<tr>
<td>11 dbo</td>
<td>utarabalgaṇī (ML utarabalgaṇī)</td>
</tr>
<tr>
<td>12 me bzhī</td>
<td>qūsā (ML qasta)</td>
</tr>
<tr>
<td>13 nag pa</td>
<td>zīdrī (ML tśītā)</td>
</tr>
<tr>
<td>14 sa ri</td>
<td>suwādi (ML svatī)</td>
</tr>
<tr>
<td>15 sa ga</td>
<td>šuṣīyī (ML šusak)</td>
</tr>
<tr>
<td>16 lha mtshams</td>
<td>anūṛad (ML anurad)</td>
</tr>
<tr>
<td>17 snron</td>
<td>čīsā (ML jist)</td>
</tr>
<tr>
<td>18 snrubś</td>
<td>mol / mul (ML mol)</td>
</tr>
<tr>
<td>19 chu stod</td>
<td>burvasad (ML burvasad)</td>
</tr>
<tr>
<td>20 chu smad</td>
<td>utarasad (ML utarasad)</td>
</tr>
<tr>
<td>21 gro bzhin</td>
<td>sirawān (ML sirāvan)</td>
</tr>
<tr>
<td>22 mon dre (gre)</td>
<td>danisda (ML satabisi)</td>
</tr>
<tr>
<td>23 mon gru</td>
<td>sadībis (ML danis)</td>
</tr>
<tr>
<td>24 khrums stod</td>
<td>burwabadrabud (ML burwabadrabud)</td>
</tr>
<tr>
<td>25 khrums smad</td>
<td>utarabadrabud (ML utarabadrabud)</td>
</tr>
<tr>
<td>26 nam gru</td>
<td>riwā (M. revati)</td>
</tr>
</tbody>
</table>

S. abhihit T. byi bzhin (ML abji qiulyun-a (sic. read qulyun-a) cilan (MT abidi)
S. šatabhisā T. mon gre (ML satabis sim) satabis
S. dhanisbā T. mon gru (ML danis sihyun u segul) (MT danista. Ishihama & Fukuda confuse mon gru with mon gru

The synonyms of the 28 lunar mansions (T. rgyu skar nyes brgyad / M. qorin naiman odun) are given in Lcang skya III et al. (1982: 56-7) and Lcang skya III et al. (2002: 1196-202). About the byi bzhin which is not used in the 27 rgyu skar system, Lcang skya III et al. (2002: 1196-7) explains: “Because the longitude of the two, gro bzhin and byi bzhin, are the same, 27 rgyu skar ...”。 (gro bzhin byi bzhin gnyis longs spyod gcig pas (M. nigen edel-
The following table is based upon Lcang skya III et al. (2002).

<table>
<thead>
<tr>
<th>T. (M.)</th>
<th>T.</th>
<th>M.</th>
</tr>
</thead>
<tbody>
<tr>
<td>tha skar (ašuwani)</td>
<td>gsal ba’i bu mo</td>
<td>todurqai-yin ökin</td>
</tr>
<tr>
<td>bra nye (barani)</td>
<td>gshin rje ma</td>
<td>erlig eke</td>
</tr>
<tr>
<td>smin drug (kirdig)</td>
<td>maŋ po karto</td>
<td>olan kirdi</td>
</tr>
<tr>
<td>snar ma (ruwagini)</td>
<td>bi rdzi</td>
<td>birzi</td>
</tr>
<tr>
<td>mgo (mergesir)</td>
<td>smal po</td>
<td>smalbuwa</td>
</tr>
<tr>
<td>lag (ardar)</td>
<td>nag mo</td>
<td>qar-a eke</td>
</tr>
<tr>
<td>nabs (burniwasau)</td>
<td>sbyin mo’i lha mo</td>
<td>Ølğeçï eke-yin ökin tngrï</td>
</tr>
<tr>
<td>rayal (büs)</td>
<td>bla ma’i lha ldan</td>
<td>suru kürü-tü</td>
</tr>
<tr>
<td>skag (aslis)</td>
<td>gdenɡ can lha mo</td>
<td>erbeger-tü ökin tngrï</td>
</tr>
<tr>
<td>mchu (meg)</td>
<td>pha mes lha skyes</td>
<td>eĉige ebüge tngrï-eĉe törügsen</td>
</tr>
<tr>
<td>gre (burwalgungi)</td>
<td>rta chung</td>
<td>Ùčiken morin</td>
</tr>
<tr>
<td>dbo (udarabalgungi)</td>
<td>phyi mo</td>
<td>uy-un eke</td>
</tr>
<tr>
<td>me bzhi (qasda)</td>
<td>rig byed</td>
<td>vid šasdïr</td>
</tr>
<tr>
<td>nag pa (čaidar)</td>
<td>bya’u’</td>
<td>sibayuqai</td>
</tr>
</tbody>
</table>

190
| sa ri (sudi) | rlung gi lta mo | kei-yin ökin tngri |
|             | rlung gi dbang phyug | kei-yin erketü |
|             | swä sti           | suwadi          |
| sa ga (šošiy) | bi šā khā      | višaka          |
|             | rayud ldna ma    | ūndüšün tegülder eke |
|             | dbang po'i lha ldan | erketü-yin tngri-tü |
| lha mtshams (anurad) | lág sor | yar-un guruyu |
|             | a na rādhā     | anurad          |
|             | mdza'i lha      | amaray-un tngri |
| snron (čisda) | lde'u          | ldeyoo          |
|             | gang bu         | qongyurčay      |
|             | lha dbang ldan  | tngri-yin erke tegülder |
|             | rdzye šta      | čisda           |
| snrubs (mul / mol) | māu la | mo(u)la         |
|             | gru soq ma      | dalan-u ūncüg-tü eke |
|             | rtsa ba        | ūndüšün        |
| chu stod (burwasad) | bre       | šing           |
|             | bu rbāsadha    | burwasad        |
|             | chu lha ldan   | usun tngri-tü  |
| chu smad (utarasad) | u tta ra ḍha | utarasad        |
|             | phul           | nigen bitegii — I don’t know how this one is equivalent to phul. — |
|             | sna tshogs lha ldan | eldeb tngri-tü |
| gro bzhin (šarawan) | šhra wa na | šrawana         |
|             | ’grog byed     | boliyči        |
|             | bon po         | bombuwa         |
| byi bzhin (abizi) | no other names. |               |
| mon dre (danisda) | nam mthong      | sömi üjegći     |
|             | thob ldan ma   | olja-tu eke    |
|             | dha ni šta     | danisda        |
| mon gru (sadibis) | chu'i lha mo   | usun-u ökin tngri |
|             | sgrøg         | čidar           |
|             | nam mthong ‘og | douratu sömi üjegći |
|             | sha ta bhinya  | sadibis        |
| khrums stod (burwabadrabad) | bya mchu | sibayun-u quisiyan |
|             | ra yi lha mo   | imayan-u ökin tngri |
|             | gnas ma        | oron-u eke     |
| khrums smad (udarabadrabad) | utta ra bha dra pā | udarabadrabad |
|             | ze’u           | turyurčay-tu   |
|             | sbrul          | moyai           |
|             | ‘chings        | büse-tü         |
| nam gru/ riwadi | bso ba’i lha mo | edegęği ökin tngri |
|             | re ba tī       | riwadi          |
|             | shes pa        | medegęći       |
|             | rgyas byed     | delgeregülgęći  |

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skar = 60³ (yul gyi chu tshod) = 4 rkang pa-s × 15 yul gyi chu tshod. Thus, 1 ecliptic = 60³ × 27 = 1620³. Therefore, 1620³ ÷ 360° = 4.5³ / 1°, i.e. 4°30' equals 1° modern unit, or 1³ = 27. Because the same units are used for time (T. dus) and space (T. yul), dus kyi chu tshod and yul gyi chu tshod are differentiated. For example, 37³ in 3³7³43²''140'''' is dus kyi chu tshod (temporal chu tshod). The first place is gza’. Meanwhile, 37³ in 3³7³43²''140'''' is yul gyi chu tshod (spatial chu tshod). The first place is rgyu skar.

The three different types of day-reckoning (zhag gsum rnam dbye) are important. Nyin zhag (civil days reckoned from sunrise to sunrise / dawn to dawn; S. sāvana dina), khyim zhag (zodiacal day; S. saura dina), which are $\frac{1}{30}$ of the interval between zodiacs.

The Sanskrit transliterations are not organized or uniformed in Lcang skya III et al. (2002). It partly shows some different transliterations for a single Sanskrit term. The same is applied for Lcang skya III et al. (1982). Their original xylographs must be checked.

The list of the 12 zodiacs is as follows.

| Lcang skya III et al. (2002: 1183-4) |
| T. (S. / Western) | M. |
| 0 lug (Mesa / Aries) | qonin |
| 1 glang (Vṛṣabha / Taurus) | üker |
| 2 'khrig pa (Mithuna / Gemini) | qamtudyaqu |

395 Two radice for the notation of the astronomical unit exist; one is for dus (temporal unit): gza’, dus kyi chu tshod, chu srang, dbugs, chas shas are used for gza’ dhru, gza’ bar, and gza’ dag, etc. The other is for yul (spatial unit): rgyu skar, yul gyi chu tshod, chu srang, dbugs, and cha shas are used for nyi dhru, nyi bar, nyi dag, and sgra gcan, etc. Different notations have been tried by modern scholars: Schuh (1973a) uses a sexagesimal position system. For example, in this case, $[3,37,43,2,140]/(7,60,60,6,707)$ is a temporal unit and $[3,37,43,2,140]/(27,60,60,6,707)$ is a spatial unit. Henning (2007) follows the example of Neugebauer: 3³7³43²''140'''' is a temporal unit and 3³7³43²''140'''' (³ = gza’, ² = chu tshod, ’ = chu srang, " = dbugs, "' = cha shas, ...); 3³7³43²''140'''' (³ = rgyu skar, ² = chu tshod, ’ = chu srang, " = dbugs, "' = cha shas, ...). This method may be used to simply discriminate among the units. In the case of cha shas, its dkyil 'khor is not always 707. See Bsam ’grub rgya mtsho (2011: 28) [= Bod rgya tshig mdzod chen mo (2000: 776)]. In this work, I will follow Huang’s method, as shown in Huang and Chen (1987).

396 The list of the 12 zodiacs is as follows.
and *tshes zhag* (lunar days, *tithi*), which are $\frac{1}{30}$ of the mean synodic month, with has various lengths. The *tshes zhag* is related to bright fortnights (T. *yar ngo. dkar phyogs* S. *śuklapakṣa*) and dark fortnights (T. *mar ngo. dmar phyogs. nag phyogs. S. *kṛṣṇapakṣa*), i.e. 1/15 of the waxing and waning moon periods, respectively. The mean motion of the Sun and the Moon in the *grub rtsis* system is calculated using the following formulae: length of a *khyim zhag* = length of a *tshes zhag* $\times$ (1 + $\frac{2}{65}$). Length of a *tshes zhag* = length of a

| 3 karka ta (Karkata / Cancer) | meneket (?)*** |
| 4 seng ge (Simha / Leo)       | arslan         |
| 5 bu mo (Kanyā / Virgo)       | ākin            |
| 6 srang (Tulā / Libra)        | ċenglegur       |
| 7 sdig pa (Vṛśčika / Scorpio) | kilincē         |
| 8 gzhu (Dhanus / Sagittarius) | numan           |
| 9 chu sri (Makara / Capricorn)| madar (?)       |
| 10 bum pa (Kumbha / Aquarius) | qomq-a          |
| 11 nya (Mīna / Pisces)        | jiyasun         |

*** *gergete* is given in Lcang skya III et al. (2002: 1167). Different Mongolian transliterations for a single Sanskrit term are seen. The same is applied to Lcang skya III et al. (1982: 49, 53). Their original xylographs must be checked. In conjunction with the linguistic complexity in Mongolian transliterations for the zodiacs, see Shōgaito (1990: 163-4) based upon the Mongolian *Mahāvyutpatti* and relevant Uyghur texts.

397 This division is essentially Indic. For example, see Varāhamihira (1977: 5-8). To further investigate the terms *sāvana* (T. *nyin zhag*), *saura* (T. *khyim zhag*), and *tithi* (T. *tshes zhag*), see Neugebauer and Pingree (1970: 185-6), Lcang skya III et al. (1982: 52), and Lcang skya III et al. (2002: 1180). This reading will also define *khyim zhag* (M. *ger-ün qonu*), *nyin zhag* (M. *edür-ün qonu*), and *tshes zhag* (M. *sin-e-yin qonu*). Ishihama and Fukuda (1989: 384) presented *ahorūtram* (S.) for *nyin zhag*, together with [ML] *edür qonu* [MT] *edür qonu*. Also see Sárközi and Szerb (1995: 542), Vogel (1997: 679, no. 13).

398 According to Schuh’s position system, this is given as $1 + \frac{2}{65} = \frac{\left[\frac{1.2}{1.25}\right]}{-0.65} = \frac{67}{65} = 1 + \frac{4}{130}$. For which, $\frac{67}{65} = 1 + \frac{4}{130}$ (which reflects the *Laghukālacakra* I. 27. See Schuh (1973a: 121)). The ratio $\frac{67}{65}$ means that the period of 67 lunar months (T. *tshes zla*) is equal to that of 65 solar months (T. *khyim zla*). See Schuh (1973a: 4-5), Schuh (1974: 561).
\[ nyin \text{ zhag} \times 1 - \frac{(1 + \frac{1}{707})}{64}. \] 399

One tshes zhag = \( \frac{65}{67} \) khyim zhag = \( \frac{11135 (nyin \text{ zhag gi cha})}{11312 (tshes \text{ zhag gi cha})} \)

nyin zhag.

1.2. METHODS WITHIN THE KĀLACAKRA RELIGIOUS FRAMEWORK

1.2.1. ADDITION OF VALUES (T. NUR STER) TO LONGITUDE (T. LONGS SPYOD)

THE DIFFERENCE BETWEEN PHUG PA GRUB RTSIS AND BYED RTSIS. RTAG LONGS

Two different systems of calendrical calculations, siddhānta and karana, are included in the Kālacakra\(^{400}\), which was an inherent conundrum in creating calendrical systems in Tibet. The grub rtsis formulated by Phug pa scholars has different rtag longs from byed rtsis.\(^{401}\) The following table is presented on the basis of previous research.\(^{402}\)

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399 According to Schuh’s position system, this is given as \( 1 - \frac{(1 + \frac{1}{707})}{64} = 1 - \frac{[0.11]}{(-64,707)} \). See Schuh (1973a: 73), Schuh (1974: 561).

400 The discrepancy between siddhānta and karana has a long history in India. See Pingree (1981: 17-40). In particular, Pingree (1981: 32) states that “Karana outside of South India are distinguished from siddhāntas by their emphasis on pragmatic rules for computing and their avoidance of astronomical theory.” Also, for further information on the principle and calculations based upon the different systems in Indian astronomy, see Plofker (2009).

401 I appreciate Henning’s (Unpublished (1)) rigorous foundation for the formation of the Tibetan grub rtsis made in the 15\(^{th}\) century. Because I focused on 18\(^{th}\) century Tibetan astronomy and did not research other grub rtsis-s except for Phug pa grub rtsis, “grub rtsis” in this manuscript indicates the Phug pa grub rtsis, unless otherwise indicated. Also, I occasionally used “Phug pa grub rtsis,” but it is just for the purpose of emphasis.
Table 12.

<table>
<thead>
<tr>
<th>khyim lo (^{404})</th>
<th><em>Phug pa grub rtsis</em> (^{403})</th>
<th><em>byed rtsis</em></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>365 nyin zhag, 16 chu tshod, 14 chu srang, 1 dbugs, 12(13) (cha shas), 121(707) (cha shas)</td>
<td>365 nyin zhag, 15 chu tshod, 31 chu srang, 3 dbugs, 2(13) (cha shas), 571(707) (cha shas)</td>
</tr>
<tr>
<td></td>
<td>= 365.27065 nyin zhag (^{405})</td>
<td>= 365.25867 nyin zhag</td>
</tr>
</tbody>
</table>

\(^{402}\) For these values, see Huang and Chen (1987: 228). For Schuh’s research into the Sde srid’s *Vaiḍūrya dkar po*, see Schuh (1973a: 89-96).

\(^{403}\) Yum pa (2006: 144-5) is an investigation into the differences between the *Phug* system and the *Mtshur* system. There is no difference with the above table in the case of *byed rtsis*, but in the case of *grub rtsis*, there is a significant difference in *rtag longs dkyil 'khor* and *rtsis 'phro* among the three following traditions.

| \(\text{Grub rtsis}\) | \(\text{Phug lugs}\) \((\text{Vaiḍūrya dkar po})\) | \(\text{Mtshur lugs}\) \((\text{Legs bshad kun 'dus})\) | \(\text{Mtshur lugs byed grub zung 'brel}\) |
|----------------|----------------|----------------|----------------|----------------|
| gza'i tshes zhag *rtag longs* | \(0^\circ 59'34"16''(707)\) | \(0^\circ 59'34"00''(13)208''''(707)\) | \(0^\circ 59'34"11''(44)\) |
| nyi ma'i tshes zhag *rtag longs* | \(0^\circ 42'15"43''(67)\) | \(0^\circ 42'15"88''(13)23''''(67)\) | \(0^\circ 42'15"26''(38)\) |
| nyi ma'i dkyil 'khor \((\text{nyin zhag})\) | 365.27065 | 365.27065 | 365.26079 |
| tshes zla gcig gi dkyil 'khor \((\text{nyin zhag})\) | 29.53059 | 29.53059 | 29.53059 |

\(^{404}\) See Ōhashi (1997: 136): The *grub rtsis* system and the *byed rtsis* system in Tibetan astronomy are basically similar, and only the length of the year and months are different. In the *grub rtsis* system, one sidereal year = 365.27065 days and one synodic month = 29.53059 days. In the *byed rtsis*, a sidereal year = 365.25867 days, while a synodic month = 29.53056 days. The numbers in the table are rounded to the nearest hundred thousandths (5 decimal places).

\(^{405}\) Schuh (1973a: 89-90): The period of the sun’s *tshes zhag dkyil 'khor* is 371 *tshes zhag*, 4 *chu tshod*, 36 *chu srang*, 5 *dbugs*, 7 *cha shas*(13) = the Sun’s *nyin zhag dkyil 'khor* 365 *nyin zhag*, 16 *chu tshod*, 14 *chu srang*, 1 *dbugs*, 12 *cha shas*(13), 121 *cha shas*(707) = decimally 365.27065 days.
<table>
<thead>
<tr>
<th></th>
<th>tshes zla’i dkyil ’khor</th>
<th>zla ba’i rtag longs (nyin zhag)</th>
<th>zla ba’i rtag longs (tshes zhag)</th>
<th>gza’i rtag longs (tshes zhag)</th>
<th>nyi ma’i rtag longs (tshes zhag)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>29 nyin zhag, 31 chu tshod, 50 chu srang</td>
<td>zla ba’i dkyil ’khor: 27.32174 day (nyin zhag)</td>
<td>zla ba’i dkyil ’khor: 27.75604 day (tshes zhag)</td>
<td>zla ba’i dkyil ’khor: 27.75604 day (tshes zhag)</td>
<td>0°59°21'5&quot;43'(67)</td>
</tr>
<tr>
<td></td>
<td>31°50'0&quot;480&quot;(707) [ = 45&quot; (67) / 345&quot; (707) (cha shas shed snyoms)]</td>
<td>daily movement: 0°59°17'3&quot;95367(149209)</td>
<td>daily movement: 0°58°21'5&quot;43&quot;(67)</td>
<td>0°59°3'4&quot;16&quot;(707)</td>
<td>0°4°21'5&quot;43(67)</td>
</tr>
<tr>
<td></td>
<td>= 29.53059 nyin zhag</td>
<td>29.75604 day (nyin zhag)</td>
<td>27.75604 day (tshes zhag)</td>
<td>0°59°3’4&quot;6&quot;1412</td>
<td>0°4°21'5&quot;9(13)14</td>
</tr>
<tr>
<td></td>
<td>= 29.53056 nyin zhag</td>
<td>= 27.32174 day (nyin zhag)</td>
<td>= 27.75604 day (tshes zhag)</td>
<td>= 0°59°3’4&quot;6&quot;1412</td>
<td>= 0°4°21'5&quot;9(13)14</td>
</tr>
</tbody>
</table>

406 Schuh (1973a: 93).

407 Schuh (1973a: 95-6): The period of the moon in tithi corresponds to grub rtsis zla ba’i tshes zhag dkyil ’khor, 27.75604 days (27 + 657 869°), which equals decimally 27.32174 days, according to grub rtsis zla ba’i nyin zhag dkyil ’khor. Also, see Huang and Chen (1987: 228) for further information.

408 See Schuh (1973a: 96), and Huang and Chen (1987: 228).

409 Schuh (1973a: 94).

410 Schuh (1973a: 118).

411 Schuh (1973a: 91).

412 see m = 2 in Schuh (1973a: 118).

As seen above, the *rtag longs* discrepancy between *Phug pa grub rtsis* and *byed rtsis* is fractions of seconds per year and month reckonings. However, it is not difficult to speculate that the different mean longitudes of the sun and moon caused by it may influence the results of eclipse calculations.  

**NUR STER FOR ACCURACY OF ECLIPSE CALCULATIONS**

Because of the longitudinal differences between *Phug pa grub rtsis* and *byed rtsis*, *nur ster* or *nur phri* has often been considered for the purpose of correspondence between *rtsis* and real eclipse phenomena. This means that either values must be added to the longitude of the sun / moon, or values must be subtracted from *sgra gcan dong* (ascending

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414 see m = 2 in Schuh (1973a: 118).

415 The general Tibetan conception is as follows: the temporal (T. *gza‘*) values are more accurate in the *grub rtsis* system, meanwhile the spatial (T. *skar*) values are more accurate in the *byed rtsis* system. Therefore, it follows that the latter is more accurate than the former for eclipse calculations. To illustrate some examples in Tibetan *rtsis* texts, Sum pa Mkhan po (2015a: pdf 331-2) states: “It is known that there are certainly possibilities for eclipse in *byed rtsis* and in *grub rtsis* for timing, etc...” (*’dzin dang mi ’dzin byed rtsis dang / ’dzin dus sos la grub pa nges zhes grogs /*). Similarly, Gser tog (2015: pdf 81) writes: “It is said that lunar eclipses are examined by *byed rtsis* and solar eclipses by *grub rtsis*, but in case that solar eclipse does not arise in *byed rtsis*, *grub rtsis* is also not comprehended as accurate in the case that the solar eclipse occurs. Therefore, corrected *byed rtsis* (*rnam dag byed rtsis*) is good for [deciding] the occurrence of an eclipse. Timing is mainly based on the planetary longitude of *grub rtsis*.” (*zla’ ’dzin byed pa ngyi ’dzin grub par brtags / zer yang ngyi ’dzin byed pa ma shar na / grub kyang shar lhar mi ’dzin de yi phyir / ’dzin dang mi ’dzin rnam dag byed pa bzang / dus tshod grub pa’i res gza’i longs spyod gtso /*).
node) / sgra gcan mjug (descending node). Phyag mdzod summarizes the nur ster explained in the Nyin byed snang ba, which computes how far either the value of sgra gcan gdong \(-31^\circ 41'4"10''\) or that of sgra gcan mjug \(-31^\circ 41'4"10''\) varies from zla yi longs spyod (longitude of the sun / moon), according to the grub rtsis in order to elucidate the possibility of a lunar eclipse.

Furthermore, subtracting \(31^\circ 41'4"10''\) from sgra gcan gdong, sgra gcan mjug, whatever is appropriate, is an infallible determinant. Investigating after comparing the value and the longitude of the sun / moon in the grub mtha’ (= grub rtsis), whatever is close, is the method of the Nyin byed snga ba.

The value \(31^\circ 41'4"10''\) has been thought to be “nine fortnights (= 18 weeks = four and half months) of the motion of Rāhu.” The application of nur ster / nur phri is tied to the difference between grub rtsis and byed rtsis in terms of the longitudinal differences of the sun and moon.

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416 See nur byin in Bsam ’grub rgya mtsho (2011: 94) [= Bod rgya tshig mdzod chen mo (2000: 1527)]: “On the occasion of eclipse, the way of subtracting more than 31 chu tshod, the longitude of four and half months from, Rāhu head / tail, whichever is closer, or of adding to the longitude of gza’ dag, etc. …” (gza’ ’dzin skabs sgra gcan dgong mjug gang rung la chu tshod gzuqs me soqs zla ba bzhi dang zla phyed kyi longs spyod kyis phyi ba dang / gza’ dag pa’i longs spyod kyi steng du nur ster tshul soqs /… ...). This explanation needs further explanation: Generally, the nur ster / nur phri is applied to the tshes ’khyud zla skar in the case of a lunar eclipse and nyi dag in the case of a solar eclipse respectively. Bsam ’grub rgya mtsho may mean the consideration of timing by “adding a value to the longitude of the gza’ dag.” Or, it may be related to the fact that the original draft of Bsam ’grub rgya mtsho (2011) was revised by someone else and published.


Dharmaśrī defends the usefulness of grub rtsis for eclipse calculations. We do not fully understand his logic, which is as follows: The byed rtsis combined with the myong rtsis (calculation by observation/experience)\(^{421}\) is fundamentally the same with the grub rtsis combined with the nur ster. Whether his explanation is persuasive or not, it is certain that the method of nur ster/nur phri was developed within the dynamics between grub rtsis and byed rtsis.

The method of the adjustment of longitude by adding or subtracting some values appears to be widespread, even before the Nyin byed snang ba. More research is needed to

\(^{419}\) Dharmaśrī (1983: 252). For an additional context for this phrase, see Henning (2007: 101-3).

\(^{420}\) Dharmaśrī (1983: 252) presents the corrected value for tshes 'khyud zla skar, i.e. tshes 'khyud zla skar + 32\(^{q}\) to judge the possibility of a lunar eclipse. See also Henning (2007: 101).

\(^{421}\) By this, Dharmaśrī may mean that 806/3/0, the epoch of the byed rtsis, was set up by reflecting observational values around the epoch. Further research is needed.
clarify this point, but, for example, Ngag dbang (active in the late 17th c.) mentions that the 16th century Lha dbang blo gros points out that eclipse calculations by the Pad dkar zhal lung are not correct in terms of the longitude of the grub rtsis.

'dzin pa snqa phyi'i skor gdan 'dus mkhan po lha dbang blo gros kyis zhal lung la skyon brjod pa'i tshes la / gza' 'dzin skabs su zhal lung grub rtsis steng / chu tshod bzhi lnga mi 'grig bsnon dgos

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422 For Ngag dbang, see Schuh (1973a: 40): “So wird z.B. die Basis für die Grub rtsis der Phug pa Schule, d.i. die Gröβe der ausgehend von der großen Konjunktion errechneten Anfangswerte, nicht in Frage gestellt. Zweifellos war Ngag dbang selbst ein Angehöriger der Phug pa Schule.” Also see van der Kuijp (2012: 2). He is a teacher of Sum pa Mkhan po’s teacher Ngag dbang rgya mtsho. Sum pa Mkhan po’s astronomy teachers include Sde pa Lha dbang, Ngag dbang rgya mtsho, and others; see Singh (1991: xiii) and Smith (2001: 169). Smith (2001: 310, n. 529-30) observes: “Sde pa Lha dbang was a Lhasa aristocrat who had studied astronomy and astrology with the Sde srid. ... Thu’u bkwan notes that Ngag dbang rgya mtsho was a student of one La Ngag dbang pa.” Among them, La Ngag dbang pa is identified in Sum pa mkhan po’s writings. He is the famous Ngag dbang who wrote a letter to the Sde srid to ask questions on the Vaidūrya dkar po. Sum pa Mkhan po (1997: 34), Sum pa Mkhan po’s autobiography in which he describes his activities in Dbus gtsang in 1726, conveys the following fact: “I learned skar rtsis and nag rtsis from three: Sde ba dang lha dbang ba (Sde pa Lha dbang) from Skyor mo lung, direct student of the Sde srid and Sgo mans pa Rab’ byams pa Ngag dbang rgya mtsho, who learned astronomy from Lā Ngag dbang, and a common physician”. (skyor mo lung nas sde srid sangs rgyas rgya mtsho’i dngos slob sde ba dang) (sic.) lha dbang ba dang / lā ngag dbang las rtsis bslab pa’i sgo mang ba sog po rab’ byams pa ngag dbang rgya mtsho dang / spyi sman pa gsum las skar rtsis dang nag rtsis skor bslab /). In Sum pa Mkhan po (1979d: 50a) [= (2001: 129)], the La Ngag dbang (Lā Ngag dbang) appears as Lnga Ngag dbang: “I pretended (Tibetan way of speech in a humble way) to learn nyin zhang gza’ lnga, etc. from Sde pa Lha dbang from Skyor mo lung, direct student of the Sde srid, lnga bsdu, etc. from Sog po Rab’ byams pa Ngag dbang rgya mtsho, a student of Bla mkhyen Lnga Ngag dbang who has reached the other side of astronomy (= expert), to whom the Baidūrya’i g.ya’ sel was granted as reply, after having offered Rtsis baidūrya dkar po’i nang gi dogs gnas dris pa snyan sgron (= Ngag dbang (2002)) to the Sde srid, and the displaying way of 45 rya rtsis rde’u of the tradition of spor thang, etc. from a common medical donator at the monastery of Bras spungs’”. (sde srid sangs rgyas rgya mtsho’i dngos slob skyor mo lung gi sde pa lha dbang las nyin zhang gza’ lnga sogs dang / rtsis baidūrya dkar po’i nang gi dogs gnas dris pa snyan sgron zhes pa sde srid la phul nas lan du baidūrya’i g.ya’ sel byed (?) ces pa gnang yul (sic.) / bla mkhyen Lnga ngag dbang zhes rtsis rig gi pha rol tu son pa de’i slob ma sog po rab’ byams pa ngag dbang rgya mtsho las lnga bsdu sogs dang / spor thang las kyi rya rtsis rde’u zhe lnga bkar dam tshul sogs ni ’bras spungs spyi’i sman sbyin pa bod pa sman rams pa zhig las bslab khul byas /). Also, in Brag dgon Zhabs drung (1987: 62), the Ngag dbang appears as Lug mgo Bla mkhyen Ngag dbang: “[Sum pa Mkhan po] studied with Sde ba Lha dbang from Skyor mo lung, direct student of the Sde srid, and Sog rams pa Ngag dbang rgya mtsho, a student of Lug mgo Bla mkhyen Ngag dbang who offered the Bai dkar la snyan sgron (= Ngag dbang (2002)).” (sde srid dngos slob skyor mo lung gi sde ba lha dbang pa dang / bai dkar la snyan sgron ’bul mkhan lug mgo bla mkhyen ngag dbang gi slob ma sog rams pa ngag dbang rgya mtsho las rtsis dkar nag la sbyangs /). For a Chinese translation, see Wu Jun et al. (1989: 67). Various titles or regional names such as La (Lā), Lnga, Lug mgo (also in the form of Lu ‘go, see above notes 154, 285), etc. are addressed before his name. They are occasionally combined with the title bla mkhyen, i.e. court astrologer.

423 Variations such as gdan du, gdan dus, etc. appear in the Tibetan rtsis texts.
na / zhal lung rjes 'brang rnams la mngon sum skyon / zhes par lan chos rje bkod po pas (sic.) mdzad par / gza' 'dzin ayt skabs 'dir mkhas pa snga ma rnams kyi byed pa'i tshes long steng du / nyin mtshan mnyam dus mda' byin zhing / lho byang mthar thug phyogs kyang byin / zhes dang / kha cig tu / nyin mtshan mnyam dus glu (sic. read klu) dang ni / bgrod gnyis mthar thug mi bdag byin / zhes sogs man ngag tu mdzad pa snang yang / grub mtha'i longs spyod byed pa'i tshes kyi nang du ma chud pa'i cha bsnon dgos pa yin la / 'dir ni grub mtha'i longs spyod rnam par dag pa yin pas / snon byed zur pa ma dgos la / ... 424

Regarding the earlier and later eclipse, when Gdan dus Mkhan po Lha dbang blo gros explained the errors of the Pad dkar zhal lung, he said that if the incorrect 4 to 5 chu tshod should be added to the grub rtsis of the Pad dkar zhal lung on the occasion of an eclipse, the Pad dkar zhal lung followers were mistaken in their observations. In Chos rje Bkod po pa’s (Grwa phug pa?) reply to him, he (Chos rje) said that here, on the occasion of eclipse, 5 (T. mda’) is added to the tshes long of the byed rtsis of the previous scholars in equinox, and 10 (T. phyogs) is also added in lho byang mthar thug. 425 Although in some cases, there appears to have been oral instruction (T. man ngag) saying 8 (T. klu) in equinox, 16 (T. mi bdag) in bgrod gnyis mthar thug 426, the longitude of the grub mtha’, cha (cha shas) that were not included in the tshes 427 of the byed rtsis needs to be added [to the longitude of the byed rtsis] because, in this case, the longitude of the grub mtha’ is accurate and does not warrant further additions.

In the above passage, the answer to the question as to why an eclipse cannot be predicted accurately by the grub mtha’ (S. siddhānta) corrections to the longitude of the sun is: the


425 Bsam ’grub rgya mtsho (2011: 117): “southward movement: to take the sun as an example, the sun goes south during 6 khyim zla, i.e. from ’khrig pa, (karka ta, seng ge, bu mo, srang, sdig pa) after summer solstice, and is the case that the daytime gets shorter and shorter, and the nighttime gets longer and longer.” (lho bgrod: nyi ma la mtshan na dbyar nyi ldog nas ’khrig pa soqs khyim zla drug la nyi ma lho bgrod de / nyin je thung dang mtshan je ring ’gro ba’i skabs so /). Bsam ’grub rgya mtsho (2011: 117): “northward movement: to take the sun as an example, the sun goes north during 6 khyim zla, i.e. from gzhu, (chu srin, bum pa, nya, lug, glang) after winter solstice, and is the case that the daytime gets longer and longer, and the nighttime gets shorter and shorter.” (byang bgrod: nyi ma la mtshan na dgan nyi ldog nas gzhu soqs khyim zla drug la nyi ma byang bgrod zer te / nyin je ring dang mtshan je thung du ’gro ba’i skabs so /).

426 See above note 425.

427 It is difficult to make sense of ’tshes’ here. I conjecture the author means the difference of gza’ dag between grub rtsis and byed rtsis by it.
byed rtsis is wrong. They talk at cross purposes! But, the problem of how to defend grub rtsis lingers.\footnote{428}

At this point, the audience may ask why Tibetans did not change rtag longs on the basis of observation and empirical data, that are assumed to have been made continuously. Mi pham’s opinion on rtag longs, regarding the motion of the sun, moon, and rāhu in the following paragraph, may show the Tibetan normative approach to the rtag longs involved in eclipse calculation. A criticism towards the Rtsis gsar thub bstan mdzes rgyan written by Rnga ban Kun dga’ reads as follows:\footnote{429}

... spyir bod snga rabs pa’i rtsis thams cad nyung ngu’i byed pa la brten pa’i rtsis kyi dbang gis longs spyod nyung ba yin zer nas longs spyod mang du btang ba / de dang shed snyams pa’i phyir sgra gcan gyi longs spyod mar phri nas zla phyed nyer dag zhag bzhi brgya so lnga tsam gyis snga ma rnams las nyung ba ‘di / nyi ma phyir bsnu ba dang bsgrig pa’i ched du sgra gcan de tsam yar ded pa las / rayud las ’di ltar bstan rigs pas ’di ltar ’thad zer ba’i gtan tshigs mi snang ste / sgra gcan dus rgyun mig skar dang bsgrig rayu ni med / gal te rtsis snga ma rnams kyis nyi zla’i longs spyod nyung ba’i skyon yin na nyi zlar bsnan pa’am / yang na sgra gcan gdong njug la de tsam bri bas ’grig pa’am / ... \footnote{430}

... This one whose [longitude of Rāhu] is smaller than the previous ones by 435 days (15 (zla phyed. half-month) × 29 = 435 days), having subtracted Rāhu’s longitude in order to equalize the increase of the longitude [of the sun], after having said that generally the longitude of [the sun] in all Tibetan predecessors’ calculations is small because of there being the calculations based upon the smaller byed rtsis (nyung ngu’i byed rtsis): moved Rāhu forward by that much in order to match the sun’s moving backward. [However,] an argument that should be taught this way is not seen in the Kālacakra, and Rāhu is not that which should always match up with the observation (mig skar). If the previous astronomers erred in terms of the small longitude of the sun and moon, it would be fine to

\footnote{428}{Regarding this, Henning’s (2007: 307) opinion may work: “Rather than the siddhānta providing highly accurate calculations for the calendar, it instead provides a methodology for regular observation and correction of the calendar, based on the solstitial adjustment to the longitude of the Sun.”}

\footnote{429}{Rnga ban Kun dga’ appears in Karma Phun tshogs (2005: 54). He is a contemporary of Mi pham.}

\footnote{430}{Mi pham (2012b: 392-3).}
Tibetan astronomers are ready to refute anything that contradicts the *Kālacakra*. Asking how to enhance the accuracy of eclipse calculations within the frame of *skar rtsis* buttressed by the *Kālacakra*, may be equal to asking which trials cannot be made within the frame of the *Kālacakra*.

1.2.2. CORRECTION OF CALCULATION REMAINDERS (T. *RTSIS ’PHRO*)

The different calculational systems in Tibet are explained by the correction *rtsis ’phro*. Schuh (1973a) and Henning (2013) present excellent research into this subject. Tibetan astronomers’ corrections of *rtsis ’phro* are tied to enhancing the

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432 Schuh (1973a: 71-6, 116-23): Ten (eleven if old and new *Phug* systems (according to Schuh’s terms) are counted separately) different calendral systems are given according to different solar (SO(m,n)) and lunar (MO(m,n)) constants [= S(m,n) and W(m,n), respectively in Schuh (2012a)]. Among them, he demonstrates the first three (four) cases (m = 1A (1B), 3, 4) in his tables. His explanation is as follows: First, m = 1 indicates old *Phug pa* [m = 1B] and new *Phug pa* [m = 1A] systems (both are *grub rtsis*). In the case of *byed rtsis*, firstly, m = 2 is ‘so-called exact *byed rtsis*’ (sogenannte exakte Byed rtsis). He calls it *Phug pa*’s new *byed rtsis*. Schuh (1973a: 75): “die durch die Verwendung der Werte, SO(2,1) [= S(2,1) in Schuh (2012a)] = SO(3,1) [= S(3,1)], SO(2,2) [= S(2,2)] = SO(2,1) [= S(2,1)], SO(2,3) [= S(2,3)], MO(2,1) [= W(2,1)] = MO(3,1) [= W(3,1)], MO(2,2) [= W(2,2)] = MO(2,1) [= W(2,1)], MO(2,3) [= W(2,3)] charakterisiert ist, kaum vor dem 14. Jahrhundert stattgefunden haben. ... dieser Typ der Byed rtsis um die Mitte des 15. Jahrhunderts im Gebrauch gewesen ist.” Hence, m = 3 is the *byed rtsis* from the *Laghu kālacakra*. Schuh (1973a: 74) explains it: “Die Verwendung der Werte MO(3,1) und SO(3,1) in der Kalenderrechnung ist für die tibetische Byed rtsis charakteristisch und wurde von allen Astronomen verwendet, die nicht bereit waren, von den Zahlenangaben der Kalenderrechnung des *Kālacratantra* zugunsten der rekonstruierten Grub rtsis vollständig abzweichen.” m = 4 is *’Phags pa*’s *byed rtsis*. Schuh (1973a: 74-5): “Für seine Kalenderrechnung verwendet *’Phags pa* SO(3,1), MO(3,1) und MO(3,3). Anstelle von MO(3,2) rechnet er mit MO(3,1) und
agreement between rtsis and the phenomenon of eclipse, as perceived by direct

... An der Byed rtsis des 'Phags pa zeigt sich insbesondere, dass die Skar rtsis im 13. Jahrhundert wenig mehr ist als eine unkritische Aufnahme und Auswahl dessen, was in den Sanskrit-Texten vorgegeben war." Schuh's explanations leave something to be desired. First, let us look into m = 1A and m = 1B. Aside from the incorrect intercalation in m = 1A (See Yamaguchi’s excellent research (1992: 890), (1990: 31) and Schuh (2008: 209ff.)), it begs the question of if his division of the old and the new Phug pa, with 1696 as a watershed, can be justified. For an explanation, see Schuh (1973a: 138-9): "... die Kalenderrreform des Übergangs von der älteren grub rtsis zur neueren grub rtsis der Phug pa Schule 1696 wirksam geworden ist. ... Die Kalenderrreform ist also offenbar erst nach dem Tod des 5. Dalai Lama realisiert worden." However, the demarcation between the new Phug pa and old Phug pa systems in 1696 C.E. is a hasty conclusion based upon Ahmad Zahiruddin’s Sino-Tibetan Relations in the Seventeenth Century (1970). See also Schuh (2008: 236), Schuh (2012a: 115): “Diese neue Methode der Einfügung von Schaltmonaten wurde im Verwaltungsbereich der zentraltibetschen Regierung im Jahre 1696 nach dem Tod des 5. Dalai Lama eingeführt.” Of course, it is highly possible that the new the intercalation method, in which the mda’ ro lhag ma 48, 49 indicates intercalation, began to be used in the 17th century. However, it is difficult to know in which text the mda’ ro lhag ma 48, 49 (50, 51 in leap months) began to be used. — Regarding this, see Janson (2014: 57, n.68). The change of the mda’ ro lhag ma into 49, 49 may be closely tied to the introduction of the concept of the sgang. It should be noted that the sgang (precisely bod sgang) is not the same as the Chinese zhongqi. It is easily verified from a lo tho that the dual system, which uses both bod sgang and rgya sgang, is used. The bod sgang is interrelated with the mda’ ro lhag ma with regards to the decision of intercalation; the rgya sgang is basically the same as the zhongqi in the Chinese lunar calendar. — In the same vein, a larger problem is that we do not know which mda’ ro lhag ma was used in the Phug system before 48, 49. It is highly possible that Phug pa scholars used 63, 64 (65, 66 in leap months) like byed rtsis — this dates back to Grags pa rgyal mtshan—or 65, 66 (0, 1 in leap months) like Mtshur phu grub rtsis but I wonder whether Schuh has any textual evidence. For Schuh’s opinion, read Schuh (1973a: 110-2). — Another relevant problem is that we do not know whether the terms old Phug / new Phug can be justified or ever existed in Tibetan literature. During a personal talk, Yum pa once communicated that, according to his long-time reading of Tibetan rtsis literature, Phug pa snga ma of Dpal mgon 'phrin las pa / Phug pa gsar ma beginning from Lhun grub rgya mtsho may be the proper way of the classification for the Phug system, as seen in real rtsis literature. Next, let us briefly mention his explanation of the byed rtsis. Aside from the byed rtsis (m = 5, 6, 7) in Abhayākaragupta’s Kālacakrāvatārā, he does not present m = 2, which would be the most useful for modern Tibetan historians. Instead, he presents m = 3 (Laghukālacakra system according to him), 4 ('Phags pa’s byed rtsis system according to him). First off, I do not know why m = 4 exists independently of m = 2, which is currently known as the byed rtsis system and dates back to Rje btsun, this also means that this system was used by Sa skya scholars, one of whom is 'Phags pa, and supported also by Bu ston. In other words, I am not sure whether 'Phags pa’s byed rtsis is different from m = 2. I understand that 'Phags pa’s texts Lnga bs dus sgra gc gnza’i lnga dang bcas pa’i rtsis gzhi (epoch: 1248), Dus gsal ba’i sgron me (epoch: 1267), and Dhru va gnyis pa’i rtsis (epoch: 1252) [with some corrections of the values in the latter part of it] are m = 2. In addition, Rtsis kyi gtsug lag dang mthun par nges pa (epoch: 1264) is different from the three texts in terms of mda’ ro lhag ma, ril cha, gza’, and nyy ma, etc. Regarding the last text, there is an explanation in Schuh (1973a: 102). I believe that he could have presented his relevant bases and detailed explanations pertaining to how the 'Phags pa’s texts have been reflected in the tables in Schuh (1973a). My current line of thinking is also applied to m = 3. I think that a detailed explanation, which pinpoints the relationship between the Laghukālacakra and his results in the corresponding table, should be given for m = 3. Lastly, even when assuming that Schuh (1973a) and Schuh (2012a) are correct, I am wondering if evidence exists that supports the concept that m = 3 and m = 4 were used in real Tibetan texts.
experience (mngon sum). In the following, I first sketch the general issues of the rtsis ’phro and then the 18th Century technical considerations of Phug pa in conjunction with eclipse predictions.

**RTSIS ’PHRO VALUE AT EPOCH**

The debate seen in Schuh (2008) and Henning (2013c) is a nice tool to understand the basic concepts involved. To balance these two opposing sides, we will begin with the Sde srid’s Vaiḍūrya dkar po. The epoch date is 1687/3/0. The epoch data given in 1687/3/0 are as follows:

<table>
<thead>
<tr>
<th></th>
<th>1687/2/30 ( = Apr 11, 1687)</th>
<th>1687/3/0</th>
<th>1687/3/1 ( = Apr 12, 1687)</th>
</tr>
</thead>
<tbody>
<tr>
<td>bshol ’phro (= mda’ ro lhag ma)</td>
<td>13</td>
<td>15</td>
<td>15</td>
</tr>
<tr>
<td>gza’ dhru’i ’phro (= gza’ dhru)</td>
<td>$5^39^7^2^&quot;212^&quot;$</td>
<td>$0^0^5^7^2^&quot;692^&quot;$</td>
<td>$0^0^5^7^2^&quot;692^&quot;$</td>
</tr>
</tbody>
</table>

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434 Day 0, the time of border between day 30 and day 1, is introduced merely for convenience in Henning (2013c) and in this text. Of course, the day does not exist in real calendars.

435 The values highlighted in bold are to demonstrate how the epoch values are arranged.
Then, how are the epoch values decided? The major principles are as follows: epoch values mainly concern gza’ dhru, ril cha, and nyi dhru. Firstly, at 3/0 (= epoch), gza’ bar is valued at 2/30, equal to the gza’ dhru value of the third month, and the nyi bar value at 2/30 equals the nyi dhru value of the third month (3/0 is included). For the calculation of gza’ dag and nyi dag at 3/0 (= epoch), the ril cha of the second month is used. The mda’ ro lhag ma, gza’ dhru’i ’phro, ril cha’i ’phro, and nyi dhru’i ’phro values are the same with those at 3/1. gza’ dag, nyi dag, and rtsa gdong mjug values are the same as those at 2/30.

The epoch date of 1927 has been debated between Schuh and Henning. Let us first look at the table below. Schuh (2008) says that 1927/2/30 equals the modern date, May 1, 1927 and 1927/3/1 equals 2 May 1927. Therefore, the epoch should be 2 May 1927.

<table>
<thead>
<tr>
<th></th>
<th>1927/2/30</th>
<th>1927/3/0</th>
<th>1927/3/1</th>
</tr>
</thead>
<tbody>
<tr>
<td>bshol ’phro</td>
<td>55</td>
<td>57</td>
<td>57</td>
</tr>
<tr>
<td>gza’ dhru ’phro</td>
<td>6°57’53”2’20””</td>
<td>1°29’43”2’500””</td>
<td>1°29’43”2’500””</td>
</tr>
<tr>
<td>ril cha’i ’phro</td>
<td>13/103</td>
<td>15/104</td>
<td>15/104</td>
</tr>
</tbody>
</table>

Table 14.
On the other hand, Henning (2013c) argues that epoch data are based upon the mean sun.\(^{436}\) In other words, 1927/3/0 is not an epoch. Therefore, what is the correct epoch date? There is an explanation based upon Julian dates in Henning (2013c), which is a sufficient explanation, but in this text I use a possible Tibetan interpretation.\(^{437}\) 3/0 is not always the epoch date. For more information on the matter, please see the following tables, which show the differences between the values at 2/0 and those at 3/0.\(^{438}\)

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\(^{436}\) Henning (2013c).

\(^{437}\) I say ‘possible,’ because I have not yet found the Tibetan textual description that substantiates this argument.

\(^{438}\) The same calendrical system is used again by a mere change in rtsis ’phro values. It is called rtsis ’go bstun gs pa / spos gs pa. It is customarily made every sixty years. This concept is also related to stong ’jug. See below note 589. In other words, the three texts, Huang and Chen (1987), Mkhyen rab nor bu (1976), and Bod ljongs gnam rig skar rtsis rig gzhung tshogs pa (1985) are the same calendar with different epoch data.
Table 15.

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>epoch</strong></td>
<td>1827/2/0</td>
<td>1927/2/0</td>
<td>1987/3/0<strong>442</strong></td>
</tr>
<tr>
<td><strong>bshol 'phro</strong></td>
<td>60</td>
<td>55</td>
<td>0</td>
</tr>
<tr>
<td><strong>gza' dhru'i 'phro</strong></td>
<td>3(^{3})37(^{3})43(^{2})140(^{m})</td>
<td>6(^{3})57(^{2})53(^{2})20(^{m})</td>
<td>3(^{3})11(^{2})27(^{2})332(^{m})</td>
</tr>
<tr>
<td><strong>ril cha'i 'phro</strong></td>
<td>22/0</td>
<td>13/103</td>
<td>21/90</td>
</tr>
<tr>
<td><strong>nyi dhru'i 'phro</strong></td>
<td>24(^{3})59(^{3})6(^{1})41(^{m})</td>
<td>25(^{3})9(^{3})10(^{4})32(^{m})</td>
<td>0(^{3})0(^{3})0(^{3})0(^{m})</td>
</tr>
</tbody>
</table>

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439 Huang and Chen (1987: 140).

440 The epoch of Mkhyen rab nor bu (1976) was changed by Mkhyen rab nor bu into 1927 from Phyag mdzod, i.e. Huang and Chen (1987), whose epoch is 1827.

441 The epoch is 1987. The text in Yum pa’s collection (possibly written in 1987) and Tshul khrims rgyal mtshan (2009) are the same calendars.

442
Table 15 (continued)

<table>
<thead>
<tr>
<th></th>
<th>1827/3/0</th>
<th>1927/3/0</th>
</tr>
</thead>
<tbody>
<tr>
<td>bshol’ phro</td>
<td>62</td>
<td>57</td>
</tr>
<tr>
<td>gza’ dhru’i’phro</td>
<td>5’9°33’2”620’’</td>
<td>1°29°43’2”500’’</td>
</tr>
<tr>
<td>ril cha’i’phro</td>
<td>24/1</td>
<td>15/104</td>
</tr>
<tr>
<td>nyi dhru’i’phro</td>
<td>0°10°4’2”58’’</td>
<td>0°20°8’5”49’’</td>
</tr>
</tbody>
</table>

In the case of 1827 and 1927, 1827/2/0 and 1927/2/0 are epoch dates. In the case that the mda’ ro lhag ma is larger than 49 and less than 66 in the grub rtsis, 2/0 is chosen as the epoch date. The rationale is as follows: the zla dag increases between mda’ ro lhag ma 49 and 66, i.e. the period (cycle) of intercalation that is not yet done. Simply put, in case that a leap month exists, the second month is actually the third one. Therefore, the epoch date is 2/0. In the case of 1987, there is no such indication by mda’ ro lhag ma, which 1827/3/0 cannot be an epoch date. See the mda’ ro lhag ma, 62.

---

443 48 and 49 indicate leap months in grub rtsis in the system of Phug pa in this period.

445 Henning hints at a right answer in Henning (2013c): “Does he disagree that it is the mean new Moon when you calculate for the 3rd month in that year from any previous epoch, before making any intercalary adjustment?”
indicates that the epoch is 3/0. In other words, Henning’s (2013c) explanation is correct. The intercalation in grub rtsis is also based upon the mean moon.

**RTSIS ’PHRO DIFFERENCES AMONG DIFFERENT SYSTEMS 1: KAḤ THOG RIG ’DZIN’S RESEARCH**

Kaḥ thog Rig ’dzin systematically classified the rtsis ’phro differences among different systems, especially in the byed rtsis/ grub rtsis tradition in Kaḥ thog Rig ’dzin (1976-1977a) (2006a), written in 1750.

First, byed rtsis (the values given are those at epoch, 1747/3/0).

Table 16.

| gza’ dhru’i ’phro | ril cha’i ’phro | nyal dhru’i ’phro |

---

446 See Kaḥ thog Rig ’dzin (1976-1977a: 275-82) [= Kaḥ thog Rig ’dzin (2006a: 104-7)]. It should be noted that Kaḥ thog Rig ’dzin (2006a) is filled with many typographical errors. So, the values in the tables are those which have been corrected by the author of this text. The colophon in Kaḥ thog Rig ’dzin (1976-1977a: 282) [= Kaḥ thog Rig ’dzin (2006a: 107)] shows that the text was written (calculated) in 1750/8 (khrum (sic. read khrums) zla)/23 (dmar phyogs rgyal ba gnyis pa). For the term, dmar phyogs rgyal ba gnyis pa, see above note 110.
Because Kaḥ thog Rig ’dzin presented the values without any explanation of how to calculate them, they may be misleading. Actually, the chu srang values in these calculations should be subtracted. In other words, the following notations may help the reader understand the values. Notation: 1'39°10' (7/60/6), 26°49'(17') (27/60/39). The calculations are that 1°38°10' (7/60/60) can be calculated from 1°39°5' (7/60/6) in the following way:

\[
\frac{5}{6} = 0.83333333333
\]

\[
0.83333333333 \times 60 = 50
\]

1°39°(7/60) - 5' (6) = 1°39° (7/60) - 50' = 1°38°10' (7/60/60).

26°48°33°5'1" (27/60/60/6/13) is calculated from 26°49°17' (27/60/39) in the following way:

\[
17 + 39 = 0.43589743589
\]

\[
0.43589743589 \times 60 = 26.1538461534
\]

26.1538461534 - 26 = 0.1538461534

0.1538461534 \times 6 = 0.9230769204

0.9230769204 \times 13 = 12

subtract 17' from 26°49°17' (27/60/39): 26°49° (27/60) - 17'(39) = 26°49° - 26°0"12'' = 26°48°33°5"1" (27/60/60/6/13). As seen in the above table, the same values with those of thams cad mkhyen 'ga' (m = 2 in Schuh’s notation) result. However, this method may be uncomfortable when compared with the thams cad mkhyen 'ga’s. For this calculation method, see Bu ston (1986: 188-93), Dpa’ bo (n.d. (1): 27b-30b) [= (n.d. (2): 21b-23b) = Yum pa (2015: pdf 37-41)], 'Bri gung Bstan ’dzin Chos kyi rgyal mtshan (1986a: 7b). The original author of the last text (in the sense that the epoch has been changed by ’Bri gung Bstan ’dzin Chos kyi rgyal mtshan (1986a) is 'Bri gung Dkon mchog lhun grub. Unfortunately, we do not know who Gye ri paṇḍi ta Yab sras are and how they calculated their byed rtsis values.

\[mda’ ro lhag ma = 29.\]

\[This value has not been specified in the text. It was calculated by me.\]

Kah thog Rig ’dzin (1976-1977a: 276) [= Kah thog Rig ’dzin (2006a: 104)] conveys an intriguing account on the history of the byed rtsis: “When debating the five places in nyi dhru zhīb rtsis, some all-knowing ones asserted: 26°48°33°5"1" (13) is well-known and reliable, the extraordinary continuation of aural transmission of Bu ston’s byed rtsis is uninterrupted.” (... nyi dhru zhīb rtsis su gnas lngar / rtsod dus thams cad mkhyen ‘gas bzhed / 26°48°33°5"1" (13) de ni grags che khung (sic. read khungs) dang ldan / bu ston gyis (sic. read gyi) / byed rtsis thun min snyan rayud rayun / chad med.) Raising the question of when did the debate occur?
Regarding the four different byed rtsis-s, he says: “phyogs mthun na yang rtsa ba'i gnad / lag len mi gcig.” 451 “[they have] the same positions, but the fundamental crucial point and the practices are different.”

Next, he presents seven grub rtsis-s (grub rtsis rnam grangs bdun). The rtsis ’phro values given are those of the epoch 1747/3/0). 452

Table 17.

<table>
<thead>
<tr>
<th></th>
<th>gza’ dhru’i ’phro</th>
<th>ril cha’i ’phro</th>
<th>nyi dhru’i ’phro</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bu ston’s Mkhas pa dga’ byed/Byang bdag grub rtsis / Mtshur phu ’Jam dbyangs chen po 453</td>
<td>2°0'7&quot;0'6&quot;''</td>
<td>24/33</td>
<td>25°59'34&quot;0'12&quot;''(67)</td>
</tr>
<tr>
<td>’Gos Lo tsā ba’s ’Khruł sel</td>
<td>0°5'1&quot;50'3&quot;159&quot;''</td>
<td>24/30</td>
<td>0°36°16'0&quot;48&quot;''</td>
</tr>
<tr>
<td>’Bras rtsis brgya rtsa mkhan brgya phrag lugs 454</td>
<td>1°54°57'4&quot;358&quot;''</td>
<td>24/33</td>
<td>26°11'54&quot;37&quot;''(67) 5''''(13)</td>
</tr>
<tr>
<td>Byang bdag rang bzha’d nor bu’i phreng / phyi rtsom ’phro</td>
<td>2°0'6'2&quot;134&quot;''</td>
<td>24/33</td>
<td>25°59'33&quot;0'54&quot;''</td>
</tr>
<tr>
<td>Mtshur lugs grub rtsis</td>
<td>1°55°27'2&quot;358&quot;''</td>
<td>24/33</td>
<td>26°31'8'5&quot;49&quot;''</td>
</tr>
<tr>
<td>Phug lugs (m = 1A in Schuh’s notation) most commonly used nowadays</td>
<td>1°52°41'2&quot;524&quot;''</td>
<td>24/19</td>
<td>26°9'37'3&quot;45&quot;''</td>
</tr>
<tr>
<td>Bsgrub brgyud mnga’ bdag ’brug pa’i srol / gdan du lugs</td>
<td>1°54°45'1&quot;23&quot;''</td>
<td>24/69</td>
<td>26°29'46'3&quot;27&quot;''</td>
</tr>
</tbody>
</table>


453 Mtshur phu ’Jam dbyangs chen po is ’Jam dbyangs Don grub ’od zer. Kaḥ thog Rig ’dzin informs us that ’Jam dbyangs chen po’s system is identical with Bu ston’s.

454 ’Bras rtsis brgya rtsa mkhan brgya phrag lugs? ’Bras rtsis is generally nag rtsis astrology. Interestingly, it also has skar rtsis elements according to Kaḥ thog Rig ’dzin.
To give more explanation of this subject, in the case of Bu ston, the method he uses is not clear. However, in this case, the quantity is calculated by using the $rtsis \ 'phro$ of byed $rtsis$ and the $rtag$ longs of grub $rtsis$. At epoch 806/3/0, $zla \ dag = 11639$ and $mda' \ ro \ lhag \ ma = 29$. Byang bdag has two different grub $rtsis$-s: earlier writing ($snga \ rtsom$) and later writing ($phyi \ rtsom$), which are difficult to pinpoint. It is assumed that the $rtsis \ 'phro$ in his earlier writings ($snga \ rtsom \ 'phro$) are identical with Bu ston’s $Mkhas \ pa \ dga'$ byed. In the case of the $rtsis \ 'phro$ in his later writing ($phyi \ rtsom \ 'phro$), at epoch 806/3/0, $zla \ dag = 11639$ and $mda' \ ro \ lhag \ ma = 30$. In the case of ’Gos Lo tsā ba’s ’Khrul sel, Henning’s software works magnificently.\textsuperscript{455} In the case of Nyer mkho’i bum bzang, written by Karma Nges legs bstan ’dzin, the epoch is 1732/3/0. The $zla \ dag = 186$ and $mda' \ ro \ lhag \ ma = 29$.\textsuperscript{456} Bsgrub brgyud mnga’ bdag ‘brug pa’i srol gdan du lugs seems to be the calculation method of the tradition of ‘Brug pa Bka’ rgyud, related to Padma dkar po (1527-1592) and Lha dbang blo gros (16th c.), which the Bhutanese calendar is based on.\textsuperscript{457} In the case of Phug lugs, which is generally well known, $mda' \ ro \ lhag \ ma = 25$.

\textsuperscript{455} Henning’s calculator software ‘Tibetan Calendar Software’ (Version 1.06) correctly outputs ’Gos Lo tsā ba’s ’Khrul sel value. Henning (2007: 318-20) presents 340/2/0 (Feb 13, 340) as the epoch of the ’Khrul sel. However, the epoch is not clear in the ’Khrul sel. According to Yum pa, two epochs may be possible considerations: 806 C.E. like Bu ston’s $Mkhas \ pa \ dga'$ byed and 1461 C.E. ($lcags \ sbrul$). For more information about the ’Khrul sel, see van der Kuijp (2006: 10-1) and Henning (2013b).

\textsuperscript{456} The $rtsis \ 'phro$ values at the epoch have been presented by Henning (2013).

\textsuperscript{457} Martin (1997: 186-7).
Bsam ’grub rgya mtsho’s research into rtsis ’phro variations among the Phug systems presents some interesting traditions not presented by Kaḥ thog Rig ’dzin (1976-1977a) (2006a):  
1) Sum pa Mkhan po’s Dga’ ldan rtsis gsar (= Zla bsil rtsi sbyor dge ldan rtsis gsar written in 1754),  
2) Go shrī Blo bzang mi ’gyur rdo rje’s (18th c.) Yang gsal sgron me (written in 1767 and again in 1770),  
3) Thu’u bkwan III’s Mkhas pa’i snying nor (written in 1796),

---

458 See Bsam ’grub rgya mtsho (1992). In it, the epoch (rtsis ’go) in each tradition has been changed to 1987. For research of a similar kind, see also Mi ’gyur rdo rje, Mig dmar tshe ring, and Yum pa (1998: 25-73), whose epoch in each tradition is also 1987.

459 Two versions of Yang gsal sgron me exist. Both of them have the same epoch, 1747. Go shrī’s (1767) colophon in ka 1 ben xia (本 下) 20 - ka 1 ben shang (本 上) 21: “Go shrī Chos rje, whose name is Blo bzang mi ’gyur rdo rje wrote completely at 1767 (S. sarvajit/4 (T. sa ga zla ba)/9 ... ) (... go shri chos rje’i ming can blo bzang mi ’gyur rdo rjes / thams cad ’dul gyi lo sa ga zla ba’i yar ngo’i tshes dgu ... rdzogs par sbyar ba’o / ...). For the term thams cad ’dul gyi lo, see Appendix I. Go shrī’s (1770) colophon in ka 1 ben (本) 20 gong (shang ershi (上: 20)): “Go shrī Chos rje whose name is Blo bzang mi ’gyur rdo rje ... in 1770 (S. vikṛti) / 12 (T. rgyal zla)/ 23.” (go shri chos rje’i ming can blo bzang mi ’gyur rdo rjes / ... nam ’gyur lo’i (1770 C.E.) rgyal zla ba’i tshes nyer gsum ... / ). For the term nam ’gyur lo, see Appendix I. The two versions are basically similar, but they have a significant difference: respective stong chen ’das lo-s have been presented by him. It is speculated that Go shrī was not content with 1767’s [epoch: 1747] calculation of stong chen ’das lo for some reason and revised it in 1771 C.E.. For the values in 1987/3/0, see Bsam ’grub rgya mtsho (1992: 190). Interestingly, Blo bzang dpal ldan (1990: 269) wrongly presents Go shrī’s (1770) stong chen ’das lo as that of the Dga’ ldan rtsis gsar. Nothing is known about Go shrī, but since the Chinese letters are scribed on the left margin of his text, Go shrī (1767), (1770), it is highly probable that he functioned or was well known in Beijing. For a brief mention of the tradition, also see Yum pa (2006: 104-5).

All of these texts changed the rtsis ’phro / stong chen ’das lo values in the Pad dkar zhal lung. However, they belong to the Phug systems: the rtag longs (mean longitude) of lnga sgra gza’ lnga and the dkyil ’khor (period) of nyi zla gza’ lnga are the same. Next, I will further explain the specifics of Bsam ’grub rgya mtsho’s research.

**PAD DKAR ZHAL LUNG**

Firstly, the rtsis ’phro values of the Pad dkar zhal lung are given for the case that the epoch is 1987/3/0.460

Table 18.

<table>
<thead>
<tr>
<th>tshes zla’i dkyil ’khor (tshes zla)</th>
<th>’khor grangs (times)</th>
<th>rtsis ’phro (tshes zla)</th>
</tr>
</thead>
</table>

460 See Bsam ’grub rgya mtsho (1992: 61). I do not explain the values here. They are explained using Sum pa Mkhan po’s method (See below). The calculation procedure is the same and simple, and therefore does not bear repeating.

461 The tshes zla’i dkyil ’khor and ’khor grangs values, which are common to the Phug pa traditions, are why they are subcategorized into the Phug pa and are well summarized in Bod kyi rtsis rig kun ’dus chen mo, Vol. 2, (1998: 125).

462 Note that in the above table given by Bsam ’grub rgya mtsho (1992), not the months left but the elapsed months from the zero point of the period (tshes zla’i dkyil ’khor) are given as rtsis ’phro (tshes zla). I think that the reason why the rtsis ’phro values are given that way is that they are related to the concept of the stong chen ’das lo (= stong chen las ’das lo, years elapsed from the stong chen (= stong chen lo tshogs, great vacuity)). All relevant calculations are easier if the years elapsed from a great conjunction at the zero point, not the years left, are used.
The table represents the case of gza’ in this way; the revolutions (8657 times) are completed after 39592 tshes zla (period). At 1987/3/0, they were completed after 28568 tshes zla (39592 – 11024 = 28568). In other words, 11024 tshes zla have already passed. From these values, gza’ dhru’i ‘phro 3’11’27’2’31”’327’” at 1987/3/0 can be calculated.\(^\text{470}\) In

\[ 39592 \times 1^{31}50'0''480''' (707) \left( \left[ = 1^{31}50'0''45''' (67)/ 345''' (707) \right] = \text{gza’ rtag longs in the Phug pa grub rtsis on a tshes zla basis} = 8657 ('khor grangs) + 0'0''0'0''0'' . \]

\[ 3528 \times 2/1 \ (\text{tshes zla}) = 253 ('khor grangs) + 0/0 . \]

\[ 82776132766945179900 \ (= \text{Stong chen 'das lo in 1987}) \times 12 \times 67 \div 65 = 1023877088378829609840 \ zla dag. \]

\[ 1023877088378829609840 \div 3528 = 290214594211686397.34694 , \ (\text{the value rounded to the nearest hundred thousandths (5 decimal places)}). \]

\[ 290214594211686397.34694 - 290214594211686397 = 0.34694 \ . \]

\[ 0.34694 \times 3528 = 1224 . \]

\[ 804 \times 2^{5}10^58'1''17''' (\text{nyi ma’i rtag longs in the Phug pa grub rtsis on a tshes zla basis}) = 65 ('khor grangs) + 0'0''0'0''0'' . \]

\[ 1023877088378829609840 \ zla dag \text{ is divided by 804. The remainder is 0.} \]

\[ \text{For the calculation method, see below note 477.} \]
the case of ril cha, the revolutions (253 times) are completed after 2304 tshes zla. At 1987/3/0, they are completed after 2304 tshes zla (3528 – 1224 = 2304). From these values, ril cha’i ’phro 21/90 at 1987/3/0 can be calculated. In the case of nyi ma, the revolutions (65 times) are completed after 804 tshes zla. At 1987/3/0, they are completed after tshes zla (804 – 0 = 804). The 0 in this equation means that it is in the beginning point of the revolution (i.e. the sun has ended the 65 revolutions during the span of 804 tshes zla). From these values, nyi’ dhru’i ’phro 0°0’0”0” at 1987/3/0 can be calculated.

The same principle and calculation methods are applied for the calculation of the stong chen ’das lo, which is based upon a bigger picture that combines the period of the 10 (9 if du ba mjug ring is excluded) planets with the rtsis ’phro value of each. Inversely, the rtsis ’phro values are also calculated from the stong chen ’das lo. In addition, it is assumed that eclipse calculations are verifed by direct experience, which may influence

\[471\] For the calculation method, see below note 478.

\[472\] For these values, see Bsam ’grub rgya mtsho (1992: 58-60). For the method, see below note 479.

\[473\] For this, see below note 601.

\[474\] For example, see tshes zla’i dkyil ’khor values in the table given by Bsam ’grub rgya mtsho; see below pp. 271 ff. Both the rtsis ’phro corrections and the stong chen ’das lo corrections concern changes in longitude. The rtag longs values are fixed values (= constants). In this sense, their approach does not basically differ from the nur ster. In the skar rtsis astronomy, which has been conditioned and postulated by the Kālacakra, possible solutions for accuracy have no choice but to be limited. Also, the geographical concern, which mostly relates to the calculation of a solar eclipse, was found; see below pp. 287-90.
the decision of rtsis 'phro and also influence the decision of the different stong chen 'das lo-s. For more information, see below.

**PHUGVARIATION - DGA’ILDAN RTSIS GSAR**

Sum pa Mkhan po’s *Dga’ ldan rtsis gsar* is one of the earliest examples of a text which changed the rtsis 'phro values from the *Pad dkar zhal lung*. To give a brief introduction to Sum pa Mkhan po’s astronomical system, Sum pa Mkhan po’i *ma* text is the *Skar nag rtsis kyi snying nor nyung ’dus kun gsal me long*, written in 1754 (epoch 1747), and the *bu* text is the *Rtsis kyi bstan ’chos kun gsal me long gi bu gzhung zla bsil rtsi sbyor dge ldan rtsis gsar* (epoch 1747). In terms of rtsis ’phro-s, it is the same with the *Pad dkar zhal lung*; at 1747/3/0, *mda’ ro’i lhag ma* is 25, *gza’ dhru’i ’phro* is 1°52′41″524″, *ril cha’i ’phro* is 24/19, *nyi dhru’i ’phro* is 26°9′37″45″, and *sgra gcan* is 31, which are identical to the *Pad dkar zhal lung*. But, the latter known as the *Dge ldan rtsis gsar*. In this system, at 1747/3/0, *mda’ ro’i lhag ma* is 10, *gza’ dhru’i ’phro* is 1°55′13″33″, *ril cha’i ’phro* 24/22, *nyi dhru’i ’phro* 26°39′51″18″, *sgra gcan* 32. The stong chen lo’das lo in 1747 is 894592876762834614360.475

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475 See Yum pa’s research in Sum pa Mkhan po (2015: Pdf, Intro). For the information included in the *ma* and *bu* text, see Sum pa Mkhan po (2015: Pdf, 98-101) and Sum pa Mkhan po (2015a: Pdf, 277-8) respectively.
The rtsis 'phro values of the Dga’ ldan rtsis gsar, in that case that the epoch is 1987/3/0, are given.476

Table 19.

<table>
<thead>
<tr>
<th></th>
<th>tshes zla'i dkyil'khor</th>
<th>'khor grangs</th>
<th>rtsis 'phro</th>
</tr>
</thead>
<tbody>
<tr>
<td>gza’</td>
<td>39592 (ⓒ)</td>
<td>8657 (ⓑ)</td>
<td>27126 (ⓐ)</td>
</tr>
<tr>
<td>ril cha</td>
<td>3528 (ⓓ)</td>
<td>253 (ⓒ)</td>
<td>470 (ⓓ)</td>
</tr>
<tr>
<td>nyi ma</td>
<td>804 (ⓓ)</td>
<td>65 (ⓑ)</td>
<td>494 (ⓓ)</td>
</tr>
</tbody>
</table>

As seen in the table, the dkyil'khor (tshes zla) and 'khor grangs are the same with the above Pad dkar zhal lung. These facts are the reason this tradition is also called the Phug system.

Based upon the table, the gza’ dhru, ril cha, and nyi dhru values are calculated as follows: gza’ dhru’i ‘phro: $1^{42}9^{24}34"618"$477, ril cha’i ‘phro: $19/92$478, and nyi dhru’i ‘phro: $25^{4}19^{15}1^{23}$ at 1987/3/0.479


477 For the values, see Bsam 'grub rgya mtsho (1992: 82). The Tibetan system may look arcane, but it involves the following calculations. The calculations are traditionally made with sa gzhong. It is possible to calculate more than 20 digit numbers with sa gzhong, but it is not easy. Because general scientific calculators do not support more than 20 digit numbers, I used a million digit calculator (http://comptune.com/calc.php).

27126 (ⓐ) × 8657 (ⓑ) ÷ 39592 (ⓒ) = 5931.243230955749
5931.243230955749 − 5931 = 0.243230955748361
0.243230955748361 × 7 = 1.702616690240453 (gza’)
1.702616690240453 − 1 = 0.7026166902404526 (thob dor)
0.7026166902404526 × 60 = 42.157000141442716 (chu tshod)
42.157000141442716 − 42 = 0.1570001414427157 (thob dor)
0.1570001414427157 × 60 = 9.42008486562942 (chu srang)
9.42008486562942 − 9 = 0.4200848656294201 (thob dor)
0.4200848656294201 × 6 = 2.520509193776521 (dbugs)
2.520509193776521 − 2 = 0.5205091937765205 (thob dor)
0.5205091937765205 × 707=368 (cha shas)
The cha shas shed snyoms is as follows:
368 × 67 ÷ 707 = 34.87411598302687
34.87411598302687 − 34 = 0.8741159830268741 (thob dor)
0.8741159830268741 × 707 = 618
Bsam 'grub rgya mtsho presents a hitherto unknown astronomer, Go shrī, who reported the epoch of Go shrī (1767) (1770). It is highly possible that he functioned during the 18th century in Beijing. The rtsis 'phro values of the Yang gsal sgron me, for Go shrī (1767) in the case that the epoch is 1987/3/0, are given.

For the meaning of cha shas shed snyoms, see Bsam' grub rgya mtsho (2011: 34) [= Bod rgya tshig mdzod chen mo (2000: 2857)].

For the values, see Bsam 'grub rgya mtsho (1992: 82). The calculations are as follows:

470 (ⓑ) × 253 (ⓒ) ÷ 3528 (ⓓ) = 33.7046485260771
33.7046485260771 – 33 = 0.70464852607975 (thob dor)
0.7046485260770975 × 28 = 19.73015873015873
19.73015873015873 – 19 = 0.7301587301587302 (thob dor)
0.7301587301587302 × 126 = 92

For the values, see Bsam 'grub rgya mtsho (1992: 83). The calculations are as follows:

494 (ⓗ) × 65 (ⓘ) ÷ 804 (ⓘ) = 39.93781094527363
39.93781094527363 – 39 = 0.9378109452736318
0.9378109452736318 × 27 = 25.32089552238806
25.32089552238806 – 25 = 0.3208955223880597
0.3208955223880597 × 60 = 19.25373134328358
19.25373134328358 – 19 = 0.2537313432835821
0.2537313432835821 × 60 = 15.22388059701493
15.22388059701493 – 15 = 0.2238805970149254
0.2238805970149254 × 6 = 1.3432835820895522
1.3432835820895522 – 1 = 0.3432835820895522
0.3432835820895522 × 67 = 23

See Bsam 'grub rgya mtsho (1992: 89).
Table 20.

<table>
<thead>
<tr>
<th></th>
<th>tshes zla'i dkyil 'khor</th>
<th>'khor grangs</th>
<th>rtsis 'phro</th>
</tr>
</thead>
<tbody>
<tr>
<td>gza'</td>
<td>39592</td>
<td>8657</td>
<td>2393</td>
</tr>
<tr>
<td>ril cha</td>
<td>3528</td>
<td>253</td>
<td>2785</td>
</tr>
<tr>
<td>nyi ma</td>
<td>804</td>
<td>65</td>
<td>61</td>
</tr>
</tbody>
</table>

According to the table, gza' dhru'i 'phro: 1°41'40"44"516", ril cha'i 'phro: 20/13, and nyi' dhru'i 'phro: 25°9'10"32" at 1987/3/0. Go shrī (1767) has the same epoch as Go shrī (1770), but has different stong chen 'das lo.

PHUGVARIATION – MKHAS PA'T SNYING NOR

The rtsis 'phro values of the Mkhas pa'i snying nor, in the case that the epoch is 1987/3/0, are given.

Table 21.

<table>
<thead>
<tr>
<th></th>
<th>tshes zla'i dkyil 'khor</th>
<th>'khor grangs</th>
<th>rtsis 'phro</th>
</tr>
</thead>
<tbody>
<tr>
<td>gza'</td>
<td>39592</td>
<td>8657</td>
<td>37750</td>
</tr>
<tr>
<td>ril cha</td>
<td>3528</td>
<td>253</td>
<td>902</td>
</tr>
<tr>
<td>nyi ma</td>
<td>804</td>
<td>65</td>
<td>494</td>
</tr>
</tbody>
</table>

481 For these values, see Bsam 'grub rgya mtsho (1992: 88). They are easily calculated in the same manner with those in the case of Sum pa Mkhan po.

482 See below p. 278.

From the above table, the following values are calculated: *gza’ dhru’i ‘phro*: 1°39'31"28'103"", *ril cha’i ‘phro*: 19/20, and *nyi’ dhru’i ‘phro*: 25°19'15"23"", at 1987/3/0.\(^{484}\)

**PHUGVARIATION – BYED MTHUN**

As the title indicates, the author Bsam gtan rgya mtsho tries to be maintain a system close to the *byed rtsis* on the basis of *Phug pa grub rtsis*. The *rtsis ‘phro* values at 1987/3/0 are given.\(^{485}\)

<table>
<thead>
<tr>
<th></th>
<th><em>tshes zla’i dkyil ‘khor</em></th>
<th><em>’khor grangs</em></th>
<th><em>rtsis ‘phro</em></th>
</tr>
</thead>
<tbody>
<tr>
<td><em>gza’</em></td>
<td>39592</td>
<td>8657</td>
<td>9523</td>
</tr>
<tr>
<td><em>ril cha</em></td>
<td>3528</td>
<td>253</td>
<td>1683</td>
</tr>
<tr>
<td><em>nyi ma</em></td>
<td>804</td>
<td>65</td>
<td>123</td>
</tr>
</tbody>
</table>

The following values are calculated: *gza’ dhru’i ‘phro*: 1°46°47'3"27"6"", *ril cha’i ‘phro*: 19/45, and *nyi’ dhru’i ‘phro*: 25°29°19°4"14"".\(^{486}\)

Taken together, the *rtsis ‘phro* values at 1987/3/0 are as follows:

\(^{484}\) For these values, see Bsam ’grub rgya mtsho (1992: 76-7). For the calculations of them, see the previous example of Sum pa Mkhan po.

\(^{485}\) Bsam ’grub rgya mtsho (1992: 91).

\(^{486}\) Bsam gtan rgya mtsho (2009: 377-8): *gza’ dhru’i ‘phro* is given as 1/46/47/3/276. In it, 276 is incorrect. For these values, see also Bsam ’grub rgya mtsho (1992: 90-1). The epochs in Bsam gtan rgya mtsho (2009) and Bsam ’grub rgya mtsho (1992) are the same (= 1987/3/0).
Table 23.

<table>
<thead>
<tr>
<th></th>
<th>gza’ dhru’i ’phro</th>
<th>ril cha’i ’phro</th>
<th>nyi’ dhru’i ’phro</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pad dkar zhal lung</td>
<td>3'11&quot;27'2&quot;31&quot;327&quot;&quot;</td>
<td>21/90</td>
<td>0</td>
</tr>
<tr>
<td>Dga’ ldan rtsis gsar</td>
<td>1'42&quot;9'2&quot;34&quot;618&quot;&quot;</td>
<td>19/92</td>
<td>2519&quot;15'1&quot;23&quot;&quot;</td>
</tr>
<tr>
<td>Yang gsal sgron me</td>
<td>1'41&quot;10'4&quot;44&quot;516&quot;&quot;</td>
<td>20/13</td>
<td>2559&quot;10'4&quot;32&quot;&quot;</td>
</tr>
<tr>
<td>Mkhas pa’i snying nor</td>
<td>1'39&quot;31'3&quot;28&quot;103&quot;&quot;</td>
<td>19/20</td>
<td>2519&quot;15'1&quot;23&quot;&quot;</td>
</tr>
<tr>
<td>Byed mthun</td>
<td>1'46&quot;47'3&quot;27&quot;6&quot;&quot;</td>
<td>19/45</td>
<td>2529&quot;19'4&quot;14&quot;&quot;</td>
</tr>
</tbody>
</table>

**PHUG VARIATIONS — A COMPARISON: GZA’ BAR / RIL CHA / NYI BAR**

The following observations regarding the differences between gza’ bar, ril cha and nyi bar among the three systems, Pad dkar zhal lung, Dga’ ldan rtsis gsar, and Mkhas pa’i snying nor, are justified.

... zhal lung rjes ‘brang nyi (sic. read nyin) snang sogs kyi dhru ba las dga’ ldan rtsis gsar gyi dhru ba ’tshol na / 0/2/33/0/516\(^487\) 0/3 ri ’char (sic. read ril cha) 0/30/13/40\(^488\) ‘di byin pas ‘char / rtsis gsar gyi dhru ba la de’i (sic.) phri bas zhal lung rjes ‘brang dhru ba ‘char zhal lung de gsum la gza’ dhru / 262 ri ’char (sic. read ril cha) / 27 nyi dhru/ 0/0/5/4 0/69 0/29/76\(^489\) ‘di rnam phri bas tho kan (sic.) snying nor gyi dhru ba ‘char mkhas pa’i snying nor la de dag byin pas zhal lung gi dhru ba gza’ dhru la / nyi dhru la / ‘char ba yin no / de bzhin dge ldan rtsis gsar gyi gza’ dhru/ 0/2/37/5/71 ri la ’char (sic. read ril cha) 0/72 ‘di dag phri bas snying nor ’char / snying nor gyi de

\(^487\) This is either a typo or misreading. The correct value: 0’23’32’0’516" = 0’23’32’0’48’636" after the cha shas shed snyoms. Also see Bsam ’grub rgya mtsho (1992: 87) for the value.

\(^488\) This is either a typo or misreading. The correct value: 0’30’13’2’40".

\(^489\) These numbers were transcribed incorrectly. Also see Bsam ’grub rgya mtsho (1992: 81): gza’ dhru: 0’05’4’24’586", ril cha: 0/69, nyi dhru: 0’26’29’46’3’27".
... If the dhru ba-s of the Dga’ ldan rtsis gsar are found from the dhru ba-s of the Nyin byed snyang ba, etc. which follow the Pad dkar zhal lung, [they] arise by adding [gza’ dhru] 0°2'32"0'516" (= 0°2'32"0'48"636"), ril cha 0/3, nyi dhru 0°30'13"2'40". By subtracting the amount from the dhru ba-s of the Dga’ ldan rtsis gsar, the dhru ba-s of [the systems] following the Pad dkar zhal lung appear. By subtracting gza’ dhru 0°0'54"24"586", ril cha 0/69, nyi dhru 0°26'29"46"3"27" from the three (gza’ dhru, ril cha, nyi dhru) of the Pad dkar zhal lung, the dhru ba-s of Thu’u bkwan III’s Mkhas pa’i snying nor appear. By adding the [three] values to [the three of] the Mkhas pa’i snying nor, the values of the dhru ba-s of the Pad dkar zhal lung, gza’ dhru, [ril cha], and nyi dhru, appear. Likewise, by subtracting gza’ dhru 0°2'37"5’71” (= 0°2'37"5’6”515”), ril cha 0/72 from [the gza’ dhru and ril cha values of] the Dga’ ldan rtsis gsar, the values of Mkhas pa’i snying nor appear. If the two values of the Mkhas pa’i snying nor are added to the values of the former (= Dga’ ldan rtsis gsar), the two values (gza’ dhru and ril cha) of the Dga’ ldan rtsis gsar appear. It is stated that, because the nyi dhru of Mkhas pa’i snying nor is the same with that of Dga’ ldan rtsis gsar, there is no addition or subtraction.

To repeat the above passage,

Dga’ ldan rtsis gsar − Pad dkar zhal lung : gza’ dhru 0°2'32"0'516" ( = 0°2'32"0'48"636"), ril cha 0/3, and nyi dhru 0°30'13"2'40".

Pad dkar zhal lung − Mkhas pa’i snying nor : gza’ dhru 0°0'54"24"586”, ril cha 0/69, and nyi dhru 0°26'29"46"3"27”.

Dga’ ldan rtsis gsar − Mkhas pa’i snying nor : gza’ dhru 0°2'37"5’71” ( = 0°2'37"5’6”515”), ril cha 0/72, and nyi dhru 0°0'0"0’0”.

The values are verified in A kya’s calculations below.

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490 Mi pham (2012a: 264-5).
PHUGVARIATIONS – A COMPARISON: A KYA BLO BZANG ‘JAM DBYANGS RGYA MTSHO’S
ECLIPSE CALCULATIONS: THE DIFFERENCES IN GZA’ DAG / NYI DAG AND ECLIPSE
CALCULATIONS.

A KYA’S CALCULATIONS AND OBSERVATIONS

A Kya serves as an example for demonstrating the differences between the Pad
dkar zhal lung (Phug pa grub rtsis) and the Dga’ ldan rtsis gsar, both of which belong to the
Phug system. His is also one of the earlier writings in which the Dga’ ldan rtsis gsar was
used for real eclipse calculation. His calculations for the lunar eclipse at 1785 (shing
sbrul)/12/15\(^{491}\) are as follows:

Phug pa grub rtsis: gza’ dag 0°21′36″29″505″″, nyi dag 19°48′41″3″57″″, sgra gcan rtsa
5°55′41″10″″, sgra gcan gdong 21°4′18″1″13″″, and sgra gcan mjug 7°34′18″1″13″″.

\(^{491}\) See A kya (2000: 3b). The dates in each tradition are as follows:

<table>
<thead>
<tr>
<th>Gregorian date</th>
<th>Jan, 14, 1786</th>
</tr>
</thead>
<tbody>
<tr>
<td>grub rtsis</td>
<td>1785 (T. shing sbrul)/12/15</td>
</tr>
<tr>
<td>byed rtsis</td>
<td>1785/12/15</td>
</tr>
<tr>
<td>dga’ ldan rtsis gsar</td>
<td>1785/12/15</td>
</tr>
<tr>
<td>Chinese lunar date</td>
<td>1785/12/15</td>
</tr>
</tbody>
</table>

The following mda’ ro lhag ma-s are used for the determination of leap moth: 48, 49 for the Phug pa grub rtsis, 63, 64 for the byed rtsis, and 46, 47 for the Dga’ ldan rtsis gsar indicate leap months. In other words, 50, 51 for Phug pa grub rtsis, 65, 66 for byed rtsis, 48, 49 for Dga’ ldan rtsis gsar are the mda’ ro lhag ma-s of the leap months.
Dga’ ldan rtsis gsar: gza’ dag 0°25′27″13′3″232″″, nyi dag 20°50′15″4″2″, sgra gcan rtsa 6°2′44″2″2″, sgra gcan gdong 20°57′15″2″21″″, and sgra gcan mjug 7°27′15″3″21″″.

byed rtsis: gza’ dag 0°8′0″5″2″, and nyi dag: 20°31′28″1″3″493. sgra gcan values: not given.

A kya’s calculations for the solar eclipse of 1785/12/30494 are as follows:

Phug pa grub rtsis: gza’ dag 1°59′26″0″36″″324″″, nyi dag 20°57′5″2″16″″, sgra gcan rtsa 5°59′13″0″6″″, gdong 21°0′46″5″17″″, and mjug 7°30′46″5″17″″.

Dga’ ldan rtsis gsar: gza’ dag 2°3′17″2″19″51″″, nyi dag 21°28′39″5″28″″495, sgra gcan rtsa 6°6′15″2″21″1496, gdong 20°53′44″3″2″497, and mjug 7°23′44″3″2″1498.

Since it is not likely that A kya was mistaken in the calculation, this seems to be a scribal error. The correct quantity is 0°25′27″12″′232″″.

Given A kya’s table, there are hitherto unknown calculations named gsar spel byed pa and gsar spel grub rtsis. Interestingly, the quantity entered in the section of gsar spel byed pa in the table given by A kya is that of the commonly used byed rtsis (m = 2 in Schuh’s (1973a) notation). I propose that gsar spel grub pa may be the tradition in which the rtsis ’phro values changed from the generally known grub rtsis. Further research is needed.

See A kya (2000a: 6b [＝ 47 ben (本) xia (下) 5]). The dates in each tradition are as follows:

<table>
<thead>
<tr>
<th>Gregorian date</th>
<th>Jan 29, 1786</th>
<th>Jan 30, 1786</th>
</tr>
</thead>
<tbody>
<tr>
<td>grub rtsis</td>
<td>1785 (T. shing sbrul)/12/29</td>
<td>1786 (T. merta)/1/1</td>
</tr>
<tr>
<td>byed rtsis</td>
<td>1785/12/30</td>
<td>1786/1/1</td>
</tr>
<tr>
<td>dga’ ldan rtsis gsar</td>
<td>1785/12/29</td>
<td>1785/12/30</td>
</tr>
<tr>
<td>Chinese lunar date</td>
<td>1785 (Ch. yisi 乙巳)/12/30</td>
<td>1786 (Ch. bingwu 丙午)/1/1</td>
</tr>
</tbody>
</table>

This seems to be a scribal error. The correct value is 21°28′39″2″28″″.

This seems to be a scribal error. The correct value is 6°6′15″3″21″″.

This seems to be a scribal error. The correct value is 20°53′44″2″2″.
VERIFICATION OF A KYA'S CALCULATIONS

Calculation #1. Phug pa grub rtsis at 1785/12/15

Epoch data at 1687/3/0 in the case of Phug pa grub rtsis
I use the Sde srid's Vaidūrya dkar po, whose epoch is 1687/3/0: zla dag: 0/15 (1/65), gza' dhru'i 'phro: 0°1°57'2"692" (707), ril cha'i 'phro: 18/33 (28/126), nyi dhru'i 'phro: 26°29'46"3"27" (67), and Rāhu: 209.499

1. zla dag: 1221, mda’ro lhag ma: 45

\[
1785 - 1687 = 98 \\
12 - 3 = 9 \\
(98 \times 12 + 9) + 36 = 1221: \text{zla dag} \\
(98 \times 12 + 9) \times 2 + 15 = 2385 \\
\frac{2385}{65} = 36......45: \text{mda’ro lhag ma}
\]

2. gza' dhru: 0°1°45'3"669"502

\[
\frac{(1221 \times 1 + 0 + 648)}{7} = 267......0
\]

---

498 This seems to be a scribal error. The correct value is 7°23'44"2"91".

499 For the epoch value, see Sde srid (1996: 30) and Henning (2013). The Lnga bs dus values of the grub rtsis by Grwa phug pa, Dharmāśrī, Sde srid, and Phyag mdzod are the same. They are all based upon the Pad dkar zhal lung and any of these values can be used in this case. According to Schuh’s classification, this case is m = 1A. See Schuh (1973a), Schuh (2012a).

500 True month (zla dag) is the number of lunar months past.

501 15 is residual (phro) from the previous rab byung.

502 The mean weekday value (gza’ dhru'i 'phro): 0°1°10'57"692" (707) is the gza’ bar value at epoch. The gza’ dhru 'phro and nyi dhru 'phro values are the same within a month, representing the time of mean conjunction at epoch.
There are two methods: 1) search for the 15th day value in the table of grub rtsis kyi gza'i rtag longs or 2) find the daily mean motion of the moon $0^\circ 59'34"16' (707) \times 15 = 0^\circ 45'55"240"'$. The results are the same.

\[
gza' bar: 0^\circ 45'55"0"240"' + gza'dhru 0^\circ 1^\circ 45'3"669"' = 0^\circ 47'40'4''202"'.
\]
6. nyi bar: 19°49'48"45"²⁵⁰⁶
There are two methods: 1) search the 15th day value in the table of grub rtsis kyi nyi ma'i rtag longs or 2) the daily mean motion of the sun 0°4°21'5"43 (67) × 15 = 1°5°29'0"42 (67). The results are the same.

nyi bar: 1°5°29'0"42 (67) + nyi dhru 18°44'19"14"² = 19°49'48"45"²⁵⁰⁶"²⁵⁰⁶ (27/60/60/67)

7. gza'i phyed dag pa. 0°22'43°3"30³"²⁵⁰⁶"²⁵⁰⁶ (the value after the cha shas shed snyoms has been applied)
(15 (tshes pa) + 5 (ril bo)) = 1²⁵⁰⁷

Table 24.

<table>
<thead>
<tr>
<th>Step Index (rkang ’dzin/rkang bzung)</th>
<th>Multiplier (sgyur byed)</th>
<th>Step Total (rkang sdom)</th>
</tr>
</thead>
<tbody>
<tr>
<td>early step (snga rkang)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>5</td>
<td>5</td>
</tr>
<tr>
<td>2</td>
<td>5</td>
<td>10</td>
</tr>
<tr>
<td>3</td>
<td>5</td>
<td>15</td>
</tr>
<tr>
<td>4</td>
<td>4</td>
<td>19</td>
</tr>
<tr>
<td>5</td>
<td>3</td>
<td>22</td>
</tr>
<tr>
<td>6</td>
<td>2</td>
<td>24</td>
</tr>
<tr>
<td>7 way</td>
<td>1</td>
<td>25²⁵⁰⁹</td>
</tr>
</tbody>
</table>

²⁵⁰⁶ 19°49'48"45"²⁵⁰⁶"²⁵⁰⁶ means that the mean sun is 49°48"45"²⁵⁰⁶"²⁵⁰⁶ away from the 19th constellation chu stod (pūrṇaḥāṣādhā) at 1785/12/15.

²⁵⁰⁷ 1: odd number. Therefore, it is unequal and is subtracted later.

²⁵⁰⁸ The gza'i rtag longs (tshes zhag, the daily mean motion of the moon) in both Phug pa grub rtsis and byed rtsis is around 0°59°3°14"16"². If + 5 ~ − 5 are added to this value, the tshes zhag approximately ranges from 54° ~ 64°. The grub rtsis and byed rtsis show little difference in value. See the table in pp. 196-8. For further information, see Yamaguchi (1974: 85-7) and Ōhashi (1984: 32-5).

²⁵⁰⁹ The Kālacakra Tantra emerged far later than the Sūryasiddhānta, one of the Indic astronomical texts in which the geometric method was used and which was already well established. — For the equation of the center in the Sūryasiddhānta, see van Wijk’s classical study (1923: 206-23), (1924: 55-62). — Strangely, the Kālacakra Tantra is based upon this arithmetic method for the motion of the sun and moon. Therefore, it may be reasonable to argue that even if the geometric model on which this table is based cannot be pinpointed, it is based upon a geometric model. In fact, modern scholars have pointed out various possible opinions. Schuh (1973a: 124-6) shows that the equation of the center of the Moon is presented in terms of nearly exact sine functions. See Ōhashi (1986: 635-7, 643). Also see Ōhashi (1997: 137): “These values were probably originally meant to be the difference between the mean motion and the true motion of the moon during one tshes zhag in terms of chu tshod. ... The maximum equation is the total of the variables, that is 25 chu tshod or 5°23°20°.” Huang and Chen’s (1987: 150-1) calculation is 5°56.
In case that rkang bzung is 6 and rkang sdom is 24, the sgyur byed is 1. Multiply it by ril bo cha shas (in this case 120) and then divide the result by 126.

\[
\frac{1 \times 120}{126} = 0 \quad \text{yang dag rayu ba'i dus kyi chu tshod} \ldots \ldots \ldots 120
\]
\[
\frac{120 \times 60}{126} = 57\quad \text{yang dag rayu' ba'i dus kyi chu srang} \ldots \ldots \ldots 18
\]
\[
\frac{18 \times 6}{126} = 0\quad \text{yang dag rayu' ba'i dus kyi dbugs} \ldots \ldots \ldots 108
\]
\[
\frac{108 \times 707}{126} = 606\quad \text{yang dag rayu' ba'i dus kyi cha shas}
\]

In the case of snga rkang, the rkang sdom is added to yang dag rayu ba'i chu tshod. In the case of phyi rkang, the rkang sdom is subtracted from yang dag rayu ba'i chu tshod. In this case, 24 (rkang sdom) + 0 = 24 is the final yang dag rayu ba'i chu tshod. Hece, zla rkang: 24 (yang dag rayu ba'i chu tshod)/ 57 (yang rayu' srang)/ 0 (dbugs)/ 606 (cha shas).

1 is odd number. Therefore, it is unequal and is subtracted from gza’ bar, i.e. gza’ bar 0°47′40″40″202″ (7/60/60/6/707) – 0°24′57″0″606″ = 0°22′43″3″303″: gza’ phyed dag pa [= 0°22′43″3″28″505″] (cha shas shed snyoms)].

8. **nyi dag 19°48′41″3″57″**

nyi bar: 19°49′48″4″56″ (27/60/60/6/67)
- 6°45″
13°4′48″4″56″
13°4′ = 784°
784° = 5 khyim \ldots \ldots \ldots 109°
\rightarrow ma dor (mi dor): non-deductible.

扩张/收缩可以帮助理解这个上下文，即使对于元朝时期的中国天文。

Śīghra (T. chu tshod) maintains that "equation of the center" and the myur rtis is "epicyclic correction." See also Ōhashi (1986: 635-6, 643). — This is controversial. For example, Petri (1967: 160): “Fairly clear are the tables of Śīghra (T. myur ba) and manda (T. dal ba) corrections of the true motion of the planets, which correspond to the first epicycle and the displacement due to eccentricity.” — Ōhashi’s calculation value for the 11 chu tshod (= 6 + 4 + 1) (= maximum equation of the sun) is 2°26′40″. Sivin’s explanation of the phase of expansion/contraction may help to understand this context even if it is for Yuan period Chinese astronomy. See Sivin (2009: 411-2).

Table 25: The table of the step index of the sun.\(^510\)

<table>
<thead>
<tr>
<th>step index (rkang_dzin/, rkang_bzung)</th>
<th>multiplier (sgyur_byed)</th>
<th>step total (rkang_sdom)</th>
</tr>
</thead>
<tbody>
<tr>
<td>early step (snga_rkang)</td>
<td>0</td>
<td>6</td>
</tr>
<tr>
<td>1</td>
<td>4</td>
<td>6</td>
</tr>
<tr>
<td>2</td>
<td>1</td>
<td>10</td>
</tr>
<tr>
<td>later step (phyi_rkang)</td>
<td>3</td>
<td>1</td>
</tr>
<tr>
<td>4</td>
<td>4</td>
<td>10</td>
</tr>
<tr>
<td>5</td>
<td>6</td>
<td>6</td>
</tr>
</tbody>
</table>

In this case, the \(sgyur\_byed\) is 6 and the \(rkang\_sdom\) is 6.

\(109^5 \times 6 = 654^1\)

\(^510\) The \(nhi\_ma\_i\_rtag\_longs\) (tshes zhag) in both Phug pa grub rtis and byed rtis are approximately \(0^4^5^21^5^0^\) (truncated value). The grub rtis and byed rtis show little difference in value. See the table in pp. 196-8. The corrected value is approximately \(0^4^4^10^0^ \sim \, 0^4^3^3^3^0^\). For more information, see Yamaguchi (1974: 86) and Ōhashi (1984: 30-2). The table of the movement of the true sun on the basis of the \(kālacakra \, skar\_rtis\) is as follows:

<table>
<thead>
<tr>
<th></th>
<th>khyim</th>
<th>(sgyur_byed)</th>
<th>corrected value (approximate value)</th>
</tr>
</thead>
<tbody>
<tr>
<td>(rim_pa)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>early step (snga_rkang)</td>
<td>karka ō (apoee)</td>
<td>6</td>
<td>(0^4^4^2^1^5^0^ - 11^3^0^ = 0^4^4^1^0^)</td>
</tr>
<tr>
<td></td>
<td>seng ge</td>
<td>4</td>
<td>(0^4^4^2^1^5^0^ - 7^4^0^ = 0^4^4^1^4^)</td>
</tr>
<tr>
<td></td>
<td>bu mo</td>
<td>1</td>
<td>(0^4^4^2^1^5^0^ - 1^5^0^ = 0^4^4^2^0^)</td>
</tr>
<tr>
<td>later step (phyi_rkang)</td>
<td>sran</td>
<td>1</td>
<td>(0^4^4^2^1^5^0^ + 1^5^0^ = 0^4^4^2^3^)</td>
</tr>
<tr>
<td></td>
<td>sdi</td>
<td>4</td>
<td>(0^4^4^2^1^5^0^ + 7^4^0^ = 0^4^4^2^9^)</td>
</tr>
<tr>
<td></td>
<td>gzhu</td>
<td>6</td>
<td>(0^4^4^2^1^5^0^ + 11^3^0^ = 0^4^4^3^3^)</td>
</tr>
<tr>
<td>(rim_min)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>early step</td>
<td>chu srin (perigee)</td>
<td>6</td>
<td>(0^4^4^2^1^5^0^ + 11^3^0^ = 0^4^4^3^3^)</td>
</tr>
<tr>
<td></td>
<td>kum pa</td>
<td>4</td>
<td>(0^4^4^2^1^5^0^ + 7^4^0^ = 0^4^4^2^9^)</td>
</tr>
<tr>
<td></td>
<td>nyo</td>
<td>1</td>
<td>(0^4^4^2^1^5^0^ + 1^5^0^ = 0^4^4^2^3^)</td>
</tr>
<tr>
<td>later step</td>
<td>lags</td>
<td>1</td>
<td>(0^4^4^2^1^5^0^ - 1^5^0^ = 0^4^4^2^0^)</td>
</tr>
<tr>
<td></td>
<td>sdi</td>
<td>4</td>
<td>(0^4^4^2^1^5^0^ - 7^4^0^ = 0^4^4^1^4^)</td>
</tr>
<tr>
<td></td>
<td>kshri</td>
<td>6</td>
<td>(0^4^4^2^1^5^0^ - 11^3^0^ = 0^4^4^1^0^)</td>
</tr>
</tbody>
</table>

\(^511\) Schuh (1973a: 126-30) shows that the “equation of the center” of the Sun is presented in terms of nearly exact sine functions. Huang and Chen’s calculation (1987: 154-5) for the maximum equation of the sun is 2°44. Ōhashi (1997: 137): “This dal rkang is, in fact, the difference between the mean motion and the true motion of the sun during one zodiacal sign’s movement of the mean sun in terms of chu tshod.” Ōhashi (1997) maintains that the dal rkang is “equation of the center” and the myur rkang is “epicyclic correction.” See also Ōhashi (1986: 635-6, 643). — This is controversial. For example, Petri (1967: 160): “Fairly clear are the tables of Śīghra (T. myur ba) and manda (T. dal ba) corrections of the mean motion of the planets, which correspond to the first epicycle and the displacement due to eccentricity.” — Ōhashi’s calculation value for the 11 chu tshod (= 6 + 4 + 1) (= maximum equation of the sun) is 2°26′40″. Sivin’s explanation of the phase of expansion/contraction may help to understand this context even if it is for Yuan period Chinese astronomy. See Sivin (2009: 411-2).
\[
\frac{654q}{135} = 4 \ldots 114 \quad \text{yang dag rgyu ba'i yul gyi chu tshod}
\]
\[
\frac{48 \times 6 + 114 \times 60}{4 \times 6 + 108 \times 6} = \frac{728}{335} = 52 \ldots 108 \quad \text{yang dag rgyu' ba'i yul gyi chu srang}
\]
\[
\frac{56 \times 6 + 132 \times 67}{135} = 68 \ldots 0 \quad \text{yang dag rgyu' ba'i yul gyi cha shas}
\]
\[
6\left(5'59'5"67"ight) - \text{nyi rkang} = 4'52'4"68" = 1'7'0"66"
\]

In the case of snga rkang, the nyi rkang is added to the rkang sdom. For the case of phyi rkang, subtract the nyi rkang from the rkang sdom.

- 1'7'0"66" + 19'49'48'56" = 19'48'41'3''57": nyi dag

9. gza’ dag: 0'21'36'2''29''505": 512

gza’ phyed dag pa 0'22'43'3''28''505'' - 1'7'0"66" = 0'21'36'2''29''505'": gza’ dag

10. tshes ’khyud zla skar: 6'18'41'3''57": 513

19'48'41'3''57'' + 13'30'' = 6'18'41'3''57'' (67)

11. sgra gcan rtsa 5'55'41'4''10'': sgra gcan gdong 21'4'18'1''13'': sgra gcan mjug 7'34'18'1''13''

Calculation #2. Phug pa grub rtsis at 1785/12/29 514

512 It is Saturday (see the gza’ gnas), which spans 21'36'2''29''505''

513 Janson (2014: 29): “the true longitude of the moon at the end of the lunar day (tshes zhag).”

514 In the case of grub rtsis, 1785/12/28 is doubled (T. lhaq) and 1785/12/30 does not exist (T. chad). 1785/12/29 is followed by 1786/1/1. Chad is a troublesome situation for eclipse calculations. The general interpretation is that, for the real occurrence of an eclipse, the day-reckoning based upon the lhaq chad according to grub rtsis works better than that based upon the lhaq chad according to byed rtsis. For example, Nor bzang rgya mtsho is critical for byed rtsis from that view: Nor bzang rgya mtsho (2002a: 587): “because
Epoch Data at 1687/3/0 in the case of Phug pa grub rtsis

zla dag: 0/15 (1/65), gza' bar: 0°10'57"2"692""(707), ril cha: 18/33 (28/126), nyi bar: 26°29'46"3"27""(67), and Rāhu: 209.

Table 26.

<table>
<thead>
<tr>
<th>1. zla dag</th>
<th>1221</th>
<th>mda' ro lhag mar 45</th>
</tr>
</thead>
<tbody>
<tr>
<td>1785 - 1687 = 98</td>
<td></td>
<td></td>
</tr>
<tr>
<td>12 - 3 = 9</td>
<td></td>
<td></td>
</tr>
<tr>
<td>(98 x 12 + 9) + 36 = 1221: zla dag</td>
<td></td>
<td></td>
</tr>
<tr>
<td>(98 x 12 + 9) x 2 + 15 = 2385</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2385</td>
<td></td>
<td></td>
</tr>
<tr>
<td>65</td>
<td></td>
<td></td>
</tr>
<tr>
<td>ma = 36 ...... 45: mda' ro lhag mar 45</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>2. gza' dhru</th>
<th>0°1'45&quot;3&quot;669&quot;&quot;</th>
</tr>
</thead>
<tbody>
<tr>
<td>(1221 x 1 + 0 + 648) = 267 ...... 0</td>
<td></td>
</tr>
<tr>
<td>(1221 x 1 + 10 + 1020) = 648 ...... 1</td>
<td></td>
</tr>
<tr>
<td>(1221 x 50 + 57 + 138) = 1020 ...... 45</td>
<td></td>
</tr>
<tr>
<td>(1221 x 0 + 2 + 829) = 138 ...... 3</td>
<td></td>
</tr>
<tr>
<td>(1221 x 480 + 692) = 829 ...... 669</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>3. ril cha</th>
<th>5/120</th>
</tr>
</thead>
<tbody>
<tr>
<td>(1221 x 2 + 18 + 9) = 88 ...... 5</td>
<td></td>
</tr>
<tr>
<td>(1221 x 1 + 33) = 9 ...... 120</td>
<td></td>
</tr>
</tbody>
</table>

according to the value by the practice of the byed rtsis, it is possible that solar and lunar eclipse occur on the first day and on the sixteenth day [respectively] ... " (... byed pa'i da lta'i laq len gyi ri mo la / nyi zla gza' 'dzin tshes gcig dang bcu drug la 'ong ba'i skabs srid kyi 'dugs pas / ... ). A solar eclipse is believed to occur on the 30th and a lunar eclipse is on the 15th, according to the skar rtsis calculations. Dkon mchog 'phrin las bzang po (1975: 53b): "An eclipse occurs even if there are lhag chad in byed rtsis. Especially, when the thirtieth day (new moon day) is chad, a solar eclipse is seen on the [following] first day. Because, if the full moon and new moon days are chad, according to grub rtsis, the moon and sun are not eclipsed [respectively]. Therefore, the lhag chad of day should be investigated in detail, ... " (byed rtsis lhag chad yol kyang 'dzin / khyad par nam gang chad pa'i tshe / tshes gcig la ni 'dzin par mthong / grub mtha' rtsis la nya stong dag / chad na nya zla mi 'dzin pas / de phyir tshes kyi chad lhag sogs / zhib mor dpyad de ... ). Also see Phyag mdzod [= Huang and Chen (1987: 36-7): "It is said that if the full moon and new moon days are chad according to grub rtsis, the moon and sun are not eclipsed [respectively], but in some cases among those that full moon and new moon days are chad, the occurrences of the eclipse are seen in a myong byang (note of observation / experience). ... Except for some (= such) cases, it is known to be unmistaken by this method [of eclipse calculation]." (grub pa'i nya stong tshes chad na / zla nya 'dzin par mi 'gyur zhes / bshad kyang nya stong chad pa 'gar / gza' 'dzin byung ba'i myong byang mthong / ... de 'dra'i 'ga' re ma gtogs pa / cho ga 'dis yis 'khrul med shes /). Phyag mdzod presents two exceptions: a solar eclipse at 1814/5/30 and a lunar eclipse at 1823/8/22. For more information regarding this passage, see also Henning (2007: 139). Overall, Tibetan astronomers believe that lhag chad in the grub rtsis system is more reliable and an eclipse rarely occurs on the occasion of the chad in the grub rtsis system. Here, in A kya’s calculations, 1785/12/30 is chad according to grub rtsis for the calculation of the solar eclipse. In other words, this case opposes the general belief of most Tibetan astronomers, including Nor bzang rgya mtsho and Dkon mchog ’phrin las bzang po, etc.. In addition, A kya’s calculations show how eclipse calculations are made in such cases that a day is chad. He supposes that a day 30 exists in this case and then calculates such things as nyi dag and gza' dag for that day 30. See his calculations below. More various cases pertaining to the exegeses on the lhag chad in the case of eclipse calculation and real calculation methods in the case of lhag chad are expected to be collected in future research.

515 Read the calculations from left to right and from top to bottom.
Table 26 (continued)

4. **nyi dhrur** 18'44"19'4"14"  
(1221 x 2 + 26 + 223)  
= 99 ...... 18  
(1221 x 10 + 29 + 1185)  
= 223 ...... 44  
(1221 x 58 + 46 + 255)  
= 1185 ...... 19  
(1221 x 1 + 3 + 310)  
= 255 ...... 4  
(1221 x 17 + 27)  
= 310 ...... 14

5. **gza' bar** 1'33'35'4'442"  
Two methods: 1) search for the 30th day value in the table of grubs tsi kyi gza'i rtag longs. 2) 0'59'3'4''16 (707) x 30 = 1'31'5'0''480''. The results are the same.  
gza' bar: 1'31'5'0''480'' + gza' dhrur  
0'1'4'5'3''669'' = 1'33'35'4'442''  
(7/60/60/6/707).

6. **nyi bar** 20'55'17'5''31''  
Two methods: 1) search for the 30th day value in the table of grubs tsi kyi nyi ma'i rtag longs. 2) 0'4'2'1''5''43 (67) x 30 = 2'10'58'1''17 (67). The results are the same.  
nyi bar: 2'10'58'1''17 (67) + nyi dhrur  
18'44'19'4''14'' = 20'55'17'5''31'' (27/60/60/6/67)

7. **gza' phyed dag pa** 1'57'38'3''543''  
[= 1'57'38'3''51''324'' (cha shas shed snyoms)]  
(30 (tshes pa) + 5 (ril bo) = 2 ...... 14

2 is an even number. Therefore, it is equal and is added to gza' bar later.  
In the case that the step index is 7, the rkang sdom is 25 and the sgyur byed is 1. Multiply 1 by ril bo cha shas (in this case 120) and divide by 126.  
1 x 120 = yang dag rgyu' ba'i dus kyi chu tshod ...... 120  
120 x 60 = 57 yang dag rgyu' ba'i dus kyi chu srang ...... 18  
18 x 6 = 0 yang dag rgyu' ba'i dus kyi dbugs ...... 108  
108 x 7 = 0 yang dag rgyu' ba'i dus kyi cha shas

In the case of phyi rkang (later step), the rkang sdom is subtracted from the yang dag rgyu' chu tshod. In this case, rkang sdom is 25. Therefore, 25 - 0'57'0''606'' = 24'2'5''101''.  
2 is an even number. Therefore, it is equal and is added to gza' bar.  
gza' bar 1'33'35'4'442''(7/60/60/6/707)  
+ 0'2'4''2'5''101'' = **gza' phyed dag pa**  
1'57'38'3''543'' = 1'57'38'3''51''324'' (cha shas shed snyoms)

8. **nyi dag** 20'57'5'2''16''  
nyi bar: 20'55'17'5''31''  
(27/60/60/6/67)  
- 6'45''  
14'10'17''5''31''  
- 0'39''  
13'30''  
0'40'17''5''31''  
40q = 0 khyim ...... 40q  
sgyur byed index: 6 -> rkang sdom step total: 0  
135 = 1 ...... 105 yang dag rgyu' ba'i yul gyi chu tshod  
17 x 6 + 105 x 60 = 6402  
135 = 47 ...... 57 yang dag rgyu' ba'i yul gyi chu srang  
5 x 6 + 57 x 6 = 2 ...... 102 yang dag rgyu' ba'i yul gyi dbugs  
31 x 6 + 102 x 67 = 52 ...... 0 yang dag rgyu' ba'i yul gyi cha shas  
1'47'2''52'' + 0 + 20'55'17'5''3  
1'' = 20'57'5'2''16'': **nyi dag**  
If it is snga rkang (early step), add.

9. **gza' dag** 1'59'26'0''36''324''  
gza' phyed dag pa 1'57'38'3''51''324'' + 1'47'2''52''  
+ 0 = 1'59'26'0''36''324'' : **gza' dag**
Table 27. *Sgra gcan* Values

<table>
<thead>
<tr>
<th><em>Sgra gcan rtsa</em> 5°59'13&quot;0&quot;6&quot;&quot;</th>
<th>*Sgra gcan gdang 21°0'46&quot;5&quot;17&quot;&quot;</th>
<th>*Sgra gcan mjug 7°30'46&quot;5&quot;17&quot;&quot;</th>
</tr>
</thead>
<tbody>
<tr>
<td>(1221+209) = 6 .... 50</td>
<td>27 − 5°59'13&quot;0&quot;6&quot;&quot; = 21°0'46&quot;5&quot;17&quot;&quot;</td>
<td>13°30'9 + 21°0'46&quot;5&quot;17&quot;&quot; = 7°30'46&quot;5&quot;17&quot;&quot;</td>
</tr>
<tr>
<td>50 × 30 + 30 = 1530</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1530 × 0/0/14/0/12 = 5°59'13&quot;0&quot;6&quot;&quot;</td>
<td></td>
<td></td>
</tr>
<tr>
<td>(27/60/60/6/23)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1530 × 0 + 5 = 5</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1530 × 0 + 359 = 5 .... 59</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1530 × 14 + 133 = 359 .... 13</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1530 × 0 + 798 = 133 .... 0</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1530 × 12/23 = 798 .... 6</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

| *Gdong* 21°0'46"5"17"" − 0°31'41"4"10(23) = 20°29'51"1"7"" --> corrected gdong value. |                                 |                                 |
| *Mjug* 7°30'46"5"17"" − 0°31'41"4"10(23) = 6°59'51"1"7"" --> corrected mjug value. |                                 |                                 |

Compare them with *nyi dag* 20°57'5'2"16"".

**Calculation #3. Sum pa Mkhan po's *Dga’ ldan rtsis gsar* 1785/12/15**

**Epoch data at 1747/3/0 in the case of *Dga’ ldan rtsis gsar***

True month: 0/10 (1/65), *gza’ dhru’i phro*: 1°55'13"3"333"" = 1°55'13"3"31""394"" (67/707), *ril /cha*: 24/22 (28/126), *nyi dhru’i phro*: 26°39'51"1"18""(67), Rāhu: 32.517.

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516 For this *nur ster/ nur phri* method, see above pp. 197-203.

517 For the epoch value, see Henning (2013). According to Schuh’s (1973a/2012) classification, this case is m = 10.
Table 28.

1. zla dag: 479, mda’ ro lhag ma: 30
   \[
   1785 - 1747 = 38 \\
   12 - 3 = 9 \\
   (38 \times 12 + 9) + 14 = 465 + 14 \\
   = 479: zla dag \\
   (38 \times 12 + 9) \times 2 + 10 = 940 \\
   \frac{940}{65} = 14 \ldots 30: mda’ ro lhag ma
   \]

2. gza’ dhru: 0\text{°}50'12.5''11''
   \[
   \left(\frac{479 \times 2 + 26}{80}\right) = 39 \ldots 19 \\
   \left(\frac{479 \times 10 + 39 + 465}{60}\right) = 88 \ldots 14 \\
   \left(\frac{479 \times 58 + 51 + 100}{60}\right) = 465 \ldots 33 \\
   \left(\frac{479 \times 1 + 0 + 121}{6}\right) = 100 \ldots 0 \\
   \left(\frac{479 \times 17 + 18}{67}\right) = 121 \ldots 54
   \]

3. ril chus 5/123
   \[
   \left(\frac{479 \times 2 + 24 + 3}{126}\right) = 35 \ldots 5 \\
   \left(\frac{479 \times 1 + 22}{28}\right) = 3 \ldots 123
   \]

4. ril cha: 5/123
   \[
   \left(\frac{479 \times 2 + 26 + 80}{80}\right) = 27 \ldots 19 \\
   \left(\frac{479 \times 10 + 39 + 465}{60}\right) = 88 \ldots 14 \\
   \left(\frac{479 \times 58 + 51 + 100}{60}\right) = 465 \ldots 33 \\
   \left(\frac{479 \times 1 + 0 + 121}{6}\right) = 100 \ldots 0 \\
   \left(\frac{479 \times 17 + 18}{67}\right) = 121 \ldots 54
   \]

5. gza’ bar: 0\text{°}50'12.5''11''
   \[
   \text{Two methods: 1) search the 15th day value in the table of grub rtsis kyi gza’i rtag longs. 2) } \left(\frac{707}{15}\right) = 0\text{°}45'55''0''240'' \\
   \text{The results are the same.} \\
   \text{0°45'55''0''240'' + gza’ dhru} \\
   \text{0°41'74''478''} = 0°50'12.5''11'' \\
   \left(\frac{7}{60/60/6/707}\right)
   \]

6. ril bar: 20\text{°}20'2.4''14''
   \[
   \text{Two methods: 1) search the 15th day value in the table of grub rtsis kyi nyi ma’i rtag longs. 2) } \left(\frac{67}{15}\right) = 1°529'00''42 (67). \text{The results are the same.} \\
   \text{1°529'00''42'' (67) + nyi dhru} \\
   \text{19¾14'33'0''54''} = 20°20'2.4''14'' \\
   \left(\frac{27/60/60/6/67}{67}\right)
   \]

---

518 As seen above, in the case of Sum pa Mkhan po’s Dga’ ldan rtsis gsar, the nyi ma’i rtag longs of a month (T. tshes zla) is 2°10'58.1'17'"(67). Schuh’s value 2°10'58.2'500''(707) is incorrect; see Schuh (2012a: 120).

519 As seen above, in the case of Sum pa Mkhan po’s Dga’ ldan rtsis gsar, the nyi ma’i rtag longs of a day (T. tshes zhag) 0°421'5.43''(67). Schuh’s value 0°421'5.488''(707) is incorrect; see Schuh (2012a: 120).
Table 28 (continued)

7. gza' phyed dag pa:

(cha shas shed snyoms)

\[
\begin{align*}
(15 + 5) &= 0 \\
14 &= 1 \ldots 6
\end{align*}
\]

1 is an odd number. Therefore, it is unequal and subtracted from gza’ bar.

In the case of step index 6, rkang sdom is 24. The sgur byed is 1.

\[
1 \times 123 = 0 \quad \text{yang dag rgyu ba’i dus kyi chu tshod} \ldots \ldots 123
\]

\[
\frac{126}{123 \times 60} = 58 \quad \text{yang dag rgyu ba’i dus kyi chu srang} \ldots \ldots 72
\]

\[
\frac{72 \times 6}{126} = 3 \quad \text{yang dag rgyu ba’i dus kyi dbugs} \ldots \ldots 54
\]

\[
\frac{54 \times 707}{126} = 303 \quad \text{yang dag rgyu ba’i dus kyi cha shas}
\]

In the case of snga rkang (early step), the rkang sdom is added to yang dag rgyu ba’i chu tshod.

\[
24 + 0^{58}3^{303}'' = 24^{58}3^{303}''.
\]

subtracted from gza’ bar

\[
0^{50}12^5''11'' (7/60/60/6/707), \quad (1: \text{odd number and is then unequal and subtracted from gza’ bar})
\]

8. nyi dag: 20\(^{20}\)20'15''2''

nyi bar: 20\(^{20}\)20'1'29''

(27/60/60/6/67) - 6\(^3\)45\(^8\)

13\(^3\)5\(^2\)1''29''

dor: deductible.

\[
-13\(^3\)30\(^6\)
\]

0\(^5\)2'1''29''

sayur byed : 6, rkang sdom step total: 0

\[
\frac{5 \times 6}{135} = 0 \ldots \ldots 30 \quad \text{yang dag rgyu ba’i yul gyi chu tshod}
\]

\[
\frac{2 \times 6 + 30 \times 60}{135} = 13 \ldots \ldots 57 \quad \text{yang dag rgyu ba’i yul gyi chu srang}
\]

\[
\frac{1 \times 6 + 57 \times 6}{135} = 2 \ldots \ldots 78 \quad \text{yang dag rgyu ba’i yul gyi dbugs}
\]

\[
29 \times 6 + 78 \times 67 = 40 \ldots \ldots 0 \quad \text{yang dag rgyu ba’i yul gyi cha shas}
\]

\[
0^{13}2'40'' + 0 + 20\(^{20}\)20'1''29'' = 20\(^{20}\)20'15''2'': nyi dag
\]

9. gza’ dag: 0\(^{0}\)25'27''12''232''

0\(^1\)3'2''40'' + gza’ phyed dag pa

0\(^{25}\)\(^{14}\)\(^{1}\)\(^{39}\)''232''

= 0\(^{25}\)\(^{27}\)\(^{4}\)''12''232'' : gza’ dag

Table 29. Sgra gcan Values

<table>
<thead>
<tr>
<th>sgra gcan rtsa</th>
<th>6'2'44'2''2''</th>
</tr>
</thead>
<tbody>
<tr>
<td>((479 + 32))</td>
<td>2 \ldots \ldots 51</td>
</tr>
<tr>
<td>(230)</td>
<td>51 \times 30 + 15 = 1545</td>
</tr>
<tr>
<td>1545 \times 0 + 6</td>
<td>6</td>
</tr>
<tr>
<td>((1545 \times 0+362))</td>
<td>6 \ldots \ldots 2</td>
</tr>
<tr>
<td>(60)</td>
<td>(1545 \times 0 + 134)</td>
</tr>
<tr>
<td>(60)</td>
<td>6 \ldots \ldots 44</td>
</tr>
<tr>
<td>(60)</td>
<td>(1545 \times 0 + 806)</td>
</tr>
<tr>
<td>(6)</td>
<td>(1545 \times 12)</td>
</tr>
<tr>
<td>\frac{23}{23}</td>
<td>806 \ldots \ldots 2</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>sgra gcan gdong</th>
<th>20'2'15'3'21''</th>
</tr>
</thead>
<tbody>
<tr>
<td>0'3'15'3'21''</td>
<td>27 - 6'2'44'2''2''</td>
</tr>
<tr>
<td>13(^3)30(^6) + 20(^{20})20'1''29'' = 7'27'57'3'21''</td>
<td></td>
</tr>
</tbody>
</table>

237
Calculation #4. *Dga’ldan rtsis gsar* 1785/12/29

**Epoch data at 1747/3/0 in the case of Sum pa’s *Dga’ldan rtsis gsar***

True month: 0/10 (1/65), *gza’* dhru'i 'phro: $1^55^13'3"333'' = 1^55^13'3"31''394''''(67/707)$, ril/cha: 24/22 (28/126), nyi dhru'i 'phro: $26^39^51'0"18'"'(67)$, Rāhu: 32.

Table 30.

<p>| | | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>1785 − 1747 = 38</td>
<td>(479 × 1 + 1 + 255) [\frac{7}{60} \times 50 + 13 + 54] = 105 ...... 0</td>
<td>(479 × 2 + 24 + 3) [\frac{28}{126} \times 1 + 22] = 3 ...... 123</td>
</tr>
<tr>
<td>12 − 3 = 9</td>
<td>[\frac{7}{60} \times 31 + 55 + 400] = 255 ...... 4</td>
<td></td>
</tr>
<tr>
<td>(38 × 12 + 9) + 14 = 465 + 14</td>
<td>[\frac{60}{6} \times 480 + 325] = 400 ...... 17</td>
<td></td>
</tr>
<tr>
<td>= 479: <em>za dag</em></td>
<td>[\frac{60}{6} \times 0 + 3 + 325] = 54 ...... 4</td>
<td></td>
</tr>
<tr>
<td>(38 × 12 + 9) × 2 + 10 = 940</td>
<td>[\frac{27}{707} \times 480 + 333] = 325 ...... 478</td>
<td></td>
</tr>
<tr>
<td>940 [\frac{60}{6} \times 1 + 9 + 121] = 100 ...... 0</td>
<td></td>
<td></td>
</tr>
<tr>
<td>65 = 14 ...... 30: <em>mda’ ro lha</em> ma</td>
<td></td>
<td></td>
</tr>
<tr>
<td>4. <em>nyi dhru</em> 19'^14&quot;33'0&quot;54''''</td>
<td>5. <em>gza’ bar</em> 1'^36&quot;7'5&quot;251''''</td>
<td>6. <em>nyi bar</em> 21'^25&quot;31'2&quot;4''''</td>
</tr>
<tr>
<td>(479 × 2 + 26 + 60) [\frac{27}{60} \times 58 + 51 + 100] = 88 ...... 14</td>
<td>(479 × 50'0&quot;480'' + <em>gza’</em> dhru 0'^4&quot;17'4&quot;478'''' = 1'^36&quot;7'5&quot;251'''' (7/60/60/6/707).</td>
<td>(479 × 2 + 26 + 60) [\frac{27}{60} \times 58 + 51 + 100] = 88 ...... 14</td>
</tr>
<tr>
<td>60 [\frac{60}{6} \times 1 + 0 + 121] = 100 ...... 0</td>
<td></td>
<td></td>
</tr>
<tr>
<td>67 [\frac{6}{6} \times 17 + 18] = 121 ...... 54</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

---

520 In the case of the *Dga’ldan rtsis gsar*, 1785/12/26 is *lha* (Jan 25, 1786 and Jan 26, 1786). 1785/12/29 (Jan 29, 1786) is followed by 1785/12/30 (Jan 30, 1786).
7. *gza’ phyed dag pa* 2'09'1"655"" (cha shas shed snyoms)

\[
\frac{30 + 5}{14} = 2 \ldots 7
\]

2 is an even number. Therefore, it is equal and added to *gza’ bar* later.

In case that step index is 7, the *rkang sdom* is 25 and the *sgyur byed* is 1. Multiply 1 by *ril cha* (in this case 123) and divide by 126.

\[
\frac{123 \times 60}{126} = 58 \text{ yang dag rgyu ba’i dus kyi chu tshod} \ldots 123
\]

\[
\frac{72 \times 6}{126} = 3 \text{ yang dag rgyu ba’i dus kyi dbugs} \ldots 54
\]

\[
\frac{54 \times 707}{126} = 303 \ldots \text{yang dag rgyu ba’i dus kyi cha shas}
\]

In the case of *phyi rkang* (later step), the *rkang sdom* is subtracted from *yang dag rgyu’ chu tshod*.

\[
25 \left( = 24^{59^5’707’’} \right) - 0^{58^3’303’’} = 24^{1’2’404’’}
\]

2 is an even number. Therefore, it is equal and added to *gza’ bar*.

*Gza’ bar* 1’36’7’’5’251’’

\[
(7/60/60/6/707) + 24^{1’2’404’’} = 2'09'1"655"" = *gza’ phyed dag pa* 2'09'1"62"51"" (cha shas shed snyoms)
\]

---

8. *nyi dag* 21’28’39’2’28’’

nyi bar: 21’25’31’2’4’’

\[
\frac{27/60/60/6/67}{6^{45^8}} = 14^{40’31’2’4’’}
\]

dor: deductible.

\[
\frac{13’30^9}{1’10’31’2’4’’}
\]

\[
1’10^i = 70^i
\]

\[
\frac{70}{135} = 0 \text{ khyim} \ldots 70^i
\]

The *sgyur byed* is 6. Then, the step total is 6.

\[
70 \times 6 = 3 \ldots 15 \text{ yang dag rgyu ba’i yul gyi chu tshod}
\]

\[
\frac{31 \times 6 + 15 \times 60}{135} = 8 \ldots 6 \text{ yang dag rgyu ba’i yul gyi chu srang}
\]

\[
3 \times 6 + 6 \times 6 = 0 \ldots 48 \text{ yang dag rgyu ba’i yul gyi dbugs}
\]

\[
\frac{4 \times 6 + 48 \times 67}{135} = 24 \ldots 0 \text{ yang dag rgyu ba’i yul gyi cha shas}
\]

\[
3’8’0’’24’’ + 0 + 21’25’31’2’4’’ = 21’28’39’2’28’’: *nyi dag*
\]

---

9. *gza’ dag* 2’3’17’2’19’’51’’

\[
\frac{2’09’1"62"51” + 3’8’0’’24’’ + 0}{2’3’17’2’19’’51’’} = *gza’ dag*
\]

---

Table 31. *Sgra gcan Values*

<table>
<thead>
<tr>
<th>sgra gcan rtsa 6’6’15’3’21’’</th>
</tr>
</thead>
<tbody>
<tr>
<td>(479 + 32)</td>
</tr>
<tr>
<td>230</td>
</tr>
<tr>
<td>[51 \times 30 + 30 = 1560]</td>
</tr>
<tr>
<td>[1560 \times 0 + 6 = 6]</td>
</tr>
<tr>
<td>[1560 \times 0 + 316]</td>
</tr>
<tr>
<td>60</td>
</tr>
<tr>
<td>[1560 \times 14 + 135]</td>
</tr>
<tr>
<td>60</td>
</tr>
<tr>
<td>[1560 \times 0 + 813]</td>
</tr>
</tbody>
</table>
| 1560 \times 12 \[\frac{23}{135} = 813 \ldots 21\]

sgra gcan gdong 20’53’44’2’2’’; sgra gcan njug 7’23’44’2’2’’

\[
27 - 6^{6’15’3’21’’} = 20’53’44’2’2’’
\]

\[
13’30^9 + 20’53’44’2’2’’ = 7’23’44’2’2’’
\]
Calculation # 5. Byed rtsis 1785/12/15

Epoch data at 806/3/0 in the case of byed rtsis

True month: 0/0 (1/65), gza’ dhru’i phro: 2°30’, ril cha’i phro: 5/112 (28/126), nyi dhru’i phro: 26°58°0”0”(13), Rāhu: 122.521

Table 32.

<table>
<thead>
<tr>
<th>1. zla dag 12118, mda’ ro lhag ma 49</th>
<th>2. gza’ dhru’i 6°46’20’</th>
<th>3. ril cha’i 6/8</th>
</tr>
</thead>
<tbody>
<tr>
<td>1785 - 806 = 979</td>
<td>(12118 x 1 + 2 + 6429) =</td>
<td>(12118 x 2 + 5 + 97) =</td>
</tr>
<tr>
<td>12 - 3 = 9</td>
<td>2649 .... 6</td>
<td>869 .... 6</td>
</tr>
<tr>
<td>(979 x 12 + 9) + 361 = 12118: zla dag</td>
<td>60</td>
<td>28</td>
</tr>
<tr>
<td>(979 x 12 + 9) x 2 + 0 = 23514</td>
<td>6429 .... 46</td>
<td>126</td>
</tr>
<tr>
<td>23514/65 = 361 .... 49: mda’ ro lhag ma</td>
<td>10098 .... 20</td>
<td>97 .... 8</td>
</tr>
</tbody>
</table>

521 For the epoch value, see Henning (2013c). According to Schuh’s (1973a/2012) classification, this case is m = 2. Schuh’s tables in Schuh (1973a) includes m = 3 and m = 4. Addition to the table the case of m = 2 in 1785 C.E. occurs as follows:

<table>
<thead>
<tr>
<th>Tibetan month</th>
<th>m = 2</th>
<th>m = 3</th>
<th>m = 4</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>the first day of each month</td>
<td>lhag chad</td>
<td>the first day of each month</td>
</tr>
<tr>
<td>1</td>
<td>10.2.1785 -3</td>
<td>19</td>
<td>-27</td>
</tr>
<tr>
<td>2</td>
<td>11.3.1785 0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>3</td>
<td>9.4.1785 -1</td>
<td>13</td>
<td>-24</td>
</tr>
<tr>
<td>4</td>
<td>9.5.1785 -27</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>5</td>
<td>7.6.1785 8</td>
<td>-20</td>
<td>0</td>
</tr>
<tr>
<td>6</td>
<td>7.7.1785 -23</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>7</td>
<td>5.8.1785 5</td>
<td>-16</td>
<td>0</td>
</tr>
<tr>
<td>8</td>
<td>4.9.1785 -19</td>
<td>30</td>
<td>0</td>
</tr>
<tr>
<td>9</td>
<td>4.10.1785 -12</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>10</td>
<td>2.11.1785 -16</td>
<td>24</td>
<td>0</td>
</tr>
<tr>
<td>11</td>
<td>2.12.1785 -10</td>
<td>27</td>
<td>0</td>
</tr>
<tr>
<td>12</td>
<td>1.1.1786 -4</td>
<td>0</td>
<td>0</td>
</tr>
</tbody>
</table>
In the case of the 15th day, the mean motion of the Sun per one lunar month. In the case of byed rtsis, 210°58’2”10”’(13) = the mean motion of the Sun per one lunar month.

In the case of byed rtsis, the gza’i rtag longs (tshes shag) is 0°59°3’4”. In the case of grub rtsis, gza’i rtag longs (tshes shag) is 0°59°3’4”16”.

---

### Table 32 (continued)

<table>
<thead>
<tr>
<th>4. ngyi dhrur: 10°25’16”5&quot;7’’’</th>
<th>gza’ bar: 0°32’15’0”'</th>
<th>6. ngyi dhrur: 20°30’46”0’’’</th>
</tr>
</thead>
<tbody>
<tr>
<td>10°25’16”5&quot;7’’’ (12118 x 2 + 26 + 2217)</td>
<td>0°32’15’0”' (7/60/60/6/13)</td>
<td>20°30’46”0’’’ (27/60/60/6/13)</td>
</tr>
<tr>
<td>210°58’2”10”’</td>
<td>0°32’15’0”'</td>
<td>1°59°1’5’’’</td>
</tr>
<tr>
<td>11807</td>
<td>135</td>
<td>210°58’2”10”’</td>
</tr>
<tr>
<td>2217</td>
<td>135</td>
<td>20°30’46”0’’’</td>
</tr>
<tr>
<td>9321</td>
<td>135</td>
<td>20°30’46”0’’’</td>
</tr>
<tr>
<td>5592</td>
<td>135</td>
<td>20°30’46”0’’’</td>
</tr>
<tr>
<td>63</td>
<td>135</td>
<td>20°30’46”0’’’</td>
</tr>
</tbody>
</table>

**Note:**
- The mean motion of the Sun per one lunar month is calculated using the formula: 
  \[ \text{Mean Motion} = \left( \frac{390}{n} \right) \times 12 \]
  where \( n \) is the number of days in the lunar month.
- The mean motion is expressed in degrees and minutes.

---

### Table 32 (continued)

<table>
<thead>
<tr>
<th>7. gza’ phyed dag pa: 0°7°18’63” (78)</th>
<th>8. ngyi dag: 20°31’28’1”3’’’</th>
<th>9. gza’ dag: 0°8°0’5”2”</th>
</tr>
</thead>
<tbody>
<tr>
<td>0°7°18’63” (15 + 6)</td>
<td>20°31’28’1”3’’’ (27/60/60/6/13)</td>
<td>0°8°0’5”2”</td>
</tr>
<tr>
<td>1 x 8</td>
<td>20°30’46’0”12”'</td>
<td>0°8°0’5”2”</td>
</tr>
<tr>
<td>126</td>
<td>0°15’46’0”12”'</td>
<td>0°8°0’5”2”</td>
</tr>
<tr>
<td>0°15’46’0”12”'</td>
<td>12°6 + 90 x 60</td>
<td>0°8°0’5”2”</td>
</tr>
<tr>
<td>0°15’46’0”12”'</td>
<td>12 x 6 + 36 x 13</td>
<td>0°8°0’5”2”</td>
</tr>
<tr>
<td>0°15’46’0”12”'</td>
<td>42</td>
<td>0°8°0’5”2”</td>
</tr>
<tr>
<td>0°15’46’0”12”'</td>
<td>36</td>
<td>0°8°0’5”2”</td>
</tr>
<tr>
<td>0°15’46’0”12”'</td>
<td>4</td>
<td>0°8°0’5”2”</td>
</tr>
</tbody>
</table>

**Note:**
- The table above shows the calculations for the mean motion of the Sun per one lunar month, along with the calculations for byed rtsis and gza’i rtag longs.
- The values are expressed in degrees, minutes, and seconds.

---

522 2°10°58’2”10”’(13) = the mean motion of the Sun per one lunar month. In the case of grub rtsis, 2°10°58’1”17”’ = the mean motion of the Sun per one lunar month.

523 In the case of byed rtsis, the gza’i rtag longs (tshes ztag) is 0°59°3’4”. In the case of grub rtsis, gza’i rtag longs (tshes ztag) is 0°59°3’4”16”.

---

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Table 33. **Sgra gsan Values**

| Sgra gsan rtsa | 5°55'41"10'" | Sgra gsan gdong | 21°4'18"1"13'" | Sgra gsan mjug | 7°34'18"1"13" |
|----------------|-------------|-----------------|-----------------|----------------|
| (12118 + 122) | 230         | 27 - 5°55'41"10'" | = 21°4'18"1"13'" | : Sgra gsan |
| 50 × 30 + 15   | 1515        | 1530 + 21°4'18"1"13'" | 7°34'18"1"13" |
| 1515 × 0 + 5   | 5           | 55               |                |
| 1515 × 0 + 355 | 55          | 41               |                |
| 1515 × 14 + 131| 55          | 41               |                |
| 1515 × 12      | 131         | 131              |                |
| 23             | 131         | 131              |                |

**Calculation # 6. Byed rtsis 1785/12/30**

Epoch data at 806/3/0 in the case of byed rtsis

True month: 0/0 (1/65), gza' dhru'i 'phro: 2°30', ril cha'i 'phro: 5/112 (28/126), nyi dhru'i 'phro: 26°58°0°0°'(13), and Rāhu: 122.

Table 34.

<table>
<thead>
<tr>
<th>1. zla dag</th>
<th>12118, mda' ro lhag ma</th>
<th>2. gza' dhru 6°46'20&quot;</th>
<th>3. ril cha: 6/8</th>
</tr>
</thead>
<tbody>
<tr>
<td>12118</td>
<td>(12118 × 1 + 2 + 6429)</td>
<td>(12118 × 1 + 2 + 6429)</td>
<td>(12118 × 2 + 5 + 97)</td>
</tr>
<tr>
<td>23514</td>
<td>(12118 × 50 + 0)</td>
<td>(12118 × 31 + 30 + 10090)</td>
<td>(12118 × 1 + 112)</td>
</tr>
<tr>
<td>65</td>
<td>6</td>
<td>6</td>
<td>6</td>
</tr>
<tr>
<td>361</td>
<td>10098</td>
<td>869</td>
<td>97</td>
</tr>
</tbody>
</table>

524 0°7°18'63" (78) = 0°7°18'4"11"'(13). The cha shas shed snyoms is as follows:

63 ÷ 78 × 6 = 4.84615384615
0.84615384615 × 13 = 11
Table 34 (continued)

<table>
<thead>
<tr>
<th>4. ngyi dhru</th>
<th>19°25'16&quot;5'&quot;7&quot;&quot;</th>
</tr>
</thead>
<tbody>
<tr>
<td>(12118 × 2 + 26 + 2217)</td>
<td>27</td>
</tr>
<tr>
<td>19</td>
<td>2217 ..... 25</td>
</tr>
<tr>
<td>(12118 × 58 + 11807)</td>
<td>60</td>
</tr>
<tr>
<td>16</td>
<td>11807 ..... 5</td>
</tr>
<tr>
<td>(12118 × 2 + 0 + 9321)</td>
<td>60</td>
</tr>
<tr>
<td>6</td>
<td>9321 ..... 5</td>
</tr>
</tbody>
</table>

5. gza’ bar: 1°18"10'0"

For the value of the 30th day, read the table of byed pa’i gza’i rtag longs and that of ngyi ma’i rtag longs.

gza’ bar: 1°31'50"0' + gza’ dhru 6°46'20"0" = 1°18'10"0" (7/60/60/6)

6. ngyi bar: 21°36'15"2'4""" |

7. gza’ phyed dag pa’: 1°42"2'2"4"

For the value of the 30th day, read the table of byed pa’i gza’i rtag longs and that of ngyi ma’i rtag longs.

gza’ bar: 1°18"10'0" + gza’ dhru 6°46'20"0" = 1°18'10"0" (7/60/60/6)

8. ngyi dag: 21°39'5'2"0"5"

nyi bar: 21°36'15"2'4"" + 0°3'36'4"1"" = 1°45'39'0"5"

9. gza’ dag: 1°45'39'0"5"

The values of gza’ dag and ngyi dag for the lunar eclipse calculations at 1785/12/15 are as follows:

---

525 I did not have a chance to seriously investigate the values and methods of the lunar and solar eclipse calculations in the three individual systems. Henning (2007: chapter 3) is the most advanced research for the eclipse calculation methods of the grub rtsis and the byed rtsis. My topic is to demonstrate background knowledge on rtsis ’phro corrections and their influence in the calculated results with regard to eclipses. For modern computations for this eclipse, see von Oppolzer, tr. Gingerich (1962: 371), Liu and Fiala (1992: 152),
Table 35.

<table>
<thead>
<tr>
<th></th>
<th>Phug pa grub rtsis (calculation # 1)</th>
<th>Dga' ldan rtsis gsar (Calculation # 3)</th>
<th>byed rtsis (Calculation # 5)</th>
</tr>
</thead>
<tbody>
<tr>
<td>gza' dag</td>
<td>0°21³6²'29''505&quot;&quot;&quot;&quot;</td>
<td>0°25³27'4''232&quot;&quot;&quot;&quot;</td>
<td>0°8³0'5''2&quot;&quot;&quot;&quot;</td>
</tr>
<tr>
<td>nyi dag</td>
<td>19°48²41'3''57&quot;&quot;&quot;&quot;</td>
<td>20°20²15'4''2&quot;&quot;&quot;&quot;</td>
<td>20°31²28'1''3''</td>
</tr>
</tbody>
</table>

ⓑ − ♂ = 0°3³51'1''49''434''"""" (7/60/60/67/707/). The result is fixed. Also, see the case at 1785/12/30.

ⓐ − ♂ is the subtraction between different radices, i.e. (7/60/60/67/707) and (7/60/60/6/13). The cha shas shed snyoms is needed.

0°21³6²'5''51''202""""  526 — 0°8³0'5''2"""

(7/60/60/6/13/67/707/). The results may vary.

ⓑ − ♂ = 0°25³27'4''2''26''188"""" (7/60/60/67/707/) — 0°8³0'5''2"""

= 0°17³26'5''0''26''188"""" (7/60/60/6/13/67/707/)

and Espenak and Meeus, Five Millenium Canon of Lunar Eclipses −1999 to + 3000 [See NASA eclipse website]. Regarding Δ T, for further information on one of the major factors that causes the observed differences in the calculations, see de Meis (2002: 3-4), Sivin (2009: 116-8).

526 29 × 707 + 505 = 21008
21008 × 13 = 273104
273104  = 386.285714286
386.285714286  = 5.76545842218
5.76545842218 − 5 = 0.76545842218
0.76545842218 × 67 = 51.2857142861
51.2857142861 − 51 = 0.2857142861
0.2857142861 × 707 = 202.000000273
\( e - d = 0^\circ31^\circ26'0"12"' (27/60/60/6/67) \) The result is fixed. Also, see the case at 1785/12/30.

\( f - d = 20^\circ31^\circ28'1"3"' (27/60/60/6/13) - 19^\circ48^\circ41'3"11"4"' (27/60/60/6/67) = 0^\circ42^\circ46'3"63""" (27/60/60/6/13/67).

\( f - e = 20^\circ31^\circ28'1"3"' (27/60/60/6/13) - 20^\circ20^\circ15'4"0"26"" (27/60/60/6/67) = 0^\circ11^\circ12'3"2"41""" (27/60/60/6/13/67).

The values of *gza' dag* and *nyi dag* for the solar eclipse calculations for 1785/12/30\(^{527}\) are as follows:

Table 36.

<table>
<thead>
<tr>
<th></th>
<th>Phug pa grub rtsis (calculation #2)</th>
<th>Dga' ldan rtsis gsar (Calculation #4)</th>
<th>byed rtsis (Calculation #6)</th>
</tr>
</thead>
<tbody>
<tr>
<td><em>gza' dag</em></td>
<td>1°59°26'0&quot;36&quot;324&quot;&quot;&quot;(a)</td>
<td>2°31'17'2&quot;19&quot;51&quot;&quot;&quot;(b)</td>
<td>1°45°39'0&quot;5&quot;&quot;&quot;(c)</td>
</tr>
<tr>
<td><em>nyi dag</em></td>
<td>20°57°5'2&quot;16&quot;&quot;&quot;(d)</td>
<td>21°28°39'2&quot;28&quot;&quot;&quot;(e)</td>
<td>21°39°52'0&quot;5&quot;&quot;&quot;(f)</td>
</tr>
</tbody>
</table>

\( b - a = 0^\circ3°51'1"49"'434"" (7/60/60/6/67/707/) \) The result is fixed. Also, see the case at 1785/12/15.

\( a - c = 1°59°26'0"7"'4"677""" - 1°45°39'0"5"" (7/60/60/6/13) = 0°13°47'0"2"'4"677""" (7/60/60/6/13/67/707/).\)

(b)−(c) = 2°3°17'2"3"46""663"""(7/60/60/6/67/707/7)−1°45"39'0"5""(7/60/60/6/67/707/7) = 0°17°38'1"11"46""663"""(7/60/60/6/13/707/7).

(e)−(d) = 0°31°26'0"12"(27/60/60/6/67) The result is fixed. Also, see the case at 1785/12/15.

(f)−(d) = 21°39°52'0"5"(27/60/60/6/13)−20°57°52'3"7""(27/60/60/6/67) = 0°42°46'4"1"60""(27/60/60/6/13/67).

(f)−(e) = 21°39°52'0"5"(27/60/60/6/13)−21°28°39'2"9""(27/60/60/6/67) = 0°11°12'3"12"38""(27/60/60/6/13/67).

It has been verified from the above tables and calculations that the different rtsis 'phro values between the Phug pa grub rtsis and the Dga' ldan rtsis gsar and the different rtag longs and rtsis 'phro values between the Phug traditions (Phug pa grub rtsis and Dga' ldan rtsis gsar) and the byed rtsis cause the difference of nyi dag (also tshes 'khyud zla skar in the case of lunar eclipses), which surely influence the determination of eclipse possibility. In the case of a lunar eclipses, the tshes 'khyud zla skar value of the 15th day is compared to the sgra gcen gdong/ mjug; in the case of a solar eclipse, the nyi dag value of the 30th day is compared with sgra gcen gdong/ mjug. 528 Of course, nur ster is considered in the case of the grub rtsis.

528 For example, the possible cases of a solar eclipse in Dharmaśrī’s Gser gyi shing rta are thus: 1) nyi dag of the 30th day – corrected (= nur ster was applied) gdong < 45 chu tshod (50 chu tshod is possible), 2) corrected mjug – nyi dag of the 30th day < 40, 3) corrected gdong – nyi dag of the 30th day < 5, 4) nyi dag of the 30th day – corrected mjug < 8. These values used are on an empirical basis (myong rtsis). For more information see Henning (2007: 129), and Dharmaśrī (1983: 256-7).
I stress the following two points: the different rtsis 'phro-s between the Phug pa grub rtsis (Pad dkar zhal lung) and the Dga' ldan rtsis gsar are the outcome from observations of eclipse occurrences for the purpose of accurate eclipse calculation.\(^{529}\) In addition, as seen in A kya’s calculations, multiple systems are used in Tibet. Under these circumstances, there is no guarantee that a certain calculation method is always right and no systems can be ruled out. This presents a paradox in which different values and methods are affirmed and referred to at the same time.

After a judgement regarding eclipse possibility, calculations of timing, direction, magnitude, etc., follow, which are beyond the scope of this current work.\(^{530}\) Instead, A kya’s observations are presented, based upon his calculations.

### A KYA’S CALCULATIONS AND OBSERVATIONS OF THE ECLIPSES

A kya’s calculation (possibly including his observation) for the lunar eclipse at 1785/12/15 is as follows:

\[
yed ni nyi nyin gza’ nyi ma’i bu\(^ {531}\) / chu tshod de nyid (25)\(^ {532}\) yongs su zad pa yi / sa mo bya yi dus kyi thog ma ru / shar nye’i phyogs nas kham gsum rnam rgyal\(^ {533}\) gyi / mjue ma’i me dpung
\]

---

\(^{529}\) For this, see Sum pa Mkhan po (1979c: 13b).

\(^{530}\) See Henning (2007: chapter 3).

\(^{531}\) \textit{res gza’ nyi ma’i bu} = Saturday (\textit{gza’ spen pa}). nyi ma’i bu is Saturn (\textit{T. spen pa}).
At the beginning of the time of the earth-female-bird (T. sa mo bya) at which 25 chu tshod completely ended, on Saturday, of the full moon day, the flame of the tail of Rāhu flared up from near to the east, 7 cha (= i.e. \( \frac{7}{10} \)) of the disc of the moon burned, and then again when 7 chu tshod passed, [the moon] was restored from the part where it began.

It began at the time of bya (possibly 5-7 p.m. in Amdo), lasted during 7 chu tshod (24 modern minutes \( \times 7 = 168 \) minutes), and was then restored. A kya’s prediction for the solar eclipse at 1785/12/30 is as follows:

---

532 This means chu tshod and below in the value of the gza’ dag. If the supralinear note 25 was written by him, it means that A kya used the value of the Dga’ ldan rtsis gsar. The chu tshod value in the Dga’ ldan rtsis gsar is 25\(^5\). See the value: 0'25"27'4"12"232". Another possibility: de nyid may just mean ‘that’, i.e. chu tshod right before it. In either case, this phrase can be interpreted as the following: according to the skar rtsis system, the timing of the eclipse is fixed as the time of termination of the tshes zhag. Of course, a correction to the timing may be applied.

533 For a synonym of sgra gcan (M. raqu), khams gsun rnam rgyal (M. γ urban oron-i tein büged ila γ či) is seen in Lcang skya III et al. (1982: 56) and Lcang skya III et al. (2002: 1195).

534 In context, it should be sa mos gnyen (the moon).

535 A kya (2000: 2b (47 ben (本) xia (下) 2)).

536 This kind of time indication is rare. The sa mo bya (earth-female-bird) looks to be the time of bird (bya. Ch. you (酉)), which falls on 17-19 (= nyi nub in the table below). For the dus tshod bcu gnyis system combined with nag rtsis or the Chinese nyi khamgs (干支), see Henning (2007: 358) (2013c). Also see Bsam ’grub rgya mtsho (2011: 25).

<table>
<thead>
<tr>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
<th>7</th>
<th>8</th>
<th>9</th>
<th>10</th>
<th>11</th>
<th>12</th>
</tr>
</thead>
<tbody>
<tr>
<td>nam langs</td>
<td>nyi shkar</td>
<td>nyi dros</td>
<td>nyi phyed</td>
<td>nyi phyed yol</td>
<td>nyi myar</td>
<td>nyi nub</td>
<td>sa sros</td>
<td>srod khor</td>
<td>nam phyed</td>
<td>nam phyed yol</td>
<td>tho rangs</td>
</tr>
</tbody>
</table>

*** for the time zone, see Henning (2007: 358). According him, it is based upon the measurement of local (Lhasa) solar time. More research is needed.
The above table may be applicable to the time of bya that A kya mentions above, but the timing may vary according to different regions, astronomers, and traditions. In conjunction with this concept, Rab byung bcu bdun rgyal ba shing rta'i lo tho nyi ma'i od zer (= 2014-2015 calendar) (2013: 196-7): nam langs ranges from modern time 06:29 to 08:24 in the case of Lhasa (Actually, the current lo tho refers to modern technology for the timing of sun rise and sun set). Another relevant issue is the length of the day and night (nyin tshad and mtshan tshad respectively) according to the month. In the current lo tho published by Lhasa sman rtsis khang, nyin tshad ranges from 33°30' (bod zla lnga pa) to 26°30' (bod zla bcu gcig pa); mtshan tshad ranges from 33°30' (bod zla bcu gcig pa) to 26°30' (bod zla lnga pa). The values were well established already during Phyag mdzod’s time, at the latest; see Phyag mdzod (1987: 59, 209-11).

537 For a synonym of nyi ma (M. adiy-a), nyin byed (edür bolyayči) is given in Lcang skya III et al. (1982: 53) and Lcang skya III et al. (2002: 1185).

538 A kya (2000a: kha 4b [= 47 ben (木) Xia (下) 4]).

539 For the term rdzogs pa, see above note 110. This description is not unproblematic. There is no 1785/12/30 in the case of the grub rtis and the Dga’ ldan rtis gsar. We need more cases to fully research this topic, but it seems that, in A kya’s case, he calculates the timing of the mid-eclipse by taking the 12/30 existent.

makara. Capricorn), ... 4 or 5 parts (T. cha. = $\frac{4}{12}$ or $\frac{5}{12}$) of the sun are obscured by the face of Rāhu, which is not round and dark in nature, at the time of snake, as conventionally known, from the direction near to the south, and then again when 4 or 5 chu tshod (S. danda) are completed, [the sun] will be sequentially restored, turning to the left from the part where it began.

The eclipse was predicted to occur at snake time (possibly around 9 -11 a.m. in January 30, 1786 in Amdo), to last during 4-5 chu tshod (96-120 modern minutes) before it is restored. In fact, it did not occur anywhere in Tibet including Amdo (see above note 527).

THE RELATIONSHIP BETWEEN RTSIS 'PHRO CHANGE AND ECLIPSE CALCULATIONS WITH A FOCUS ON SUM PA MKHAN PO’S DGA’LDBAN RTSIS GSAR

I maintain that, by adjusting rtsis 'phro, Phug pa astronomers tried to enhance the agreement between rtsis and visible phenomena, including eclipses, solstices, etc. In this section, I investigate the arguments against this point by using Sum pa Mkhan po. First, I examine how he positions his new system in conjunction with the previous grub rtsis / byed rtsis and the Chinese calendar. Then, I mention the relationships involved in his new system, based upon the rtsis 'phro changes and eclipse calculations.

Firstly, the colophon of his Zla bsil rtsi sbyor dge ldan rtsis gsar is evidence of his clear voice regarding the appraisal of such different systems as byed rtsis, grub rtsis, and the Chinese calendar. His opinion on byed rtsis is as follows:

541 This is not likely. In fact, the duration of a solar eclipse at observer’s position is short.
... although byed rtsis is a little rough since Vimalaprabhā states that because Laghukālacakra, which, merely by the words, considers foremost being compatible with mundane persons in a way of being common to non-buddhists, should change the root quantity (nges pa = rtsa ba = dhru ba = S. dhruva / dhruvaka) of gza’ dhru and ‘nyi dhru every 60 year, it is impermanent, because the calculations of ‘nyi skar (= spatial position of the sun) made in detail by most of previous learned scholars of Tibet (Bu ston, ‘Jam dbyangs Chos kyi mgon po, and Mkhas grub, Karma pa (Karma pa III ?), etc) later are very accurate, eclipse, etc are accurate, and [the values of] the sun and moon are close to observation, but because cha (= chas shas), etc. of most of those byed rtsis-s are rough, errors appear a little respectively when many years passed. Because of that, the value of the gza’ is extremely inaccurate.

He defends byed rtsis, because he supposes that its accuracy is verified by eclipse observation. But, the gza’ value in byed rtsis is not accurate because of cha shas.543

His criticism towards the grub rtsis in the Pad dkar zhal lung on the basis of empirical and observational results, and research into Chinese calendar are followed.

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542 See Sum pa Mkhan po, Yum pa ed. (2015: Pdf, 587-8). A similar remark is found in his other writings such as Sum pa Mkhan po (1979: 180b) (1979c: 5a-5b).

543 See also note 418.
The one which is known as the calculation compatible with our \textit{siddhānta} is actually accurate, but in the traditions which follow the currently renowned \textit{Pad dkar zhal lung}, the investigation of the shadow of the sun etc are rough and inaccurate or faulty in the examination, in any case. In a way that the center of Tibet is not located in the center of the southern continent, \textit{Pad dkar zhal lung} calculated the three \textit{rtsis 'phro}-s on top of \textit{stong chen} \footnote{Precisely, it means \textit{stong chen 'das lo} in which \textit{rtsis 'phro} is reflected.} in order to tally solstice, etc. with the statement that the 7th, 8th, 14th, [something like that] whatever joint (border) of the west from the center of the east (\textit{rnga yab gzhan}), but because [it] only found \textit{tshes gza}, \textit{nyi} (\textit{nyi dhru}), and \textit{ril} (\textit{ril cha}), which are close to the actual exposition of the \textit{Kālacakratantra} and in accordance with its own assertions, [it] became different up to one month from the actual exposition of the \textit{Kālacakratantra}. Due to that, \textit{nyi dag} (true longitude of the sun) and \textit{nyi bar} (mean longitude of the sun) are inaccurate a little and thus, eclipse, which should be investigated by relying upon the values, is not certain, and because it then follows that \textit{khyim sleb}, \textit{dbugs}, \textit{sgang}, \textit{nyi ldog}, etc. \footnote{To understand how the terms \textit{dbugs thob}, \textit{khyim slebs}, and \textit{sgang} are used, see Henning (2007: 50-4). Also read Bsam 'grub rgya mtsho (2011: 112, 114-5) and Schuh (2012: 1501, 1347). To take bod zla bdun pa in 2010 (lcag stag) as an example, the \textit{dbugs} / \textit{khyim slebs} / \textit{sgang} calculations are as follows: 40 (bshol 'phro of the month) \times 6 \div 13 = 18 \text{ (quotient. T. nor)} and 6 \text{ (remainder. T. lhag)}.} are late and intercalary months are early, they do not agree with the \textit{khyim lnga} bsdus sngon med legs bshad kyang 'god pa dang ... /\footnote{To take bod zla bdun pa in 2010 (lcag stag) as an example, the \textit{dbugs} / \textit{khyim slebs} / \textit{sgang} calculations are as follows: 40 (bshol 'phro of the month) \times 6 \div 13 = 18 \text{ (quotient. T. nor)} and 6 \text{ (remainder. T. lhag)}.}
corresponding signs of season (T. nam zla), four seasons (T. dus bzhi), the shadow [of the sun] and nya skar, etc. and are remote. In addition, it made a rough error by merely relying upon nyi bar, without exactly obtaining dbags tshad, [sgang tshad], etc. by nyi dag. Also, [the following] some errors are seen: the values of the moon, sun, and the five planets are extremely remote from observation and no match is seen by mngon sum tshad ma, etc. [Dga’ ldan rtsis gsar] eliminated the mistaken distortions, also by mngon gum

3 = 0°13’37’’4’’438’’ — For this, see Huang and Chen (1987: 87) — Then, lnga cha value 1 = 0°05’43’’76’’.
— For this, see Huang and Chen (1987: 88), Bsam ’grub rgya mtsho (2009: 122-3). — Next, zla ba de’i gza’ dhru + tshes de’i gza’i rtags longs + ’dod cha + lnga cha = 3°00’0’’0’’ (For this, see Bod ljongs sman rtsis khang gi lo tho. 2010-2011 calendar (2009: 120)) + 3°49’40’’2’’176’’ (7/60/60/6/707) + 0°13’37’’4’’438’’ + 0°05’43’’76’’ = 0°41’12’’3’’690’’ is the gza’ bar value of the dbugs in the day 11. For the result, see the calendar (2009: 122).

zla ba de’i ngyi dhru + tshes de’i ngyi ma’i rtags longs + ’dod cha + ngya cha = 7°39’24’’1’’5’’ (For this, see the calendar (2009: 120)) + 0°48’1’’2’’4’’ (27/60/60/6/67) + 0°12’’2’’46’’ + 0°04’0’’12 = 8°28’30’’0’’0’’ is the ngyi bar value of the dbugs in the day 11. For the result, see the calendar (2009: 122).

The calculations of the khyim slebs values are as follows: look up the day 18. 3°00’0’’0’’ + 3°43’6’’0’’288’’ + 0°27’15’’3’’170’’ = 10°10’21’’3’’458’’ is the gza’ bar of the khyim slebs. For the result, see the calendar (2009: 123).

7°39’24’’1’’5’’ + 1°18’34’’5’’37’’ + 0°29’0’’25’’ = 9°00’0’’0’’0’’ is the ngyi bar value of the khyim slebs. For the result, see the calendar (2009: 123).

The calculations of the sgang values are as follows: 3°00’0’’0’’ + 4°35’35’’2’’416’’ (day 26) + 0°40’53’’1’’690’’ + 0°05’43’’76’’ = 1°17’23’’1’’394’’ is the gza’ bar value of the sgang. For the result, see the calendar (2009: 125).

7°39’24’’1’’5’’ (see Bod ljongs sman rtsis khang gi lo tho. 2010-2011 calendar (2009: 120)) + 1°53’30’’2’’46’’ (27/60/60/6/67) + 0°31’2’’4’’ + 0°04’0’’12 = 9°36’0’’0’’0’’ is the ngyi bar value of the sgang. For the result, see the calendar (2009: 125).

And the notation of the sgang in almanac is as follows: Schuh’s (2008: 226-30) finding and speculation are aloof from Tibetan practice. Phyag mdzod (Huang and Chen (1987: 91)) specifies the method: compare the gza’ bar value of the sgang with gza’ gnas (in gza’ dag) value of the relevant date. In doing so, the harmony of the former is not considered. For example, Bod ljongs sman rtsis khang gi lo tho: 2010-2011 calendar (2009: 155): the sgang value in bod zla bcu pa is of day 29, but consider gza’ gnas value: 1. Then, it is written in day 30. Bod ljongs sman rtsis khang gi lo tho: 2010-2011 calendar (2009: 165): the sgang value in bod zla bcu gcig pa is of day 30, but due to the harmony with the gza’ gnas (the value: 4), the sgang is written in day 1 in bod zla bcu gcig pa phyi ma. In case that gza’ gnas-s are the same, just write the sgang down in the same cell. For example, in the case of the bod zla gnyis pa in Bod ljongs sman rtsis khang gi lo tho: 2010-2011 calendar (2009: 201), the sgang is written in the same cell (day 6). In this case, both the values of the gza’ gnas-s are 4.

548 The nya skar is the skar ma of the moon at full moon.

549 Indian Buddhist logicians have accepted pratyaśa (mngon sum) and anumāṇa (rjes dpag) as two valid areas of knowledge since Dignāga (T. Phyogs kyi glang po. active early 6th c.). See Dignāga’s Pramāṇasamuccaya (T. Tshad ma kun btsus) chapter I and Dharmakīrti’s (chos kyi grags pa. flourished 7th c.) Pramāṇavārttika (T. Tshad ma rnam ’grel) chapter III. However, in the system of Phya pa Chos kyi seng ge (1109-1169), who laid the foundation of tshad ma in Tibet, a distinction between direct perception (mngon sum) and valid perception (mngon sum gyi tshad ma) was made, deviating from Dharmakīrti who never claimed that some perceptions are not valid. Phya pa’s contention is that cognition is affected by external objects, which are assumed to be real, and thus may be invalid. Meanwhile, the stance of Dharmakīrti’s Yogācāra is that the external object is
tshad ma, after having examined four dus gzer (two solstices and two equinoxes) by the miraculous circle of dus tshod bla byed (may be watch?) which came from a major country (major region. T. yul chen) of Thod dkar, \textsuperscript{550} in order to agree with the geographical border of the great Tibet. Nyi dhru, etc. are several days later than the general byed rtsis, and are over six days earlier than the Pad dkar zhal lung, and thus [it] agrees with observation, and the tshes zhag, which was corrected to be close to the current Chinese calendar / rgya rtsis\textsuperscript{551} and the unprecedented good saying regarding nyin khyim lnga bs dus,\textsuperscript{552} which agree with tshes zhag, are also written down.

It has been speculated that his criticism towards the grub rtsis in the Pad dkar zhal lung is based upon his real observations of eclipses, solstices, etc., whose accuracy is immediately perceived by direct perception (mngon sum). He believes that the Pad dkar zhal lung attempts to figure out the difference between the geographical location of India on, that which is manifested by consciousness, and thus cognition cannot be invalid. Despite Sa skya Paṇḍita Kun dga’ rgyal mtshan’s (1182-1251) claim in his Tshad ma rigs pa’i gter that the distinction between mngon sum and mngon sum gyi tshad ma is not justified, Phya pa’s epistemology has been dominant among Tibetan intellectuals. Sum pa Mkhan po’s use of this term is also based upon Phya pa’s understanding and includes cognitive identification.

\textsuperscript{550} Martin, https://sites.google.com/site/tibetological/-ol-mo-lung-ring: “Thod dkar might be interpreted to mean ‘white turban’, although some connection with the thod dkar, or Tokharian people, might be posited.”.

\textsuperscript{551} The word rgya rtsis is frustrating; we do not know, in most cases, whether it means Chinese astronomy/ astrology in China or Chinese astronomy / astrology researched in Tibet. In addition, this sentence is intriguing in that it shows Sum pa Mkhan po’s notion of Chinese astronomy / calendar system. It has been speculated that his understanding of this subject did not increase after the Dpag bsam ljon bzang (1748), where we find the same point of view of Chinese astronomy / calendar, in conjunction with tshes zhag and gso sbyong (See chapter 2). His conviction is based upon his own observations of eclipses.

\textsuperscript{552} Lnga bs dus (yan lag lnga. S. pañcāṇga) includes tshes pa (S. tithi. lunar day), rgyu skar (S. nakṣatra), res gza’ (S. vāra. weekday), byed pa (S. karana. half of tithi), and sbyor ba (S. yoga). The components are essentially Indic. See the classical study by Jacobi (1892: 403-60) [= (1970: 948-1005)], Sewell, Diśṣita and Schram (1996: 3), Schuh (1973a: 81-99), and Schuh (1974: 561).
which the values in the Kālacakra are based, and the Tibetan geographical location, but the rtsis 'phro and stong chen 'das lo values calculated by the system are not accurate. In particular, the nyi dhru'i 'phro value is not accurate. Thereby, the nyi dag value does not reflect real phenomena, such as seasons, eclipses, and solstices, and the intercalation is also incorrect in Tibet. Being motivated by the inaccuracy, he creates his own system, Dga’ ldan rtsis gsar, by means of changing rtsis 'phro / stong chen 'das lo values to achieve correspondence between rtsis and astronomical phenomena. This is basically the same approach taken by the Pad dkar zhal lung. In other words, the Pad dkar zhal lung and Sum pa Mkhan po are similar in that they try to create a system with accurate rtsis 'phro / stong chen 'das lo values by reflecting both the Kālacakra and the geographical location of Tibet. In that sense, his criticism towards grub rtsis, which looks to be tied to his research and attitude towards Chinese calendar / rgya rtsis, and especially his emphasis on the accurate nyi dag for accurate intercalation in Chinese calendar / rgya rtsis, can be understood to be based upon the concepts and solutions sought within the Kālacakra. He believes his system

553 Tibetans have attempted to correct the position of the sun through the determination of accurate equinoxial / solstitial points with a consideration of the different seasonal points between India and Tibet. See Henning (2007: 322 ff). Regarding this issue, Schuh presents an essential problem in the skar rtsis based upon the Kālacakra: because there is no division between the horizontal coordinate system and equatorial coordinate system in it, it is inevitably reconciled with the incacophony between real observations and the Kālacakra. See Schuh (1973a: 54-5), and Schuh (1973a: 57-8): “Die den Himmelsäquator definierende golarekhā ist in diesem System zunächst nichts anderes als der, durch die Mitte zwischen den Wendepunkten gegebene, Breitenkreis‘ des Himmelsgewölbes innerhalb des Horizontsystems.” Its corollary that the position of γ is not fixed. See Schuh (1973a: 63): “... dass das Eintreffen der Sonnenwenden für die verschiedenen geographischen Orte dieser Welt in Ost-West-Richtung variiert. Mit anderen Worten: Bei Orten, deren geographische Längen hinreichend verschieden sind, finden die Sonnenwenden an verschiedenen Tagen statt.” Schuh (1973a: 113-5) argues that because of this fundamental defect, the fact that the solstice / equinox in Tibet is different from the Kālacakra has been recognized by gnomon and ensuingly, some measures have been taken by the 5th Dalai lama, Padma dkar po, Nor bzang rgya mtsho, etc.. For the last one, see Phyag mdzod (1987: 94) as reproduced by Huang and Chen.
is successful in creating an accurate \textit{nyi dag} by calculating accurate \textit{nyi dhrui’i} ‘phro values. Taken together, his new system, which was written in 1754, was combined with real observations and \textit{byed rtsis}. In addition, the impact of Chinese astronomy on determining accurate \textit{nyi dhrui’i} ‘phro and \textit{nyi dag} values in his system is connected to his criticism towards \textit{Phug pa grub rtsis}. However, his method to improve them is still conventional.

In the 1780s, specifically his later period, it is still possible ask similar questions regarding the role of Chinese calendars/\textit{rgya rtsis}, the process of the \textit{rtsis} ‘phro change, and effect of the \textit{rtsis} ‘phro change, etc in his system as interpreted through his letters, included in Sum pa Mkhan po (1979c). Firstly, We will assess Sum pa Mkhan po’s concern about the Chinese calendar/\textit{rgya rtsis} and its role in the formation of his system. I think this issue is important because it may be a part of his criticism, as seen above. Sum pa Mkhan po’s correspondence with Ngag dbang nyi ma, a Sku ’bum lama, in 1785/1786 reads as follows:

\begin{quote}
... \textit{rtsis gsar du sngon kha ba can du ma dar ba’i zhag gsum ga’i lnga sgra gza’ lnga / da lta’i rgya rtsis dang nye ba’i nyi ldog khyim slob dbug thob sqang slob ri si soqs dang / da dus kyi rgya nag rang gi ‘byung rtsis dang mthun pa’i sa bdag ‘pho tshams soqs khyad thon yod do / ...}  

... In \textit{Dga’ ldan rtsis gsar}, there are excellent features/ uniqueness, such as \textit{lnga bsdus, sgra gcan, gza’ lnga} of three days (T. zhag gsum, tshes zhaq, nyin zhaq, khyim zhaq), which did not spread previously in Tibet, and solstices, khyim slob, dbug thob, sqang slob, ri si, etc which are approximate to the current Chinese astronomy/ \textit{rgya rtsis} and the transition of \textit{sa bdag}, etc., which accord with \textit{‘byung rtsis} of the present Qing China, etc.
\end{quote}

\footnote{Sum pa Mkhan po (1979c: 91b).}

\footnote{For pioneering research into \textit{sa bdag}, see Schuh (2013). The \textit{sa bdag} \textit{‘pho tshams} is tied to winter solstice.
He is mainly concerned with the intercalation of Chinese astronomy and *rgya rtsis*.\(^{556}\) This occurs commonly in the colophon of the *Zla bsil rtsi sbyor dge ldan rtsis gsar*, but that is not all. He expresses his opinion on the longitude of the *du ba mjung ring*\(^{557}\) in a reply to the Pañ chen lama.

\[\ldots\ 'di la bu ston rin po ches 'gros bzhi rigs pas bsgrubs kyang mkhas pa grags seng gis rgyud kyi ngos zin dang bstun nas 'gros gnyis kho na bshad pa de rgya nag gi rtsis dang nya (sic. nye) ba 'dra'am snyam / rgya rtsis shig na du ba'i zhag gi longs spyod 'di (linear note: unclear. /6 / 41 ?) yod pa rim bsags kyis lo dag nas de' i longs spyod rdzoqs te nyi ma'i snga phyir thon pa'i rtsis 'char zer ba snang / longs spyod bod rtsis la mthun par byed na (linear note: the numbers unclear. / . / . / 30) 'di'am snyam /\]

Regarding this, I think that Bu ston proved four movements (*gros bzhi*)\(^{558}\), but Mkhas pa Grags seng’s (Zhwa dmar I Grags pa seng ge (1283-1349)) explanation of only two movements (*gros gnyis*) is in agreement with the recognition that the Kālacakratantra is close to Chinese astronomy / *rgya rtsis*. There is a statement that, in Chinese astronomy / *rgya rtsis*, the daily longitude of *du ba* with this quantity (illegible) is fulfilled from the true year (T. *lo dag*) by gradual accumulation, and the calculation appears (?) which comes out

\[^{556}\] By this evidence, I think that his interests in Chinese astronomy / astrology throughout his life do not show any relationship to the *Mā yang rgya rtsis*. The letter was written around 1785/1786, three years before his death in 1788. — For information on his interests in Chinese astronomy / astrology in his earlier age, see above note 551. — This may mean that the *Mā yang rgya rtsis* did not exist until the 1780s in Amdo. If it had existed, Sum pa Mkhan po, with acuity, would have mentioned it. It is strange that he has never mentioned this text anywhere in his writings.

\[^{557}\] Bsam 'grub rgya mtsho (2011: 105): “Ketu (*du ba mjung ring*) is known as eastern *du ba mjung ring* among the ten planets. The *skyes khyim* is *chu smad* (S. *uttarāṣāḍhā*), the *rtag longs* is the same with the sun, but is visible because of the difference of the beginning steps (T. *rkang pa*) of the four movements (T. *'gros bzhi*) ...” (*du ba mjung ring: ke tu zhes pa gza’ bcu’i nang thsan shar gyi du ba mjung ring du grags / skyes khyim chu smad / rtag pa’i longs spyod nyi ma dang mtshungs kyang / ’gros bzhi rtsom pa’i rkang pa’i khyad kyis ’char ba ste / ....*).

\[^{558}\] Sum pa Mkha po (1979c: 10a).

\[^{559}\] For *’gros bzhi* / *’gros gnyis*, see above note 557.
before and after the sun [appears].\textsuperscript{560} I think that if the longitude is calculated in accordance with Tibetan calculation, the quantity is like this (illegible).

The above passage shows how he understands Chinese astronomy with respect to the \textit{Kālacakra/ skar rtsis}. Unfortunately, because we cannot read the values properly, it is difficult to assess how he equated the Chinese values with the Tibetan ones, but it is known that the concept and ways of the \textit{skar rtsis} function in his understanding of \textit{rgya rtsis}. After this correspondence, the Paṇchen lama asked again about the \textit{du ba mjug ring} in the subsequent letter and Sum pa Mkhan po answered this way,

\begin{verbatim}
yang ma ha tsi na'i ljang kyi bde ldan tong kun\textsuperscript{561} rayal po'i rtsis gzhung nang ltar gyi mjug ring gi rtsis bya tshul bod rtsis dang btsun nas sa ri 'bri tshul ni / lo gang gi nyin zlag spyi zlag gnas lnga bkod de / nyin zlag gcig gi rtag longs 'di 0/0/30/9/ bel la / rab 'dog me yos yki rtsis 'phro 'di 8/7/53/6/ byin nas / khor lo 'di 27/60/60/6/24 (?)\textsuperscript{562}bsgril\textsuperscript{563} na 'char te / lo dgu nas skar ma'i 'khor lo rdzogs par bshad lags / 'on kyang rgyud du 'di 'char ba'i cha shas mtha' yas yod par gsungs pa dang / rgya nag gi skar ma btags pa'i myong byang na ang / nam mkha'i skar ma rags pa phal cher la ming btags te / de'i la la'i steng na du 'od rtsie lnga dang 'gla' zhig la rtsie gsum dang kha cig la zlum po bal 'dra dang phal cher la rtsie gcig 'char pa yod pa bshad 'dag / des na rgyud dang 'grel bar zla ba don lnga nas du ba 'char gsungs pa byed pa rags rtsis spyi bshad tsam las gzhana dbysibs dang dus sog s mtha' yas pas / zla 'dzin nyo' 'dzin ltar du ri mo'i lam nas ji bzhin mtha' gcig tu nges bzungs rto gs dka' snyam pa'i dogs pa snang lags /\textsuperscript{564}
\end{verbatim}

\textsuperscript{560} A different translation may be possible: “There is a statement in a Chinese astronomy / \textit{rgya rtsis} that ….” It is assumed in this case that Sum pa Mkhan po personally read the Chinese astronomy / \textit{rgya rtsis}. I am not sure where he cites by \textit{zer ba}.

\textsuperscript{561} For this term, see van Schaik and Galambos (2011: 170-3) and van der Kuijp (2010: 125).

\textsuperscript{562} Unfortunately, again the values are not properly readable. We need more research into this topic, but I am not sure of the last quantity and do not know why the radix suddenly changed into that of five units. The radices of the previous \textit{rtag longs} and \textit{rtsis 'phro} are composed of four units.

\textsuperscript{563} \textit{bsgril} means excess/ surplus. See Bsam ’grub rgya mtsho (2011: 39).

\textsuperscript{564} Sum pa Mkhan po (1979c: 12b-13a).
Also, the arithmetic method [obtained] after having compared the calculation method of *mjug ring*, included in the astronomical text of Elhe taifin Kangxi Emperor of Qing China with the Tibetan calculation method is: it is explained that [the values] will appear if [ ] write *nyin zhag* and *spyi zhag* of any year in five rows, multiply (*T. sbel*) the longitude of a *nyin zhag* by 0/0/30/9/, add 8/7/53/6/, which is the *rtsis 'phro* of the fire-hare year (1747 C.E.) of the 13th *rab byung* [to it], divide by the period 27/60/60/6/24 (?) ... (I do not understand this), and the period is completed in 9 years. However, the *Kālacakratantra* states that the *cha shas* in which this appears is unlimited, and it is also explained in the experience note (*T. myong byang*) which examined Chinese constellation that [ ] gave names to most of the constellation of the heaven roughly, and on top of some of them, there appear *du ba* with light and five peaks, *du ba* with three peaks in a few cases, *[du ba whose shape is] something like round wool in some cases, du ba with one peak in most cases. Therefore, because the statement in the *Laghukālacakra* and the commentary (= *Vimalaprabhā*) that the *du ba* appears within 75 months [is] nothing more than a general explanation [based upon] the rough calculation in the *byed rtsis* system, [and in reality] different shapes and timing, etc. are limitless, there arises a doubt in which I think it is difficult to consistently recognize by values, like lunar and solar eclipse.

It is known from the above passage that research existed into Chinese astronomy, as written in the *myong byang*, in which period, shape, color, etc. of the *du ba mjug ring* were recorded. In this passage, Sum pa Mkhan po’s approach is to piece the Chinese calendar and *Kālacakra / skar rtsis* together and then to arrive at a conclusion. The Tibetan arithmetical considerations of *rtsis 'phro* and *rtag longs*, which were deemed to be the main determinants of different astronomical systems in Tibetan conception, are used to tally *rgya rtsis* calculations with Tibetan ones. The *rtsis 'phro* values combined with the observations are understood to be those that negate the difference between *skar rtsis* and Chinese astronomy, and finally to match *skar rtsis* calculations to real phenomena. This

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565 *Bde ldan* is Elhe taifin Kangxi. This may be the *Rgya rtsis chen mo*. Unfortunately, it seems impossible to pinpoint the exact text.

566 This means that Sum pa Mkhan po does not completely agree with the statement in the *Laghukālacakra*. It may be his passive way of making an criticism within the frame of the *Kālacakra*. 

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means that his approach is very conventional, similar to other Tibetan astronomers. They do not get out of the realm of Kālacakra. It is difficult to know how much he understood Chinese astronomy, but it does not make him criticize the skar rtsis system, which is based upon the Kālacakra. The understanding of the times is reconciled with the deep-rooted skar rtsis system, as far as it accords with observations / mngon sum and contributes “to save the phenomena”. From a different perspective, as the world Tibetans witnessed expanded in the 18th century, the skar rtsis emerged with a much more complicated context, i.e. how to make sense of Chinese astronomy / rgya rtsis within the frame of the Kālacakra / skar rtsis.567

Next, how does Sum pa Mkhan po creates his own system with different rtsis 'phro from the Pad dkar zhal lung? It is an essential question with regard to the Tibetan astronomical systems, whose differences are determined by rtsis 'phro changes. Sum pa Mkhan po’s correspondence with the Paṇchen lama reads as follows.

... yang du ba can zhig nam mthong ba nas rtsis 'phro 'dzin na / rab 'dod (supralinear note: 13) sa yos gsum par tho rangs mthong ba la dper mtshon na / lo de'i gsum pa'i tshes zhaq gi zla dag 'di ... nyin zhaq yin / de njug ring gi 'khor los (supralinear note: 65) phud pa'i nor 'di (70/21) byung la / de sa yos kyi tho rangs shar ba dang ma 'grigs pas / nor 'dis (supralinear note: 27) 'khor lor (supralinear note: 75) phri (sic.) lhag la lnga (supralinear note: 5) byung ba 'di rtsis 'phro byas te / sngar (supralinear note: 70) gi nor la byin nas 'khor los (supralinear note: 75) phud pa'i nor la

567 In conjunction with this, the reason why rtsis 'phro corrections with the creation of new stong chen 'das los became prevalent in the 18th century may be related to Tibetan exposure to Chinese astronomy. Sum pa Mkhan po functioned in Inner Asia and Go shri must have functioned or was influential in Beijing or in Inner Asia, given the xylographs whose numbering in margin is written in Chinese. In addition, as seen from the above quotation from Sum pa Mkhan po, it can be verified that he believed the Chinese almanac / calendar was a reliable source. Under such situations, where the presumably accurate system can be compared with the traditional skar rtsis system that already exists and eclipse calculations in the skar rtsis method are occasionally proven wrong by direct preception (mngon sum), Tibetan astronomers with acuity and a sense of comparison, like Sum pa Mkhan po, may have been quick on the draw.
Also, if rtsis 'phro is grasped by the observation of a du ba every time, to take that which was seen in the third month of the earth-hare year (1759 C.E.) in the thirteenth rab byung as an example, this zla dag according to tshes zhag (better to say tshes dla) of the third month of the year ... is nyin zhag. The accumulated quotient 70/21 (I do not know whether this is right or not. What is 21?) appeared by the division (T. phud pa) of the period (supralinear note: 65) of the mjüg ring, and because it did not accord with the daybreak [on which day?] of the earth-hare year, [ ] took 5 (supralinear note: 5), the remainder by the subtraction of the quotient (supralinear note: 27 ?) from the period (supralinear note: 75 ?), as rtsis 'phro, and added [the rtsis 'phro] to the previous quotient (supralinear note: 70), and then, accuracy appears in the case of the quotient divided by the period (supralinear note: 75). Therefore, it accords with the daybreak of the earth-hare year, and it needs to be said that half month elapsed, after the du ba was observed. The rtsis 'phro is always fine to be certain according to this new calculation (T. rtsis gsar). I suppose that previous learned scholars also placed each rtsis 'phro like that.

The following things are explained in this passage: tshes zhag is transformed to nyin zhag and the rtsis 'phro correction for the purpose of the correspondence between rtsis and observed phenomena (= the occurrence of mjüg ring). We need more research into this subject to be able to properly assess it. However, despite this lack of clarity, the reason I present it is because it clearly states that observations determine the rtsis 'phro changes.

The rtsis 'phro was changed by the observation to “save the phenomena”. The rtsis 'phro correction is empirical with regards to nature. This may also mean that the continuous observations of eclipses in Tibet played a certain role in the change of rtsis 'phro. The

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568 Sum pa Mkhan po (1979c: 13b).
569 Sum pa Mkhan po explains a method for calculating nyin zhag from tshes zhag. Since the par ma is not clear, I could not read it properly.
570 Henning (2007: 305-6): “Eclipses are good data points for anybody trying to set up astronomical and calendrical calculations. ... used to adjust the longitude of the Sun and/or Răhu.”

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disagreement between rtsis and the occurrence of eclipses is manifest through observations. Of course, even if it can be safely assumed that the rtsis 'phro-s are composed of and produced by empirical components, there are still more questions: Does the change go beyond the Kālacakara? Can it be regarded as those corrected by canonical knowledge? Has the possibility that the correction of rtsis 'phro has been caused by factors of a non-Kālacakra origin, such as Chinese calendar, been ruled out?\textsuperscript{571} At present and according to my knowledge, I cannot answer these important question. We need to accumulate more textual proofs.

Next, let us consider the effects of rtsis 'phro corrections in the Dga’ ldan rtsis gsar, in terms of eclipse predictions. The second letter to Ngag dbang nyi ma in 1785/1786 reads as follows:

\begin{verbatim}
... zhal lung bai dkar dang kho bo'i ma ltar gyi gza' 'dzin skabs su phri bson mang po dang / khyim che ge dang gza' skar ge ge dang 'phrad dus dang / nya'am stong chad dus dang / sbyangs lhag chu tshod la bzhi man dang / nyi bul bsres soqs kysis thig bzhi ma shar na mi 'dzin zhes soqs man ngag lta bu mang du bshad pa ni de dag ltar na de lta bu dgos kyang / kho bo'i zla ni' 'dzin cha 'dzin dus soqs la mi nor ba'i man ngag ni bu gzung rtsis gsar yin pas / de ltar na sngar mo (sic. read snga ma) la de dag gang yang mi dgos par bu'i x (unclear) ltar byas na nor pa med dam snyam ste / de ni bu gzung brtsams pa'i shing khyi nas da lo'i shing sbrol bar gi gza' 'dzin kun (nya stong gi gza' 'dzin ri mo phal cher mthun tsam 'dod) yar log gis bris na shes shing / de ltar nyi ldog soqs la'ang 'dra bas nges la dri ba rab mang ci dgos /\textsuperscript{572}

... On the occasion of an eclipse in accordance with the Pad dkar zhal lung, Vaidūrya dkar po, and my mother-text (= Skar nag rtsis kyi snying nor nyung 'dus kun gsol me long), there are many additions and subtractions, and that which abundantly state such upadeśa [in the three texts] that if four accuracies, the time when khyim such and such and gza' skar such and such meet, chad in full moon or new moon day, four and below in the remainder of chu
\end{verbatim}

\textsuperscript{571} For a similar account, Schuh mentions the possibility of the influence of Chinese astronomy on 'Phags pa’s astronomical system. See Schuh (1973a: 101-2): the value correction in the latter part of 'Phags pa’s Dhru va gnyis pa’i rtsis (epoch: 1252), written in 1259, was probably influenced by Chinese astronomy.

\textsuperscript{572} Sum pa Mkhan po (1979c: 91b-92a).
tshod after subtraction (T. sbyangs lhag chu tshod), and adding nyi bul, do not appear, no eclipse occurs, etc. should be like that according to them. However, I think that since the unmistaken upadesa for magnitude, timing, etc. of lunar and solar eclipse is my son-text, Dga’ ldan rtsis gsar (= Zla bsil rtsi sbyor dge ldan rtsis gsar), therefore, there are no mistakes if calculated by my son-text, without needing whichever among the previous three texts: it is known if all the eclipses from the wood-dog year (1754 C.E.) to this year wood-snake year (1785/1786 C.E.) are calculated backwards (it is claimed that the values of the eclipses at the full-moon and new moon day mostly accord), and solstice, etc. are also certain in the similar manner. Then, why [do you] need so many questions?

The Pad dkar zhal lung and Sum pa Mkhan po’s ma text are the same calendar in terms of the same rtsis ’phro. But, his bu text, which is called Dga’ ldan rtsis gsar, has different rtsis ’phro-s. In the above passage, the difference between ma and bu in conjunction with eclipse calculation is explained. He was clearly very proud of his new system. The concept of yar log gi rtsis is mentioned in arguing for the accuracy of eclipse predictions in his system. The following account also shows that Sum pa Mkhan po is very proud of his new system because of ist accuracy in the prediction for the solar eclipse of 1761.

In the first half of the month of the sa ga of the year, the values of the occurrence of the solar eclipse did not occur in the case of the Pad dkar zhal lung, Vaidūrya dkar po, and byed rtsis, but in the case of the Dga’ ldan rtsis gsar, the correspondence [between rtsis and the

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573 For nyi bul, see Bsam ’grub rgya mtsho (2011: 92): It indicates the summation of nyi dag and sgra gcan rtsa.

574 About the rtsis ’phro change in the Dga’ ldan rtsis gsar and its effect on eclipse calculations, Schuh (1973a: 107) states: “Wahrscheinlich haben Probleme, die sich bei der Berechnung der Mondfinsternisse ergaben, bei der Änderung der Anfangswerte eine wichtige Rolle gespielt.”

575 Sum pa Mkhan po (1979d: 129a) [= (2001: 336)].
eclipse] was seen in Amdo like the occurrence of the value of more than $\frac{1}{12}$ of the sun being eclipsed at the time of approximately 6 chu tshod passed from the dawn (T. nam langs).

At that time, there was a half eclipse in Alaša (M. Alaša / Ch. Helanshan 賀蘭山 / T. A la sha) and a total eclipse in the Blue City (M. Kökeqota), ... .

As seen above, Sum pa Mkhan po is convinced that the new calculations led to accuracy in the eclipse calculations. It may be assumed that his rtsis 'phro change is clearly tied to eclipse calculations and to his continuous observations on eclipse phenomena for that purpose. At this point, I raise this hypothesis: his argument may be right in his period. From a modern perspective, he just changed rtsis 'phro without any theoretical basis. Thus, the effects would be temporary.

Then, did he understand whether or not the effects of rtsis 'phro corrections are temporary? Straightforwardly, he simply “saved the phenomena” without proving that his system is correct.

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576 The 'dzin cha index in the Dga’ ldan rtsis gsar tradition is also 12 like other traditions. —I have not found any other instances in which it is not 12.— For example, see Dbyangs can grub pa’i rdo rje ((n.d.): 7b) (2007: Vol 3, 430).

577 'mtshams’ means ‘border.’ It means the time which is about to become ‘6 chu tshod from the dawn’. I rendered it as ‘approximately.’

578 The Tibetan approach by rtsis 'phro change, which has been made possible from observations of eclipses, equinoxes, etc., is basically applicable during a limited time span, even if it is done properly. The Dga’ ldan rtsis gsar may have worked in the 18th century due to the corrected rtsis 'phro, which possibly reflects real eclipse observations that happen in the 18th century. In the same manner, Byed mthun (20th c.) may function well in the 20th century. Modern mathematical research would further illuminate this point.

579 According to Quine (1951) and Quine (1975), who uses Duhem in a holistic approach to theory evaluation in science, it is understood that Sum pa Mkhan po “saved the phenomena by rtsis 'phro change,” but did not prove that his system is correct. Rather, Sum pa Mkhan po’s new system justifies the Kālacakra system. He changed the rtsis 'phro and thereby contributed to maintaining the stability and reliability of the Kālacakra astronomy.
tshul khrims (1740-1810) maintains that the*Dga’ ldan rtsis gsar*/Chinese calculations of eclipses are precise.\(^5\)

... *de yang byed rtsis la bod snga rabs pa’i lugs legs kyang dbugs sgang nyi ldog khyim sleb sogs snga zhing* / *des gza’i chu tshod kyis gza’dzin gyi dus mi’gri pa sogs’ byung ba dang / grub rtsis la pad dkar zhal lung gi lugs legs kyang nyi dhrus la ma dag pa yod pas / zla ba’i cha’phel’grib\(^6\) kyi tshes mtshams sogs ma dag par’gyur bar bshad / lugs re gnyis las khyad par du’phags pa dge ldan rtsis gsar ni rgya rtsis dang nye zhing / mtshan mo mngon sum du mthong ba’i mig skar la’ang mthun pa dang / gza’dzin sogs kyi dus tshod kyang ma nor bar nges pa yin par gsungs so /\(^7\)

... Furthermore, it is explained that, in the case of the*byed rtsis*, the earlier Tibetan tradition was good, but *dbugs sgang*, solstices, *khyim sleb*, etc are early and that which the eclipse timing is not right by the amount of the *chu tshod* of the*gza’*value occurs and that in the case of*grub rtsis*, the tradition of the*Pad dkar zhal lung* is good but because there is inaccuracy in the*nyi dhrus*, the bordering day between waxing and waning moon, etc are not accurate. It is stated that the*Dga’ ldan rtsis gsar*, which is particularly superior to some traditions, is close to Chinese astronomy/*rgya rtsis*\(^8\), and accords with the observations seen by *mngon sum* at night and the timing of eclipse is also certain without mistakes.

He repeats the seemingly widespread idea at that time that*byed rtsis* has a problem in the calculation of temporal*gza’*and*grub rtsis* has a problem in the calculation of spatial*nyi dhrus*. The reason why he reiterates Sum pa Mkhan po’s opinion and follows the*Dga’ ldan rtsis gsar* may have been caused by ethnic considerations. Actually, the tradition of*Dga’ ldan rtsis gsar* was mostly developed in the Amdo/Mongolian areas, about which

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\(^5\) This quotation was first used by Schuh (1974: 564-5).

\(^6\) The *zla ba’i cha’phel kyi tshes* ranges from *tshes zhag* 1 to 15; the *zla ba’i cha’grib kyi tshes* ranges from *tshes zhag* 16 to 30.

\(^7\) Čaqar Dge bshes (2002: 1b).

\(^8\) It is not clear what Čaqar Dge bshes means by “Chinese astronomy/*rgya rtsis*” and no ground is given here by him.
more research is needed. As Čaqar Dge bshes asserts, Dga’ ldan rtsis gsar may have worked in Inner Mongolia, but modern mathematical and astronomical research with a focus on accuracy could work to prove / disprove it. However, contrary to Čaqar Dge bshes, Mi pham (2012a) shows that in the later period, many trials to correctly calculate eclipses were made incessantly, even after the Dga’ ldan rtsis gsar. All in all, rtsis ’phro changes were not a fundamental solution.

In the above, we briefly examined Sum pa Mkhan po’s earlier and later

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584 It appears that the development of the Dga’ ldan rtsis gsar has a strong connection to Mongolian lamas. Sum pa Mkhan po himself says he is a Mongolian. See Sum pa Mkhan po (2001: 23-5). Mi pham (2012a: 262) conveys some information on Mongolian adherents of the Dga’ ldan rtsis gsar: “Lnga bs dus b lo gsal ’dod ’jo which revised the rtsis ’phro of the 15th rab byung according to the tradition of the Dga’ ldan rtsis gsar: ... the one which changed the dhi ru ba of the text with the rtsis ’phro written by Sum pa Mkhan po (= Zla bsil rtsi sbor dge ldan rtsis gsar), the same rtsis ’phro with the Rab gsal me long [I introduced] previously, ... the one that Lcang skya ho thog thu’s (M. Jangjia-y-a qutuytu) attendant Dza saq (M. Ja saq / T. ja saq) Mkhan sprul Blo bzang bstan ’dzin nyi ma wrote after having been encouraged by him (= Lcang skya) at the monastery of Chu bzang has many calculation tables.” (... dge ldan rtsis gsar lugs kyi rab byung bco lnga pa’i rtsis ’phro gsar bsgrigs Inga bs dus b lo gsal ’dod ’jo zhes pa / ... ye shes dpal ’byor gyis mdzad pa’i rtsis ’phro can de’i nges pa spos pa / snagar gyi rab gsal me long dang rtsis ’phro gcig / ... / chu bzang dang du cang (sic.) skyas bs k ul nas / de’i zhab s ’digs dza saq mkhan sprul blo bzang bstan ’dzin nyi ma bris pa / de’i re’u mig skor mang /). For Blo bzang bstan ’dzin nyi ma, see Yum pa (2006: 104): Lcang skya’i Yongs ’dzin Ja sag Bla ma Or tu su (< M. Urdus) Zhab drung Blo bzang bstan ’dzin nyi ma is the author of the Blo gsal ’dod ’jo which changed the epoch of Sum pa Mkhan po’s bu gzhung into 1867. Given the epoch, ‘Lcang skya ho thog thu’ seems to be the Lcang skya V Ye shes bstan pa’i nyi ma (1849-1874). Because I do not have information on both the ‘Lcang skya’ and Blo bzang bstan ’dzin nyi ma, I leave this open. For the text Rab gsal me long, see Mi pham (2012a: 259-62). The epoch is 1867. Given the same rtsis ’phro with the Dga’ ldan rtsis gsar, it is highly possible that it is one of the Dga’ ldan rtsis gsar texts. For the author, see Mi pham (2012a: 262): “There is mdzad byang (author’s colophon) stating that Ngag gi dbang po wrote [it.]” (ngag gi dbang po bsebs zhes mdzad byang ’dug /). At present, we cannot identify him. Čaqar Dge bshes, A kyā Yongs ’dzin Ngag dbang nyi ma (?- 1794 ?) who wrote the Nyi ma’i ’od zer, and U cu mu min (sic. = M. Üjümcin) Zhab drung ’Jam dpal dgyes pa’i rdo rje (?) who wrote the Me tog chun po (epoch: 1846) are also classified as the Dga’ ldan rtsis gsar adherents in Yum pa (2006: 104). Also, see Yum pa’s introduction to Gser tog, which is included in Gser tog (2015) (not available to me as of March, 2016) for the history of the Dga’ ldan rtsis gsar. I speculate that the lamas mentioned here are ethnically Mongolian.

585 Mi pham (2012b) is critical of all the different systems in skar rtsis from earlier Phug system to contemporary Rnga ban Kun dga’, which involve the change of rtsis ’phro for accuracy in eclipse calculation, and concludes that there is no reliable skar rtsis system for eclipse calculation.
fragmentary ideas on rtsis 'phro, such as the relationship between skar rtsis and the Chinese calendar/rgya rtsis, his astronomical observations, function of empirical knowledge, and his rtsis 'phro corrections and their effect of rtsis 'phro corrections, etc.

Fundamentally, I should admit that there is not a great deal of materials to argue these issues in the system of the Dga' ldan rtsis gsar in particular and in the Phug systems in general. Next, let me propose a fundamental question to conclude this section: The main difference between the Dga’ ldan rtsis gsar and the Pad dkar zhal lung is the rtsis 'phro difference. This means that in Sum pa Mkhan po’s conception, the fallacy of an astronomical system is caused by rtsis 'phro. If it is so, is his thinking correct? Does he not cast doubt upon this idea?

On the issue of rtsis 'phro and eclipse calculations, more explanation, or the repetition or overlap, of the explanation of the agreement between rtsis and visible phenomena will be given below in the section of stong chen 'das lo, because this concept is coupled with rtsis 'phro, but with a larger scheme including all planets except for du ba mjug ring. Basically, the Kālacakra / skar rtsis diagnosis and solutions for accurate eclipse calculations from nur ster, rtsis 'phro and stong chen 'das lo concern the differentiation of longitude.
1.2.3. CORRECTION OF ELASPED YEARS FROM A GREAT CONJUNCTION AT THE ZERO POINT (T. STONG CHEN ’DAS LO)

GREAT CONJUNCTION (STONG CHEN/ STONG CHEN ’DAS LO)

The Great Conjunction is an event where the planets are aligned. Its equivalent concept in Tibet is stong chen / stong chen lo tshogs of Indic origin: Petri showed the textual basis in the Laghukālacakra I. 88-89. Schuh also pointed this out: “Diese Idee der grossen Konjunktion aller Planeten war dem tibetischen Astronomen aus dem Kalacakratantra bekannt.” The relevant concept is stong ’jug (entry into vacuity) as described by Schuh “… der Gedanke eines Ausgangspunktes für die Kalkulationen, für den alle Anfangswerte gleich Null zu setzen sind, ….” The concept is also related to epoch value. Tibetans customarily change epoch (rtsis ’go spos pa) every 60 years.

587 Schuh (1973a: 103).
589 Kong sprul Blo gros mtha’ yas, tr. ’Gyur med rdo rje (2012: 348): “Concerning the timing of this entry into [the state of] vacuity (strong jug), … … at the end of the solar mansion Pisces (nya khyim), on the thirtieth day of the month of Phālguna (dbo zla bu), in the fire-tiger year [which is the last year of the sexagenary cycle], the exact longitude (longs spyod rnam par dag pa) of the planets and constellations is conventionally designated as an “entry into vacuity”. Then, once again from the first day of the month of caitra (nag zla) in the [fire-hare] year of prabhāva (rab byung), [which is the first year of the next sexagenary cycle], the mean longitudinal positions (rtag pa’i longs spyod) pertaining to all the years, months, planets, and constellations newly arise.”
There must have been discussions and debates over the issue of stong chen / stong 'jug even before the Phug tradition tackled it in earnest, but especially in the Phug system, it is a pivotal and crucial topic in terms of accuracy of an astronomical system.\textsuperscript{590}...

\textsuperscript{590} For example, the letter exchanges between Byang bdag and Mkhas grub clearly show their understanding of the Laghukālacakra and Vimalaprabhā chapter I, verse 88, in which stong chen/ stong 'jug is mentioned together with their astronomical points of view. Byang bdag supports the grub rtsis, meanwhile Mkhas grub supports the byed rtsis in terms of stong 'jug calculation. See Mkhas grub (1897a: 763 ff) and Byang bdag (1) (n.d.: 65b ff): Mkhas grub uses byed rtsis for the calculation of stong 'jug. Byang bdag does not raise a strenuous objection. Byang bdag (1) (n.d.: 65b-66a): “Also, if you agree with the way of planets’s entry into vacuity (T. stong pa la ‘jug pa) by adhering a little while to the exposition of the byed rtsis known as common to non-buddhists (T. phyi rol). My reading is phyi rol pa), without being based upon the fine exposition of the extraordinary grub mtha’, ... is compatible with the byed rtsis known as common to non-buddhists (T. phyi rol), without being based upon the fine exposition of the extraordinary byed mtha’ ...” (yang khyed kyis thun mong ma yin pa grub mtha’i rtsis kyi dbang du byas pa’i rnam bzhag zhib mo ma yin par / phyi rol dang thun mong du graqs pa’i byed rtsis kyi rnam bzhag la re zhiq gnas nas gza’ rnam stong pa la ‘jug pa’i tshul dang bstun pa na / ... rgyud kyi rgyal po’i dngongs pa dang mthun zhdin / khyed kyis ji ltar bshad pa ltar lags /).

\textsuperscript{591} For the great conjunction in Indian astronomy, there is much research; see Varāhamihira, tr. Burgess (1977: introduction ix ff.), Billard (1971), van der Waerden (1980). Van der Waerden (1987: 529-34): Āryabhaṭa’s (476-550) śīghra and manda motions of planets during the mahāyuga period are explained. Most of all, for the conceptual frame of the mahāyuga year 4320000, see Brahmagupta (7th c.), tr. Sengupta, (1934: xi, especially, 39-47): the relationship between the the revolutions of each planet in the mahāyuga year and the daily motion of each planet is well explained in an Indic context.

\textsuperscript{592} Schuh’s (1973a: 103) figure 279623511548502090600 is incorrect. It seems to be a typing mistake which is repeated in Schuh (2012a: 109-10). The correct value of the Stong chen lo tshogs is 2796235115048502090600.
As clarified in the above passage, the *stong chen lo tshogs* calculation is based upon an astonishing arithmetic understanding of the planetary periods as described in the Tibetan astronomical texts.\(^{594}\)

The following section presents how the terms *stong chen/ stong chen lo tshogs* are calculated by using Bsam 'grub rgya mtsho (1992: 188). Subsequently, the *stong chen las 'das lo* (simply *stong chen 'das lo*. elapsed years from a Great Conjunction at the Zero Point) combined with *rtsis 'phro* is related to the issue of eclipse calculation. Bsam 'grub rgya mtsho presents the following table which is difficult to understand because there is no explanation. It is based on *khyim lo*. It is also calculation based, not theory based, which is clarified below. Basic knowledge of the idea of *zhag gsum rnam dbye* and period (cycle) is necessary to understand how the numbers are calculated. In it, *zla rkang* means *ril cha* (lunar anomaly), *gza’ tshes* means the value related to *gza’ dhru* (weekday).

---


Table 37.

<table>
<thead>
<tr>
<th></th>
<th>nyi ma’i zhag gsum mthun lo sgur byed (times)</th>
<th>so so’i zhag gsum mthun lo (khyim lo)</th>
<th>rang rang zhag mthun sgur byed (times)</th>
<th>drug cu’i skor mthun dag lo (khyim lo)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sun (Nyi ma)</td>
<td>1</td>
<td>65</td>
<td>12</td>
<td>780</td>
</tr>
<tr>
<td>zla rkang</td>
<td>294</td>
<td>19110</td>
<td>2</td>
<td>38220</td>
</tr>
<tr>
<td>gza’ tshes</td>
<td>9898</td>
<td>643370</td>
<td>6</td>
<td>3860220</td>
</tr>
<tr>
<td>Sgra gcan</td>
<td>115</td>
<td>7475</td>
<td>12</td>
<td>89700</td>
</tr>
<tr>
<td>Mars (Bkra shis / Mig dmar)</td>
<td>323806</td>
<td>21047390</td>
<td>6</td>
<td>126284340</td>
</tr>
<tr>
<td>Jupiter (Phur bu)</td>
<td>2041816</td>
<td>132718040</td>
<td>3</td>
<td>398154120</td>
</tr>
<tr>
<td>Saturn (Spen pa)</td>
<td>15223124</td>
<td>989503060</td>
<td>3</td>
<td>2968509180</td>
</tr>
<tr>
<td>Venus (Pa sangs)</td>
<td>1059086</td>
<td>68840590</td>
<td>6</td>
<td>413043540</td>
</tr>
<tr>
<td>Mercury (Lhag pa)</td>
<td>12438958</td>
<td>808532270</td>
<td>6</td>
<td>4851193620</td>
</tr>
</tbody>
</table>

The basic ideas are as follows. \( \text{ⓑ} = \text{ⓐ} \times 65, \text{ⓓ} = \text{ⓑ} \times \text{ⓒ}. For example, in the case of the sun in \( \text{ⓑ} \), 65 means that the nyi dhru value becomes 0, i.e. \( 0'0''0''0''0''0'' \) every 65 years. For example, the nyi dhru value at 1987/3/0 (according to the Pad dkar zhal lung grub rtsis) is \( 0'0''0''0''0''0'' \), the nyi dhru value at 1922/3/0 is \( 0'0''0''0''0''0''0''0''0''0'' \). There is a 65 year difference between the two. From \( \text{ⓒ} \), ches chung ba’i spyi’i ldab grangs (least common multiple) should be understood.\(^{596}\) In the column of \( \text{ⓒ} \), the reason why multiply 12, 2, 6, 12, 6, 3, 3,

---

\(^{595}\) The grub rtsis values of the Pad dkar zhal lung at 1922/3/0 are as follows: gza’ dhru 4°35'56"2"434", ril cha 3/42, nyi dhru: 0'0''0''0''0''.

\(^{596}\) Any modern dictionary of mathematics will explain it. For a modern Tibetan work, see Bod yig gi grangs rig tshig mdzod (1999: 219-20).
6, 6 respectively is that they are the minimum integers that make each quotient become an integer when the values of  are divided by 60. In other words,  

\[
\begin{align*}
65 \times 1 &= 65, \\
65 \times 2 &= 130, \\
65 \times 3 &= 195, \\
65 \times 4 &= 260, \\
65 \times 5 &= 325, \\
65 \times 6 &= 390, \\
65 \times 7 &= 455, \\
65 \times 8 &= 520, \\
65 \times 9 &= 585, \\
65 \times 10 &= 650, \\
65 \times 11 &= 715, \\
65 \times 12 &= 780.
\end{align*}
\]

When dividing the results by 60, the quotient is not an integer until 780. Therefore, the least multiple 12 is multiplied. Note again that 60 years are used customarily because of the rab byung system. The subsequent table is calculated on a month (tshes zla) basis.  

Table 38.

<table>
<thead>
<tr>
<th></th>
<th>zhag mthun khyim</th>
<th>zhag mthun tshes zla</th>
<th>'khor grangs (times)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Nyi ma</td>
<td>780</td>
<td>804 ( = 804 \times 1)</td>
<td>65 ( = 65 \times 1)</td>
</tr>
<tr>
<td>zla rkang</td>
<td>229320</td>
<td>236376 ( = 3528 \times 67)</td>
<td>16951 ( = 253 \times 67)</td>
</tr>
<tr>
<td>gza' tshes</td>
<td>7720440</td>
<td>7957992 ( = 39592 \times 201)</td>
<td>1740057 ( = 8657 \times 201)</td>
</tr>
<tr>
<td>Sgra gcan</td>
<td>89700</td>
<td>92460 ( = 230 \times 402)</td>
<td>402 ( = 1 \times 402)</td>
</tr>
<tr>
<td>Bkra shis</td>
<td>252568680</td>
<td>260340024 ( = 1295224 \times 201)</td>
<td>11190675 ( = 55675 \times 201)</td>
</tr>
<tr>
<td>Phur bu</td>
<td>1592616480</td>
<td>1641620064 ( = 8167264 \times 201)</td>
<td>11190675 ( = 55675 \times 201)</td>
</tr>
<tr>
<td>Spen pa</td>
<td>11874036720</td>
<td>12239391696 ( = 60892496 \times 201)</td>
<td>33572025 ( = 167025 \times 201)</td>
</tr>
<tr>
<td>Pa sangs</td>
<td>826087080</td>
<td>851050144 ( = 2118172 \times 402)</td>
<td>111906750 ( = 278357 \times 402)</td>
</tr>
<tr>
<td>Lhag pa</td>
<td>9702387240</td>
<td>1000922232 ( = 12438958 \times 804)</td>
<td>3357202500 ( = 4175625 \times 804)</td>
</tr>
</tbody>
</table>


598 See also Pa sangs lhun grub and Nor bu tshe ring (1998: see especially 125).

599 For a understanding of how each 'khor grangs is calculated, see above notes 464, 466, 468. It depends on the tshes zla longs spyod of each planet.

600 I indicated the values of tshes zla'i dkyil'khor and 'khor grangs of nyi ma, ril cha (zla rkang), and gza' tshes (gza') in boldic. For these, see Bsam 'grub rgya mtsho (1992: 57-91) which was used on pp 216-23.

272
\( i = c \times \frac{67}{65} = a \times 804 \). The numbers in the column of \( i \) are multiples of 67.

The stong chen lo tshogs calculation (khyim lo based calculation) is the procedure to find the least common multiple for all the periods. The following tables are given by Bsam ’grub rgya mtsho. Du ba mjug ring is excluded out of 10 planets.\(^{601}\)

Table 39.

<table>
<thead>
<tr>
<th>Nyi ma</th>
<th>Sgra gcen</th>
<th>Bkra shis</th>
</tr>
</thead>
<tbody>
<tr>
<td>65</td>
<td>3860220</td>
<td>443925300</td>
</tr>
<tr>
<td>60</td>
<td>89700</td>
<td>126284340</td>
</tr>
<tr>
<td>5</td>
<td>3120</td>
<td>65072280</td>
</tr>
<tr>
<td>(12)</td>
<td>2340</td>
<td>61212060</td>
</tr>
<tr>
<td>ril cha</td>
<td>780</td>
<td>3860220</td>
</tr>
<tr>
<td>780</td>
<td>115</td>
<td>3308760</td>
</tr>
<tr>
<td>38200</td>
<td></td>
<td>551460</td>
</tr>
<tr>
<td>49</td>
<td></td>
<td>229</td>
</tr>
<tr>
<td>gza’ tshes</td>
<td></td>
<td></td>
</tr>
<tr>
<td>38200</td>
<td>3860220</td>
<td></td>
</tr>
<tr>
<td>101(^{602})</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

\(^{601}\) Generally, ten planets exist in the Tibetan tradition. The reason why the du ba mjug ring is excluded is that its movement is consistent with the movement of the sun. For example, Sum pa Mkhan po (1979c: 10a): “I think that [the movement of] the du ba is seen, being consistent with the movement of the sun: at the time of its rise, its peak is shown over there from the sun (= seen from the same direction with the sun), and its length also depends on the distance to the sun, and ...”. (... du ba de nyi ma’i ’gros dang mthun par mthong ngam snyam ste / de ’char tshe rtse mo nyi ma las phar ston pa dang / ring thuing yang nyi ma la nye ring gis yin pa dang / ... ). Also see Bsam ’grub rgya mtsho (2011: 105).

\(^{602}\) The result of 780, 49, 101 is as follows: consider the following two conditions: multiple of 60 and minimum number. 38200 ÷ 780 = 49 . 3860220 ÷ 38200 = 101 . See also Blo bzang dpal ldan (1990: 263-4).
Table 40.

<table>
<thead>
<tr>
<th>Phur bu</th>
<th>Spen pa</th>
<th>Pa sangs</th>
<th>Lhag pa</th>
</tr>
</thead>
<tbody>
<tr>
<td>10165893700</td>
<td>73317721251400</td>
<td>5644284764232660</td>
<td>6039384697728946200</td>
</tr>
<tr>
<td>398154120</td>
<td>2968509180</td>
<td>413043540</td>
<td>4851193620</td>
</tr>
<tr>
<td>129593100</td>
<td>1331775900</td>
<td>162129240</td>
<td>3080455560</td>
</tr>
<tr>
<td>1374820</td>
<td>304957380</td>
<td>88785060</td>
<td>1770738060</td>
</tr>
<tr>
<td>7720440</td>
<td>111946382</td>
<td>73344180</td>
<td>1309717500</td>
</tr>
<tr>
<td>1654380</td>
<td>81064620</td>
<td>15440880</td>
<td>461020560</td>
</tr>
<tr>
<td>1102920</td>
<td>30881760</td>
<td>11580660</td>
<td>387676380</td>
</tr>
<tr>
<td>551460</td>
<td>19301100</td>
<td>3860220</td>
<td>73344180</td>
</tr>
<tr>
<td><strong>722</strong></td>
<td>11580660</td>
<td><strong>107</strong></td>
<td>20955480</td>
</tr>
<tr>
<td></td>
<td><strong>7720440</strong></td>
<td></td>
<td><strong>10477740</strong></td>
</tr>
<tr>
<td></td>
<td><strong>3860220</strong></td>
<td></td>
<td><strong>463</strong></td>
</tr>
<tr>
<td><strong>769</strong></td>
<td></td>
<td></td>
<td><strong>2796235115048502090600</strong></td>
</tr>
</tbody>
</table>

The calculations are as follows:

Sgra gcana

\[
\begin{align*}
3860220 & = 89700 \times 3 + 3120 \\
89700 & = 3120 \times 28 + 2340 \\
3120 & = 2340 \times 1 + 780 \\
2340 & = 780 \times 3 + 0 \\
89700 & = 780 \times 115 \\
(3860220, 89700) & = 115
\end{align*}
\]

Bkra shis

\[
\begin{align*}
443925300 & = 126284340 \times 3 + 65072280 \\
126284340 & = 65072280 \times 1 + 61212060
\end{align*}
\]

\[603\] 89700 is obtained in the following way:

\[
\begin{align*}
230 \times 402 & = 115. \\
115 \times 65 & = 7475. \\
7475 \times 12 & = 89700 \text{ year.}
\end{align*}
\]

See Blo bzang dpal ldan (1990: 259).

\[604\] 3860220 \times 115 = 443925300.

\[605\] 126284340 is obtained in the following way:

\[
\begin{align*}
323806 \times 65 & = 21047390 \\
21047390 \times 6 & = 126284340
\end{align*}
\]

See Blo bzang dpal ldan (1990: 260-1).
\[
65072280 = 61212060 \times 1 + 3860220 \\
61212060 = 3860220 \times 15 + 3308760 \\
3860220 = 3308760 \times 1 + 551460 \\
3308760 = 551460 \times 6 + 0 \\
126284340 = 551460 \times 229 \\
(443925300, 126284340) = 229
\]

Phur bu
\[
101658893700^{606} = 398154120^{607} \times 255 + 129593100 \\
398154120 = 129593100 \times 3 + 1374820 \\
129593100 = 9374820 \times 94 + 7720440 \\
9374820 = 7720440 \times 1 + 1654380 \\
7720440 = 1654380 \times 4 + 1102920 \\
1654380 = 1102920 \times 1 + 551460 \\
1102920 = 551460 \times 2 + 0 \\
(101658893700, 398154120) = 551460. \\
101658893700 = 551460 \times 184326 \\
398154120 = 551460 \times 722 \\
(101658893700, 398154120) = 722
\]

Spen pa
\[
73317721251400^{608} = 2968509180^{609} \times 24725 + 1331775900 \\
2968509180 = 1331775900 \times 1 + 304957380 \\
1331775900 = 304957380 \times 1 + 111946380 \\
304957380 = 111946380 \times 2 + 81064620 \\
111946380 = 81064620 \times 1 + 30881760 \\
81064620 = 30881760 \times 2 + 19301100 \\
30881760 = 19301100 \times 1 + 11580660
\]

\[
606 \quad 443925300 \times 229 = 101658893700. \\
607 \quad 398154120 is obtained in the following way: \\
2041816 \times 65 = 13272090. \\
13272090 \times 3 = 398154120. \\
See Blo bzang dpal ldan (1990: 261).
\]

\[
608 \quad 101658893700 \times 722 = 73317721251400. \\
609 \quad 2968509180 is obtained in the following way: \\
15223124 \times 65 = 989503060 \\
989503060 \times 3 = 2968509180 \\
See Blo bzang dpal ldan (1990: 262).
\]
19301100 = 11580660 × 1 + 7720440
11580660 = 7720440 × 1 + 3860220
7720440 = 3860220 × 2 + 0
2968509180 = 3860220 × 769
(73317721251400, 2968509180) = 769

Pa sāngs
56442847642326600610 = 413043540611 × 136651084 + 162129240
413043540 = 162129240 × 2 + 88785060
162129240 = 88785060 × 1 + 73344180612
88785060 = 73344180 × 1 + 15440880
73344180 = 15440880 × 4 + 11580660
15440880 = 11580660 × 1 + 3860220
11580660 = 3860220 × 3 + 0
413043540 = 3860220 × 107
(56442847642326600, 413043540) = 107

Lhag pa
6039384697728946200613 = 4851193620614 × 1244927572 + 3080455560
4851193620 = 3080455560 × 1 + 1770738060
3080455560 = 1770738060 × 1 + 1309717500
1770738060 = 1309717500 × 1 + 461020560
1309717500 = 461020560 × 2 + 387676380
461020560 = 387676380 × 1 + 73344180

610 73317721251400 × 769 = 56442847642326600.

611 413043540 is obtained in the following way:
1059086 × 65 = 68840590
68840590 × 6 = 413043540
Blo bzang dpal ldan (1990: 262).

612 It was incorrectly scribed as 7344180 in Bsam ’grub rgya mtsho (1992: 189).

613 56442847642326600 × 107 = 6039384697728946200.

614 4851193620 is obtained in the following way:
12438958 × 65 = 808532270
808532270 × 6 = 4851193620
Blo bzang dpal ldan (1990: 263).
Finally, the *stong chen lo tshogs* = $780 \times 49 \times 101 \times 115 \times 229 \times 722 \times 769 \times 107 \times 463 = 2796235115048502090600$ khyim lo.\textsuperscript{615}

In Tibetan tradition, besides *stong chen lo tshogs*, *stong chen las 'das lo*, which reflects *rtsis 'phro* at the epoch of each tradition, is also calculated.\textsuperscript{616} The *stong chen las 'das lo* value of each of the traditions belonging to the *Phug* school whose epoch is 1987/3/0 is given in *Bsam 'grub rgya mtsho* (1992) by the following\textsuperscript{617}:

Table 41.

| Stong chen lo tshogs | 2796235115048502090600*\textsuperscript{618} |

---


\textsuperscript{616} *Yum pa* (2006: 139).

\textsuperscript{617} See *Bsam 'grub rgya mtsho* (1992: 190). I do not know how to calculate the value particular to each tradition. Future research is needed.

\textsuperscript{618} See *Nor bzang rgya mtsho* (1980: 17a) [= *Nor bzang rgya mtsho* (2002: 434)].
Table 41 (continued)

<table>
<thead>
<tr>
<th>Stong chen ’das lo in 1987</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pad dkar zhul lung</td>
</tr>
<tr>
<td>Mkhas pa’i snying nor</td>
</tr>
<tr>
<td>Dga’ ldan rtsis gsar</td>
</tr>
<tr>
<td>Yang gsal sgron me [= Go shrī (1767)]</td>
</tr>
<tr>
<td>Yang gsal sgron me [= Go shrī (1770)]</td>
</tr>
</tbody>
</table>

In the case of the Yang gsal sgron me, two different values caused by the differences of the rtsis ’phro-s are given.

Sum pa Mkhan po’s explains how his stong chen ’das lo was created in the second letter to Ngag dbang nyi ma in 1785/1786.

... gtsang chung chos grags rgya mtsho (supralinear note: 1) slob ma phugs (sic. read phug) pa lhan grub rgya mtsho (supralinear note: 2) dang rje nor bzang rgya mtsho (supralinear note: 3) rnam gnyis kyi dus ’khor rtsa rgyud kyi dgongs pa ltar du lung rigs kyi dpyad de sa gzhung (sic. read gzhong) la sa ris tsam bris nas stong chen gsum ... (illegible) legs pa byung nas rtsis ’phro bzhag te zhal lung ma bu bkod la / ... de rjes su kha bos kyang de dag ji bzhin du ... (illegible) lo tsam spos pa’i m’gzhung bkod par... / ... bu’i rtsa ba stong chen lan gcig btsal bas ... (illegible) (sublinear note: 3 ?) gza’ ’ga’ re’i ’gro ba ri mo dang mig mthong ma ’grigs pas / slar yang gcig btsal kyang ... (illegible) gnyis kyi ’gros ma dag pas / slar gsum pa btsal nas lnga sgra gza’ lnga’i ’phro gtsang dang bsreg bcad brdar ba’i gser bzang ltar du byung pas rang luhs thun mong min pa bzhag la... / de lua’i byed rtsis dang grub rtsis gsar rnying gsum po gser dngul ra gan ltar mi ’dra ba ni / rtsis ’phro mo ’dra ba’i dbang gis yin pas / grub rnying dang byed pa’i bar la zhag

619 The values given by Bsam ’grub rgya mtsho (1992: 190) are those of the stong chen ’das lo in 1987. In the case of the Pad dkar zhul lung, see Nor bzang rgya mtsho (1980: 17a-17b) [= (2002: 434)]: 82776132766945179900 is the value for the year 1486 (epoch: 1447 C.E.). 82776132766945179900 – 82776132766945179399 = 501 years, i.e. 82776132766945179900 = 1987’s value. In the case of the Mkhas pa’i snying nor, see Thu’u bkwan III (2000: 27b): 173018324949111375919 is the value for the year 806 (the epoch: 1796 C.E.) 173018324949111375919 – 173018324949111375919 = 1181 years, i.e. 173018324949111375919 = 1987’s value. In the case of the Dga’ ldan rtsis gsar, see Sum pa Mkhan po as edited in Yum pa (2015a: Pdq 278): 894592876762834614600 is the value for the year 1747 (the epoch). 894592876762834614600 – 894592876762834614600 = 240 years, i.e. 894592876762834614600 = 1987’s value. In the case of the Yang gsal sgron me, see Go shrī (1767: ka, 19 gong [= 1 ben (本) shang (上) 19]): 716963718294274361520 is the value for the year 1747 (the epoch). 716963718294274361520 – 716963718294274361520 = 240 years, i.e. 716963718294274361520 = 1987’s value. In the case of Go shrī (1770: ka 18b [= 1 ben (本) xia (下) 18]): 157778943639903177960 is the value for the year 1747 (the epoch). 157778943639903177960 – 157778943639903177960 = 240 years, i.e. 157778943639903178200 = 1987’s value.
Gtsang chung Chos grags rgya mtsho’s students Grwa phug pa and Nor bzang rgya mtsho examined by scripture and reasoning according to the intention of the *Kālacakramūlatantra*, calculated arithmetic with sand abacus, and then the three *stong chen* (= *stong chen ’das lo*) ... having appeared, [they] put *rtsis ’phro* and composed the *Pad dkar zhal lung* and its son-texts (Nor bzang rgya mtsho’s texts). ... After that, I also composed the mother-text (= *Skar nag rtsis kyi snying nor nyung ’dus kun gsal me long*) which changed only the year [of epoch] according to them ... . [I calculated] the *stong chen (= stong chen ’das lo*)*, the basis of the son-text (= *Zla bsil rtsi skyor dge ldan rtsis gsar*), one time, ... the values did not agree with the observations in the case of the individual movements of some planets. So, [I] calculated [the *stong chen ’das lo*] again, ... the movements of the two ... are not accurate. So, [I calculated] again for the third time, and the *rtsis ’phro* values of *lnga bsdus*, *sgra gcan*, *gza’ lnga* emerged like the best gold which was purified, burned, cut, and polished. That way, my own extraordinary tradition was created. ... 621 Because the dissimilarity of the three, *byed rtsis* and new and old *grub rtsis*-s 622 like gold, silver, and brass is due to the difference of *rtsis ’phro*, there are differences ... more than 8 days between the old *grub rtsis* and *byed rtsis*, more than 6 days between the *Dga’ ldan rtsis gsar* and the *Phug* tradition, more than one day between *Dga’ ldan rtsis gsar* and *byed rtsis*. Therefore, [the differences of] the three, for example, are like the differences of the individual tradition, *mdo sde pa* (S. *sautrāntika*), *sems tsam pa* (S. *vijñānavādin*), and *dbu ma pa* (S. *mādhyamika*).
Sum pa Mkhan po found his own stong chen 'das lo like Grwa phug pa calculated three times, which may mean that the former tried to find the three values of the latter to gain a mastery of the method of calculating the stong chen 'das lo. Unfortunately, we do not have them any more. We just have the final value in both Sum pa Mkhan po and Grwa phug pa.

As mentioned above, the rtsis 'phro difference is reflected in the stong chen 'das lo. What does this mean? More in-depth research is necessary. However, my current findings on the relationship between rtsis 'phro and stong chen 'das lo are as follows: rtsis 'phro-s are computed from the stong chen 'das lo. The stong chen 'das lo $\times 12 \times \frac{67}{65} = zla\ dag$. After that, the normal calculations, e.g. calculations of gza' dhru, ril cha, nyi dhru, etc. sequentially, are followed. Since the stong chen 'das lo has too many digits, it is difficult to calculate with sa gzhong. Meanwhile, the calculations using rtsis 'phro at a certain epoch are easy. To illustrate, Blo bzang dpal ldan (1880/1881-1944) presents:

157787943639903178155 (chu rta; 1942 C.E.), Go shri's (1770) stong chen 'das lo value at 1942/3/0, is incorrectly given as that of the Dga' ldan rtsis gsar.\footnote{In addition, the quantity itself is also wrongly given in Blo bzang dpal ldan (1990: 265): 15778794363903178155 is incorrect.} Anyway, in this case, zla dag = 1951715487484340849794. mda' ro lhag ma = 10. gza' 'dhru 'phro: $4^441^946^3'27'\footnote{Blo bzang dpal ldan (1990: 265-6). The calculations are as follows: A million digit calculator (http://comptune.com/calc.php) was used and the numbers were rounded off to the nearest millions (6 decimal places). 1951715487484340849794 $\div$ 39592 = 49295703361394747.671095. 0.671095 $\times$ 39592 = 26570. 26570 $\times$ 8657 $\div$ 39592 = 5809.670893 (230016490 $\div$ 39592 = 5809 $+$ remainder 26562).}^{624}$

\footnote{Blo bzang dpal ldan (1990: 265-6). The calculations are as follows: A million digit calculator (http://comptune.com/calc.php) was used and the numbers were rounded off to the nearest millions (6 decimal places). 1951715487484340849794 $\div$ 39592 = 49295703361394747.671095. 0.671095 $\times$ 39592 = 26570. 26570 $\times$ 8657 $\div$ 39592 = 5809.670893 (230016490 $\div$ 39592 = 5809 $+$ remainder 26562).}
In another example, Phug pa grub rtsis at 1942/3/0: stong chen 'das lo 82776132766945179855. Lastly, stong chen ma 'ongs lo tshogs = stong chen lo tshogs − stong chen 'das lo.

5809.670893 − 5809 = 0.670893.
0.670893 × 7 = 4.696252 (26562 ÷ 39592 × 7 = 4 + remainder 27566).
4.696252 − 4 = 0.696252.
0.696252 × 60 = 41.775106 (27566 ÷ 39592 × 60 = 41 + remainder 30688).
41.775106 − 41 = 0.775106.
0.775106 × 60 = 46.506365 (30688 ÷ 39592 × 60 = 46 + remainder 20048).
46.506365 − 46 = 0.506365.
0.506365 × 6 = 3.038190 (20048 ÷ 39592 × 6 = 3 + remainder 1512).
3.038190 − 3 = 0.038190.
0.038190 × 707 = 27 (1512 ÷ 39592 × 707 = 27).

5809.670893 − 5809 = 0.670893.
0.670893 × 7 = 4.696252 (26562 ÷ 39592 × 7 = 4 + remainder 27566).
4.696252 − 4 = 0.696252.
0.696252 × 60 = 41.775106 (27566 ÷ 39592 × 60 = 41 + remainder 30688).
41.775106 − 41 = 0.775106.
0.775106 × 60 = 46.506365 (30688 ÷ 39592 × 60 = 46 + remainder 20048).
46.506365 − 46 = 0.506365.
0.506365 × 6 = 3.038190 (20048 ÷ 39592 × 6 = 3 + remainder 1512).
3.038190 − 3 = 0.038190.
0.038190 × 707 = 27 (1512 ÷ 39592 × 707 = 27).

625 The stong chen 'das lo is incorrectly given in Blo bzang dpal ldan (1990: 266): 8277613276694519855 is incorrect.

0.264372 × 39592 = 10467.
10467 × 8657 ÷ 39592 = 2288.664857 (10467 × 8657 ÷ 39592 = 2288 + remainder 26323).
2288.664857 − 2288 = 0.664857.
0.664857 × 7 = 4.653996 (26323 ÷ 39592 × 7 = 4 + remainder 25893).
4.653996 − 4 = 0.653996.
0.653996 × 60 = 39.239745 (25893 ÷ 39592 × 60 = 39 + remainder 9492).
39.239745 − 39 = 0.239745.
0.239745 × 60 = 14.384724 (9492 ÷ 39592 × 60 = 14 + remainder 15232).
14.384724 − 14 = 0.384724.
0.384724 × 6 = 2.308345 (15232 ÷ 39592 × 6 = 2 + remainder 12208).
2.308345 − 2 = 0.308345.
0.308345 × 707 = 218 (12208 ÷ 39592 × 707 = remainder 218).

627 In the case of the Pad dkar zhal lung, the value is 2713458982281556911201 = 2796235115048502090600 − 82776132766945179399. See Nor bzang rgya mtsho (1980: 17b) [= (2002: 434-5)].
RELATIONSHIP BETWEEN STONG CHEN AND ECLIPSE CALCULATION

Go shrī (1767) explains the relationship between the corrections of rtsis 'phro / stong chen 'das lo and the accuracy of eclipse calculations.

... padma dkar po'i zhal lung du / gsungs pa'i nyi ma'i rtsis 'phro ni / nyung bas gza' 'dzin la sog la / mi 'grig lta bur snang ba'i phyur / stong chen lo tshogs las btsal te / nyi ma'i chu tshod nyi shu lhaq / rtsis 'phro gzhon mnams snga ma dang / mthun pa 'tshol te bkod pa 'di'i / stong chen 'das pa'i lo tshogs ni / mkha' mig tshes dus me chu ri / lag mtsho bug mig nor zla thub / me mtshams qer rgyan gzu gs rig ste (supralinear note: 716963718294274361520) /... stong chen ma 'ongs lo tshogs ni / mkha' klu thig qer mig ri thub / lag zung chu dbang gza' dus bug / 'dod pa 'khor lo bug ri mkha' / mig ste ... / stong chen 'das pa'i lo tshogs las / rtsis 'phro spo bar res gza' yi / dkyil 'khor mig bug mda' rtsa me (supralinear note: 39592) / ril cha'i klu lag 'byung me (supralinear note: 3528) dang / nyi ma'i dkyil 'khor chu mkha' klu (supralinear note: 804) / sgra gcan zla ril mkha' me lag (supralinear note: 230) / 'zla phyed mkha' dus chu (supralinear note: 460) yin no ... 628

Go shrī's (1767) Table A1.

| 8657   | gza'   | 39017 |
| 253    | ril cha| 3345  |
| 65     | nyi ma | 309   |
| khor grangs 629 | rtsis 'phro |

The one that ... [I] calculated from the stong chen lo tshogs, [increased] more than 20 chu tshod in [the rtsis 'phro] of the sun, and sought the other rtsis 'phro-s which agree with (did not change from) the previous one (=Pad dkar zhal lung) because such things that eclipse, etc. do not agree appear, due to the rtsis 'phro of the sun stated in the Pad dkar zhal lung being small: The stong chen 'das lo of this text [created that way. the epoch is 1747] is 716963718294274361520. 630 ... Stong chen ma 'ongs lo tshogs is 2079271396754227729080 (= 2796235115048502090600 (stong chen lo tshogs) - 716963718294274361520 (stong chen 'das lo)). ... For the change of the rtsis 'phro from the stong chen 'das lo, the planetary period (res gza' yi dkyil 'khor) is 39592 [tshes zla], the ril cha is 3528 [tshes zla], the period of the sun (nyi

628 Go shrī (1767: ka, 19 gong-20 gong [= 1 ben (本) shang (上) 19-1 ben shang 20]).

629 For the values, which are common to the Phug traditions with different stong chen 'das lo-s, see also Bsam 'grub rgya mtsho (1992: 57-91). See also above pp. 215ff. The values of the period are common to the Phug traditions including Dga’ ldan rtsis gsar, Mkhas pa’i snying nor, etc..

630 This shows that this text was written in 1767 C.E..
ma'i dkyil 'khor) is 804 [tshes zla], the period of Rāhu (sgra gcan [gyi dkyil 'khor]) is 230 months (tshes zla) and is 460 half months (tshes zla).

In this passage, i.e. as of 1747/3/0 (epoch), the zla dag = 886829684747639794801, stong chen ma 'ongs lo tshogs: 2079271396754227729080 = 2796235115048502090600 - 716963718294274361520. gza’ 'dhru'i 'phro: 1°54’44”5”437”, ril cha'i 'phro: 24/69, nyi dhru'i 'phro: 26°29’46”3”27”. From the above passage, it is clear at least in the case of Go shrī that the stong chen 'das lo corrections (basically the same with rtsis 'phro correction) were made for an accurate eclipse calculation. As seen in the previous section, Sum pa Mkhan po also believed so. It may be assumed that Tibetans believed that the rtsis 'phro / stong chen 'das lo corrections contribute to accuracy for eclipse calculation.

1.2.4. A COMPREHENSIVE VIEW: SKAR RTSIS ECLIPSE CALCULATION

Rtag longs and rtsis 'phro / stong chen 'das lo are major determinants of different astronomical traditions. These have been regarded among Phug pa scholars as the primary cause for the disagreement between rtsis and eclipse phenomena. Therefore, “saving the phenomena” has been tried by figuring out a possible correct / accurate longitude calculated from the considerations of nur ster, rtsis 'phro / stong chen 'das lo in an

631 Compare the values given in Kaḥ thog Rig 'dzin (1976-1977a) [= Kaḥ thog Rig 'dzin (2006a)]. The epoch is the same. See above pp. 210-3.
arithmetic way. The process goes together with observations and empirical data/ values of real eclipses verified by direct perception.

Moreover, it should be stressed that all the efforts for accuracy of eclipse calculation are based upon the fundamental religious meaning of eclipse in chapter 1, bstan rtsis. In other words, tallying rtsis 'phro / stong chen 'das lo of each system with the lunar eclipse at the Buddha’s enlightenment was pivotal and crucial in the Phug traditions. Mi pham says,

... grub rtsis kyi rtsis 'phro btsal ba'i rtsis gzhung rnams la / sngon ston pa sangs rgyas pa'i dus kyi gza' 'dzin sogs dang bsgris shing / stong chen gyi lo tshoqs sogs skar rtsis kyi gnad rnams mthar chags su dpyad pa zhib mos gan la phab pas phug pa'i lugs nyid grags che la / phug pa'i rtsis gzhung lag len du bstar ba'i gzhung tshang la dpyis phyin par bshad pa smin gling lo chen pa'i rtsis gzhung nyin byed snang ba 'di legs bshad che bar mgon / 'di dang rtsis 'phro ster rgyu cung zad mi 'dra ba'i khyad par las / mtshur rtsis zhes grags pa dang / phyis su sum pa ye shes dpal 'byor gyis rtsis 'phro btsal ba da' / idan rtsis gsar du grags pa dang / tho kwan gyi rtsis gzhung sogs rtsis 'phro'i dbang gis cung zad mi 'dra ba'i rtsis gzhung dun ma gsar du byung / rnga ban kun dga'i mtshan can gyis rtsis gsar thub bstan mzhes rgyan zhes pa gza' 'dzin thig par de dus grags che yang gzhung nor tshabs che ba can du mthong / gzhan rnam rtsis 'phro'i dbang gis cung zad mi 'dra bar ayur cing / so so'i lugs kyi stong 'jug dang 'grigs pa dang / gza' 'dzin thig pa sogs rang bstod can de dag rtsa rgyud dngos las gsungs pa'i rtsis 'phro rnam dag nyes pa yin min nges dka' yang re zhiig de ltar byas pa la 'gal ba med do //

... By a decision according to the detailed investigation of the agreement with the [lunar] eclipse which occurred when the Buddha previously attained enlightenment and of the crucial points such as the stong chen lo tshoqs, etc, one after another among the astronomical texts which sought the rtsis 'phro of the grub rtsis, it is manifest that Smin grol gling Lo chen Dharmaśrī's Rtsis gzhung nyin byed snang ba, which explains completely all the texts that put Phug pa's astronomical texts into practice, is a supreme exposition among the texts known as the Phug system. From the qualities that the rtsis 'phro-s that should be added are a little different from this (= Rtsis gzhung nyin byed snang ba) newly

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632 Mi pham (2012: 1027-8). Since he wrote Mi pham (2012a) not long after writing Mi pham (2012), the overlap of contents between the two are seen. For the account for Rnga ban kun dga'i mtshan can gyi rtsis gsar in Mi pham (2012a), see Mi pham (2012a: 249-58). The year when Mi pham (2012a) was written is uncertain. However, it looks to have been written in the last phase of his life. He died in 1912. The colophon in Mi pham (2012a) says: “[this text was written by] astronomer 'Jam dpal dgyes pa (= Mi pham), the one who summarized the eclipse of the ninth month (T. dbyug zla = tha skar zla ba) in the water-mouse year (= 1912) of the 15th rab byung (i.e. 1912/9/15), wrote. Be virtuous!” (rab tshes chu byi dbyug zla'i nya yi gza’ 'dzin mdoñ bsdus pa rtsis rig smra ba 'jam dpal dgyes pas bris pa dge /).
arose many astronomical texts which are a little different in terms of rtsis 'phro such as the one known as Mtshur rtsis, the one known as the Dga’ ldan rtsis gsar whose rtsis 'phro was calculated by Sum pa Mkhan po later, Thu’u bkwan III’s astronomical text, etc. The one called Rtsis gsar thub bstan mdzes rgyan [written] by a monk named Rnga ban Kun dga’ was famous for the accuracy of eclipse at that time, but it is seen as a text with serious fallacy. [In the case of] the other texts [except for the Rtsis gsar thub bstan mdzes rgyan], they became a little different by rtsis 'phro, agree with the stong 'jug of the individual tradition, and self-praises such as the accuracy of eclipse, etc. are difficult to ascertain whether or not they are the correct rtsis 'phros (rtsis 'phro rnam dag) which have been stated in the Mūlatantra, but there is no contradiction in doing so for a while.

The meaning and significance of the eclipse is not only a system tester (barometer of the accuracy of an astronomical system), together with solstice measurement. Importantly, it is also related to the essential and core parts of the entire astronomical system (especially in the Phug system), i.e. rtsis 'phro and stong chen calculation. More fundamentally, the accuracy of eclipse calculation is buttressed by the religious concept bstan rtsis (the calculation of the lunar eclipse at the Buddha’s enlightenment). Under the larger rubric of stong chen combined with rtsis 'phro, the Buddha’s enlightenment should be explained properly and correctly calculated according to each Phug system. That is also the meaning of rtsis 'phro / stong chen 'das lo.

However, nur ster, rtsis 'phro / stong chen 'das lo corrections based upon arithmetic were not good solutions in the sense that inaccuracy was inevitable. Whatever observational, empirical corrections, scholarly exchanges of information were adopted, they may not work, especially for a solar eclipse. In the same vein, in spite of the efforts made by his predecessors, Mi pham was not content with the eclipse predictions made by previous Phug systems based upon rtsis 'phro / stong chen 'das lo change.
Since these *rtsis gzhi*-s\(^{634}\) that Phug system, Mtshur system, Dgon lung pa (= Sum pa Mkhan po’s *Dga’ ldan rtsis gsar*),\(^{635}\) etc. claim are mostly difficult to [show] the correspondence between the eclipse calculations, etc. and observation, and the values of stong ‘jug, etc. do not agree with the accuracy of the *Kālacakratantra*, if there is a system which is not contradictory to all the meanings of the entire *Laghukālacakra*, i.e. actual teaching of the glorious *Mūlatantra*, which is an irrefutable system [by] direct perception in terms of the movement of season, *gza’ skar*, (*gza’*) lnga, Sgra gcan, [I] will offer rejoice hundred times and should follow it.

He stated the status quo of eclipse calculations in the early 20\(^{th}\) century and was critical of the existing systems. In all the Phug, Mtshur, Dga’ ldan rtsis gsar systems, no correspondence between *rtsis* and phenomena (eclipses) exists. Of course, it is certain that he did not go beyond the boundary of the *Kālacakra* like all other Tibetan astronomers. He presents the following reasons for inaccuracy in eclipse calculation:

\(^{633}\) Mi pham (2012b: 351-2).

\(^{634}\) The *rtsis gzhi* literally means the foundation of calculation. It can be regarded as *rtsis‘phro*, because *rtsis‘phro* is basic and foundational in *skar rtsis* calculations, being related to such values as *gza’dhru*, *nyi dhru*, lnga bs dus, etc..

\(^{635}\) The *dgon lung pa* is Sum pa Mkhan po. For a brief introduction to Sum pa Mkhan po’s life, see Yang (1969: 3-5, especially 5): “In 1746, he was appointed as abbot of Dgon lung.”
... it seems that here in Tibet, there is peculiarity of way of being seen [by] high and low, and in addition to that, there is peculiarity that [an eclipse] is seen above / in front of this land and in the east and west [respectively] according to the timing of eclipse, and it is manifest that in accordance with it, manifold detailed analyses that [make timing] agree with regional time are necessary. Especially, a solar eclipse is difficult to be accurate. Although in general, the calculated values are not inaccurate, the timing (T. dus), sign (T. ltas), and karmic action (T. las) are not grasped according to the values, and it was stated that although the values did not appear, there was an eclipse. And at the time of an eclipse, there are stories of real happenings that some local Tibetans observed a half-eclipse and some observed a total eclipse. So, on some occasions, the certainty of inaccurate rtsis ’phro does not exist by the inaccuracy of an eclipse according to the value which predicts an eclipse, and an astronomical text that is accurate in all cases according to the value which predicts an eclipse is rare in Tibet.

Two key concepts and methods can be extracted: 1) geographical concerns, 2) Mā yang rgya rtsis. Firstly, he mentions that in the case of solar eclipse, there is no guarantee that the rtsis ’phro / stong chen ’das lo corrections are incorrect because there are possibilities that some other factors like geographical features are involved. He holds the view that attempts to increase the accuracy of eclipse calculations by rtsis ’phro / stong chen ’das lo correction may be an incorrect approach when the same eclipse appears differently according to different regions. Therefore, he stresses the considerations for geographical

636 Mi pham (2012: 1030).


638 This means that there is no guarantee that the incorrect rtsis ’phro is the only reason why eclipse calculation is incorrect.
and regional features. As a matter of fact, these kinds of statements are found passim in Tibetan rtsis literature, especially in the case of the calculations of the solar eclipse, which also evidences that Tibetans have continuously made observations. As an example, Dkon mchog 'phrin las bzang po’s (1656-1718) (or his predecessors’) empirical knowledge about solar eclipse is as follows:

\[
\text{de yang ri la nye ring dang / ri yang shar nub mtho dma’ dang / ri klungs sa khyad yangs dogs (sic. read dog) dang / lung pa’i shar nub lho byang dang / lho byang nyi zla’i bgro mtha’ dang / skabs de’i nyi zla’ char nub pa / legs par brtags pa gnad du che }\]^{639}

Furthermore, it is important to investigate [following] the crucial points well: closeness to mountain, east, west, high and low of mountain, wide and narrow of mountain and valley and different geographical features, north, east, south, and west of region, movement of the sun and moon to the far end of south and north,\(^{640}\) rise and set of the sun and moon on that occasion.

The geographical / local features are considered. The same kind of geographical concern for solar eclipse calculation is found in the 18th century Bstan ’dzin dpal ’byor. His considerations for a solar eclipse at 1776/10/30 –it did not occur– include nur ster (empirical data), height of mountain, the position of the sun in the summer and winter (T. dbyar dgun gyi nyi ma), territorial features (sa khyad), Chinese calculations (thang brtsi (sic.)), etc.\(^{641}\) Also, Ku sri skyabs (1979), which is based upon the Sde srid, mentions the following geographical concern.

\[\]^{639} Dkon mchog ‘phrin las bzang po (1975: 53b).

\[\]^{640} For lho bgro and byang bgro, see Bsam ’grub rgya mtsho (2011: 117). See also note 428.

\[\]^{641} For this quotation, see above p. 98.
lung ston bya ba'i yul de yi / shar nub ri bo'i mtho dma' dang / ri dang sa khyad nye 'gyangs dang / nya yi 'od dkar bdag po dang / nam mkha'i nor bu 'char nub dus / nyin mtshan chu tshod tsam sles sogs / zhib tu brtags nas ma smras na / mkhas rlom byed pa'i rtsis mkhan 'ga'/ 'dzin tshul kha dmaw log pa mang

If [] do not speak after examining in detail east, west, mountain height, mountain and geographical features, distance, and the moon of the full moon day, the time of sun rise and sun set, the elapse of the chu tshod of day and night, etc. of the region that will be predicted, there are many cases in which some astronomers who pretend to know [how to predict an eclipse] make incorrect predictions.

Similar accounts on the geographical differences are reiterated in Tibetan skar rtsis texts but all of them are mere intuitive descriptions of the territorial features. Mi pham’s above statement is basically an extension of the long-last ed intuition and belief that they influence the eclipse calculation results.

Secondly, in conjunction with Tibetan geographical concerns, Mi pham may imply the Mā yang rgya rtsis in the last line of the above passage (see above page 287), which is a contrast to the mere Tibetan geographical intuitive descriptions. From a modern

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642 For the synonyms of zla ba (M. sumiy-a < S. saumya), 'od dkar (M. čayan gerel-tū), mtshan mo'i bdag po (söni-yin ejen), snar ma'i bdag po (ruwagini (sic. < S. rohini)-yin ejen, – It also appears as rigini even in the same text. There is no consistency in some Mongolian romanizations of Sanskrit words in Lcang skya III et al. (1982), Lcang skya III et al. (2002): kha ba'i 'od (časan-u gerel-tū), rta dkar (čayan mori-tu), etc. are seen in Lcang skya III et al. (1982: 54-5), Lcang skya III et al. (2002: 1189-91).


644 For this term, see Bod rgya tshig mdzod chen mo (2000: 205).

645 Ku sri skyabs (1979: 36a).

646 Since he knows the existence of rgya rtsis (more precisely Mā yang rgya rtsis), his statement may allude to it. Actually, the Mā yang rgya rtsis is mentioned in Mi pham (2012a: 1030-1), Mi pham (2012: passim). For Mi pham (2012), see Henning (2007: 99).
perspective, such factors as parallax, refraction, semi-diameter, etc should be incorporated for an accurate eclipse calculation. The Rgya rtsis chen mo from the Xiyang xinfa lishu and the Mā yang rgya rtsis from the Lixiang kaocheng, which will be briefly mentioned in the following section, are equipped with geometrical methods based upon trigonometry for the calculation of such crucial components.647

The following section has a two-fold aims: 1) to show fundamentally different methods, approaches, and bases for solar eclipse calculation in the two rgya rtsis astronomies translated into Tibetan, i.e. the Rgya rtsis chen mo and the Mā yang rgya rtsis, 2) to show how the heterogenous traditions have been received, understood, assimilated by the skar rtsis astronomy of Indic Kālacakra origin. The second purpose is a continuation of 2.4-2.5. in chapter 3 for logical consistency: the different “series” converge towards the Kālacakra on Tibetan soil.

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647 Research into the theory in the two Chinese texts/ systems, the Xiyang xinfa lishu and the Lixiang kaocheng, is beyond my scope. A series of difficult research is expected, and is being made by Chinese scholars. So, I just briefly mention the mathematical aspects related to understanding the Tibetan texts, the Rgya rtsis chen mo and the Mā yang rgya rtsis with a focus on the significance of them in the history of Tibetan astronomy.
2. **RGYA RTSIS**

2.1. **GEOMETRIC AND TRIGONOMETRIC METHODS FOR THE CALCULATION OF A SOLAR ECLIPSE**

2.1.1. **A SKETCH OF THE METHODS DESCRIBED IN THE TNGRI-YIN UDQ-A**

The *Xiyang xinfa lishu*, which is the original text of the *Tngri-yin udq-a / Rgya rtsis chen mo*, incorporates several unprecedented factors into an eclipse theory for accurate prediction, being based upon Tychonic astronomy. As such, the translations, the *Tngri-yin udq-a / Rgya rtsis chen mo* have the factors, whether they were understood or not.

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648 For example, on the basis of the memorial addressed by Li Zhizao (李之藻 1565-1630) to the emperor Wanli (萬曆) in 1613 in which the publication of a calendar on the basis of western astronomical knowledge was requested, Chinese historian Gu Yingtai (1620-1690) summarizes some geographical knowledge where Western methods were superior to Chinese approaches. In it, some components incorporated into an eclipse calculation are as follows: Gu (1977: 1224-5): 一 ... 地經各有測法，從地窺天，其自地心測算，與自地面測算者，都有不同。... 九曰太陰小輪，不但算得遲疾，又且測得高下遠近大小之異，... 十曰日月交食，隨其出地高低之度，看法不同。...十一曰日月交食，... 凡地面差三十度，則時差八刻二十分。十二曰日食與合朔不同。日食在午前，則先食後合；在午後，則先合後食。... 十三曰日食所在之宮，每次不同 ... . The translation with my explanation is as follows: “1) ... there is an individual method for measurement of the diameter of the earth: being measured and calculated from the center of the earth is different from that from the surface of the earth, in observing the sky from the Earth. — This explains the diurnal parallax (Ch. *dibanjingcha*) — ... 9) The epicycle (Ch. *xiaolun* 小輪) of the moon is calculated not only by slackening / hastening difference (Ch. *chijicha* 遲疾差), but also by the difference of high and low, distance, and size. ... 10) As for lunar and solar eclipse, the way of its being seen is different according to the latitude (Ch. *beiji chudi* 北極出地) or *beiji gaodu* (北極高度) = the angle between surface of the earth and light from polaris. This is similar to present-day latitude. 11) As for lunar and solar eclipses, ... in general, a 30° difference of the surface of the earth (i.e. the difference of longitude) equals the time difference (Ch. *shicha* 時差) 8 *ke* (刻) 20 *fen* (分) (= 120 modern minutes = 2 modern hours = 30°. 1 *ke* = 14.4 modern minutes and 10 *fen* = 2.4 modern minutes according to traditional Chinese calendrical units before the *Shixianli* was used. For these units, see below note 750). 12) [the timing of] a solar eclipse is not identical with the conjunction (Ch. *heshuo* 合朔). When a solar eclipse occurs in the morning, the eclipse first occurs and then conjunction (合) occurs; when [a solar eclipse occurs] in the afternoon, a conjunction
It is impossible to show the entire contents of the Tngri-yin udq-a / Rgya rtsis chen mo. Simply, the original text Xiyang xinfa lishu is a technically difficult text. I briefly introduce the concept of the parallax (Ch. shicha 視差, M. qaraq dutayu / T. blta ba’i dman pa) included in the Jiaoshibiao (交食表 Tables for Eclipse Calculation) in the Xiyang xinfa lishu, which is the central concept for eclipse calculation. In fact, as the Jiaoshibiao, the title of the chapter, indicates, it is filled with the tables which were created on the basis of a trigonometric method, except for some explanations. It attests to the fact that the Tngri-yin udq-a / Rgya rtsis chen mo were translated for practical purpose, not for theoretical purpose. In the Jiaoshibiao / solbīcan bariqu-yin bodurul / bsnol bar ’dzin pa’i ngos ’dzin, the nonagesimal point is used to calculate parallax necessary for such cases as the eclipse possibility, apparent longitude of the sun and moon, time of apparent mid-eclipse, etc.

表右直行從二十七起至八十九止分三段為地平高度 地平高度即距天頂之餘 上横行從一至八十九為太陽距黃平象限之度 算日食必以黃平象限表求太陽距本限若干

occurs first and then the eclipse occurs. — This is related to the use of the nonagesimal later in Qing China. In fact, the calculation is made with respect to the nonagesimal (Ch. huangpingxiangxian 黃平象限 / baipingxiangxian 白平象限), not the meridian (Ch. ziwuxian 子午線) as stated here. — 13) the zodiac (Ch. gong 宮) in which eclipse occurs is different every time.” Among them, 1), 9), 12) are closely tied to parallax. 10), 11) reflect knowledge of a coordinate system, latitude and longitude. They were two main factors that Qing Chinese astronomers thought were pivotal for accurate eclipse calculation results.

649 For a relevant explanation, see above pp. 161-4.

The Tibetan translation of the above Mongolian passage is as follows:

ngos 'dzin gyi g.yon gyi thig drang po la / nyer bdun nas 'go byas te gya dgur skëbs pa'i bar du / dum bu gsum du bgos te / sa'i snyoms pa'i zhag mthon por byas so / sa'i snyoms kyi zhag mthon po ni / gnam nyid kyi gtsug nas rgyang ba'i lhag pa / steng gi 'phred thig la / gcig nas gya dgu'i bar du / ní ya ma ser po snyoms babs kyi thun las rgyang ba'i zhag tu byas so / ní ya ma 'dzin pa dpyad pa la / dbang med par ser po snyoms babs kyi thun kyi ngos 'dzin dgos te / ní ya rang gi thun las rgyang ba'i ji tsam btsal ba'o /i6i

A possible Tibetan reading would be like this.

Dividing the vertical line of the right in the recognition into three portions beginning from 27 until reaching 89, [ ] take [them] as high degree of the earth’s level (T. sa'i snyoms pa'i zhag mthon po. This is a literal translation of M. yajar-un tübsin-ü öndür qonuy < Ch. diping gaodu 地平高度, altitude). The high degree of earth’s level is the remainder of the distance from the zenith. [ ] take the upper horizontal line as the degree of the sun distant from the session of yellow even descending (T. nyi ma ser po snyoms babs kyi thun las rgyang ba'i zhag < M. naran, sir-a tübsin baidal-un quyuča-ača böglegüül-yin qonuy < Ch. taiyang ju huangpingxiangxian zhi du 太陽距黃平象限之度) from 1 to 99, In investigating a solar eclipse, [ ] inevitably needs the recognition of the session of yellow even descending (T. ser po snyoms babs kyi thun kyi ngos 'dzin), finds the amount distant from the session of the sun (T. nyi rang gi thun las rgyang ba < M. naran, über-ün quyuča-ača böglegüül < Ch. taiyang ju benxian 太陽距本限).

The Tibetan terminology used is not understandable. It is mostly literal rendering from Mongolian done without an understanding of the concepts. No Tibetanization of the concepts and terms are seen. The point in this example is that no Tibetan would

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651 Čeden et al. (1990: 647).

652 Rgya rtsis chen mo (1715/1716: 2a).
understand the Tibetan without an understanding of modern astronomy in Chinese. Even with such knowledge, this kind of Tibetan renderings is awkward. The above passage means the following:

The first column from the right in the table, [in which] 27 to 89 [are written and which is] divided into the three [27~47, 48~68, 69~89], is altitude. The altitude is the remainder of the distance from the zenith. The uppermost row [in which] 1 to 89 [is written] is the degree of the sun’s distance to the nonagesimal. In the calculation of solar eclipse, it is necessary to find the sun’s distance to the relevant quadrant (Ch. 太陽距本限) by looking up in the table of the nonagesimal.

Parallax in solar eclipse is determined by the altitude of the nonagesimal and the distance of the sun from it. It is not likely that Tibetans knew this basic, but crucial geographical knowledge from the West thru China.

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653 Parallax increases the apparent zenith distance of a celestial object. In the case of solar eclipse, it significantly influences the instant of opposition, duration, magnitude, etc. In the Xiyang xinfa lishu, the nonagesimal point (also called the mid-heaven (L. medium coeli). Ch. huangpingxiangxian 黄平象限) is computed for parallax. To give an explanation of the point, it is the highest point of the ecliptic above the horizon, and its altitude is reckoned from the rising point, i.e. intersection of the ecliptic with the horizon. The reason why it is used to calculate parallax is that when a celestial object is on the nonagesimal point, only its latitude is affected (= there is no longitudinal parallax on that point. The parallax on the point is entirely latitudinal. Therefore, the increase and decrease of the longitude can be determined with this point as a division point.). Neugebauer (1962: 71) holds that the term nonagesimal was coined by Kepler. Parallax calculation in the case of Kepler is explained well in Kepler. tr. Donahue (1992: translator’s introduction 12-5, 237, n. 10). The formular is given in Kepler. tr. Donahue (1992: 238, n.13): “The longitudinal parallax = \( P \sin A \sin d \), where \( P \) is the total parallax at the horizon; \( A \) is the altitude of the nonagesimal; \( d \) is the distance of the planet from the nonagesimal.” Also see Smart, revised by Green (1977: 204-6). Since Kepler, the method using the nonagesimal point became wide-spread in 17-8th century Europe. Many technical books on ocean navigation published at that time introduce the method. For example, peruse the judgement of eclipse in Samuel Vince (1749-1821) (1810: 173): “To the latitude of the given place, and the horizontal parallax of the moon from the sun at the time of the ecliptic conjunction, compute the moon’s parallax in latitude and longitude from the sun; the parallax in latitude applied to the true latitude gives the apparent latitude of the moon from the sun; and the parallax in longitude shows the apparent difference of the longitudes of the sun and moon. ... If the moon be to the east of the nonagesimal degree, the parallax increases the longitude; if to the west, it diminishes it. ... find the sun’s and the moon’s true longitude, and the moon’s true latitude, from their horary motions; and to the same time compute the moon’s parallax in latitude and longitude from the sun; apply the parallax in latitude to the true latitude, and it gives the apparent latitude of the moon from the sun; take the difference of the sun’s and moon’s true longitude, and apply the parallax in longitude, and it gives the apparent distance of the moon from the sun in longitude.” This algorithm is totally understandable and familiar to contemporary Qing China.
My explanation of the parallax calculation in the Tngri-yin udq-a / Rgya rtsis chen mo stops here. There are several reasons. Firstly, the theory and mathematics in the Rgya rtsis chen mo were never understood in Tibet. In fact, there is no evidence that the text was freely circulated. In fact, the Rgya rtsis chen mo had no significance in Tibetan intellectual history. The general mathematical method for the parallax calculation by astronomers who studied the Xiyang xinfa lishu and the Lixiang kaocheng / Lixiang kaocheng houbian of Jesuit origin — It also means that the algorithm was introduced in the Tngri-yin udq-a / Rgya rtsis chen mo and the Mā yang rga rtis from the Xiyang xinfa lishu and the Lixiang kaocheng respectively. — Especially about the method using the nonagesimal, it clearly states that when a celestial body is to the east of the nonagesimal, the parallax increases the longitude; and when it is to the west, it diminishes the longitude. — This instruction is also seen in the Tngri-yin udq-a / Rgya rtsis chen mo and the Mā yang rga rtis. — At this point, I think that it is highly possible that the Jesuits, who came to Qing China with considerable knowledge of astronomy and navigation, were familiar with the method based upon trigonometry and disseminated the knowledge by means of writing astronomical books and teaching it in Qing court. If we move the topic to the context of Indian astronomy, it is verified that intriguingly, calculating parallax from the nonagesimal (S. vitribha) in the case of solar eclipse has been a typical way of computing parallax in India from ancient time. Let me introduce a little bit because it helps to understand the nonagesimal method in the Rgya rtsis chen mo and the Mā yang rga rtis. In the same manner with the previous European method, in the Indian tradition, the astronomers have broadly divided the effect of parallax in two parts, namely the parallax in longitude (S. lambana) and the parallax in latitude (S. nati). See Montelle and Plofker (2014: 8): "Longitudinal parallax (lambana) along the ecliptic is determined chiefly by the distance of the body from the nonagesimal, a point on the ecliptic 90° west of the ascendant or intersection point of the ecliptic with the eastern horizon. Latitudinal parallax (nati) perpendicular to the ecliptic is based on the zenith distance of the nonagesimal, hence dependent on the situation of the ecliptic with respect to the local zenith." This is basically the same with the aforementioned European method. Since the Indian method is not my topic, I restrict myself to introducing some research into primary sources. For a understanding by the example of actual calculation, see Brahmagupta’s Khaṇḍakhādyaka. tr. Sengupta (1934: 104-14) with a mathematical explanation (1934: especially, 99-100) and Sengupta (1918: 1-18). Additionally, there are hundreds of excellent research into the method of the nonagesimal in Indian ancient astronomy. For example, see the translation of the Sūryasiddhānta by Burgess (1977 [c. 1860]: introduction 37-40, 161-77), research into Varāhamihira’s Pañcasiddhāntikā by Thibaut and Sudhākaradivedi (2002 [c. 1889]: 71-4), the updated research into the Pañcasiddhāntikā with corrections of the errors of Thibaut and Sudhākaradivedi by Neugebauer and Pingree (1970-1971: Part 1: 82-99; Part 2: 56-77), Pingree (1978), research into Āryabhaṭa’s (476-550) Āryabhaṭīya by Yano (1980: 71-2), a nice research into Brahmagupta’s Brāhmaśputasiddhānta by Yano (1982: 391-406). Tang2 and Qu (2005: 56-62), Tang2 and Qu (2005a: 197-213), an excellent research by Montelle (2011: passim), Tang2 (2011), research into Nīlakaṇṭha Somayājī’s (1443-1545) Tantrasaṅgraha by Ramanubramanian and Sriram (2011: introduction xliii-xliv, 305-20), an excellent research into Jñānarāja’s (16th c.) Siddhāntasundara by Knudsen (2014: 267-92), Shah (2015), etc. Intriguingly, in the Jiuzhili (九執曆 c. 718), the Indian calendar in Tang China, written by Jutanxida (瞿曇悉達 < S. Gautama siddha), latitudinal parallax of the moon was reflected together with the semi-diameter, meanwhile longitudinal parallax was not applied. For the information, see Yabuuchi (1979: 47-8).
using the Mā yang rgya rtsis is explained below. The mathematics is the same and the method using the nonagesimal is also the same in the Mā yang rgya rtsis, not because it derives from the Rgya rtsis chen mo, but because it is from the Lixiang kaocheng.

### 2.1.2. A SURVEY OF THE METHODS DESCRIBED IN THE MĀ YANG RGYA RTSIS

The Mā yang rgya rtsis is a Tibetan version of the algorithm of eclipse calculation in the Lixiang kaocheng.\(^{65}\) It incorporates elements such as parallax, semi-diameter, etc.

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\(^{65}\) To give a sense of the algorithm, I pinpoint the corresponding parts between the two texts. [ ] below is Huang and Chen’s (1987a) numbering adopted by me for convenience sake.

<table>
<thead>
<tr>
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</thead>
<tbody>
<tr>
<td><strong>Lunar eclipse</strong></td>
<td><strong>Solar eclipse</strong></td>
</tr>
<tr>
<td><strong>Step 1</strong> mean motion at mean full moon day (Ch. pingwang zhu pingxing 平望諸平行).</td>
<td>mean motion at mean new moon day (pingshuo zhu pingxing 平朔諸平行).</td>
</tr>
<tr>
<td>(650a~650b)</td>
<td>(677a~677b)</td>
</tr>
<tr>
<td><strong>Step 2</strong> the difference between the sun and moon (riyue xiangju 日月相距).</td>
<td>nges pa'i rgya grors</td>
</tr>
<tr>
<td>(650b~651b)</td>
<td>(677b~678a)</td>
</tr>
<tr>
<td><strong>Step 3</strong> true argument (shiyin 實引).</td>
<td>nges pa'i rgya grors</td>
</tr>
<tr>
<td>(651b)</td>
<td>(678a~678b)</td>
</tr>
<tr>
<td><strong>Step 4</strong> true full moon (shiwang 實望).</td>
<td>true new moon (shishuo 實朔).</td>
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<td>(652a~652b)</td>
<td>(678b~679b)</td>
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<tr>
<td><strong>Step 5</strong> jiaozhou (交周).</td>
<td>rā gde mgs bar khyad</td>
</tr>
<tr>
<td>(652b~653a)</td>
<td>(679b)</td>
</tr>
<tr>
<td><strong>Step 6</strong> true longitude of the sun (taiyang shijing 太陽實經).</td>
<td>nges pa'i rgya grors</td>
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<tr>
<td>(653a~653b)</td>
<td>(679b~680a)</td>
</tr>
<tr>
<td><strong>Step 7</strong> shishe shingzhi (食甚用時).</td>
<td>dag pa'i rgya grors</td>
</tr>
<tr>
<td>(653b~654b)</td>
<td>(680b~681a)</td>
</tr>
<tr>
<td><strong>Step 8</strong> shishen juwe (食甚距緯) and mid-eclipse (shishen 食甚)</td>
<td>dag pa'i rgya grors</td>
</tr>
<tr>
<td>(654b~655b)</td>
<td>(681a~681b)</td>
</tr>
<tr>
<td><strong>Step 9</strong> shishen shiwue (食甚食時).</td>
<td>dzin rdzogs bar khyad dag pa'i rgya grors</td>
</tr>
<tr>
<td>(655b)</td>
<td>(682b~683a)</td>
</tr>
<tr>
<td><strong>Step 10</strong> shishen juwe (食甚距緯) and mid-eclipse (shishen 食甚)</td>
<td>dzin rdzogs bar khyad dag pa'i rgya grors</td>
</tr>
<tr>
<td>(655b)</td>
<td>(682b~683a)</td>
</tr>
</tbody>
</table>

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296
which are unprecedented in skar rtsis. Steps 9, 10, 11, 12, 13 for the calculation of a solar eclipse according to the division of the steps in the Lixiang kaocheng (also in the Mā

<table>
<thead>
<tr>
<th>Step</th>
<th>Description</th>
<th>Details</th>
</tr>
</thead>
<tbody>
<tr>
<td>9.</td>
<td>shishen jinishtshod (食甚真時)</td>
<td>(685a~687b)</td>
</tr>
<tr>
<td>10.</td>
<td>true time of mid-eclipse (shishen zhenshi)</td>
<td>n/a</td>
</tr>
<tr>
<td>11.</td>
<td>first contact (chukui 初虧).</td>
<td>(690b~693b)</td>
</tr>
<tr>
<td>12.</td>
<td>true time of last contact (fuyuan zhenshi)</td>
<td>(694a~699a)</td>
</tr>
<tr>
<td>13.</td>
<td>true time of first and second contact</td>
<td>(685a~687b)</td>
</tr>
</tbody>
</table>

**Note:**[80]~[99] has not been given by Huang and Chen (1987a). It is not difficult to know the reason before reading the manuscript of the Rgya rtsis snying bsdus. In case that I do not find a Tibetan equivalent in the Mā yang rgya rtsis, I leave the relevant entry blank.

Step 1 is the computation of mean conjunctions. Step 2 to step 7 are the computation of true conjunctions. In them, step 5 is the calculation of the distance between Rāhu and the moon (T. rā gdong bar khyad: longitudinal distance between the moon and the node (rā gdonq). With this distance as the argument, the latitude of the moon is calculated) for the judgement of the possibility of an eclipse. Step 6 is the computation of true longitude of the sun according to the Chinese equatorial coordinate system. — Traditionally in China, the equatorial coordinate has been used. It was not regarded as an important part in the Mā yang rgya rtsis, possibly because the Tibetan Kālacakra/ skar rtsis astronomy is based upon the ecliptic coordinate system.— Step 8 is the calculation of the timing of true mid-eclipse to which parallax corrections will be followed in the case of solar eclipse. — We do not need to calculate parallax effect in the case of lunar eclipse. — Step 9 to step 10 in the case of solar eclipse are the process of parallax corrections through which the timing of apparent mid-eclipse is approximated. Most of all, exploiting the three steps (step 8 to step 10), yongshi (用時, T. mkho ba’i dus tshod / mkho dus), jinshi (近時, T. rye ba’i dus tshod / rye dus), and zhenshi (真時, T. bden pa’i dus tshod / bden dus) is known as the method of the Lixiang kaocheng. For the explanation, see Zhang (2014: 166–9). — It means that the method of the Mā yang rgya rtsis is closely tied to that of the Lixiang kaocheng. — Step 11 to Step 13 in the case of solar eclipse are the computation of magnitude and timing of each contact, being based upon geographical / observational knowledge on the semi-diameter, distance between the moon and the earth, the semi-diameter of the earth’s shadow, and parallax. Given the Rgya rtsis snying bsdus, the Mā yang rgya rtsis has several features; generally, it omitted detailed sub-steps in the Chinese algorithm. And its renderings are not based upon conceptual or theoretical understanding. Rather, it is focused on the process of calculations and did not take a good care in grasping the new Chinese astronomical concepts and theories. And it does not understand trigonometry which is one of the major mathematical bases in the Lixiang kaocheng. — see the following explanation for step 9. — Instead, it just uses the tables which have been created by trigonometrical calculations. — For the tables used in the Mā yang rgya rtsis, see above pp. 159–60. —

655 No consideration on such factors as semi-diameter of the sun and moon, semi-diameter of the earth’s shadow, parallax in skar rtsis eclipse calculations shows a sharp contrast with Mā yang rgya rtsis. However,
yang rgya rtsis) shows clearly that the mathematical basis for parallax calculation is trigonometry. The procedures for each step in the five steps are basically the same. So, step 9 is briefly described below. Note that many sub-steps are omitted and trigonometry is not explicit in the Mā yang rgya rtsis. It just uses the tables copied from the Chinese texts, the Lixiang kaocheng / the Lixiang kaocheng houbian. A comparison of the step 9 between the Lixiang kaocheng and the Rgya rtsis snying bs dus is as follows:

Table 42.

<table>
<thead>
<tr>
<th>Lixiang kaocheng</th>
<th>Rgya rtsis snying bs dus</th>
</tr>
</thead>
</table>

about parallax in skar rtsis calculations, Henning (2007: 126-7): “There is no component of the Tibetan calculations for eclipses that corrects for an observer’s position on the Earth. However, the numbers used in attempting to predict eclipses are clearly based on observations in the northern hemisphere, ... the basic calculations are effectively relative to the center of the Earth.”

656 The above step 9 dramatically shows that the Mā yang rgya rtsis omitted most of the complex and difficult sub-steps in the Lixiang kaocheng. While the latter covers detailed sub-steps for the target of the step, the former calculates huangpingxiangxian juwudufen (T. mkho dus bgood mnyam dkyil khyad dus tshod) and huangpingxiangxian gongdu (T. mkho dus bgood mnyam dkyil gyi khyim zhaq) directly from the target of the previous step, i.e. shishen yongshi (T. 'dzin rdzogs kyi mkho ba'i dus tshod). And on the basis of them, the shishen jinshi (T. 'dzin rdzogs kyi nye ba'i dus tshod) is calculated. Simply, 'dzin rdzogs kyi nye ba'i dus tshod = 'dzin rdzogs kyi mkho ba'i dus tshod + nye dus bar khyad (= parallax corrections). — This omission is repeated in step 10: 'dzin rdzogs bden pa'i dus tshod is calculated directly from 'dzin rdzogs kyi mkho ba'i dus tshod (the target of this Step) with parallax corrections. In other words, 'dzin rdzogs bden pa'i dus tshod = 'dzin rdzogs kyi mkho ba'i dus tshod + bden dus bar khyad. — And this step omits the relevant calculations which are needed to compute the dongxicha (T. shar nub dman cha. For this term, see below note 669) from xianjudigao (T. mkho dus dkyil sa'i bar khyad mtho zhaq). I think that this kind of tendency is partly because of the use of the tables and partly because of ignorance of trigonometry by the author of the Rgya rtsis snying bs dus.

657 I do not know how to render each technical vocabulary. As such, this is left for future study.
See He et al. (1985: 682a) presents this proportional expression based upon trigonometry:

\[
\cos(\varepsilon = 23°29'30'') : \text{semi-diameter 10000000 of bentian (本天, deferent)} = \tan(\text{yongshi chunqiu fen juwu chidaodu}); \tan(a).
\]

\[
a = \frac{180/\pi \times \arctan(10000000 \times \tan(\text{yongshi chunqiu fen juwu chidaodu} \times \pi / 180)}{\cos(23.491667 \times \pi / 180)) = \text{yongshi chunqiu fen juwu huangdaodu}.
\]

The \(\varepsilon\) is \text{huangchi daju (黄赤大距)} / \text{huangchijiaojiao (黄赤交角)} in Chinese. The \text{Lixiang kaocheng} changed \(\varepsilon\) from 23°31'30'' (value in the \text{Xiyang xinfu lishu}) into 23°29'30'' (= 23.491667). For the information, see He et al. (1985: 3b) stating that it is a value of Tycho Brahe. See also Shi (1993: 460-1). — This kind of information is nowhere in the \text{Rgya rtsis snying bsdus}. It is nonsensical to say that the \text{Mā yang rgya rtsis} is based upon Tychonic astronomy. It is just the algorithm of eclipse calculation which derives from the \text{Lixiang kaocheng}. — For the motion of the sun in the \text{Lixiang kaocheng}, see Ōhashi (2007).

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658 See He et al. (1985: 682a) presents this proportional expression based upon trigonometry:

\[
\cos(\varepsilon = 23°29'30'') : \text{semi-diameter 10000000 of bentian (本天, deferent)} = \tan(\text{yongshi chunqiu fen juwu chidaodu}); \tan(a).
\]

\[
a = \frac{180/\pi \times \arctan(10000000 \times \tan(\text{yongshi chunqiu fen juwu chidaodu} \times \pi / 180)}{\cos(23.491667 \times \pi / 180)) = \text{yongshi chunqiu fen juwu huangdaodu}.
\]

659 He et al. (1985: 682b):

\[
10000000 : \sin(\varepsilon) = \sin(\text{yongshi chunqiu fen juwu huangdaodu}); \sin(b).
\]

\[
b = \frac{180/\pi \times \arcsin(\sin(23.491667 \times \pi / 180) \times \sin(\text{yongshi chunqiu fen juwu huangdaodu} \times \pi / 180))}{10000000} = \text{yongshi zhengwu huangchi juwei}.
\]
Table 42 (continued)

<table>
<thead>
<tr>
<th>yongshi huangdao yu ziwujuan jiaojiao (用時黃道與子午圈交角)</th>
<th>n/a</th>
</tr>
</thead>
<tbody>
<tr>
<td>yongshi zhengwu huangdao gongdu (用時正午黄道宫度)</td>
<td>n/a</td>
</tr>
<tr>
<td>yongshi zhengwu huangdaogao (用時正午黄道高)</td>
<td>n/a</td>
</tr>
</tbody>
</table>

660 He et al. (1985: 682b):
\[
\sin(yongshi chunqiufen juwu huangdaodu) : 10000000 = \sin(yongshi chunqiufen juwu chidaodu) : \sin(c) = \frac{180}{\pi} \times \sin \left( \frac{10000000 \times \sin(yongshi chunqiufen juwu huangdaodu \times \pi/180)}{\sin(yongshi chunqiufen juwu huangdaodu \times \pi/180)} \right) = yongshi huangdao yu ziwujuan jiaojiao .
\]

661 He et al. (1985: 682b-683a): In case that yongshi zhengwu huangdao gongdu is 3 to 8 gong (宮), yongshi zhengwu huangdaogao = yongshi zhengwu huangchi juwei + 50.083333. In case that it is 9 to 2 gong, yongshi zhengwu huangdaogao = 50.083333 - yongshi zhengwu huangchi juwei. 50.083333 equals 50°05', the value of the equatorial altitude at Beijing (Ch. jingshi chidaogao wushi du lingwu fen 京師赤道高五十度零五分). In other words, the calculation of the Lixiang kaocheng / Mā yang rgya rtsis is based upon Beijing.
He et al. (1985: 683a):
\[
\cos(yongshi huangdao yu ziwujuan jiaojiao) = \tan(yongshi zhengwu huangdaogao) \cdot \tan(d).
\]
\[
d = \frac{180}{\pi} \times \arctan\left(\frac{1000000 \times \tan(yongshi zhengwu huangdaogao \times \pi/180)}{\cos(yongshi huangdao yu ziwujuan jiaojiao \times \pi/180)}\right)
\]
\[
90 - d = yongshi huangpingxiangxian juwudufen.
\]

For the calculation of a solar eclipse at a particular place, parallax in latitude and longitude of point of observation should be reflected. That is why the value of the huangpingxiangxian juwudufen is calculated. In this case, the value is based upon the latitude (φ) at Beijing, 39°55' (Ch. beijichudi 北极出地). — For this value, see He Mei et al. (1985: passim). —

The Bgrad mnyam bar khyad kyi re’u mig (Table {ma}. Ch. huangpingxiangxian biao 黃平象限表) on which the Mā yang rgya rtsis is based for the calculation of the value of mkho dus bgrad mnyam dkyil ayi khyim zhag (Ch. huangpingxiangxian juwudufen) may have not worked properly since it was not created on the basis of the latitude of Tibetan areas. And it looks that Tibetan lamas who functioned in Beijing and witnessed the new method did not have information on the latitude and longitude in Tibetan areas. — It is a difficult issue. Manchu dynasty implemented nationwide measurements of latitude and longitude in the 18th century. Mongolian and Tibetan areas were also included. The topic is beyond my scope. It would suffice to conjure up the latitude information for Mongolian regions included in chapters 24–32 in Tngri-yin udq-a. See above note 356. — My argument is supported by my reading on later Mā yang rgya rtsis texts: there is no evidence that the Mā yang rgya rtsis authors had an accurate information on latitude / longitude in such regions as Lhasa, Amdo, Khams, etc., where they lived. Most of all, the word ‘latitude’ does not appear in the Mā yang rgya rtsis texts. — In them, the dkyus zhag is used for ‘longitude.’ — Of course, because the skar rtsis texts show a clear sense of different length of day and night according to different region, it may be assumed that Tibetan astronomers were aware of the parallel-/quasi concept of φ. Research is need in both skar rtsis and Mā yang rgya rtsis traditions.
<table>
<thead>
<tr>
<th><strong>yongshi yuejuxian</strong> (用時月距限)</th>
<th><strong>mkho dus zla dkyil bar khyad ([107]).</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>yongshi xianju digao</strong> (用時限距地高)</td>
<td><strong>mkho dus dkyil sa'i bar khyad mtho zhag ([108]).</strong></td>
</tr>
<tr>
<td></td>
<td>Table {ma}:bgrod mnyam bar khyad kyi re'u mig</td>
</tr>
<tr>
<td><strong>yongshitaiyingaohu</strong> (用時太陰高弧)</td>
<td>n/a</td>
</tr>
<tr>
<td><strong>yongshi huangdao gaohu jiaojiao</strong> (用時黄道高弧交角)</td>
<td>n/a</td>
</tr>
</tbody>
</table>

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665 He et al. (1985: 683b):

\[
10000000 : \sin(yongshi huangdao yu ziwujuan jiaojiao) = \cos(yongshi zhengwu huangdaogao) : \cos(e).
\]

\[
e = \frac{180}{\pi} \times \arccos\left(\frac{\sin(yongshi huangdao yu ziwujuan jiaojiao \times \pi/180) \times \cos(yongshi zhengwu huangdaogao \times \pi/180)}{10000000}\right)
\]

= **xianju digao** (限距地高; T. dkyil sa'i mtho zhag. altitude of the nonagesimal point)

666 He et al. (1985: 683b-684a):

\[
\sin(yuejuxian) \cdot \cot(yongshi xianju digao) = 10000000 : \tan(f)
\]

\[
f = \frac{180}{\pi} \times \arctan\left(\frac{\sin(yuejuxian \times \pi/180) \times 10000000}{\tan(90 - yongshi xianju digao \times \pi/180) \times 10000000}\right)
\]

= **huangdao gaohu jiaojiao**.
Table 42 (continued)

| yongshi baidu gaohu jiaojiao (用時白道高弧交角) | 667 |
| taiyangjudi (太陽距地) | |
| taiyinjudi (太陰距地) | |
| yongshi gaoxiacha (用時高下差) | 668 |

| zla sa’i bar khyad ([101]). | |
| Table {ba} zla sa’i phyed srid bar khyad kyi re’u mig. | |
| zla ba’i mtho dma’ ([102]). | |
| zla ba’i mtho dma’i cha rags ([103]). | |
| mkho dus dus cha chen po ([109]). | |
| Table {tsha}: dus cha’am shar nub lho byang dman cha’i re’u mig. | |

---

667 He et al. (1985: 684a). The Lixiang kaocheng uses baikpingxiangxian (白平象限), not huangpingxiangxian (黄平象限). For a theoretical explanation and justification of it, see He et al. (1985: 312-76): the huangpingxiangxian (= the nonagesimal in the Western sense) is measured from the ecliptic. Meanwhile, the baikpingxiangxian (白平象限, the nonagesimal in the Chinese sense) is measured from the path of the moon. However, the difference was slight. For more information, see Tang (2011: 193-5), Zhang1 (2014: 177). It may be the reason why the Mā yang rgya rtsis is based upon the former method. Or, it may be due to the Tibetan tradition which is accustomed to using the ecliptic, not the lunar orbit. In contrast, traditional Chinese astronomy is accustomed to using the lunar orbit in calculating astronomical phenomena.

668 He et al. (1985: 684b): gaoxiacha (Ch. 高下差, lit. high-low difference. > T. mtho dma’i bar khyad) = taiyin dibanjingcha (Ch. 太陰地半經差 = diurnal parallax of the moon. T. zla sa’i phyed srid) – taiyang dibanjingcha taiyang dibanjingcha (Ch. 太陽地半經差 = diurnal parallax of the sun). For an explanation in the Mā yang rgya rtsis, see Huang and Chen (1987a: 638).
Table 42 (continued)

| yongshi dongxicha (用時東西差)\(^{669}\) | mkho dus shar nub dman cha ([110]).
|------------------------------------------|-----------------------------------------------
|                                          | Table (tsha): dus cha’am shar nub lho byang dman cha’i re’u mig. |

<table>
<thead>
<tr>
<th>jinshi jufen (近時距分)</th>
<th>nye dus bar khyad ([111]).</th>
</tr>
</thead>
</table>

<table>
<thead>
<tr>
<th>shishenjinshi (食甚近時)</th>
<th>’dzin rdzogs kyi nye ba’i dus tshod ([112]).</th>
</tr>
</thead>
</table>

The *Lixiang kaocheng* indicates each mathematical formula based upon trigonometry for each sub-step. It also introduces how to use the tables. Note also that the tables in the *Lixiang kaocheng* are much more complex. In other words, the author of the *Rgya rtsis snying bsdus* simplified the steps, the sub-steps in the steps, tables, etc., which may mean

\(^{669}\) Lunar parallax (\(\pi\)) influences the possibility, magnitude, and timing of mid-eclipse, half-duration, etc., in the case of a solar eclipse. It depends on the longitude (\(\lambda\)) and latitude (\(\phi\)) at observer’s position. In the *Lixiang kaocheng*, three differences (Ch. sancha 三差), i.e. gaoxiacha, dongxicha (Ch. 東西差, lit. east-west difference. \(\ast\) T. shar nub dman cha’i bar khyad), and nanbeicha (Ch. 南北差, lit. north-south difference. \(\ast\) T. lho byang dman cha’i bar khyad) are calculated for \(\pi\). The gaoxiacha is calculated first. From the gaoxiacha, the nanbeicha, which influences the latitude, magnitude, etc. and the dongxicha, which influences the timing, are calculated. For the research into \(\pi\) in the Mā yang rgya rtsis, see Huang and Chen (1987a: 620-45). For an explanation in the *Lixiang kaocheng*, which is the same with Mā yang rgya rtsis in terms of theory and practice of eclipse calculation, see He et al. (1985: 319-31, 684b). For modern research, see Chen (1990: 121-4). Zhang1 (2014: 178-200), which is an excellent research into it. The following formular has been given in Zhang1 (2014: 184): 

\[
\text{dongxicha} = \text{atan} \left( \cos \left( \text{baidao gaohu jiaojiao} \right) \times \tan \left( \text{gaoxiacha} \right) \right), \quad \text{nanbeicha} (\text{nanbeicha}) = \text{asin} \left( \sin \left( \text{baidao gaohu jiaojiao} \right) \times \sin \left( \text{gaoxiacha} \right) \right). \\
\text{--- the value of the baidao gaohu jiaojiao depends on } \phi. \\
\text{--- The methodological approach to the parallax calculation in the Lixiang kaocheng was well established. In the case of the dongxicha, when the moon is on the west of the nonagesimal (= bai ping xiang xian) (= true moon is ahead of apparent moon), time difference is added; when the moon is on the east of the nonagesimal (= apparent moon is ahead of true moon), time difference is subtracted. For the same approach, see Vince in note 664. In the case of the nanbeicha, the values vary according to the relative position (south or north) of the bai ping xiang xian to the zenith. For an excellent explanation of the method in English, see Swerdlow and Neugebauer (1984: 278-82) based upon Copernicus.} 
\]
that he was very familiar with calculating and using this algorithm.

Another aspect of the *Lixiang kaocheng* (also reflected in the *Mā yang rgya rtsis*) is that it is based upon geographical / geometric knowledge based upon real measurements. For example, lunar eclipse step 9: calculation of magnitude (Ch. *shifen* 食分 / T. 'dzin cha) (step 11 in the case of solar eclipse) is as follows:

Table 43.

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>tāiyān jūdī (太陽距地)</td>
<td>tāiyān jūdī (太陽距地)</td>
<td>zla phyed ([56]). Table {tha}: zla ba’i phyed srid kyi re’u mig.</td>
</tr>
<tr>
<td>the distance of the sun to the earth</td>
<td>the distance of the moon to the earth</td>
<td></td>
</tr>
<tr>
<td>tāiyān bānjing (太陽半徑)</td>
<td>tāiyān bānjing (太陽半徑)</td>
<td>grib ma’i phyed srid kyi re’u mig. Table {da}: grib ma’i phyed srid kyi re’u mig. grib ma’i dman cha ([58]). Table {na}: grib ma’i dman cha’i re’u mig. nges pa’i grib ma ([59]) = ([57]) − ([58]).</td>
</tr>
<tr>
<td>semi-diameter of the moon.</td>
<td>semi-diameter of the moon.</td>
<td></td>
</tr>
<tr>
<td>diying bānjing (地影半徑)</td>
<td>diying bānjing (地影半徑)</td>
<td>'dzin mtsams bar khyad ([60]) = ([56]) + ([59]).</td>
</tr>
<tr>
<td>semi-diameter of earth’s shadow</td>
<td>semi-diameter of earth’s shadow</td>
<td></td>
</tr>
<tr>
<td>bīngjīng (並徑)</td>
<td>bīngjīng (並徑)</td>
<td>'dzin cha bar khyad ([61]). 'dzin cha ([62]).</td>
</tr>
<tr>
<td>summation of the diameters</td>
<td>summation of the diameters</td>
<td></td>
</tr>
<tr>
<td>shīfen (食分)</td>
<td>shīfen (食分)</td>
<td></td>
</tr>
<tr>
<td>magnitude</td>
<td>magnitude</td>
<td></td>
</tr>
</tbody>
</table>

670 The semi-diameter of the sun (Ch. *tāiyān bānjing* 太陽半徑 / T. *nyi phyed*) and that of the moon (Ch. 太陰半徑 / T. *zla phyed*) influence eclipse limit and magnitude. For the size of the apparent semi-diameter of the sun and moon with respect to the distance between the sun and moon and the earth in the *Lixiang kaocheng*, see Zhang1 (2014: 121).

The semi-diameter of the sun (Ch. taiyang banjing 太陽半徑, T. nyi phyed) and the moon (T. zla phyed) influence eclipse limit and magnitude. Most of all, the size of the apparent semi-diameter of the sun and moon should be found with respect to the distance between the sun and moon and the earth. Such elements in the Lixiang kaocheng (also reflected in the Mā yang rgya rtsis) for calculation of magnitude, which are based upon real observations and measurements by astronomical instruments, is a contrast to skar rtsis. In the case of skar rtsis, the calculation of magnitude is not based upon geographical knowledge and techniques such as lunar declination, distance to the moon, semi-diameter of the sun and moon, parallax, etc. It is based upon observational and empirical values.

**RELATIONSHIP BETWEEN THE RGYA RTSIS CHEN MO AND THE MĀ YANG RGYA RTSIS**

The Mā yang rgya rtsis also uses basically the same method for parallax calculation as the Rgya rtsis chen mo. However, the method using a nonagesimal is commonly used in

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672 For the explanation in the Lixiang kaocheng, see Zhang1 (2014: 121).

673 For example, Dharmasrī’s (1983: 252-3) Gser gyi shing rta, which shows a typical Tibetan method, is as follows: Judge according to the division of the integers (chu tshod) given by the calculation (= longitude of the moon – sgra gcen gdong or sgra gcen mjug) by 5. Then, the degree of each obscuration is as follows: 1, 2, 3: total (T. ril bor sgrib), 4: almost total (white (= not obscured) part remains), 5: about \( \frac{5}{6} \) (= \( \frac{1}{6} \) remains), 6: \( \frac{2}{3} \), 7: \( \frac{1}{2} \), 8: \( \frac{1}{2} \), 9: \( \frac{1}{6} \), 10: \( \frac{1}{6} \) etc. The total value of magnitude of a lunar eclipse is 10 cha. For the information, see also Henning (2007: 108-9). The method in the Mā yang rgya rtsis is a sharp contrast to that in skar rtsis.
Manchu dynasty astronomy that is based upon Western Jesuit astronomy. Then, it is natural that a mathematical continuation is seen also in the Tibetan translations, the Rgya rtsis chen mo and the Mā yang rgya rtsis. It the Pope catholic?

I showed that the Mā yang rgya rtsis derives constants, tables (See chapter 3), algorithm, etc. from the Lixiang kaocheng. Additional evidence that there is no textual relationship between the Rgya rtsis chen mo and the Mā yang rgya rtsis is difference in terminology. Some specific expressions can be highlighted:

Table 44. Terms for the coordinate system:

<table>
<thead>
<tr>
<th>Chinese / English</th>
<th>Tngri-yin udq-a / Rgya rtsis chen mo</th>
<th>Mā yang rgya rtsis</th>
</tr>
</thead>
<tbody>
<tr>
<td>huangdao (黃道): ecliptic</td>
<td>sir-a jam / lam ser po</td>
<td>gnam thig ser po</td>
</tr>
<tr>
<td>tianding (天頂): zenith</td>
<td>tngri-yin orui / gnam gyi gtsug</td>
<td>dkyil gnam</td>
</tr>
<tr>
<td>gaodu (高度): altitude</td>
<td>öndür qonu / zhag mthon po</td>
<td>mtho zhag</td>
</tr>
</tbody>
</table>

Table 45. Terms for the position of the sun and moon:

<table>
<thead>
<tr>
<th>Chinese / English</th>
<th>Tngri-yin udq-a / Rgya rtsis chen mo</th>
<th>Mā yang rgya rtsis</th>
</tr>
</thead>
<tbody>
<tr>
<td>yinshu (引數): argument</td>
<td>uduridyuчи toy-а / 'dren grangs</td>
<td>n/a. the value of rang 'gros is the argument.</td>
</tr>
<tr>
<td>shijing (實經): true longitude</td>
<td>mayad yulduryaryu qonuy / nges pa'i dkyus zhag</td>
<td>dkyus zhag is used to mean longitude.</td>
</tr>
<tr>
<td>dingshuo (定朔): true conjunction</td>
<td>toytayaysan sin-e / gtan bzhag gi tshes</td>
<td>dag tshes</td>
</tr>
</tbody>
</table>

Table 46. Terms for parallax:

<table>
<thead>
<tr>
<th>Chinese / English</th>
<th>Tngri-yin udq-a / Rgya rtsis chen mo</th>
<th>Mā yang rgya rtsis</th>
</tr>
</thead>
<tbody>
<tr>
<td>gaoxiacha (高下差): diurnal parallax</td>
<td>öndür boyuni-yin dutaya / mtho dma'i dman pa</td>
<td>dus cha chen po</td>
</tr>
<tr>
<td>huangpingxianxiandu (黃平象限): nonagesimal</td>
<td>sir-a tübsin baidal-ün quyуча / ser po snyoms babs kyi thin</td>
<td>bagrod mnyam dkyil</td>
</tr>
</tbody>
</table>
Table 47. Terms for eclipse:

<table>
<thead>
<tr>
<th>Chinese / English</th>
<th>Tngri-yin udq-a / Rgya rtsis chen mo</th>
<th>Mā yang rgya rtsis</th>
</tr>
</thead>
<tbody>
<tr>
<td>chukui (初虧): first contact</td>
<td>toytam goruydaqu / thog mar grib pa</td>
<td>'dzin mgo ('dzin 'go)</td>
</tr>
<tr>
<td>shishen (食甚): mid-eclipse</td>
<td>ülemji bariqu / rab tu 'dzin pa</td>
<td>'dzin rdzogs</td>
</tr>
<tr>
<td>fuyuan (復圆): last-contact</td>
<td>tügürig bolqu / zlum por 'gyur pa</td>
<td>btang zin</td>
</tr>
</tbody>
</table>

Two observations can be highlighted from the textual research sketched in the above tables: 1) there are remarkable differences in translating the same Chinese terms between the *Rgya rtsis chen mo* and the *Lixiang kaocheng*. Then, is it reasonable to argue that the *Mā yang rgya rtsis* evolved from the *Rgya rtsis chen mo*? 2) while the renderings of the *Rgya rtsis chen mo* are verbatim renderings from the Mongolian *Tngri-yin udq-a*, those of the *Mā yang rgya rtsis* are based upon a certain understanding of the Chinese methods and Chinese language. Unfortunately, a theoretical understanding of Chinese astronomy by the latter is not read from the *Rgya rtsis snying bsdus*.

Before ending this section, it should be stressed that the *Mā yang rgya rtsis* is not an astronomical system, but just a technique for eclipse calculations (especially for a solar eclipse, given the incorporated factors such as parallax, semi-diameter, etc.) from the *Lixiang kaocheng*. It is a duplication of the algorithm in the *Lixiang kaocheng*. It is not theoretical at all. It has no theory about the planets. Further, there is little theory on the sun and moon.\(^{674}\) It just shows how to use the tables. Thus, it cannot be viewed as having

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\(^{674}\) For example, [26]-[35] in Huang and Chen (1987a) show the process calculating true sun from mean sun without explaining the theoretical bases. For the solar motion in the *Lixiang kaocheng*, see Ōhashi (2007: 663-308)
the same status as skar rtsis with coverage of astronomical expositions and calculation methods.

2.2. TIBETAN WAY OF UNDERSTANDING THE CHINESE ECLIPSE CALCULATION METHODS

2.2.1. UNDERSTANDING OF THE CHINESE METHODS ON THE BASIS OF THE SKAR RTSIS

The Mā yang rgya rtsis is of Chinese origin. However, it should be stressed that it is not a simple duplication of the Lixiang kaocheng. Rather, it is a Tibetanized Chinese system in terms of the change of the values at epoch (rtsis 'go) according to skar rtsis method, the calculation of zla dag, use of monthly dhru ba values and daily mean values of the sun and moon, use of integers, etc.. In other words, the Mā yang rgya rtsis can be understood within a broader frame and in the context of Tibetan attempts to understand the eclipse calculation of a neighboring tradition.

EPOCH DATA, ZLA DAG, CONVERSION OF EPOCH

5) and Wang (2013: 439-43): the sun’s motion is explained on the basis of the geometric model using deferent (bentian 本天) and double epicycles (benlun 本輪).
The Chinese calendar, including the *Lixiang kaocheng*, begins the year at the winter solstice (Ch. *dongzhi* 冬至, T. *dgun nyi ldog*). The epoch in the *Lixiang kaocheng* is Elhe taifin Kangxi 23rd year jiazi tianzhengdongzhi (甲子 (1684) 天正冬至). However, the *Mā yang rgya rtsis* begins the year at 12/0 according to *grub rtsis*. A *mchan bu* given by anonymous4 reads as follows:

"lugs 'di'i zla ba'i dang po hor zla bu gnyis pa rgyal gyi zla ba yin pas ... / dus 'khor pa rnams kyang zla grangs kyi ang rtags hor zla'i grangs dang mthun par 'bri srol yod pas 'dir yang de dang mthun par ngo thog gi grangs" kyis bsgyur bas chog par byas so /

Because the first month of this tradition (= *Mā yang rgya rtsis*) is the 12th *hor* month, i.e. *rgyal zla*, ... because *Kālacakra* adherents also has the method of calculating the numbers of months in accordance with the numbers of *hor zla*, it is fine to multiply by the current numbers also for this (= *rtsa ba'i dhru wa* ((monthly) root quantities) in the context) in accordance with it (= *hor zla*).

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675 For this term, see Ōhashi (2011: 160).

676 This may be misleading: 12/0 belongs to the previous year of the epoch year. For more explanation, see below note 682.

677 I use anonymous4 to denote the person who added some *mchan bus* in the original manuscript retyped in Huang and Chen (1987a). He must be a different person from the author of the *Rgya rtsis snying bsdus*.

678 The *ngo thog gi grangs* means the current number. For example, if it is the second month currently, the number is 2. It equals 'das zla + 1.

679 Huang and Chen (1987a: 356). For the calculation of epoch data at winter solstice in the Chinese calendar, see Sivin (2009: 71). Sivin (2009) is a research into *Shoushili*, Yuan period calendar, but the calculation methods of elements relevant to epoch are basically the same with the *Lixiang kaocheng*, one of the Qing calendars.

680 For this, see below pp. 322-3.
The epoch of the above text, i.e. the *Rgya rtsis snying bsdus*, is 1743/12/0\(^{681}\) according to the Tibetan *grub rtsis* calendar. Or, it may be said that it basically begins from winter solstice like Chinese lunar calendar.\(^{682}\)

Next, the calculation of the *zla dag*. The *Rgya rtsis snying bsdus* calculates *zla dag* according to *skar rtsis* method, which is the first step for the calculations of the *rtsa ba'i dhru wa lnga* calculation. Ser chen Zhabs drung mentions,

\[\ldots\text{dang po zla dag sgrub tshul ni / thun \dhy{t} khri lo gsum pa'am / rab yid shing pho byi ba sogs / 'dus lo gnyis bsagur sgang lo yi / glang zla la sogs 'das las bsres / gnas gnyis bzhag la 'og mig (2) bsagur / mkha' me byin la mda' ros bgos / thob nor steng bsres zla dag go / 'di ni dus 'khor lugs dang bstun / rgya la zla dag brtsi srol med /}\]

\(^{681}\) I conjecture that since the epoch 1744 (*jiazi* year) was set in order to adjust the *rtsis 'phro* values to the *yingshu* values of the *Lixiang kaocheng* whose epoch is also a *jiazi* year (1684). It may have been written around the epoch, 1744, for real use.

\(^{682}\) We need a understanding of the Chinese lunar calendar: *tianzhengdongzhi*, winter solstice of the immediately previous year of the year that will be calculated is set as a reference point. For example, Chinese lunar calendar 2015 (乙未)/11 (戊子)/12 (壬申) is winter solstice (= December, 22, 2015); Seen from 2016 (丙申)/1 (庚寅)/1 (庚申) (= February, 8, 2016), the winter solstice belongs to the previous year. To explain it by using 1744, the epoch of the *Rgya rtsis snying bsdus*, the winter solstice of the year 1743 = the *tianzhengdongzhi* of the year 1744. However, note that the first *Mā yang rgya rtsis* text does not use the *tianzhengdongzhi* as epoch! It changes the epoch into 1743/12/0 according to *grub rtsis* by reflecting the calculational differences between 12/0 and the winter solstice of the year 1743. — In Huang and Chen (1987a: 353), “*jiazi*, the ninth year (1744) of Abkai wehiyehe Qianlong 乾隆.” (gnam skyong lo dgu shing byi) means that the epoch date is 1743/12/0. — The *yingshu* (應數, equivalent to *rtsis 'phro* in Tibetan *skar rtsis* astronomy) has been adjusted to 1743/12/0 by *skar rtsis* method. From a different perspective, because the difference between 12/0 and winter solstice is already reflected in the system as *rtsis 'phro*, it may be assumed that the epoch of the *Mā yang rgya rtsis* system is still winter solstice like Chinese calendar. And meanwhile earlier *Mā yang rgya rtsis* texts use *shing byi* (Ch. *jiazi*) as epoch according to Chinese tradition, later *Mā yang rgya rtsis* texts use *me yos* as epoch according to the *skar rtsis* tradition by means of *rtsis 'go spos pa*. The *rtsis 'go spos pa* is also made according to *skar rtsis* method.

\(^{683}\) Ser chen Zhabs drung (1861: 1b).
... firstly, as for the method of calculating zla dag, multiply by two (-> twelve) the elapsed years from the third year of Yooningga dasan Tongzhi's (T. thun ti) reign, i.e. the wood-male-mouse year (1864 C.E.) of the 14th rab byung, add [the result] to the elapsed months from the ox month (glang zla = rgyal zla), etc of the previous year. [ ] put two rows and multiply by 2, add 30 (= rtsis 'phro value), and divide by 65. Adding the quotient to the upper row (value) makes zla dag. This accords with the method of the Kālacakra, there is no calculation method of the zla dag in China.

As seen above, it is clear that Mā yang rgya rtsis calculates the zla dag according to the method of skar rtsis.

In the following, I show the calculations of zla dag and winter solstice values in the Mā yang rgya rtsis with a focus on the difference from the Chinese system. The left column in the following table briefly shows the Chinese method. In fact, the steps in the Chinese systems including the Lixiang kaocheng are more complex. I just show the Chinese concepts to understand the Tibetan steps. For convenience sake, let me take the example of grub rtsis 2014 (T. shing rta)/8/15 [= jiawu (甲午) year (2014), 9th month jiaxu (甲戌), 15th

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684 This is incorrect. This should be 12.


686 This means that the epoch is 1863/12/0.

687 This is a rare indication which explicitly states that glang zla is equated with the 12th month according to Mā yang rgya rtsis system. We need more materials to confirm this. For several equation methods between the name of month according to 12 animals and nya skar gyi zla ba, see above note 185.

688 For an example, see below p. 313.
day renzi (壬子) according to the Chinese lunar calendar for October 8, 2014]. The comparison table is as follows:

Table 48.

<table>
<thead>
<tr>
<th>Lixiang kaocheng</th>
<th>Bsam ’grub rgya mtsho (1987)</th>
</tr>
</thead>
</table>

689 The corresponding processes are arranged in the same row in this table. The left column in the above table shows how the date is found in the Lixiang kaocheng system. Note that the Chinese steps are much more complex. I simplified them to a considerable degree. My point is that the Chinese method is not the same with the Tibetan method. The latter is based upon the skar rtsis method as seen above.

690 I use ([] in order to show the numberings given by Huang and Chen (1987a). The division ([1]-([10]) in the edition is strange. The contents are not properly given. Especially, ([8])-([10]) are problematic. It is not known whether or not they existed in the Rgya rtsis snying bsdus. Since the Rgya rtsis snying bsdus has never been made public, some philological and astronomical issues remain unsolved. Fortunately, some information on them is found in later texts, -for example, see Mkhyen rab nor bu (1943: 2a). To show all the components from ([1])-([10]), I use Bsam ’grub rgya mtsho (1987) whose epoch is 1986/12/0.

691 Sivin (2009: 429): “The Intermediate Accumulation is the number of day parts from winter solstice at the calendrical epoch to winter solstice of the current year.” It should be noted that in Chinese calendars including the Lixiang kaocheng, zhongji is the number of days between yuandongzhi and tianzhengdongzhi. However, the Mā yang rgya rtsis calculates zla dag (the number of months) in accordance with the skar rtsis tradition.

692 This is the skar rtsis method as mentioned above. The boldic is rtsis ’phro. For 57, see Bsam ’grub rgya mtsho (1987: 2). The rtsis ’phro value in case that the epoch is 1986/12/0 in the tradition of the Mā yang rgya rtsis is different from that of skar rtsis. (Cf. 1986/12/0: mda’ ro lhag ma is 61). Huang and Chen (1987a: 353): In the case of the Mā yang rgya rtsis whose epoch is 1743/12/0, the rtsis ’phro value is 10. (Cf. 1743/12/0 grub rtsis: mda’ ro lhag ma is 12). Essentially, because the Mā yang rgya rtsis follows the intercalation method of the Chinese lunar calendar, the differences are followed.
Table 48 (continued)

<table>
<thead>
<tr>
<th>tongji (通積 “series accumulation” (Sivin’s (2009) term)) = zhongji + qiying.</th>
<th>lo’pho’i zhag grangs. ( \frac{27 \times 365 + (27 \times 60 + 60)}{247} ) = 9861( \frac{198}{247} )</th>
</tr>
</thead>
</table>

693 The calculation of tianzhengdongzhi is displayed in the following diagram.

Yuandongzhi is the winter solstice (the epoch). Jiaziri zizheng is the midnight (Ch. zizheng 子正) of the first day in a sexagenary cycle (Ch. jiaziri 甲子日) immediately before the yuandongzi. Tianzhengdongzhi is the winter solstice of the year which will be calculated. The interval between jiaziri zizheng and yuandongzhi is qiying (氣應 “qi interval constant”). For more information on qiying, see Sivin (2009: 386): “the Ch’i (qi) Interval Constant is the interval from the beginning of the last sexagenary day cycle to the epochal winter solstice—in other words, the sexagenary date of the solstice.” — In the Tngri-yin yuq, it is rendered as ayur-un neileč; in the Rgya rtsis chen mo, it is rendered as dbugs kyi ’grig pa. — And for the concept of ying in the Chinese astronomy and the relevant diagram, see Sivin (2009: 373-4). For the reason why the qiying is needed, see Sivin (2009: 393): “The purpose of this procedure is to find the date (i.e. ordinal number of the day within the sexagenary cycle) of the winter solstice of the desired year.” And the inverval between yuandongzi and tianzhengdongzhi is zhongji (中積). The inverval between jiaziri zizheng and tianzhengdongzhi is tongji (通積).

694 To understand the calculations, understanding of some concepts such as lo’pho and lo’pho’i zhag are necessary. Bsam ’grub rgya mtsho (2011: 119-20) [= Bod rgya tshig mdzod chen mo (2000: 2810) = Tshul khrims rgyal mtshan (2009: 369)]: the lo’pho: “the border time between the completion of the previous year and the emergence of the new year.” (lo snga ma rdzogs pa dang phyi ma gsar du shar ba’i dus mtshams /). The lo’pho’i zhag: “day (nyin zhag) numbers elapsed before the winter solstice of the calculated year (= tianzhengdongzhi) of the border time at which the new epoch was set up (= 12/0. epoch).” (rtsis ’phro spos mtshams nas brtsi bya’i gnam lo’i dgu gn yl chad la nyin zhag ci tsam song ba’i grangs yin /). Also for the definition, see Bsam ’grub rgya mtsho (1987: 2). The lo’pho’i zhag is used for the subsequent calculations of nyi ma, skar ma, gza’, spar kha, and sme ba of the tianzhengdongzhi, which will be explained below.

695 For the number 60, see Bsam ’grub rgya mtsho (1987: 2). 53 is given in Huang and Chen (1987a: 353). The first Mā yang rgya rtsis text (= the Rgya rtsis snying bs dus) must have been produced by means of manipulating the Chinese qiying. The way it was drawn is worth studying. The number 53 may be that which was calculated in conformity with the tianzhengdongzhi of 1684 (= epoch of the Lixiang kaocheng) or the tianzhengdongzhi of 1723 (= epoch of the Lixiang kaocheng houbian).
Table 48 (continued)

<table>
<thead>
<tr>
<th>tianzhengdongzhi ganzi (天正冬至干支)</th>
<th>l'o pho'i nyin de'i (= dgun nyi ldog nyin) nji ma (nyi khams):</th>
</tr>
</thead>
<tbody>
<tr>
<td>23(9861 + 37696) ÷ 60 = 16458697</td>
<td>23 is given in Huang and Chen (1987a: 354). Likewise, the way 23 was drawn is worth studying.</td>
</tr>
</tbody>
</table>

697 58 falls on renxi in the Tibetan Mā yang rgya rtsis system, showing a difference from the Chinese one. Firstly, 60 jiazi (甲子) is used to count days in the Chinese calendar. The combination between 10 tiangans (天干): jia (甲), yi (乙), bing (丙), ding (丁), wu (戊), ji (己), geng (庚), xin (辛), ren (壬), gui (癸), and 12 dizihs (地支): zi (子), chou (丑), yin (寅), mao (卯), chen (辰), si (巳), wu (午), wei (未), shen (申), you (酉), xu (戌), hai (亥) makes 60. The Chinese 60 jiazi is presented as follows:

<table>
<thead>
<tr>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
<th>7</th>
<th>8</th>
<th>9</th>
<th>10</th>
</tr>
</thead>
<tbody>
<tr>
<td>jiazi</td>
<td>yichou</td>
<td>bingyin</td>
<td>dingmao</td>
<td>wuchen</td>
<td>jisi (己已)</td>
<td>gengwu</td>
<td>xinwei</td>
<td>renhen</td>
<td>guiyou</td>
</tr>
<tr>
<td>jiaxu</td>
<td>yihai</td>
<td>bingzi</td>
<td>dingchou</td>
<td>wayin</td>
<td>jinmao</td>
<td>gengchen</td>
<td>xinsi</td>
<td>renwu</td>
<td>guiwei</td>
</tr>
<tr>
<td>jiachen</td>
<td>yiyou</td>
<td>bingxi</td>
<td>dinghai</td>
<td>wuzi</td>
<td>jichou</td>
<td>gengyin</td>
<td>xinmao</td>
<td>renchen</td>
<td>gui</td>
</tr>
<tr>
<td>jiawu</td>
<td>yiwei</td>
<td>bingshen</td>
<td>dingyou</td>
<td>wuxu</td>
<td>jihai</td>
<td>gengzi</td>
<td>xinhou</td>
<td>renyin</td>
<td>guimao</td>
</tr>
<tr>
<td>jiachen</td>
<td>yis</td>
<td>bingmei</td>
<td>dingwei</td>
<td>wuxi</td>
<td>jiyou</td>
<td>gengxi</td>
<td>xinhai</td>
<td>renzi</td>
<td>guichou</td>
</tr>
<tr>
<td>jiazhin</td>
<td>yimao</td>
<td>bingchen</td>
<td>dingsi</td>
<td>wuxi</td>
<td>jiewei</td>
<td>gengshen</td>
<td>xinyou</td>
<td>renxu</td>
<td>guihai</td>
</tr>
<tr>
<td>---</td>
<td>---</td>
<td>---</td>
<td>---</td>
<td>---</td>
<td>---</td>
<td>---</td>
<td>---</td>
<td>---</td>
<td>---</td>
</tr>
</tbody>
</table>

Secondly, the Tibetan jiazi in the case of the Mā yang rgya rtsis = Chinese 60 jiazi – 1.
Table 48 (continued)

<table>
<thead>
<tr>
<th>0</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
<th>7</th>
<th>8</th>
<th>9</th>
<th>10</th>
<th>11</th>
<th>12</th>
<th>13</th>
</tr>
</thead>
<tbody>
<tr>
<td>T. nag pa (Ch. jiao)</td>
<td>sa ri (kang)</td>
<td>sa ga (di)</td>
<td>tsa tri mshams (fang)</td>
<td>snron (xin)</td>
<td>snrubs (wei)</td>
<td>chu stod (ji)</td>
<td>chu smad (dou)</td>
<td>gro bzhin (niu)</td>
<td>byi bzhin (ni)</td>
<td>mon gre (xu)</td>
<td>mon gre (wei)</td>
<td>khrums smad (shi)</td>
<td>khrums smad (bi)</td>
</tr>
<tr>
<td>14</td>
<td>15</td>
<td>16</td>
<td>17</td>
<td>18</td>
<td>19</td>
<td>20</td>
<td>21</td>
<td>22</td>
<td>23</td>
<td>24</td>
<td>25</td>
<td>26</td>
<td>27</td>
</tr>
<tr>
<td>nam gru (kui)</td>
<td>thar skar (lou)</td>
<td>bra nye (weil)</td>
<td>smin drug (mao)</td>
<td>snar ma (bi)</td>
<td>mgo (zi)</td>
<td>lag pa (can)</td>
<td>nabs so (jing)</td>
<td>rgyal (gui)</td>
<td>skag (liu)</td>
<td>mchu (xing)</td>
<td>gre (zhang)</td>
<td>dbo (yi)</td>
<td>me bzhin (zen)</td>
</tr>
</tbody>
</table>

For more information, see Bsam ’grub rgya mtsho (1987: 24).

698 see Bsam ’grub rgya mtsho (1987: 2)

699 The equation of 27 rgyu skars in the skar rtsis with Chinese ones is as follows: 0 tha skar (equivalent to Ch. luo), 1 bra nye (wei), 2 smin drug (mao), 3 snar ma (bi), 4 mgo (zi), 5 lag pa (can), 6 nabs so (jing), 7 rgyal (gui), 8 skag (liu), 9 mchu (xing), 10 gre (zhang), 11 dbo (yi), 12 me bzhin (zhcn), 13 nag pa (jiao), 14 sa ri (kang), 15 sa ga (di), 16 tsa tri mshams (fang), 17 snron (xin), 18 snrubs (wei), 19 chu stod (ji), 20 chu smad (dou), 21 gro bzhin (niu), 22 mon gre (xu), 23 mon gre (wei), 24 khrums smad (shi), 25 khrums smad (bi), 26 nam gru (kui). Because 28 xiü system is used in the Chinese calendar, byi bzhin (niu) — placed between 21 gro bzhin and 22 mon gre — is not calculated in Tibet. For relevant information, see Huang (2002: 50-2), Henning (2007: 356-7, 362-3), Sivin (2009: 90-4). In the case of the Mā yang rgya rtsis, it adopts 28 xiü system with different numbering from Chinese calendar: jiao = 0, kang = 1, di = 2, ... and finally zhen = 27. 20 falls on can (T. lag pa). See the following table in Bsam ’grub rgya mtsho (1987: 23).

It should be noted that in the Mā yang rgya rtsis, Tibetan astronomers assimilated ying (rtsis ’phro), jiazi, rgyu skar, etc. in a Tibetan way. See above notes 682, 693, and 695.

700 See Bsam ’grub rgya mtsho (1987: 2).

701 1 = Sunday. In this case, it falls on December 22, 2013. The result of the lo ’pho’i nyin de’i gza’ (Ch. tianzhengdongzhi) in the Mā yang rgya rtsis was adjusted to be identical with that of skar rtsis. In other words, the weekday values in the Mā yang rgya rtsis: 0 = Saturday, 1 = Sunday, 2 = Monday, 3 = Tuesday, 4 = Wednesday, 5 = Thursday, 6 = Friday.
The zla dag is calculated from 12/0, not from the winter solstice in the method of skar rtsis. And the values of the winter solstice are calculated together. In other words, lo 'pho'i nyin is winter solstice ((tianzheng dongzhi 天正冬至) = Chinese lunar calendar 2013/11/20 [= December 22, 2013]). According to the above calculation, nyi khams (= nyi ma. Ch. ganzhi 干支) is chu khyi (Ch. renxu) which agrees with the Chinese lunar calendar. The skar ma (Ch. xiu 宿) is xing, which is irrelevant to skar rtsis. The gza' (Ch. yao 曜) is Sunday, which is the same as skar rtsis. The spar kha (Ch. gua 卦) and sme ba (Ch. 宮) calculations are

Table 48 (continued)

| lo 'pho'i nyin de'i sme ba: | (9861 - 6) \(\text{mod}\) 9 = 1095, i.e. 0 = 9. |

702 See Bsam 'grub rgya mtsho (1987: 2).

703 ([7])-([10]) appear as only titles in Huang and Chen (1987a). They do not exist in the Lixiang kaocheng and the origin of them is dubious.

704 See Bsam 'grub rgya mtsho (1987: 2).

705 Bsam 'grub rgya mtsho (1987: 2): “The remainder after the division is also subtracted from nine.” (dor lhag gis kyang rtsa la phri). In other words, if the remainder is 1: 9 - 1 = 8, 2: 9 - 2 = 7, 3: 9 - 3 = 6, 4: 9 - 4 = 5, 5: 9 - 5 = 4, 6: 9 - 6 = 3, 7: 9 - 7 = 2, 8: 9 - 8 = 1, 9: 9 - 9 = 0. Because the dkyil 'khor is 9, 9 equals 0.

706 For the calculations of the values of each day, see Bsam 'grub rgya mtsho (1987: 19-20).

707 Huang and Chen (1987a) does not present the rtsis 'phro values.
not from the Chinese system. – They are divinations of Chinese origin. However, it is not certain when they were incorporated into the Mā yang rgya rtsis. – They may have a close relation to the contemporary nag rtsis method.708

Tibetan commentators have expressed their opinions about the origin of the five elements, i.e. nyi ma, skar ma, gza’, spar kha, and sme ba values. For example, Ser chen Zhabs drung says that they are unnecessary for eclipse calculation, but necessary for huangli. He may be true, but I disagree here since the calculations of correct tshes grangs are a basic step for eclipse calculation. He may have meant that the correct tshes grangs, which is verified by the calculation of the winter solstice, is necessary, but the values of the five elements are unnecessary. If so, I would agree with him. Mkhyen rab nor bu’s opinion on origin are as follows:

.. rgya nag hwang le la / nyin re’i gza’ skar sme ba gsum / mi ’byung rgya la grags pa dang / bstun pa’i lag len rtsis rgyun du / snang phyir ’dir yang ’phro spo bgyis /709

708 The Sde srid’s Vaidûrya dkar po states that they were introduced from the Tang dynasty; see Macdonald (1963: 73-4). However, it is not certain whether or not the calculation methods used in earlier period (period of Tibetan Empire) are the same with those in later period (for example, the system after the 5th Dalai lama and the system used in Mā yang rgya rtsis) and whether or not the calculations of the contemporary nag rtsis are the same with those of the Mā yang rgya rtsis. More research is needed. See also pp. 14-6.

709 See Mkhyen rab nor bu (1943: 2a)/ Kun dga’ rig ’dzin and Phur bu don grub (1998: 572). There are many issues that have yet to be solved to understand this passage. For example, I am not sure what Mkhyen rab nor bu indicates by rgya nag hwang le (Chinese huangli < Ch. huangli 皇歷 or huangli 黃歷). In addition, according to him, there are no calculations of gza’, spar kha and sme ba in it. Is it a contemporary wannianli (萬年曆) calendrical system? Moreover, I do not understand what tradition he mentions by rgya la grags pa dang bstun pa’i lag len rtsis. It may be nag rtsis. Anyway, he maintains a continuation of the calculation methods of gza’, spar kha and sme ba, by saying that they had existed in Tibet and were added by Mkhyen rab nor bu himself.
... gza', spar kha, sme ba of each day do not exist currently in the Chinese hwang le (Ch. huangli 皇歷). I (= Mkhyen rab nor bu) changed the rtsis 'phro [of them] also here, because the practice, which accords with the one known in China, existed at all times.

He understands that the calculations of the gza\(^{710}\), spar kha, sme ba included in the later Mā yang rgya rtsis texts derive from the past. That is all. No more information is given in the above text. This leaves us with the question: how did Mkhyen rab nor bu change the rtsis 'phro for the five elements? Are they part of the contemporary nag rtsis? All in all, the key point is that the Mā yang rgya rtsis is a tradition that compromises skar rtsis and a Chinese method: skar rtsis method for zla dag, mixture between skar rtsis and Chinese method for winter solstice values.

There is also another skar rtsis method the Mā yang rgya rtsis uses: rtsis 'go spos pa. We use the Rgya rtsis snying bsdus, three Bsam 'phel dbang gi rgyal po-s with different epochs to show how the epoch has been changed. The rtsis 'phro values for the zla dag calculation are as follows\(^{711}\):

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\(^{710}\) The gza' value accords with that of the skar rtsis.

\(^{711}\) Rtsis 'go spos pa has been made by the following calculations which evidence that the three Bsam 'phel dbang gi rgyal po-s with different rtsis 'go-s are basically the same calendar with the Rgya rtsis snying bsdus.

\[
\begin{align*}
1864 - 1744 &= 120 \\
120 \times 12 &= 1440 \\
1440 \times 2 + 10 &= 44.615384615 \\
0.4615384615 \times 65 &= 30 \\

1927 - 1864 &= 63 \\
63 \times 12 &= 756 \\
\frac{756 \times 2 + 30}{65} &= 23.7230769231 \\
0.7230769231 \times 65 &= 47 \\

1987 - 1927 &= 60 \\
60 \times 12 &= 720 \\
\frac{720 \times 2 + 47}{65} &= 22.8769230769 \\
0.8769230769 \times 65 &= 57 \\
\end{align*}
\]
Table 49.

<table>
<thead>
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</thead>
<tbody>
<tr>
<td>10</td>
<td>30&lt;sup&gt;714&lt;/sup&gt;</td>
<td>47</td>
<td>57</td>
</tr>
</tbody>
</table>

**UNITS, DHRU BA, AND ARITHMETIC**

Investigating the lunar eclipse, the first step is the calculation of the mean motion at the mean full moon day (Ch. *pingwang zhu pingxing* 平望 諸平行) and that of the solar eclipse, the first step is the calculation of the mean motion at the mean new moon day (Ch. *pingshuo zhu pingxing* 平朔 諸平行<sup>715</sup>). I will show how the Tibetans apply the skar rtsis measurement units and concepts such as rtag longs and rtsis ’phro to understand the Chinese concept of yingshu. Firstly, basic constants of the movements of the sun and moon are as follows:

<sup>712</sup> In this text, the epoch was changed by Mkhyen rab nor bu into 1927 from Ser chen Zhabs drung (1861) (epoch: 1864) and the mjug byang was added by him.

<sup>713</sup> The epoch of this text was changed by Kun dga’ rig ’dzin and Phur bu don grub into 1987 from Mkhyen rab nor bu (1943) (epoch: 1927).

<sup>714</sup> The numbers in Ser chen Zhabs drung (1861) are unreadable. It is based upon my calculation.

<sup>715</sup> The step numbers given here follow the *Lixiang kaocheng*. For the information, see above note 654.
Table 50.

<table>
<thead>
<tr>
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<th>rtag longs per tshes zhag</th>
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<tbody>
<tr>
<td>synodic month</td>
<td>29°12'44&quot;3&quot;111&quot; (30/24/60/60/60/360) ÷ 30 = 29.53059 days</td>
</tr>
<tr>
<td>(30/24/60/60/60/360) (= 29.53059 days)</td>
<td>23°37'28&quot;6&quot;39&quot;21&quot; (24/60/60/60/60/30) = 0°59°3&quot;18&quot; (7/60/60/60/60/360)</td>
</tr>
</tbody>
</table>

| nyi spyi         | 29°6'24"15"103" (30/60/60/60/60/360) ÷ 30 = 58°12'40"183"13" (60/60/60/60/360/30) |
| (30/60/60/60/60/360) | 0°4"21'5"51" (27/60/60/60/60/360) |

| nyi rang         | 29°6'19"9"242" (30/60/60/60/60/360) ÷ 30 = 58°12'38"116"2" (60/60/60/60/60/360/30) |
| (30/60/60/60/60/360) | 0°4"21'5"46" (27/60/60/60/60/360) |

| zla rang         | 0°25°49°0"3"317" (12/30/60/60/60/360) ÷ 30 = 12°51°38°0"46"17" (30/60/60/60/60/360/30) |
| (12/30/60/60/60/360) | 0°57°52°2"7" (27/60/60/60/60/360) |

716 This value is used for the tshes dhru which is the interval between epoch and the mean new moon (Ch. pingshuo 平朔) in which a solar eclipse occurs.

717 Compare this with that of the grub rtsis value: 0°59°3"16" [= 29.53059 days]. See above p. 195. Both are nearly the same. This kind of similarity may have convinced Tibetan astronomers of understanding the Chinese method introduced as the Mā yang rgya rtsis through the lens of skar rtsis.

718 The nyi ma'i spyi 'gros (= nyi spyi. Ch. taiyang pingxing 太陽平行) means the monthly mean movement of the sun. The value equals 104784°.2547685. See above p. 157.

719 Compare the value of the sun’s mean movement per lunar day in the grub rtsis: 0°4"21'5"43"; see above note 504.

720 The nyi ma’i rang ‘gros (= nyi rang. Ch. taiyang zixing 太陽自行) means the sun’s angular motion (solar anomaly) from the perigee on a monthly basis. — the equation of the center of the sun is 0 at perigee. For the information, see Evans (1998: 226-7). — The value equals 104779°.1612037; see Huang and Chen (1987a: 524) and above p. 157.

721 The zla ba’i rang ‘gros (= zla rang. Ch. taiyin zixing 太陰自行) means the moon’s angular motion (lunar anomaly) from the perigee on a monthly basis. The value equals 92940°.064675925; see Huang and Chen (1987a: 524) and above p. 157.

722 Compare the zla ba’i rtag longs (tshes zhag) value of the Phug pa grub rtsis whose daily movement is 0°58°21’43”; see above p. 196.
As seen above, Tibetan Mā yang rgya rtsis astronomers transformed the modern measurement units used in the Xiyang xinfa lishu into the skar rtsis measurement units. Although they did not use the latter units in real calculations, they compared and contrasted the Mā yang rgya rtsis values according the familiar skar rtsis values. Secondly, the calculations of root quantities are based upon skar rtsis approach and methods, i.e. calculating a monthly value and then calculating a daily value, which is different from Chinese methods. Concretly, rtsa ba’i dhru wa lnga ([11])-([15]) are monthly values like dhru ba values in skar rtsis (gza’ dhru, nyi dhru, etc.). The calculations are as follows:

The rtsis 'phro values (equivalent to the Chinese yingshu) are all those at epoch:

([11]) rtsa ba’i tshes dhru = zla dag × 29°12'44"3"111"" + rtsis 'phro.

([12]) nyi ma’i spyi ’gros dhru wa = zla dag × nyi ma’i spyi ’gros [= 29°6'24"15"103""] + rtsis 'phro.

([13]) nyi ma’i rang ’gros dhru wa = zla dag × nyi ma’i rang ’gros [= 29°6'19"9"242""] + rtsis 'phro.

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723 The rā gdong bar khyad means the moon’s monthly motion with respect to the sgra gcan gdong (= rā gdong). The value equals 110413.924398248; see Huang and Chen (1987a: 524) and above p. 157.

724 For the method in the Lixiang kaocheng, see He et al. (1985: 649-50). This falls beyond the scope of this work.
([14]) \( \text{zla ba'i rang 'gros dhru wa} = \text{zla dag} \times \text{zla ba'i rang 'gros} = [25^\circ 49'0'' 3'' 317''] + \text{rtsis 'phro}. \)

([15]) \( \text{rā gdong bar khyad dhru wa} = \text{zla dag} \times \text{rā gdong bar khyad} = [1^\circ 25^\circ 49'0'' 3'' 317''] + \text{rtsis 'phro}. \)

And then, ([16])–([20]) are mean daily values at new moon and ([21]–[25]) are mean daily values at full moon, which are parallel values such as gza' bar, nyi bar, etc. in skar rtsis. The nya yi dhru wa is used for the calculation of [21]–[25]. For example, [21] = [11] + \( \frac{1}{2} \times 29^d 12^h 44^m 3's 111'' = 14^d 18^h 22^m 1's 32''. \) Overall, the writer of the Rgya rtsis snying bs dus

725 The underlined part may not cause a large difference in calculational results but are not unproblematic: I have no idea why the other three are different from the Rgya rtsis snying bs dus, the original text of the three. As seen in the table, different radices are possible: 5 measurement units: (30 (day)/24 (hour. dus)/60 (thun)/60 (srang)/60 (cha)), 6 measurement units: (30/24/60/60/60/360 (cha)), and 7 measurement units: (30/24/60/60/60/360/30 (cha)). They are already transformed to Tibetan notation of units.
and later commentators may have thought that basically, the Lixiang kaocheng system was not different from Tibetan skar rtsis in terms of units, monthly values, daily values of the sun, moon and sgra gcan. They appropriated the Chinese method.

We turn now to the use of integers. Tibetan astronomers are not used to using fractions. Their calculations are integer based. Therefore, when they encounter fractions in the Lixiang kaocheng, they transform them into integers by any possible means. For example, when calculating the equation / true motion of the sun and moon, they Tibetanized the values in the Lixiang kaocheng. For example, see the components for the calculations of the spyi yi dus kyi bar khyad ([28] < Ch. pingjushi (平距時)), zla ba'i nges pa'i rang 'gros ([30]. < Ch. taiyin shiyin (太陰實引)), nyi ma'i nges pa'i spyi 'gros ([36]. < Ch. taiyang pingxing (太陽平行)), etc..

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726 Huang and Chen (1987a: 385-6)’s explanation is compelling: the Lixiang kaocheng value for yue ju ri yi xiaoshi pingxing (月距日一小時平行) is \( \frac{1828'6121108}{3600'} \) (1 hour). — For this value, see He et al. (1985: 651a). — However, Mā yang rgya rtsis value is \( \frac{9143}{18000} \), which was created by converting 1828'.6121108 to an integer by multiplying 5, i.e. 1828'.6121108 \times 5 \approx 9143. And 3600 \times 5 = 18000. This explanation is also a firm evidence that the Mā yang rgya rtsis is created from the Lixiang kaocheng.

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727 Huang and Chen (1987a: 386-7) ’s explanation is compelling: taiyin yi xiaoshi pingxing (太陰一小時平行) in the Lixiang kaocheng is \( \frac{1959'7476542}{3600'} \) (1 hour). — For this value, see He et al. (1985: 651b) — The Mā yang rgya rtsis value \( \approx \frac{871}{1600} \). The conversion method is as follows: 1959'.7476542 \div 2.25 \approx 871, and 3600 \div 2.25 \approx 1600.

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728 Huang and Chen (1987a: 388-9) ’s explanation is compelling: taiyang yixiaoshi zixing (太陽一小時自行) in the Lixiang kaocheng is \( \frac{147'8471049}{3600'} \) (1 hour). — For this value, see He et al. (1985: 653a). — The Mā yang rgya rtsis value \( \approx \frac{2129}{51840} \). The conversion method is as follows: 147'.8471049 \times 14.4 = 2128. 99831056 \approx 2129, and 3600' \times 14.4 = 51840.
Taken together, the Mā yang rgya rtsis is not a systematical approach to astronomy. It just presents an algorithm for eclipse calculation which derives from the Lixiang kaocheng. There are some later Mā yang rgya rtsis texts, but no further development and understanding of modern astronomy has been made. – This may indicate that Tibetans do not understand the basis of the calculations at all. – It may be claimed that after the Mā yang rgya rtsis, the Tibetan astronomy got out of the mere intuitive descriptions of geographical features that is seen in skar rtsis, but if they had had a firm understanding of the Mā yang rgya rtsis, the Tibetans themselves would have revised and created the values and tables based upon the longitude, latitude, nonagesimal in Tibetan areas in other for the system to work properly in Tibet for the calculation of a solar eclipse. But, this has never happenend simply because they did not know theory and pratice which the Mā yang rgya rtsis is based upon.

In the same vein, the issue how to assess the author (= a Beijing lama) of the first work, Rgya rtsis snying bsdus, may be raised. When it comes to modern astronomy, he may have had an understanding of modern mathematics, but the text itself does not suggest this. At minimum, it is certain that he introduces the well-known methods for eclipse calculation in Beijing during his time. Certainly, his contribution was to introduce the method on how to use the tables as far as modern astronomy is concerned. We also give him credit for the renderings of Chinese technical vocabularies into Tibetan. As far as skar rtsis is concerned, his contribution is quite clear. Being equipped with skar rtsis knowledge, he adjusts the rtsis ’phro values to yingshu values of the Lixiang kaocheng. Because of his contribution, the Mā yang rgya rtsis came into being and has been equated with the skar
rtsis. From another perspective, the boundary of the skar rtsis has broadened together with the emergence of the Mā yang rgya rtsis, which obviously shows Tibetan endeavors for assimilating and equating the Chinese method into Tibetan. Moreover, the skar rtsis succeed in making sense of the different system within the frame of the time-honored skar rtsis / Kālacakra astronomy.

Finally, the Mā yang rgya rtsis was created for eclipse calculation (especially solar eclipse calculation). However, we have little knowledge about whether it was actually used in Tibet and whether it really improved the accuracy of eclipse calculation in Tibetan area, especially when compared with skar rtsis method. In conjunction with this, the concrete instances and examples used in real history - including skar rtsis eclipse calculations - could be collected, investigated, and compared to modern astronomical / mathematical data, which may be now possible with just one click on many websites and with software. Through those processes, we would be able to clarify the venue, time, etc. of the values which appear in Tibetan texts, whether they were calculated or observed. We have a long way to go.
CONCLUSION

Philosophy and religion respond to science by their own means. In the Tibetan context, the religious and philosophical Kālacakra system incorporated astronomical elements, which may be regarded as science in a modern sense, through the logic of the phyi nang gzhan gsum. Since my writing concerned some concepts for eclipse calculations in the skar rtsis formulated from the Kālacakra, I conclude by discussing the relationship between the Kālacakra and skar rtsis in terms of the folding and unfolding of the astronomical concepts in the Kālacakra.

The religious and philosophical schemes in the first chapter of the Kālacakra are combined with astronomical and cosmological expositions for the outer world, interrelated to the other chapters by using the same terms and concepts to explain both religion/philosophy and astronomy/mathematics. In other words, the Kālacakra attempts the paradoxical connection, intersecting religion and astronomy with orientation and methodology, respectively. The para (< G. παρά) literally means two/multiple directions. It is also self-referential in that the undifferentiated conceptual link

Deleuze, tr. Patton (1994: xvi): “Every philosophy must achieve its own manner of speaking about the arts and sciences, as though it established alliances with them. It is very difficult, since philosophy obviously cannot claim the least superiority, but also creates and expounds its own concepts only in relation to what it can grasp of scientific functions and artistic constructions. A philosophical concept can never be confused with a scientific function or an artistic construction, but finds itself in affinity with these in this or that domain of science or style of art. The scientific or artistic content of a philosophy may be very elementary, since it is not obliged to advance art or science, but it can advance itself only by forming properly philosophical concepts from a given function or construction, however elementary. Philosophy cannot be undertaken independently of science or art.”

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between religion and astronomy ultimately completes the religious system, which is
classified into the most supreme tantra in the Tibetan taxonomy of the Buddhist texts. It
inevitably denotes its own “sense” by itself.

Meanwhile, skar rtsis is in a different situation. It forms relations with the
Kālacakra: it participates in critical investigations into it, shares explanations with it, and
ultimately creates a new ground for the Kālacakra. Concretely, it extracts astronomical /
mathematical elements from the undifferentiated and paradoxical religious and
astronomical concepts in the Kālacakra. Consequently, the mathematical and
philosophical concepts, methodologies, etc. in the Kālacakra are inevitably resystemized,
reorganized for the sake of calculation. And skar rtsis transforms the religious and
astronomically abstract concepts of the Kālacakra into tangible and quantitative ones.
Such justification of the abstract in the Kālacakra leads us to the world of arithmetic,
replete with concrete mathematical, but not religious experiences. Conversely, the
Kālacakra secures its reality through skar rtsis. The Kālacakra is restrengthened by it. The
recursive binary structure between the Kālacakra and skar rtsis, which may be termed
unfolding and folding, postulates the supreme authority of the Kālacakra.

Under such circumstances, eclipse calculation in the skar rtsis is essentially a study
of mathematical concepts formulated and articulated in the Kālacakra. Because of the lack
of information in the Kālacakra, empirical components are merged, but it is still
conditioned by the Kālacakra. The interplay as the two conflicting elements unfold is
reified as a paradoxical connection in real calculations.

Eclipse calculation is religious in terms of the multiplication of paradoxes. Tibetan
astronomers, who are equipped with knowledge of the Kālacakra, reconcile the calculations based upon the Kālacakra and those based on Buddhist texts. Kālacakra adherents have devised the bstan rtsis, which is supported by the religious frame that the accuracy of a certain system is guaranteed by the accurate calculation of the lunar eclipse at the Buddha’s enlightenment. They reconcile Buddhist chronological information in some Buddhist texts with their skar rtsis systems for the link between astronomy/ math and religion, which are mutually regulated and restricted. The paradoxical connection is the basis of the multiplication of meanings. However, contradiction is inevitable between the Kālacakra and the texts which do not fit the Kālacakra. Possible interpretations of the skar rtsis and the Buddhist texts ruled out evidence that “sense” (meaning) is generated, with priority given to the Kālacakra.

The rite of gso sbyong, which concerns time-keeping, shows that paradoxical connections have been formed in conjunction with the phenomena of eclipse. The zhag mi thub based upon the concept of the accuracy of skar rtsis for the performance of gso sbyong is based upon religious lamas’ reading of the Abhidharma. Their priority is religion, embracing skar rtsis. However, with the phenomena of eclipse verified by direct perception and the different date in Chinese astronomy, some astronomers in Amdo have suggested the logic of the yul bstun gso sbyong. In other words, when a contradiction between religious expositions and empirical observations and knowledge was caused by eclipse phenomena, the religious rite of gso sbyong was adjusted because of empirical evidence. The accuracy of a certain system has a close tie to empirical evidence. Various “game rules” (in Wittgenstein’s sense) may exist, but the priority given to empirical
components has compromised religious practice. However, the core fact is that the two contradictory concepts, *zhag mi thub* and *yul bstun gso sbyong*, are both affirmed. The “sensation” unfolds paradoxically.

The religiously framed paradox for eclipse calculation that arises in the relationship between religion and astronomy makes Tibetan astronomers improve / get rid of the circumstances in which the incongruity between the inaccuracy of *rtsis* and real phenomena is manifest (*mngon sum*). However, the *Kālacakra* cannot give an answer to individual astronomical phenomena and elements, especially in the case of eclipse. Simply, it does not include much information on eclipse calculation. The approaches and methods taken in the *skar rtsis* are to assimilate many knowledge sources under the rubric of the *Kālacakra*. The eighteenth century witnessed the various strata such as observation, empirical knowledge, and research ensued into different traditions and various media such as *myong byang*, *man ngag*, *dris lan*, and Chinese texts / word of mouth. Understanding a solar eclipse requires geographical and geometric knowledge. The *Tngri-yin udq-a* and the *Mā yang rgya rtsis* were designed with new modern astronomical knowledge and introduced by non-Tibetans (= Mongolian lamas) and Tibetans, respectively.

The paradoxical connections to the many sources have been resolved only in the sense of their being located in a bigger web of the *skar rtsis* and the *Kālacakra*. The *skar rtsis* affirms multiple solutions of explaining them within the boundary of the *Kālacakra*. The unfolding of the *skar rtsis* for eclipse calculation and the “sensation” attached to it is paradoxical. From a different angle, it shows the paradox of making sense of itself by
means of many sources. Ironically, the process of assimilating different knowledge sources has enriched the astronomical meanings of skar rtsis and interpretations of the Kālacakra. The rearrangement and resystemization of the skar rtsis have created a world in which the Kālacakra overarches the whole conception and methods of the skar rtsis and even the Mā yang rgya rtsis of Qing Chinese origin. The following hermeneutics have supported this approach that makes sense of itself and others to reconcile them with the Kālacakra: Intention (T. dgongs pa) in the Kālacakra was applied to the components within the boundary of Tibetan astronomy. In addition, compatibility (T. mthun pa) has been presupposed for the relationship between skar rtsis and rgya rtsis. The mthun pa may be also subsumed under the dgongs pa. The Kālacakra is overarching.

In the same manner, the unfolding of the mathematical approach for eclipse calculation in skar rtsis is conditioned by the mathematical concepts in the Kālacakra. The application of nur ster and the mere change of rtsis 'phro and stong chen 'das lo are fundamentally associated with such concepts and ideas presented in the Kālacakra as rtag longs and stong chen. They are tied to enhancing the eclipse calculation results, and the change of longitude by the manipulations of them is essentially empirical, based on the observations of astronomical phenomena. In fact, there is no guarantee that the eclipse calculation would become accurate by merely changing them and most of all, there is no guarantee that they are the real reasons for the inaccuracy of eclipse calculation.

Being aware of the defect in the calculation of solar eclipse, Tibetans attempted paradoxical connections. They intertwined the Chinese tradition later known as the Mā yang rgya rtsis. They focused on “saving the phenomena.” The new spatio-temporal
measurement in eclipse calculations using different concepts and mathematical
approaches, armored with geographical / geometric knowledge for solar eclipse was not
a concern to them. The skar rtsis method framed by the Kālacakra was a tool to accept the
non-religious Qing Chinese tradition. As a result, the Mā yang rgya rtsis nestles in a
paradoxical stability between the Kālacakra and non-Kālacakra elements. The skar rtsis
establishes the paradoxical relationship because of the unfolding of the Kālacakra
elements.

All in all, the Tibetan religious and astronomical justification of the rationale
involved in eclipse calculation is based upon the unequal relationship between the
Kālacakra and non-Kālacakra elements. The skar rtsis affirms both and forms paradoxical
relations. Two or more different “series” responded to each other and affluent meanings
emerged (“sensation”). The “sensation” is the process of making sense of different
elements in different “series”. Thereby, the “sense” of skar rtsis/ Kālacakra expands.
However, that is not all. The dynamics of the paradoxical connections have been
embodied, oscillating between abstraction and concreteness between the Kālacakra and
skar rtsis. It is a möbius strip traversing the entire loop and ending up at the starting point
of the Kālacakra. “Saving the phenomena” is a task for Tibetan astronomers, and the
Kālacakra postulates the way to “save the phenomena” religiously and astronomically.

Deleuze might have summarized in this way if he had studied eclipse calculation
in Tibetan skar rtsis / Kālacakra : “The Tibetan eclipse calculation is paradoxical, and
thereby, it is perfectly logical. It has its own logic: the combination and arrangement of
the components and connections in it are made possible because of paradoxical elements
(aka “quelconque” (“aliqüid”), “differentiator,” “fundamental blank,” “aleatory point,” (“point aléatoire”) etc.), which bring about the “event” (“événement”) in which multiple bifurcation of meaning / “sense” (“sens”) is generated. The “becoming” of the “event” unfolds in a limitless way. The “sense” is not separate from paradox. The “non-sense” (“non-sens”) makes possible the “sensation.” I pay homage to the journey of the philosophy of the “event” and “becoming” in the Tibetan astronomy.”

Lastly, I would like to stress that since my reading is based mostly upon later period skar rtsis texts, the early period skar rtsis texts may lead us to a different scenario. Also, in the early period, the Kālacakra corpus is pivotal and central in terms of the formation of skar rtsis. In conjunction with that, we (current and future scholars who work and will work on the field of Indian and Tibetan astronomy/ astrology) need to completely translate the first chapter of the Laghukālacakra and Vimalaprabhā.
APPENDIX I.

UNSOLVED PROBLEMS IN THE MONGOLIAN 60-YEAR CYCLE

Here is the table of the equation of Chinese, Mongolian and Tibetan 60-year cycles.

Table 51.

<table>
<thead>
<tr>
<th>T. shing byi (58)/mig dmar (S. raktākṣi)</th>
<th>shing glang (59)/khro bo (krodhana).</th>
<th>me stag (60)/zad pa (ksayā).</th>
<th>me yos (1)/rab byung (prabhava).</th>
<th>sa 'brug (2)/byung (vibhava).</th>
<th>sa sbrul (3)/dkar po (sukla).</th>
</tr>
</thead>
<tbody>
<tr>
<td>M. köke quluyan-a.</td>
<td>kökegočiñ üker.</td>
<td>ulayan bars.</td>
<td>uleyčin taulai.</td>
<td>sīr-a luu.</td>
<td>sīr-a moyai.</td>
</tr>
<tr>
<td>Ch. jiazi (戊子 (11)).</td>
<td>yichou (乙丑 (2)).</td>
<td>bingyin (丙寅 (3)).</td>
<td>dingmao (丁卯 (4)).</td>
<td>wuchen (戊辰 (5)).</td>
<td>jisi (己巳 (6)).</td>
</tr>
<tr>
<td>lcags rta (4)/rab myos (pramodādīta).</td>
<td>lcags lug (5)/skyes (prajāpati).</td>
<td>chu spre'u (chu srepl) (6)/ang gi ra (āṅgūra).</td>
<td>chu bya (7)/depl gdong (śrimukha).</td>
<td>šing khyi (8)/dnag po (bhāva).</td>
<td>šing phag (9)/ntshod lan (yava).</td>
</tr>
<tr>
<td>čāyan mori.</td>
<td>čāyačin qoni.</td>
<td>qar-a beči.</td>
<td>qar-a ychiy-a.</td>
<td>köke noqai.</td>
<td>kökegočiñ qaqai.</td>
</tr>
<tr>
<td>gengwu (辰午 (7)).</td>
<td>xinwei (辛未 (8)).</td>
<td>renṣhen (壬申 (9)).</td>
<td>gugyin (癸酉 (10)).</td>
<td>jiau (甲戌 (11)).</td>
<td>yihai (乙亥 (12)).</td>
</tr>
<tr>
<td>me byi (10)/'dzin byed (dāhīṭ).</td>
<td>me glang (11)/dbang phuyug (īśvara).</td>
<td>sa stag (12)/bru mang (bahuḍhānya).</td>
<td>sa yos (13)/myos ṭaṅ (pramāṭha).</td>
<td>lcags 'brug (14)/myos ṭaṅ (vikrama).</td>
<td>lcags sbrul (15)/khyu mchog (vṛṣa).</td>
</tr>
<tr>
<td>ulayan quluyan-a.</td>
<td>ulayan bars.</td>
<td>sir-a bars.</td>
<td>sir-a ychiy-a.</td>
<td>gungchen (庚辰 (17)).</td>
<td>ghayin (庚午 (24)).</td>
</tr>
<tr>
<td>bingzi (辰子 (13)).</td>
<td>dingchou (丁丑 (14)).</td>
<td>wuyin (戊寅 (15)).</td>
<td>jimao (己卯 (16)).</td>
<td>gungchen (庚辰 (17)).</td>
<td>gungchen (庚辰 (17)).</td>
</tr>
<tr>
<td>qar-a mori.</td>
<td>gungchen (庚辰 (17)).</td>
<td>jiašen (己卯 (16)).</td>
<td>yiṣyin (乙酉 (22)).</td>
<td>gungchen (庚辰 (17)).</td>
<td>gungchen (庚辰 (17)).</td>
</tr>
<tr>
<td>renwu (壬午 (19)).</td>
<td>renwu (壬午 (19)).</td>
<td>me khyi (20)/mi zad (vyaya).</td>
<td>gungchen (庚辰 (17)).</td>
<td>gungchen (庚辰 (17)).</td>
<td>gungchen (庚辰 (17)).</td>
</tr>
<tr>
<td>cha rta (16)/sna tshogs (citrabhānu).</td>
<td>cha lug (17)/nīy ma (subhadhānu).</td>
<td>sa stag (18)/nīy srepl byed (tārāna).</td>
<td>šing bya (19)/sya gong (pārthiva).</td>
<td>me phag (21)/thsuns cad 'dul (sarvajit).</td>
<td>me phag (21)/thsuns cad 'dul (sarvajit).</td>
</tr>
<tr>
<td>renwu (壬午 (19)).</td>
<td>renwu (壬午 (19)).</td>
<td>sa glang (23)/'gal ba (virodhān).</td>
<td>lcags yos (25)/bong ba (kharā).</td>
<td>sa 'bya (26)/maṁ 'gyur (vikṛti).</td>
<td>sa 'bya (26)/maṁ 'gyur (vikṛti).</td>
</tr>
<tr>
<td>sir-a quluyan-a.</td>
<td>bingxiu (庚未 (20)).</td>
<td>sa glang (23)/'gal ba (virodhān).</td>
<td>lcags rgyal (29)/maṁ 'gyur (vikṛti).</td>
<td>sa sbrul (27)/maṁ raṅ (vijāyā).</td>
<td>sa sbrul (27)/maṁ raṅ (vijāyā).</td>
</tr>
<tr>
<td>wuxi (戊子 (25)).</td>
<td>bingxiu (庚未 (20)).</td>
<td>lcags rgyal (29)/maṁ 'gyur (vikṛti).</td>
<td>lcags rgyal (29)/maṁ 'gyur (vikṛti).</td>
<td>sa sbrul (27)/maṁ raṅ (vijāyā).</td>
<td>sa sbrul (27)/maṁ raṅ (vijāyā).</td>
</tr>
<tr>
<td>köke mori.</td>
<td>lcags rgyal (29)/maṁ 'gyur (vikṛti).</td>
<td>lcags rgyal (29)/maṁ 'gyur (vikṛti).</td>
<td>lcags rgyal (29)/maṁ 'gyur (vikṛti).</td>
<td>sa sbrul (27)/maṁ raṅ (vijāyā).</td>
<td>sa sbrul (27)/maṁ raṅ (vijāyā).</td>
</tr>
<tr>
<td>jiawu (甲午 (11)).</td>
<td>lcags rgyal (29)/maṁ 'gyur (vikṛti).</td>
<td>lcags rgyal (29)/maṁ 'gyur (vikṛti).</td>
<td>lcags rgyal (29)/maṁ 'gyur (vikṛti).</td>
<td>sa sbrul (27)/maṁ raṅ (vijāyā).</td>
<td>sa sbrul (27)/maṁ raṅ (vijāyā).</td>
</tr>
<tr>
<td>(甲午 (31)).</td>
<td>lcags rgyal (29)/maṁ 'gyur (vikṛti).</td>
<td>lcags rgyal (29)/maṁ 'gyur (vikṛti).</td>
<td>lcags rgyal (29)/maṁ 'gyur (vikṛti).</td>
<td>sa sbrul (27)/maṁ raṅ (vijāyā).</td>
<td>sa sbrul (27)/maṁ raṅ (vijāyā).</td>
</tr>
</tbody>
</table>
To give some explanations for the understanding of the table, the cycle of the Chinese system begins in jiazi; that of the Tibetan system begins in me yos. That is why the numbers in the brackets are different. The two systems based upon 60-year cycles are used in Tibet: the upper row in the each cell is the rab byung (S. prabhava) system and the lower row is the system of Jovian cycle (S. brhaspaticakra) from Bde mchog stod 'grel which is a commentary to Caksaramvara.731 As there are different Tibetan renderings of the

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original sanskrit words in the latter system, it is much more complex than presented here.\textsuperscript{732} For the Chinese system in the table, see Sivin (2009: 68-70).

The Mongolian sexagenary system (M. \textit{saitur yaruysan} / \textit{masida yaruysan} \textless{} T. \textit{rab byung}) in the table features the color-animal based system with the principle of the harmony between \textit{ary-a} (T. \textit{pho} / Ch. \textit{yang 陽}) and \textit{bilig} (T. \textit{mo} / Ch. \textit{yin 隱}) (M. \textit{ary-a bilig jokilduqu}) in which original color indicates \textit{ary-a} and (original color + ċin) indicates \textit{bilig}. However, be careful! It is difficult to verify when the principle was fixed. It is found in later periods but not in the early one (sixteenth-seventeenth c.). Therefore, special care is needed to use the Mongolian list. Let me briefly expand upon this point.

Since it seems that the beginning of the Mongolian \textit{saitur yaruysan} system was not introduced to Mongolia until the political and religious alliance between Mongolia and Tibet under Altan Qa\textsuperscript{γan of the Tümed (1507-1582), I consulted some materials from that period.\textsuperscript{733} Given the remaining literature, as far as I know, the earliest evidence of a possible use of the Tibetan \textit{rab byung} system in Mongolia is the colophon of \textit{Manjūśrī-yin ner-e-yi üneker ögilekū} (S. \textit{Mañjuśrīmasaṁgiti}. T. \textit{Jam dpal mtshan brjod}) which is presumed to have been created in the late sixteenth century by Altan Qa\textsuperscript{γan’s grandson Bayayud

\textsuperscript{732} For the information, see van der Kuijp (unpublished (1)).

\textsuperscript{733} When the \textit{saitur yaruysan} system was first used in Mongolia is still unknown. We may be able to guess by investigating some possible sources. Because it looks that the system based upon only 12 animals according to the Chinese system had been used before the sixteenth century in Mongolia, the \textit{saitur yaruysan} system is immediately distinguishable.
bayatur dai qung taiji and his son Čos irgyamsu (< T. Chos kyi rgya mtsho ?) finds čayan taulai jil-ün arban nigen sara-da ... “in the eleventh month of the white-hare year.” In it, the “čayan taulai” is problematic. As seen in the table, there is no “čayan taulai,” but there is čayayčin taulai (1591). I think that the principle of ary-a bilig jokilduqu may not have been applied or fixed until the late sixteenth century when the colophon was written.

Another evidence of the use of the saitur ɣaruysan system in the early seventeenth century is the records of Altan Qayan’s birth and death in Erdeni tunumal neretü sudur whose author is unknown and which might have been written in the early seventeenth century. In it, Altan Qayan’s birth is given as yal qutu ěm-e taulai jil-ün budaday-ă kökeler sara-yin ɣučin-a ūker edür-ţür... “on the thirtieth day of the twelfth lunar month, an ţox day, in the fire blessed female rabbit year”. His death is given as čayan moγai jil-dür ... kökeler sara-yin arban yisun-e bars edür-ţür... “in the white snake year ... on the 

734 For the colophon, see Mañjuśrīnāmaṃgīti in Mongolian, Tibetan, Sanskrit and Chinese, and Sekoddeśa in Tibetan and Mongolian, Ed. Raghu Vira (19??: 230).

735 ?. Kollmar-Paulenz’s (2001: 154, 231) suggestion for bodatai-ă is “wirklich.” But, it does not look like a good solution.

736 The English translation is given in Elverskog (2003: 77-8). For the interesting term kökeler sara, there has been a great deal of modern research in the west and the east. Among the western works, see Rybatzki (2003: 264-5).

nineteenth tiger day of the twelfth month.” The “čąγan moγai” is a problem. It does not exist in the table. It is indicated as čąγaγčin moγai (1581) according to the table. In addition, I think that the principle of ary-a bilig jokilduq may not have been established until the early seventeenth century. Another intriguing issue in the phrases is that the five-element system of γal (T. me), sirui (T. sa), temür (T. lcags), usu (T. chu), modun (T. shing), together with the division between er-e (male) / em-e (female) [= five element + male/female] was used with the color-animal based system (→ see the phrase indicating his death). See his birth, in which not ulayčin taulai (= 1507. the color-animal based system), but γal qutuqtu em-e taulai jil (= 1507. the element-male/female system) is given. In other words, the phrase indicating his birth is an example of the early seventeenth century Mongolian use of the division between male (T. pho) and female (T. mo) and the

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240) dates reckoned from Qing Chinese calendar cannot be justified: according to Qing Chinese calendar, 1507/12/30 does not exist. In other words, January 31, 1508 (Monday) [= dingmao (丁卯) year, guichou (癸丑) month (small month composed of 29 days), wuxu (戊戌) day] falls on 1507/12/29, and February 1, 1508 (Tuesday) [= wuchen (戊辰) year, jiayin (甲寅) month, jihai (己亥) day] falls on 1508/1/1]. January 13, 1582 (Saturday) [xinsi (辛巳) year, xinchou (辛酉) month, jiyou (己酉) day] falls on 1581/12/19]. Yoshida et al (1998: 240), which reiterates Morikawa (1987: 114), knows that 1507/12/30 does not exist in Qing Chinese lunar calendar. However, it suggests that 1507/12/30 is a mistake of 1507/12/20. The ground is as follows: 20 resembles 30 in Mongolian handwriting and the twentieth day is also an ox day. Are this kind of arbitrary corrections justified? Huang and Shen (2005: 185-6) points out that in the late sixteenth century (possibly in the early seventeenth century, given the date of the Erdeni tumumal neretü suduri), Tibetan day reckoning system, in which the first day falls on tiger (T. stag) or monkey (T. spre’u) day, the twentieth day is chicken (T. bya) or hare (T. yos) day, and the thirtieth day is sheep (T. lug) or ox (T. glang) day, was being used. In other words, the fact that the thirtieth day is an ox day is not strange. Rather, the twentieth day cannot be an ox day in the Tibetan day-reckoning system. Whether or not we accept Huang and Shen’s (2005) argument, Morikawa (1987: 114) and Yoshida et al (1998: 240) cannot be accepted. It is also difficult to know which Tibetan system Mongolians used for day reckoning at that time. The same scenery unfolded in Tibet. Phug pa’s m = 1B was used according to Schuh (1973a) in the early seventeenth century? We do not have evidence.

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738 The translation is given in Elverskog (2003: 176).
five elements like the Tibetan rab byung system. Taken together, the color-animal based system and the system based upon the five elements coexist in Erdeni tunumal neretü sudur. In the case of the former, the principle of ary-a bilig jokilduqu in the table is not applied. 739

Another example of the Tibetan rab byung system in early seventeenth century Mongolia is the inscription (1624) of Čoγtu Taγji (1581-1637). 740  sčayan takiγya jil-iun namur-un ekin sarayin (sic. read sar-a-yin) qorin nigen-e ...  741 “on the twenty-first day of the first autumn month of the white-chicken year (1621).” Again, the čayan takiγya is problematic. It should be čayaγčin takiγya (1621) according to the table. The date of the inscription was founded is given as follows: Činggis qaγyan-i törüγsen usun morin jil-ece inaysi dörben jayun jiran dörben jil boluyan-a jil-iun eki modun quluyana jil sarayin eki yal bars sarayin arban tabun yeke čayan eđür-e ...  742 “on the big white day, which is the fifteenth day, of the fire-tiger month which is the first month [in] the wood-mouse year (1624) which is the first year,

739 The combination of the two systems may have later evolved into the color-animal based system with the principle of the harmony between ary-a and bilig. If an animal is taken from the color-animal based system and male or female is taken from the five element system combined with male/female, the color-animal based system with the principle of the harmony between ary-a and bilig is possible. However, I have no evidence at all.

740 The inscription has been recently researched again and transcribed in Ц. Баттулга, Е. Жанчив, et al, 2005. Цогт хүнтайжид хөлбөгдөх бичгийн дүрсэллүүд (эх бичгийн судалгаа), Corpus Scriptorum, Tomus III. It is not available to me.

741 See Vladimirtsov (1884-1931) (1926: 1254).

742 Vladimirtsov (1926: 1259-60).
when it became the 464th year743 after the water-horse year (1162) when Činggis qayan (possibly 1162-1227) was born, ... .” In this case, the year reckoning is based upon the five-element system. See usun morin jil and modun quluqana jil. In other words, it is verified that the two systems were being used together in early seventeenth century Mongolia and the principle of ary-a bilig jokilduqu in the table was not applied.

In summary, given these examples744 in the initial stage of the introduction of the Tibetan system, possibly in the late sixteenth (perhaps at the latest) / early seventeenth century, the color-animal system and five-element system seem to have been co-used for rendering the Tibetan rab byung system. It seems that in the early period, the clear division between color (Ch. yang) and color + čin (Ch. yin) has not been made. In other words, the use of the color-animal system based upon the ary-a bilig jokilduqu seems to have been fixed later.

Lastly, I have several doubts. The Mongolian translation of the Altan Fanjur completed in 1628-1629 (note that it was already being used in the early seventeenth century) where the Mongolian Laghukālačakra has been included, may have influenced on the practice of the saitur yaruqsan system in Mongolia. Or, the beginning of the Mongolian

743 The arithmetic is strange, but the translation is according to the Mongolian sentence.

744 I used very limited textual evidence. So, my conclusion is tentative. A fundamental problem is that not many Mongolian texts or inscriptions have survived. And each region may show a different method and tradition. In other words, the examples may not represent the use of entire Mongolian regions. For example, it is certain that the Tibetan rab byung system began to be used at the latest in the sixteenth century. Then, where in Mongolia? In conjunction with the gravity of the question, Öljelbayar (2004) suggests on the basis of Mongolian chronicles created during the period of Čing ulus that Mongolian chronicles use many different calendars such as Chinese and Tibetan. Different systems have been used during the same period in different regions and there is no uniform system.
saitur yaruysan system may be coupled with the transmission of the Tibetan skar rtsis (M. odun-u jiruqai) in Mongolia. However, we do not know when the Mongolian tradition of the odun-u jiruqai began in Mongolia.
APPENDIX II.

THE PREFACE OF THE TNGRI-YIN UDQ-A

[Tngri-yin udq-a (1990: 1); Tngri-yin udq-a (1711: 1)] Kitad-un jiruqai-yin sudur-ača mongyolčilan orčiyuluyan jiruqai-yin orusil.

The preface of the astronomy translated into Mongolian from a text of Chinese astronomy.

Erte enedkeg-ün oron-dur dotuγadu yosun-u jiruqai kiged yadayadu yosun-u jiruqai kemekü goyar juul boluyad yadayadu yosun-u jiruqai inu, šakimuni burqan yirtinči-dür ögede bolju-yin uridača delgeregzen ajuyu, dotuγadu yosun-u jiruqai-yi čay-un kürdün-eče nomlaysan anu, burqan yirtinči-dür ögede bolju, čay-un kürdün-ü ündüsün-i nomlaysan-u qoyin-a delgeregjüküi,

745 Tngri-yin udq-a (1711: 1-13) [= Tngri-yin udq-a (1990: 1-3)]. It should be noted that in the case of Tngri-yin udq-a (1711), the pagination is arbitrarily given by me according to the original print, because there are no page numbers in the print. The preface has already been translated twice: Matsukawa (1988: 40-62) in Japanese, and Huang and Shen (1988: 272-84) in Chinese. The former is a good translation which reflects Mongolian grammar—Mongolian is linguistically close to Japanese—and contains only some minor mistakes. The latter is relatively loose; the general idea is well presented but the rhetoric of Chinese makes the translation loosely tied to the Mongolian original text. Lastly, in contrast to the printer’s colophon in the Rgya rtsis chen mo (see Appendix III), which is filled with Buddhist ideas and concepts such as bstan rtsis, this preface is relatively neutral to Buddhism, evincing criticism towards the inaccuracy of eclipse calculations in the Kālacakra / skar rtsis.

746 The term sudur (S. sūtra) is generally used for Mongolian Buddhist texts. The Chinese astronomical texts Xiyang xinfa lishu (and maybe others) have nothing to do with Buddhism. Nevertheless, they are given the title sudur in Mongolian. In that sense, ‘text’ may be a better rendering for the term.

747 Lessing (1960: 630): “ögede bolqu”: “to pass away (honorific)”. As will be clear in the colophon of the Rgya rtsis chen mo, this term seems to be related to the fact that the authors of the preface base themselves upon the Phug pa interpretation of the date of the Buddha’s Kālacakra teaching. In the Phug pa tradition, the Kālacakra is regarded as the last tantra taught by the Buddha before his death. For more information, see chapter 1. Huang and Shen (1988: 274) incorrectly translate: “was born.” Actually, “pass away” looks not to be a nice fit to the context. And Öbör mongyol-un yake suryayuli-yin mongyol kele bičig sudulqu tasuy (1976: 276) [= Öbör mongyol-un yake suryayuli-yin mongyol sudulul-un küriyleng-ün mongyol kele bičig sudulqu yajar (1999: 276)] presents jialin (驾临), “advent/ descent”. In any case, the meaning is not generally well-understood.
Long ago in the land of India, two kinds [of astronomies] existed, called the astronomy of inner (Buddhist) principle and that of outer (non-Buddhist) principle. The astronomy of outer principle blossomed even before Śākyamuni Buddha passed away from the world; that which preached the astronomy of inner principle from the Kālacakra prospered after the Buddha passed away from the world, and [maybe Sucandra and the Kālacakra adherents] preached the Kālacakratantra.

Since the periods in which many emperors appeared in the land of China, astronomy has blossomed from the periods of the historical emperors of the twenty-two periods (dynasties) whose family origins are not the same; and although in their periods many astronomers, etc. of the successive seventy-two schools (?) purely performed the method of reckoning \(^\text{\textsuperscript{749}}\) time (M. čay möče < Ch. shike. lit. hour and minute),\(^\text{\textsuperscript{750}}\) etc. from the

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\(^{748}\) For the Mongolian term ‘ger,’ Huang and Shen (1988: 274) suggest ‘jia’ (家) meaning ‘school, sect’. This choice may not be plausible in Mongolian because it just means ‘tent, house.’ However, I follow their rendering because the term does not make sense if it is translated as ‘tent’ and also because the fact that this text was written by Qing Mongolian scholars under the strong influence of Chinese scholarship should be taken into account.

\(^{749}\) Two possibilities exist for rendering the strange term bodalan taniqu: 1. bodala. Lessing (1960: 108): “to count or number cattle by the head.” In this case, the rendering could be ‘reckon’ 2. bodatu. Lessing (1960: 109): “material, tangible, substantial, concrete, real, original.” In this case the rendering could be ‘really recognize.’ I think both of them would work. For tani-, see Lessing (1960: 778): “to know, to recognise, to be familiar with.”

\(^{750}\) In this sentence, čay is missing. However it is confirmed from other sentences that the authors mean ‘čay möče’, which seems to be a calque from the Chinese shike (時刻; hour and minutes); ‘čay’ is ‘shi’ and ‘möče’ is ‘ke.’ Sivin (2009: 82) renders the terms as “double hour and marks”; he states: “twelve equal intervals (shi 時), which I translate “double-hour. ... equal marks (ke 刻), each equivalent to 14.4 minutes on a modern clock.” This reflects the Yuan dynasty unit-system, which is based upon the 100 ke (刻) system. In the Manchu dynasty, the temporal units were changed to a 96 ke system. In other words, before the Shixianli was introduced, 1 day = 12 double-hours composed of 100 ke-s; 1 double-hour \(8 \frac{1}{2}\)ke-s; and 1 ke = 14.4 minutes. After the Shixianli was introduced, 1 day = 12 double-hours composed of 96 ke-s; 1 double-hour = 8 ke-s; and 1 ke = 15 minutes. The Xiyang xinfa lishu / Tngri-yin udq-a / Raya rtsis chen mo are based upon the latter.
motion of the sun, moon, planets, and stars, knowing accuracy without a mistake became unclear.

In the land of Tibet, each of the two, byed rtsis (M. üile-yin jiruqai), known as the astronomy common to outer and inner [principles], and grub rtsis (M. siddi-yin jiruqai), known as the astronomy that is of inner [principle and] is not universal, has prospered from ancient times. However, at the same time there are those [texts] which explain that it is necessary to concretly recognize the shike, etc. of the solar and lunar eclipses, after one has understood by measurement the height of the place (= altitude) and the rise of the sun and moon in the morning and evening [respectively]. Because the methods, etc. of observing the level of the height of the place were not clear in the texts, astronomers had difficulty in unerringly understanding the shike, etc..

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751 From the context, it looks to be the case that “tüidküi”, meaning “obstruct”, is rarely used for denoting eclipses. Naran bariqu for solar eclipse and saran bariqu for lunar eclipse are commonly used in Mongolian literature.

752 It is difficult to translate “kemjiyen” in “kemjiyen-dür onužu”. My suggestion is “measurement.”

753 This word is rarely seen. It may be related to “bodatai”, meaning “concrete/ substantial.”

754 My suggestion for “kemjiyen” in “kemjiyen-i üjeküi” is “level.”

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Although in the land of Mongolia, astronomy translated from Tibet has prospered, there is the exact same difficulty in reckoning shike, etc. For that reason, the Mañjuśrī Elhe taifin Kangxi Emperor, (M. Manjusiri degedü (engke) amuyulang qayan / Man. Elhe taifin)\(^{756}\) having clearly grasped all the very delicate accuracy of [the different] kinds of astronomy exactly according to the principles, exclaimed (honorific) something which would become useful to all astronomers: "Newly add [the contents] necessary to bring accuracy to that which has become unclear in those nice texts, gathering it from the astronomical texts, the essence of astronomy, which has blossomed in the land of China blessed by Mañjuśrī. Then clearly bring out the method of observing the level of the height of each region, and the method of accurately reckoning shike of the sun, moon, planets, and stars, etc, whichever there may be, without any mistakes. Then newly edit and compose in Chinese this unprecedented good teaching, which stems from the astronomical texts, the essence of astronomy; then translate [it] into Mongolian again, and then carve [it] into blocks!"\(^{757}\) Being respectful of and following such a command, [we] have translated them.

\(^{755}\) emphatic word.

\(^{756}\) T. bde ldan rgyal po is given in the Rgya rtsis chen mo.

[We] translated the text (=Xiyang xinfa lishu) that had been newly edited by the heavenly holy Mañjuśrī Elhe taifin Kangxi Emperor, as well as the teachings of many kinds and categories of pictures and tables for realizing accurate measures, etc. of the shike of the sun, moon, planets, and stars, and of the height of the place, and similarly additional texts considered necessary for research, and carved [them] into printing blocks. Because in the land of China, the Middle Great Empire which prospered 759, there are many instances of astronomy, a field of knowledge preached by the bodhisattva Mañjuśrī having been translated into Tibetan, and because it is difficult to betray the command to translate [it] into Mongolian, as it was certainly something written by the Mañjuśrī

757 It is difficult to literally translate the phrase üjegesn sonusuysan čögen-ečes masi čögeken: üjegesn sonusuysan is a calque from the Chinese jianwen (見聞), meaning 'knowledge,' or literally '[what one] has seen and heard.' čögen-ečes masi čögeken means 'extremely few from being few,' which means 'really few even while being few.' Taken together, I translate the phrase as 'extremely little knowledge.'

758 The phrase oyun bilig ber bidayu moquduy büküi may look interesting to European readers. Firstly, it literally means 'wisdom [that] is stupid and dull,' which means 'stupid and dull.' Secondly, two synonyms are consecutively used: oyun is a synonym of bilig, while bidayu is a synonym of moquduy. This tradition looks to be related to the time-honored Uyghur literary tradition. For example, the phrase 'bilgä bilig,' in which each word meaning 'wisdom' is consecutively used, is seen in Uyghur Buddhist texts. - I think specialists of Uyghur Buddhism have a clear sense of this and all relevant issues which are currently beyond my ability. - Modern Uyghur calls it jüpsöz (چۇپ سۇز), a paired word.

759 The manduysan is given in the Mongolian text. It is the past tense.
Emperor himself, [we] rejoiced with one another by respectfully following [this order] with very pure and truthful hearts, and have translated to the best of our ability. After newly editing the texts of astronomy, the absolutely deep field of knowledge, when [we] initially translated those [texts] which came especially from the center of the ocean of the deep intellect of the Mañjuśrī Emperor, as well as those yet-untranslated texts inherited from ancient times, need we even mention that we were unable to understand [them] clearly? May scholars and wise people not blame [us for this] when they are reading it! Because of [our] extremely limited knowledge, and furthermore our stupidity and dullness, although being able to truly know is very difficult, may those wise persons who have studied many of the fields of learning correct this one, which has been translated by finding simple (normal) terminology, by examining and clearly knowing the principle and essence! If there is something corrected by [your] finding, may it be useful to all without fault! By means of this text, thus translated, may the entire field of astronomy prosper well and unmistakenly throughout every place, and may it exist permanently, incessantly, always, firmly and perfectly, and may it always fulfill all that is hoped for! Starting from the Chinese text, we translated [this] into Mongolian on the eighth day of the eighth month in Elhe taifin Kangxi 50th year (1711 C.E.) (= September 20, 1711).

[Tngri-yin udq-a (1711: 9)] orčiyulyği kelemürčińer-ün ner-e inü.

Names of the translators and interpreters.⁷⁶⁰

⁷⁶⁰ Throughout the Manchu dynasty (Man. Daicing gurun; commonly Qing dynasty), hundreds of Manchu and Mongolian astronomers were produced. This began from Elhe taifin Kangxi’s (r. 1662-1722) concern for Western astronomy and science, and his insistence on teaching these subjects to Manchus and Mongolians of the eight banners (Man. jakūn gūsa). It is not difficult to find information on this subject. Citing Xi Yufu’s (席裕福. ? - 1929) Huangchao zhengdian leizuan (皇朝政典類纂), juan 217: Xuexiao Suanxuesheng (學校 算學生), Li (1989: 37) shows that training in astronomy was provided to the Mongolian eight banners (Man. monggo gūsa / Ch. baqi menggu 八旗蒙古) at least from Elhe taifin Kangxi 9th year (1670), in equal measure to that given to the Manchu eight banners (Man. manju gūsa / Ch. baqi manzhou 八旗滿洲) and the Chinese eight banners (Man. ujen cooha gūsa / Ch. baqi hanjun 八旗漢軍). Li (1989: 37) also cites the Qingchao wenxian tongkao (清朝文獻統考), juan 66 Xuexiao San (學校 三) to show that in Elhe taifin Kangxi 52nd year (1713), the Suanxueguan (算學館) was established at Mengyangzhai (蒙養齋) in Changchunyuan (暢春園), Beijing, and elected students from the eight banners received astronomy/ mathematics training there. As an example from a later period: the Menggu minzu tongshi bianweihui (滿族通史編委會) of 2002 indicates, based on the jiaqing Daqinghuidian (嘉慶, Saicungga fengšen Jiaqing. r. 1796 ~ 1820. 大清會典), juan-s (卷) 64 and 65, that shixianke (時憲科) was established as a subsection of the Qintianjian (欽天監), while two Mongolian wguanzheng-s (五官正), two Mongolian boshi-s (博士), and four Mongolian tianwensheng-s (天文生) were assigned to be responsible for the creation and publication of the Mongolian shixianshu (時憲書), the
calculation of eclipses, and so on. This kind of imperial policy may help us understand the reason why
Mongolian astronomers with knowledge of Western astronomy appear in the Preface of Tngri-yin u dq-a.

\[761\] Jayuči: Qayan-u bičišen tabun jüü-l-un üsüg-iyer qabsuruuyan manju ügen-ü toli bičig (1957: 1173). Jayučiši :

\[762\] ‘Dotuyadu’ and ‘sidar’ literally mean ‘inner’ and ‘close’ respectively. Since I am not a specialist in the field
of Mongolian law or politics, I am unsure whether or not the ‘dotuyadu sidar’ is a part of the title kiy-a. - It
literally mean ‘one who exists closely to Emperor’ like ‘drung na’ khod pa’ (drung na’ khod pa’i khya ya bkra shis,
“Kiy-a Raši who exists in (Emperor’s) presence”) in the Tibetan printer’s colophon of the Rqya rtis chen mo.
In the case of the term kiy-a, we have a clearer understanding: Serruys (1958: 91-2): “‘kiy-a’ is not a
personal name, but the name of an office, or a title.” It is defined in a Chinese text as “shouling (首領
foreman)”, “an able manager in the court of a taiji, in charge of great and small affairs of the tribe.” Lessing
Lessing (1960: 1215): “Jayučin kiy-a. imperial guard officer who reports on Mongolian affairs to the emperor.”
Kiy-a’s Manchu equivalent is hiya. See Norman (1978: 131): “guard, page, specifically an imperial guard who
侍衛. Imperial Guard or Imperial Guardsman.” All in all, the title seems to indicate different Mongolian
titles in different time periods, but it must refer to those persons who closely assisted emperors in the Qing
dynasty. For Raši (aka Rasi) (?-1720s ?), see Gongzhong manwen zu pi zouze (宫中满文硃批奏摺) no. 24. at
1717 (Elhe taifin Kangxi 56th year)/7/1 (according to the Chinese lunar calendar), included in Suo and Guo.
ed. (2004: 62-71). Furthermore, in the Mongolian colophon of the Sīngan Γanjuur in Red Ink completed
1720, included in Čidalu (2005: 187-8), he is mentioned among those persons in charge of the production of
the Γanjuur blockprint (M. yanjuur-un keb-i baiyulqi-yin jaktriyči): čyam čung min-i sidar ayči (? . ‘sidar’ seems
to be a word which is related to ‘dotuyadu sidar (maybe shiwei ?).’ Čidalu’s (2005) Mongolian computer input
is not reliable) teriγiin jerge-yin kiy-a rašī. (“The first-rank shiwei Kiy-a Raši at Qianqingmen 乾清門.”) Nata
(1991: 245-6): ... tunglay (C, D: tungyalay). For the different four editions of Altan Erike, see Nata (1991: the
editor Čorji’s preface, 1-4): there are differences in editions A, B, C, and D. A is an edition from Gandan
Temple in Mongolia and Corji has never seen it. B has been stored in Ôbör mongol-yin neigem-ün sinjilekii
uqayin akademi-yin nom-un sang. The manuscript is composed of three volumes: first volume: 1b-45b,
second volume: 1b-52b, and third volume: 1b-62b. C is three different editions (Mong 95, Mong 141, Mong
351) from the Royal Library in Copenhagen, Denmark. Among them, Mong 95 is complete, but several lines
are missing in the case of its colophon. In the case of Mong 141 and Mong 351, many parts are missing
and are in bad condition. D has been stored in Ôbör mongol-yin nom-un sang (Ch. Neimenggu tushuguan): no.
01715. It is incomplete: being compared with the manuscript in Ôbör mongol-yin neigem-ün sinjilekii
uqayin-yin nom-un sang, the first volume and 1b-40b in the second volume are missing. But, the colophon is
complete) oytaγyai-yin egüden-ü (B, C, and D has teriγiin jerge-yin kiy-a rasi ... “(the first-rank officer) Kiy-a
Rasi at Qianqingmen.” According to Clark, Walravens, Krueger, Taube and Walter (2006: 12, no. 3), Raši,
Danjan [Danjin is better], Arbidqu Abida, Sengge Arana, Sengge, Batuvčir, Misig, and Pürbü authored The 36
Category Explanatory Dictionary (M. Pučin jirγyuyatu tailbur-i tol) (published year: ?). Among them, Raši, Danjan

Dotuyadu sidar Kiy-a (Ch. shiwei 侍衛) Raši (aka Rasi; Ch. Laxi 拉錫), a mediator of Tibetan-Mongolian affairs. Baysi (teacher, instructor)765 at the School of Tibetan (Ch. Tanggutexue 唐古特學. M. Töbed bič-ūn suryayuli) and Jasay-un lam-a Danjin gelung (T. Dge slong Bstan ’dzin) who studied Tibetan and Mongolian books and documents, et al.766 Baysi Arbidqu, instructor at the School of Tibetan. Baysi Beki, Mongolian astronomer.

(Danjin), Arbidqu Abida, Sengge Arana, and Sengge collaborated for the compilation of the Tngri-yin udq-a. He is further mentioned in any number of modern articles and books in Chinese. All in all, it is speculated that dotuyadu sidar kiy-a became a Mongolian high-officer in Elhe taifin Kangxi’s favor, and was involved in many political, academic and religious activities related to Mongolia. Elhe taifin Kangxi must have consulted him about many issues related to Mongolia.

763 ‘tölülen’: ‘representative.’ ‘tölülen kögeçči’ is rarely found in Mongolian literature. A more commonly-used phrase is ‘orulan kögeçči’ (‘the assistant of janggi’). For janggi, see below note 767. There are two for each sumun. See Oka (2007: 134-5), Lessing (1960: 622): ‘lieutenant.’

764 This transliteration is tentative. Generally, it is difficult to write Chinese names in Mongolian for phonetical reasons. Consequently, strange scripts are often introduced to write them in Mongolian.

765 For the textual evidence of various usage and meaning of this term, see van der Kuijp (1995: 275-302).

766 This lama appears in the printer’s colophon in the Rgya rtsis chen mo. See below pp. 358-9.
Baysi Očir (S. Vajra), Mongolian translator. Adjutant in the Dumbai district, Chinese Translator. Qo guo zong, Chinese astronomer. Baysi Liu yu si, Chinese astronomer. Second rank civil officer at the Cabinet (M. dotuyadu yamun. Ch. nei̇ge 内閣) Očir, who carved the blocks after having carefully investigated and edited astronomy. Second rank civil officer Laduyn. Copyist (T. yi̇ ge pa) officer-s Sengge (T. Seng ge) and Samadi (S. Samādhi). Lieutenant Arana. Commander of Horse Herds Bajār (S. Vajra), Dunju (T. Don grub), Sereng (T. Tshe ring), Gendüsjab (T. Dge 'dun skyabs), Sambuuj, Giyonju / Giyünjü, Sereng, Bandi, Gowambuu (T. Mgon po), Jünggüi, Fiyantu, Idam (T. Yi dam), and Čanglu. Wuguanzheng at Qintianjian.

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767 M. janggi (Man. janggin / Ch. zhangjing 章京) is adjutant / captain of the district (M. sumun / Ch. zuoling 佐領. For these terms, see Oka (2007: passim).

768 This man seems to be He Guozong (何國宗, ? - 1767). However, Qingshigao, Liezhuan (列傳) 70: 崇熙五十一年進士 ... 命直內廷學算法. 五年, 命編輯律歷淵源."He [achieved] the rank of jinshi (Ch. 进士) [in the imperial exam] ... was ordered to study astronomy/ mathematics (算法) at the Palace in 1712. He was ordered to edit the Sources of Musical Harmonics and Mathematical Astronomy (Ch. Lüliyuanyuan 律歷淵源) in 1713." This Preface was created in 1711. More detailed research on his life is necessary.

769 He participated in the compilation of the Rgya rtsis chen mo, according to the printing colophon of the Rgya rtsis chen mo. I have no idea who he is.


771 For zhongshuguan 中書官, see Hucker (1985: 193, no. 1606).

772 Bandi (Ch. 班第) which appears in Qing Chinese texts may derive from the Mongolian word Bandi which may be related to T. ban dhe. Actually, Bandi refers to a low-ranking monk in the Mongolian monastic hierarchy in the Manchu dynasty.


774 The Qintianjian 欽天監 was the Bureau of Astronomy in the Manchu dynasty.
Cangju, Čangming (Ch. Changming 長命), Qo giyün si, and Buu ge čeng. Boshi\textsuperscript{775} officials U čen, Li šang gi, Šuu yün long, and Ša du. Tianwensheng\textsuperscript{776} Fa ru jen.

\textsuperscript{775} For boshi (博士), see Hucker (1985: 389, no. 4746). Also see Hucker (1985: 510, no. 6727): tianwen boshi (天文博士).

\textsuperscript{776} tianwensheng (天文生) is student and disciple of astronomy in the Qintianjian.
APPENDIX III.

THE PRINTER’S COLOPHON OF THE RGYA RTSIS CHEN MO

‘Jam dbyangs bde ldan rgyal pos / mdzad pa’i rgya rtsis bod skad du bsgyur ba’i spar byang /

The printer’s colophon of the Tibetan translation of the Chinese Calculation composed by Mañjuśrī Kangxi Emperor.

[shang 1] Om swa sti / mthon mthing ral pa’i khurb ‘dzin gser gyi mdog / shes rab ral gri sher phyin glegs bam bsnams’ / mi shes mun sel blo gros mchog stsal shā / ‘jam pa’i dbyangs kyis rtag tu ’gro nams skyongs / ngag gi dbang phyug ‘jam dpal gzhon nu nying / skye dgu’i bsod nams legs byas dpal yon du / ’khor los bsgyur ba’i rgyal po’i tshul bstan pa / bde ldan rgyal po’i zhabz zung spyi bos bsten / gang de’i blo gros yangs pa’i mkha’ dbyings las / legs bshad rtsis kyi ’od stong ’di shar bas / mi shes mun pa ma lus sel nges kyi / blo ldan gzhon nu’i tshogs nams spro ba bskept /

\[a\] This should be xia 1 [= 1b]
\[b\] khur : I take this as the past from of ’khur (to carry, shoulder, bear, etc.). I use the present form to render the word.
\[c\] bsnams is the past form of snom. I use the present form to render the word.

Om Svasti! May all beings be permanently protected by Mañjuśrī, who carries dark blue braided hair [with] a golden-colored [body] and holds a sword of wisdom and the book of the Prajñāpāramitā, the divine being who clears away the darkness of ignorance and who grants the highest intelligence!\[777\] By [bowing down our] crown of head, [we] serve the

\[777\] For the Tibetan appellation of Elhe Taifin Kangxi Emperor, Bde skyid is well known. See Tuttle (2011: 194-5. And see Karsten (unpublished: 5): Bde ‘jag is given together with Bde skyid. In this colophon, Bde ldan is given as the Tibetan appellation of Elhe Taifin Kangxi. Since the Mongolian Tngri-yin udq-a from which the Tibetan Raya rtsis chen mo was translated addresses him as ‘manjuśrī degedii amuyulang qayan,’ which is reconstructed as “’Jam dbyangs gong ma bde ldan rgyal po’ in Tibetan and which appears later in this colophon, it is highly possible that the Tibetan appellation Bde ldan reflects that of the Mongolian original text Tngri-yin udq-a. It should be also noted that both the Tngri-yin udq-a and the Raya rtsis chen mo were created by Mongolian lamas.

\[778\] In the Tibetan Buddhist iconography, Mañjuśrī holds a sword of wisdom in his right hand and the book of the Prajñāpāramitā on his left shoulder.

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two feet of the Kangxi Emperor, Lord of Speech (S. vāgīśvara), Mañjuśrīkumāra\textsuperscript{779}, the one who showed the form of wheel-turning king (S. cakravartinrāja) for the excellence, virtuous actions, and lustrous qualities of all beings. Since this text, a thousand (immeasurable) rays of the well-put calculations, appeared from the spacious expanse of his vast intelligence, those young wise ones who will be certain to eliminate ignorance and darkness [by it], with none remaining, will produce pleasure.

ces tshig gi spros pas rngun\textsuperscript{a} bsus nas skabs su cung zad gleng bar bya ba ni / spyir sangs rgyas shākya thub pa'i 'khrungs lo 'dir mkhas pa'i luigs mi 'dra ba mang du yod kyang / phug pa'i luigs la ston pa shākya thub pa de nyid 'dzam bu'i gling gi yul rgya gar gyi grong khyer ser skya'i lumbini'i tshal du lcaqs spre zla ba bzhi pa'i tshes bdun la sku bitams / dgu ng lo nger du pa sa byi zla ba bzhi pa'i tshes bco lnga la rab tu byung / dgu ng lo so lnga pa shing rta zla ba bzhi pa'i tshes bco lnga la sangs rgyas / lo de ga'i zla ba drug pa'i tshes bzhi nas bzung wa ra ṇa si sogs su chos kyi 'khor lo bkor te gdul bya rnams phan bde'i lam la bkod / dgu ng lo gya gcig pa lcaqs 'brug zla ba gsum pa'i tshes bco lnga la dpal ldan 'bras spungs su sham bha la'i rgyal po zla ba bzang po la dus 'khor rtsa rgyud gsungs nas grub rtsis dar / lo de ga'i zla ba bzhi pa'i tshes bco lnga la rtswa mchog grong du mya ngan las 'da' ba'i tshul bstan pa nas bzung lo zhe bzhi pa shing pho byi lo'i hor zla bcu gcig pa'i tshes bco lnga'i sbrul gyi dus ri bo rtse lngar triksa\textsuperscript{b} zhes pa'i shing gi lba ba las / rje btsun 'jam pa'i dbyangs sku mdog gser btsa ma lta bu zhig sku bitams nas lha mi sogs / [shang 2] 'khor rnam pa lngas bskor te bzhugs pa'i dus lha tshangs pas gser gyi 'khor lo rtsibs bcu pa dang / lha mo rnam rgyal mas lha'i me tog tsam pa ka phul te sens can gyi don du rtsis kyi rgyud gsung bar gsol ba btab pa la brten / 'jam dpal gyi sku gsung thugs yon tan 'phrin las kyi rgyud sogs rtsis sgo brayad khrì bzhi stong dang / gab rtse\textsuperscript{780} sum brgya drug cu sogs gsungs shing lo brgya'i bar

\textsuperscript{779} According to Lamotte, a bodhisattva on the tenth bhūmi such as Mañjuśrī has the titles of a young man (or prince) (S. kumārabhūta) and ekajātipratibaddha (Ch. yisheng buchu (一生補處); T. skye ba gcig gis thogs pa), the bodhisattva who is “bound to (only) one more birth” to attain buddhahood. For kumārabhūta, Lamotte (1960: 13-4): “Le Bodhisattva de la dixième terre porte les titres de ekajātipratibaddha et de kumārabhūta. … L’épithète de kumārabhūta, en tibétain gzhon nur gyur pa, est presque synonyme: dans la dixième terre, le Bodhisattva reçoit l’onction (abhiṣeka) qui le consacre prince héritier (kumāra) du Roi de la Loi ….” For ekajātipratibaddha, Lamotte points out that only a bodhisattva on the tenth bhūmi can obtain the Śūraṃgamasamādhi. See Lamotte (1960: 14): “c’est dans la dixième terre que le Bodhisattva entre en possession du Śūraṃgamasamādhi „concentration de la Marche héroïque” qu’il ne partage qu’avec les Buddha.” For a detailed understanding of this term, read Sara Boin-Webb tr. (1998: 119 ff).

\textsuperscript{780} No unanimous understanding for the term gab rtse (gab tse) has been reached. Tucci’s rendering of the term is ‘jiāzi’ (甲子) referring to the Chinese sexagenary cycle. See Tucci (1949: 739, n. 31). Stein’s rendering for the term is “oracle.” See Stein, Mckewon Trans. (2010: 266, 271, n. 51). For the various understandings suggested by more scholars, see Tseng and Lin (2007: 169-207; especially 181, n. 39). Throughout the article, Tseng and Lin’s suggestion is ‘divination (Ch. zhanbu 占卜).’ Here, I roughly render the term as ‘Chinese divination.’
After having placed to the fore such an elaboration of words, as for speaking a little about the context: generally, though there are many dissimilarities among the scholarly traditions here regarding the year Śākyamuni was born, according to the Phug tradition he was born in the Lumbinī grove of an Indic town Kapilavastu, a place in Jambudvīpa, on the seventh day of the fourth month in the iron-monkey year (961 B.C.E.).[781] [He] was ordained at the age of 29 on the fifteenth day of the fourth month in the earth-mouse year (933 B.C.E.). [He] attained enlightenment at the age of 35 on the fifteenth day of the fourth month of the wood-horse year (927 B.C.E.). [He] turned the dharma wheel in Vārāṇasī, etc., from the fourth day of the sixth month of the same year, and established those to be disciplined on the path of happiness and well-being. After he proclaimed the Kālacakramūlatantra to the Śambhala king Sucandra (T. Zla ba bzang po) at the age of 81, on the fifteenth day of the third month of the iron-dragon year (881 B.C.E.) in lustrous Dhānyakaṭaka (T. 'Bras spungs), the siddhānta astronomy (T. grub rtsis) spread. At the snake time[782] of the fifteenth day of the eleventh Mongolian month of the wood-male-mouse year (837 B.C.E.), which was the forty-fourth year beginning from [his] achieving

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[781] According to the Sde srid (2002: 276-80), this tradition dates back to Lang tso ldang (sic. read ldong) yags who operated during the period of Khri srong lde'u btsan (8th c.) and his descendant Mi nyag Rgyal mtshan dpal bzang po, who received teachings from Khyung nag Shāka dar. Then, around the 15th century, the three famous Rgya mtsho-s appeared, followed by Dpal mgon 'phrin las pa (15th c.-16th c.), Padma Chos skyong, 'Chi med bde ba (16th c.), Ldum po Don 'grub dbang rgyal, et al. Dharmāśrī and the Sde srid are here said to be the zenith of the tradition. For more information, see also Yum pa’s summary introduction to this book (deb ’di’i ngo sprod mdor bs dus) that is included in Grwa phug pa (2002: 1-4), and see above note 285.

[782] Snake time (Ch. sishi 巳時) is one of the 12 two hour periods of the day which falls from 9 to 11 (midmorning). For the Chinese context, see Chen (1983: 118-32), and Needham, Wang and de Solla Price (1986: 199-202). For the Tibetan context, see Henning (2007: 358), and above note 543.
nirvāṇa in the village of Kuśinagara, on the fifteenth day of the fourth month in the very year (881 B.C.E.), venerable Mañjughoṣa, one with a seemingly pure gold-colored body, was born from a burl of the tree named vṛksa in Wutaishan. Then, when he was surrounded by a five-fold assembly including celestial and human beings, Brahma offered him a golden wheel with ten spokes and the goddess Vijayā offered campaka and they pleaded for him to speak the calculational tantra for the benefit of sentient beings. On that basis, he stated the eighty-four thousand doorways to calculations and the three hundred and sixty kinds of Chinese divination, which are the tantra-s, etc. of Mañjuśrī’s body, speech, mind, merit, and buddha activity, and brought immeasurable benefit for sentient beings up to one hundred years, as it is stated in the Thang yig of the great teacher Padmasambhava from Oḍḍiyāna. It is known that when a full five hundred and sixty years had elapsed (277 B.C.E.), as calculated from Mañjughoṣa’s year of birth, having been petitioned by many people including the sage S.ṛṣi Sūryaratha (T. Nyi ma’i shing rta) and others to the Śambhala king Kalki Mañjuśrī Yaśas (T. Rigs ldan ’Jam dpal grags pa), saying “please summarize all the meanings of the Kālacakramūlatantra and teach [it]”, he spoke the Laghukālacakra, and then the karaṇa astronomy (T. byed rtsis) spread.

da ni rtsis kyi bstan bcos ’di nyid ji ltar byung ba’i rgyu mtshan ni gong gi ‘jam dbyangs ’khrungs pa’i lo nas rtsis pa’i’ lo nyis stong dang bzhi brgya dgu cu go gnyis song ba na/ ’chi med dbang po’i grong khyer sa la ’phos pa ltu bu rgyal khab chen po pe cing zhes bya bar/ ’jam dpal gzhon nur gyur pa de nyid mi’i dbang po’i tshul bzung nas phyoṣ gs med pa’i ‘gro ba mtha’ dag phan bde’i lam la ’god par dgongs te stobs kyi ’khor los bsgyur ba shun ji rgyal po’i sras su shing rta zla ba

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783 Many books of Tibetan Materia Medica (T. ’khrungs dpe) can be used to identify this plant. For example, Pasang Yonten’s (1998: 194) glossary reads as follows for campaka: “Oroxylum indicum vent. It is a white smooth and flat seed found in large numbers inside a long, flat pod which is about the size of an arrow.”


785 Many different spellings exist: Oḍḍiyāna, Uḍḍiyāna, Uḍḍiyāna, Udıyāna, Udyāna, Udyāna, etc.

786 He is sometimes wrongly sanskritized as Mañjuśrīkīrti; see Newman (1987: 156-7). For the history of Śambhala kings, see Newman (1985: 51-90).

787 For the appellation of Eyeber Jasaγči Shunzhi Emperor in Tibetan, see Tuttle (2011: 194). Also see Karsten
Now, as for the process of how this astronomical text came into being: when twenty-four hundred and ninety-two years had passed, as calculated from Mañjughoṣa’s year of birth above, the Mañjuśrī kumārabhūta, having appeared in the form of a human ruler and intending to establish the path without partiality for the happiness and well-being of all beings, was born as a son of the Shunzhi (Ch. 順治 r. 1644-1661) Emperor, a powerful wheel-turning king, with auspiciousness and many miraculous signs, on the eighteenth day of the third month of the wood-horse year (May 4th 1654 C.E.) in the great capital called Beijing, a city comparable to the immortal king’s city shifted to the earth. In the first Mongolian month of the iron-ox year, (1661 C.E.) after Brahma, the worldly forefather, had opened the gate of the sky, he (Kangxi Emperor) was empowered (S. abhiṣeka) as the one called the golden cakravartin of merit, the Mañjughoṣa (Mañjuśrī)

(unpublished: 4).

788 It literally means happiness and well-being. But, it is highly possible here that it denotes Elhe Taifin Kangxi Emperor. See above note 359.

789 For the notion of golden cakravartin in the Tibetan Buddhist cosmology, see Walter (2009: 289-90). He cites Inagaki’s article in which the following interpretation on golden cakravartin is found: “A golden
Emperor the Great King with Happiness, on the precious throne supported by a golden dragon. He was honored by the multitudes, and having placed his toenails on the crown of the tops of the heads of all the gods, humans, and sentient beings, he placed all sentient beings under the shade of saṃsāra in [the state of] the luster of Emperor Kangxi, to the extent that the all-victorious banners from all directions were raised up to the summit of the world and the white parasol (S. sitātapatrapā) of law (S. dharma) completely filled the entirety of the sky [or: “the entirety of heaven and earth” (see note c above)].

In order to spread the precious teaching of the Buddha in one hundred directions (every direction), he pays limitless respect to the teaching, such as the construction of temples and statues, scriptures and stūpas, and the establishment and worship of the divisions of buddhist communities, etc. Having examined in depth all the scriptural traditions of astronomy, he restored what was damaged, corrected what was wrong, and made the incomplete complete. He himself added what should be newly added, and in order [for them] to be easily understood and easily known, having united as one the quintessence of calculations, and written [it] in Chinese, he spread and expanded [it] to places all over great China. Then, based upon the command given to his attendant Kiy-a Raši, and others, saying “translate [it] into Mongolian,” the great Chinese and Mongolian translators translated [it] into Mongolian.

**cakravartin** is the noblest and the most powerful of all four kinds of cakravartins, or ideal kings in India, and is said to reign in the four continents. The other three are silver, copper, iron cakravartins.” For the citation, see Inagaki Hisao, “Kūkai’s Sokushin jōbutsu gi,” *Asia Major* 17, no. 2 (1972: 196, n. 4).

790 For religious implication of sitātapatra in the Qing dynasty, see Sørensen (2011: 112). For its flourishing in the Yuan dynasty, see Cleaves (1957: 455, n. 124). For a textual study based upon different Mongolian sitātapatra (M. čaγan šikürtei) texts, see Sárközi (2007). For a brief review of Western scholarship on sitātapatra, see Sárközi (2007: 231, n. 2).

791 For a general history of Qing astronomical systems including the Xiyang xinfu lishu in the above context, Shi (2008) is recommendable.

792 For Raši, see above note 762. For phonetic relationship between bkra shis and raši, see Lessing (1960: 236): “dasi and rasi are given for the Mongolian equivalents of Tibetan bkra shis.” Also see Kara as translated in Krueger (2005: 134): “In the later, non-Ando-style, phonetic transcriptions two Mongolian ways to read Tibetan words are reflected, for instance, the name Bkra shis ‘fortune, happiness’, is transcribed in the form Daši among the Khalkhas, Buryats and some North-Eastern (for instance, Khorchin) Mongols but Raši among the Oirats and the Southern Mongols (Ordos, Chahar, Tümet, Khorchin).”
After that, as for how it was translated into Tibetan, the Mañjughoṣa Great Emperor dispatched as envoys his students, the bhikṣus Ngag dbang blo bzang and Bstan pa rgyal mtshan, who had become learned in this tradition, and gave the calculational volumes translated into Mongolian to the Jibjundamba Qutu (Rje btsun Dam pa Blo bzang bstan pa'i rgyal mtshan, 1635-1723), et al. According to the command he gave, saying “translate them into Tibetan,” headed by the holy great master (Rje btsun Dam pa), [he] and the Qubilyan Rabjamba / Rabjimba Güng Bandida (T. Hu bil la gan Rab 'byams pa Gun Pañḍita) and Erdeni Biligtü (T. Er te ni Bhi lig thu) translated [them]. Many persons who knew reading and writing, including the skilled writer Grags pa, made it into a book, and

793 Precisely, qubilyan (M.) is sprul pa in Tibetan and qubilyan-u bey-e (M.) is sprul pa'i sku (sprul sku) in Tibetan. But, qubilyan (‘Hu bil la gan’ in Tibetan in this colophon) simply denotes sprul sku.

794 Güng is ‘duke’ which derives from Chinese gong (公); meanwhile gün means ‘deep’ in Mongolian. The former makes more sense than the latter for the Tibetan gun.
it was offered into the hands of the Emperor. At that time, relying upon the stainless command which came upon the crowns of [our heads, saying “proofread well and carve [it] into printing blocks”, we, the mistaken, inferior holders of Śākyamuni’s tradition, who live in Beijing under the shade of the Great Emperor’s compassion, Aywangbaljuur Qutuytu (T. Ngag dbang dpal ’byor Hu thog thu), the chief administrative [lama] (T. ja sag gi gtso bo) and the holder of law (dharma) of the lamas and buddhist communities in Beijing, and the administrative lama Manramba Güng(ya)sang(bu) (T. ja sag gi bla ma Sman rams pa Kun dga’ bzang po)⁷⁹⁵, the administrative lama Damba Gelüng (T. ja sag gi bla ma Bstan pa Dge slong), the administrative lama Danjìn Gelüng (T. ja sag gi bla ma Bstan ‘dzin Dge slong), the Da lam-a Rabjamba / Rabjimba Čülrimsangbu / Čültümsangbu (T. Tā bla ma Rab ’byams pa Tshul khrims bzang po)⁷⁹⁶, the Da lam-a Rabjamba Raybalubsang (T. Tā bla ma Rab ’byams pa Grags pa blo bzang), Bayasqulang⁷⁹⁷ Gelüng, and Sudnamčorji / Sudnamčoyijji Qubilyan (T. Bsod nams Chos rje Hu bil la gan (T. sprul

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⁷⁹⁵ M. Jasay-un lam-a > T. ja sag gi bla ma, Ch. zhasake lama 扎薩克喇嘛. M. manramba < T. sman rams pa. Güng(ya)sang(bu) < T. Kun (dga’) bzang (po).

⁷⁹⁶ M. da lam-a > T. tā bla ma, Ch. da lama 達喇嘛. rabjamba /rabjimba < T. rab ’byams pa. M. Čülrimsangbu / Čültümsangbu < T. Tshul khrims bzang po.

⁷⁹⁷ I tentatively take bhas so lang as the Mongolian bayasqulang meaning rejoicing, gladness, happiness, etc.
compared the Mongolian and Tibetan thoroughly and with great enthusiasm.\footnote{798} [We] have compared all that was not easy to understand with the Chinese text. The Chinese astronomer-instructor (T. pō shi < Ch. boshi 博士) Le’u yus sī\footnote{799} wrote (drew) all of the sky-maps and the measured figures which needed to be put in writing,\footnote{800} and many persons who know reading and writing, such as the skilled reader and writer bhikṣu Ngag dbang chos x (illegible) and others, proofread [it] well according to their intellectual abilities, and then carved [it] in the wood-female-sheep year, the Kangxi fifty-fourth year (1715 C.E.-1716 C.E.) of the Great Qing. *Māngalam!*

\footnote{798}{The titles listed in this colophon are found in *Qinding lifanbu zeli* (欽定理藩部則例) issued in 1908. — The history and lineage of the text is complex. And note that there existed relevant articles and clauses for the organization of Mongolian lamas and monasteries in Qing law books from the earlier Qing period. — There also exist a number of modern works enabling us to identify these titles. Some notable examples include Brunnert and Gagelstrom (1911: 477); Yu (1992: 491-2); Zhang2 (2002: vol. 2, 615 ff); and Luo (2005: 564). To give a brief explanation of these titles as ranked from top to bottom: (1) *zhangyin zhasake lama* 掌印扎薩克喇嘛. *Zhasake* derives from Mongolian *ǰasaγ* meaning ‘administration.’ See Lessing (1960: 1039-40), Norman (1978: 156): *jasak* ‘chief of a Mongol banner’, (2) *fu zhangyin zhasake lama* 副掌印扎薩克喇嘛, (3) *zhasake lama* (扎薩克喇嘛), (4) *dalama* (達喇嘛), (5) *fudalama* (副達喇嘛), (6) *sula lama* (蘇拉喇嘛): leisured lama, lama without a fixed position. The latter derives from the Mongolian *sula* meaning loose, free, unoccupied. See Lessing (1960: 736), Norman (1978: 252): sula: ‘loose, idle, unemployed in an official capacity,’ (7) *demuqi* (德木齊) (< M. *demči*). Lessing (1960: 250): ‘business manager in a monastary,’ (8) *gesiqui* (格斯貴) (< M. *gebküi*, gesküi < T. *dge skos*). See Lessing (1960: 372): ‘master of a discipline, proctor in a temple.’). Chief *javayin lam-a*, my rendering for *ja sag gi gtsö bo* in this colophon, seems to indicate the first-ranked *zhangyin zhasake lama* ((1) in the above) or the second-ranked *fu zhangyin zhasake lama* ((2) in the above). More research is needed to identify their Mongolian titles, but it is beyond the present concern. The identification of the titles and activities of the Mongolian lamas listed in this colophon is regrettably not possible at the moment. We have no accumulated research and knowledge for them.}

\footnote{799}{More research is needed to identify this Chinese astronomer.}

\footnote{800}{There are two possibilities for *ri mo*: first, *ri mo* is ‘figures’ in astronomical text. Secondly, *ri mo* is ‘picture’, ‘diagram,’ etc. The reason why I side with the former is that ‘the pictures that have been measured out’ may not make sense. Moreover, they possibly had astronomical knowledge.}
APPENDIX IV.

EIGHTEENTH CENTURY MONGOLIAN LAMAS’ KĀLACAKRA KNOWLEDGE AND
THE TRANSLATION OF THE RGYA RTSIS CHEN MO

The preface of the Tngri-yin u dq-a (see Appendix II, pp. 344-6) shows that professional scientists and astronomers existed at the Qing court among the Mongolian translators. In contrast, the printer’s colophon in the Rgya rtsis chen mo (See Appendix III, especially 353-5) shows that the Mongolian lamas in Beijing and Ulaγanbayatur were ordered to translate the Tngri-yin u dq-a into the Rgya rtsis chen mo based upon knowledge of bstan rtsis / Dus ’khor (Kālacakra), and, as such, the overall contents in the colophon are religious.

From such observations, I seek to answer the following questions with a focus on the formation and development of astronomical terms and concepts within the broader framework of eighteenth century Mongolian lamas’ knowledge of the Kālacakra (Čay-un kürdün): what knowledge of the Čay-un kürdün (Kālacakra) did the translators of the Tngri-yin u dq-a have in terms of astronomical research in general and eclipse calculations in particular? Is there any sign that knowledge of the Čay-un kürdün was used to translate the Tngri-yin u dq-a filled with modern knowledge?

801 This appendix is a brief sketch of knowledge regarding the Mongolian lamas in the 18th century. Because I used limited Mongolian sources to sketch the topic, my arguments will be able to be reinforced with more evidence and specifications. I hope that this appendix will be read in concordance with chapters 3 and 4.
For the first question, I briefly sketch the following issues: 1) the use of the Чay-un kürdüн terms in Mongolian, 2) mistranslations, 3) the relationship between the Чay-un kürdüн and odun-u jiruqi (skar rtsis). Firstly, the Чay-un kürdüн terminology was established at a relatively early time. To illuminate this fact, it is important to consider the Mongolian Laghukālacakra, which is included in the so-called Altan Гanǰuur (completed during the years 1628-1629). It has been publicized in a modern format, together with that in the Singqun Гanǰuur, was created during the period of the Elhe taifin Kangxi Emperor (1718-1720). Given the translations, the technical astronomical vocabularies must have been already well-established when the Altan Гanǰuur was created. The terms and concepts of the Laghukālacakra in the Singqun Гanǰuur generally follow those of the Laghukālacakra in the Altan Гanǰuur.

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802 The Altan Гanǰuur is known to be one of the earliest translation of the Tibetan Bka’ ’gyur into Mongolian. It has been reported by modern Mongolian scholars that some included texts remain in Öbör mongyol-un neigem-un sinjilekü uqayan akademi-yin nom-un sang (Ch. Neimenggu shehui kexueyuan tushuguan 内蒙古社会科学院图书馆) in Kokeqota, Inner Mongolia, notably the Laghukālacakra (M. Angqan-u degedü burqan-ača yaryaysan čay-un kürdüн neretu dandris-un qayan). About the Altan Гanǰuur, Nata’s Altan erike (c. 1817) (1991: 110) states that it is composed of “one hundred three kelemli” (jayun arban yurban kelemli). — The strange term kelemli appears in Čidaltu (2005: passim) in the form of kalmali / gelmeli. Nearly no Mongolian dictionaries include this term except for Rikugunshō (1933: 1599) and Lessing (1960: 375): “gelmeli: tome, volume, division, chapter.” My suggestion for it is “wooden box.” More research is clearly needed. — In addition, Nata (1991: 110-1) conveys how the Altan Гanǰuur was created: a man named Tai Ling baras (sic. read bars) (B: Gilinarbini (?), C: Dgiligsrebins (?). Regarding the differences among the four versions, see above note 762.). According to the editor Čorji, Dge legs rab rgyas was written in the edition C, He also had a manuscript of the Гanǰuur and it is not known whether it was a Tibetan or Mongolian version. Biligtü Sečen ombu (onbo) (← bingtü (B: biligtü) Sečen umku (sic. read ombru/ onbru)) is known to have requested it and then the blockprint of the Altan Гanǰuur was completed. For Sečen ombu, see Kollmar-Paulenz (2002: 177-87, 180-2).

803 See the Гanǰuur, vol. 1 (1996: 25a-164a). The appendix in this volume clearly presents the different entries between the Altan Гanǰuur and the Singqun Гanǰuur. It is the only version which presents the Mongolian Laghukālacakra in the Altan Гanǰuur. The issue as to what is the Tibetan original Bka’ ’gyur of the Altan Гanǰuur and the Singqun Гanǰuur appears difficult to solve.
Likewise, the astronomical section uralaqu uqay-u youl in the later text Merged yarqu-yin oron (1742) basically reflects the well-established astronomical terminology and concepts found in a period of the early 17th century at the latest. Even if the Merged yarqu-yin oron was designed to clarify the terminologies for the creation of the Danǰuur,\textsuperscript{804} the Danǰuur translators could not change the renderings of the Altan Fanǰuur / Singqun Fanǰuur by using it. For example, a synonym of gdengs can meaning eight, is given as erbeger-tü\textsuperscript{805} in the Merged yarqu-yin oron, but the following rare word was already given in the Altan / Singqun Fanǰuur translations that were maintained in the Mongolian Vimalaprabhā: tongloiysan terigü-tü.

Table 52.

<table>
<thead>
<tr>
<th>Tibetan Laghukālacakra I. 27</th>
<th>Mongolian Laghukālacakra I. 27</th>
</tr>
</thead>
<tbody>
<tr>
<td>lag pa gdengs can zla ba\textsuperscript{806} = 182.</td>
<td>yar tongloiysan\textsuperscript{807} terigü-tü saran.\textsuperscript{808}</td>
</tr>
</tbody>
</table>

\textsuperscript{804} For the reason why the Tibetan Dag yig mkhas pa’i byung gnas was created, see Seyfort Ruegg (1974: 257-8).


\textsuperscript{806} P. Bka’gyur rgyud, ka, 26a. Also see Henning (2007: 221).

\textsuperscript{807} Sumatiratna (1959: vol. 1, 1059): “tonglayar” for “dengs ka” can be observed. I do not know the precise meaning, but it seems to be related to the above “tongloiysan.”

\textsuperscript{808} Fanǰuur, vol. 1 (1996: 28b). To check the differences between the Altan Fanǰuur and the Singqun Fanǰuur, see appendix, p. 4. There is no difference in this case.
It looks difficult to find the etymology of specific words. The Mongolian translations may not be based upon a complete understanding of the terms. The Mongolian *Laghukālacakra* I. 27 presents “tongloīyan terigūtū” (lit. with head), but the Mongolian *Vimalaprabhā* I. 27 just presents “tongloīyan” without terigūtū, and added a rare word “čo(u)ngnoimal-tū.”

More research is needed, but it can be speculated that “čo(u)ngnoimal-tū” may be an archaic word from Mongolian Buddhist texts. My point is that the astronomical terms and concepts in the Ĉagy-un kürdūn, that were established in the early 17th century at the latest by the completion of the Mongolian *Laghukālacakra*, and in the *Altan Ganǰuur* have been sources for later period translations of and research into the Ĉagy-un kürdūn corpus.

Secondly, mistranslations are seen in the *Gkīr ῦgei gerel-tū*, which was first created in the 18th century as a part of the *Danǰuur*. The translation is deft, but it sometimes does

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809 P. Bstan ’gyur, rgyud ’grel, ka, 77b. See also Henning (2007: 222).

810 Sumatiratna (1959: vol. 1, 1059): “čo(u)ngnoimal” for “dgengs ka” and “čo(u)ngnoimal-tū” for “dgengs ka can” / “gdengs can” are given.

not closely shadow the original Tibetan text (possibly the P. Bstan ’gyur). The following simple errors are intriguing:

Table 54.

<table>
<thead>
<tr>
<th>Dri med ’od l. 30</th>
<th>Gkir ügei gerel-tü l. 30</th>
</tr>
</thead>
<tbody>
<tr>
<td>mi bداع  ces pa mi drug bcu ste ...</td>
<td>kümün-ü ejen kemekü ini araban jiruyan buyu ...</td>
</tr>
</tbody>
</table>

This is understandable because mi bداع / kümün-ü ejen equals 16. The Tibetan is read as 16, not 60, even if 60 was written. The Mongolian rendering just presented 16 without applying the bhūtasamkhya system. However, things are not always so simple, as shown below.

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812 It was completed in 1749 during the reign of Abkai wehiyehe Qianlong Emperor. The Tibetan original appears to be the P. Bstan ’gyur (1724); see Dharmatāla (1987: 388-9): “That edition was based on the Tibetan Tengyur (edited by Miwang Sangye Gyatsho as the long-life offering to the All-Knowing Royal One (= the Great Fifth Dalai lama). … Besides the standard contents, (the Mongolian Tengyur) included some new translations. Its catalogue, however, follows the one compiled by the All-Seeing Great Fifth (Dalai lama),” For the Tibetan Bstan ’gyur (1688) that Dharmatāla mentions, see Vostrikov (1970: 213-5), Deleanu (2006: 85-6), van der Kuijp (2012: intro 1), etc.. Rintchen (1964-74: 11-3) also maintains that the Mongolian Danjur is based upon P. Tibetan Bstan ’gyur. However, the issue appears complicated in the case of the Gkir ügei gerel-tü. See below note 820. I am doubtful about the premise that each and every text in the Mongolian Danjur was created from a single source. Individual text may vary significantly.


815 See the bhūtasamkhya system in above pp. 186-7.
Table 55.

<table>
<thead>
<tr>
<th>Dri med 'od I. 31</th>
<th>Gkir ügei gerel-tü I. 31</th>
</tr>
</thead>
<tbody>
<tr>
<td>rkang pa bcu pa dang chu gter zhes pa cha'ĩ lhag ma rkang pa bzhi pa mthong na nyi shur gcig gis dman par 'gyur ro /(^{816}).</td>
<td>köl arban ba usun-u sang kemekű qubi-yin ülegsen köl dörben-i üjebesi üučin-dür nigen-iyer simedekű boluyu.(^{817}).</td>
</tr>
</tbody>
</table>

In the Dri med 'od, 20 (nyi shu) is given. In the Gkir ügei gerel-tü, 30 (yučin) is given. This is a problem. Again, in the Dri med 'od I. 32,

Table 56.

<table>
<thead>
<tr>
<th>Dri med 'od I. 32</th>
<th>Gkir ügei gerel-tü I. 32</th>
</tr>
</thead>
<tbody>
<tr>
<td>... bzhi pa la bzhi pa'i gnas na gnas pa bzhi dang lhan cig nyi shur gcig gis dman pa'o / Inga pa la Inga pa'i gnas na gnas pa gsum dang lhan cig nyi shu rtsa gnyis so / (^{818}).</td>
<td>... dütığer-tür dütığer-iün oron-a aysan dütığer läge qamtu yučin nigen-iyer doruitayluq bolai. tabdayar-tur tabdayar-un oron-a aysan yurban lüy-a qamtu yučin gøyar bolai.(^{819}).</td>
</tr>
</tbody>
</table>

This issue also arises in the Dri med 'od: 20 and 22, and in the Gkir ügei gerel-tü: 30 and 32. It is unclear how to make sense of this. It is not likely that the translators made intentional corrections for accurate gza’ value in Mongolia, given the fact that the Gkir ügei gerel-tü is a literal translation of the Dri med 'od. Then, are these simple mistakes which occurred in the course of the translation? Or, did the translators use other Tibetan editions or sources?

\(^{816}\) P. Bstan 'gyur, rgyud 'grel, ka, 80a. For the translation and explanation of this, see Henning (2007: 233, 235).


\(^{818}\) P. Bstan 'gyur, rgyud 'grel, ka, 80b. For the translation and explanation of this, see Henning (2007: 237).

What other possibilities are there to account for the mistranslations? At any rate, it is also true that the Gkir ügei gerel-tü was created through research into well-established terminology from the past.

Thirdly, let us ponder the relationship between the translations of the Mongolian Čay-un kürdün texts and odun-u ĵiruqai in terms of technical vocabularies and concepts. Little is known about the beginning of the odun-u ĵiruqai in Mongolia, and especially about eclipse calculations. Fortunately, in the 18th century, Mergen gegen Lobsangdambijalsan (< T. Blo bzang bstan pa'i rgyal mtshan. 1717-1766) could be used. At least three (one comparatively longer, two shorter) ĵiruqai (rtsis) texts are included in the fourth volume

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820 The colophon of the first two chapters of the Mongolian Vimalaprabhā in the Danjuur, vol. 2 (2007: 275a-275b) [= Rintchen (1964-1974: 21) = "Mongyol yanjuur danjuur-un yarcay"-un nayirayulqu jöblel (2002: 174-5)], which shows that they were translated by the great translator Bilig-ün Dalai (? ~ ?) known as Urad Güüsi Bilig-ün dalai Sirabamsu (< T. Shes rab rgya mtsho) with the help of Urad Güüsi Erdem-ün gerel (? ~ ?), conveys the following information regarding how they were translated: “Bilig-ün Dalai, dā (tā) lama at Jingzhusi (浄住寺 > M. Jing ju sē keid / Ariyun sayurin keid), translated the first chapter into this chapter (= the second chapter) from Tibetan to Mongolian by comparing and contrasting two sūtra-s, i.e. a xylograph and a manuscript, with the Tibetan and Mongolian Kālacakratantra (my suggestion for this is the Laghukālacakra). Also, once again, the translators Bilig-ün Dalai and Urad Güüsi Erdem-ün gerel proofread, edited, and x (illegible) into [this] sūtra by comparing and contrasting the very one with the Great Commentary written by Mkhas grub and Mongolian rtsis texts (= my suggestion for mongyol ĵiruqai-yin sudur-uud. I am not sure what they might be.).” (... čay-un kürdün-ü tailburi egün eni ekin-ece ene bülüg kürtele ğing jii sē keid-ün terițiün blam-a bilig-ün dalai darumal bičemel qoyar sudur-i töbed mongyol čay-un kürdün-ü dandir-a luy-a tokiyalduyul-un. This form is strange. My suggestion is “by –ing.”) töbed-ün kelen-ece mnyolčilan orčiyulba. jiićii basa daftant mūn kii orčiyuluyči bilig-ün dalai kīged urad gūüsi erdem-ün ğeral qoyarulqula qairu(0)b (maybe qaído(u)b) čörjii-yin jokiy悭aysan yeke tailburi kīged mongyol ĵiruqai-yin sudur-uud luy-a tokiyalduyulun ariyadqaju nairayuluyah sudur-tur x (illegible)). This colophon informs us that Bilig-ün Dalai referred to different versions of Tibetan and Mongolian texts, specifically Mkhas grub’s Great commentary and Mongolian astronomical texts, in order to create the translation of the Mongolian Vimalaprabhā. This may be realted to the strange change of the values. Let me leave the issue open to future research. With regards to the life of Bilig-ün dalai, little is known, but Heissig (1954: passim, especially 87-8) and Taube (1978: 172, n. 14) have presented information of his titles in Beijing. According to the Merged yarça-yin oron, he was a “vice professor (M. ded baysi) at Tangyud bičig-ün suryayuli (School of Tibetan Language) and dā (tā) bla ma (terițiün lama) at Jingzhusi.”; see Lcang skya III et al. (1982: 20): tangyud bičig-ün suryayulii-yin ded baysi buqed ğing jii sī-yin da blam-a sirabamsu, and Lcang skya III et al. (2002: 1422): bod kyi bslab grwa’i rim pa gnyis pa ’i slob dpon cing ju ji’i tā bla ma dge long shes rab rgya mtsho.
of his gsung 'bum, Včir-dhara mergen diyanči blam-a-yin gegen-ü 'bum ğarlig. 1) Tegüs čoytu čay-un kürdün-ü jiruqai-yin yar-dur abqui-yi toda üjegülügsen naran gerel (simply Naran gerel) 823, 2) І'aray kiged naran-u türgen jiruqai-yin yarun abuly-a 824, 3) Üiles-ün jiruqai-yin yarun abulya-yin temdeg. 825 Basically, the writings follow the typical order and sequence seen in the Tibetan skar rtsis texts.

Let me first look into the third text. It describes üiles-ün jiruqai (T. byed rtsis), whose epoch is 1747 (M. 1747 [= küsel-tü (13) brabadau-a-yin (< S. prabhava) nügčigsen...]

821 His collected works were published in Beijing after his death and during the years 1780 ~ 1783. The carving quality is bad. Many typographical errors exist, especially numbers that were badly carved. Chinese carvers who do not know Tibetan and Mongolian must have carved them. The sequence of the volumes are given according to the Qianziwen (千字文): the first volume: tian (天), the second volume: di (地), the third volume: yuan (元), and the fourth volume: huang (黄). For information on his gsung 'bum, see Heissig (1954: 151): "... in vier Bänden 130 Werke. ... Die 130 Werken sind nicht chronologisch, sondern ihrem Thema nach angeordnet. Viele von ihnen waren schon 1774 in den Chos spyod des Öljej baradārāsā śūme veröffentlicht worden." For the titles of the individual texts, see Uspensky, Inoue, and Nakami (2001: 113-45). Also see Humphrey and Ujeed Hürelbaatar (2013: passim).

822 The yar-dur abqui is a Mongolian rendering of lag len.

823 A rough division in the text ranging from huang shang yi ri (黄上一日) 49 ~ huang xia yi ri (黄下一日) 81 is as follows: the folios huang xia yi ri 49 ~ huang shang yi ri 50 are introduction (T. sngon 'gro) and things such as synonyms for numbers (the bhūtasaṃkhyā system) are given. Huang xia yi ri 50: 1 ~ huang shang yi ri 58:25 depicts the bstan rtsis, including the Mongolian qayans. Huang shang yi ri 58:26 ~ Huang xia yi ri 61:24 describe grub rtsis (M. sidi-yin jiruqai). Huang xia yi ri 61:25 ~ huang xia yi ri 62:18 are byed rtsis (M. iiles-ün jiruqai). Then, an incomprehensible (for my ability), but certainly 'byung rtsis (elemental calculation) follows. Mongolian folio numbers exist in the left margin and Chinese folio numbers in the right margin. I think that because the block print was carved in Beijing by Chinese carvers, who do not know Mongolian, the Chinese pagination is a better method for presenting the folio numbers.

824 Mergen gegen (1998a: huang shang yi ri 82–huang shang yi ri 83). The türgen jiruqai is a rendering of mayogs rtsis. The yarun abulya is another Mongolian rendering of lag len. See above note 822.

The mda’ ro lhag ma is given as 29 (M. sübe nidü) and ril cha is given as 24/33 ((M. oron (24), yal üjügür (33)). It seems that the gza’ dhru and nyi dhru values at 1747/3/0 were calculated incorrectly as 1°38′4″ (M. dürsü (1), loos yal (38), usu (4)) and 26°48′11″ (M. jabsar nidün (26), loos usu (48), doysin (11)), respectively. Let me single out the expressions of the conceptual and astronomical terms, according to the sequence of the general calculations.

Table 57.

<table>
<thead>
<tr>
<th>Mergen gegen (1998b)</th>
<th>relevant skar rtsis terms</th>
</tr>
</thead>
<tbody>
<tr>
<td>ariyün sar-a</td>
<td>zla dag</td>
</tr>
<tr>
<td>rilbu časai (čaša)</td>
<td>ril bo cha shas</td>
</tr>
<tr>
<td>yaray-an dho(a)ru-a</td>
<td>gza’ dhru</td>
</tr>
<tr>
<td>naran-u dho(u)ru-a</td>
<td>nyi dhru</td>
</tr>
<tr>
<td>an explanation was not found</td>
<td>gza’ bar</td>
</tr>
<tr>
<td>an explanation was not found</td>
<td>nyi bar</td>
</tr>
<tr>
<td>saran-u köl</td>
<td>zla rkang</td>
</tr>
<tr>
<td>the term was not found</td>
<td>gza’ phyed dag pa</td>
</tr>
<tr>
<td>naran-u köl</td>
<td>nyi rkang</td>
</tr>
<tr>
<td>saran odu</td>
<td>zla skar</td>
</tr>
</tbody>
</table>

My general assessment is as follows: Mergen Gegen’s explanation of the sequence of the byed rtsis is incomplete, which may mean that his understanding on the Tibetan skar rtsis was meager and terse. Most of all, astronomical technical terms were not conceptualized in Mongolian and some Tibetan / Sanskrit terms were used without being translated into Mongolian. It can be assumed that because of his low-level understanding, he could not... 

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826 The correct values are as follows: the gza’ dhru is 1°38′10″ and the nyi dhru is 26°48′33″11″.

827 The folio huang xia yi ri 85 shows the process of the calculation in the gza’ phyed dag pa. However, no Mongolian equivalent of the Tibetan gza’ phyed dag pa was found.
present thorough and appropriate renderings of all the skar rtsis technical terms. Of course, the coinage of Mongolian words attempted by Mergen Gegen was not common in later period of Mongolian Buddhism when Mongolian lamas used Tibetan texts.

Next, let us look into his understanding of eclipse calculations as seen in the Naran gerel, which is filled with undecodable and strange orthography and scripts passim. His explanations for the calculation of a lunar eclipse range from huang xia yi ri 76 (= 29b) to huang xia yi ri 77 (= 30b). The eclipse limit is as follows: terigün (T. (sgra gcan) gdong) − saran (T. zla ba) < 50. saran − segül (T. (sgra gcan) mjug) < 40. busud-a (“other cases”) < 45. Interestingly, he mentioned that the following factors need to be examined for a lunar eclipse: “length of evening, the moon’s movement to the south and the north, wide and narrow and high and low of a place, etc.” (söni-yin urtu aqur ba. saran-u emünegsi umaraysi odqui ba. oron-u ayui čiql öndür boyuni terigüten). In addition, the magnitude (M. yeke bay-a) can be calculated in the same manner as skar rtsis: the möče (chu tshod) value of the node-difference is divided by 5. For example, “in the case of terigün − saran” (saran-iyar terigün-i arilyabasu), 0-4 : total eclipse (M. büküli bariyu), 5: $\frac{5}{6}$, 6: $\frac{2}{3}$, 7: $\frac{1}{2}$, 8: $\frac{1}{3}$, 9: $\frac{1}{6}$, 10: $\frac{1}{8}$ is

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828 For his explanation on the calculation method of raquyin (sic. read raqu-yin) ündüsü (T. rtsa), terigün (T. gdong), and segül (T. mjug), see Mergen gegen (1998: huang shang yi ri 61 (= 14a)–huang xia yi ri 61 (= 14b)) in the same text.

829 The busud-a means either the following two cases: 1) segül − sara, 2) sara − terigün.

830 Mergen gegen (1998: huang xia yi ri 76 (= 29b)). These factors are usually mentioned in the Tibetan skar rtsis calculation of a solar eclipse. See above pp. 287-90. In fact, geometric and geographical knowledge is necessary for the calculation of a solar eclipse.
obscured, respectively. Also, another interesting statement can be found: “due to the fact that time is [calculated by] tshes zhag (M. sin-e-yin qonuy), all lunar eclipses occur on the sixteenth, solar eclipses occur on the first tshes zhag. because of that ... .” (čay inu sinyin (sic. read sin-e-yin qonuy-un erkeber. saran bariqui bügüde arban jiruyan-a, naran bariqui sine-yin nigen-e bolqui-yin tula ...). This may be a deviation from the traditional understanding of skar rtsis.831 If this is the case, the interpretation may have been influenced by the Qing Chinese lunar calendar. Solar eclipses occur on the first lunar day according to the Chinese lunar calendar. By “sin-e-yin qonuy,” he may have meant the Chinese lunar date, not the Tibetan tshes zhag. Another possibility is that he may have meant that lunar and solar eclipses occurred on those dates if calculated by the values of the gza’ dag in the skar rtsis calculations and ensuing corrections to the calculation results are made to reflect Inner Mongolian time. In this case, he meant tshes zhag in skar rtsis by the “sin-e-yin qonuy” and it would be the case that his statement is based upon empirical data from Inner Mongolia. More research is needed.

His explanation of the calculation of a solar eclipse (M. naran-i bariqui) ranges from huang xia yi ri 77 (= 30b) to huang shang yi ri 79 (= 32a). The eclipse limit is given as: terigün − naran (T. nyi ma) < 5. naran − segül < 8. busud-a (“other cases”)832 < 40. The magnitude, timing (M. čay), color (M. üngge), and direction (M. jüg) are followed as expected in the

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831 In the case of skar rtsis, the timing of a lunar and solar eclipse is fixed as that of the termination of the 15th and 30th tshes zhag, respectively. Additionally, corrections to the time may be applied.

832 This means either the following two cases: 1) nara − terigün, 2) segül − nara.
skar rtsis eclipse calculations. He says that he learned the calculation methods from Bančin Šakiy-a śrii (possibly < Paṇ chen Śākyaśrī). Generally, his descriptions are merely reiteration of the algorithm for the calculations of lunar and solar eclipses. Basically, no difference or further development from the Tibetan skar rtsis methods in terms of mathematics and technical considerations is observed.

On the basis of my readings of the Angqan-u degedü burqan-ača yarγaysan čog-tu čay-un kürdüń neretü dandris-un qayan, Gkir ügei gerel-tü and Mergen Gegen’s texts, I suggest that Mergen Gegen did not use or read the Mongolian Kālacakra corpus. No relationship between Čay-un kürdüń and odun-u jiruqai can be found in terms of astronomical technical terms and concepts.

As a matter of fact, it is not likely that the Γanǰuur / Danǰuur was accessible or studied seriously by the Mongolian lamas. More research is needed, but the terminological and conceptual uniformity seen in the Mongolian Kālacakra corpus, which dates back to the Altan Γanǰuur at the latest, may have been fossilized without being used by Mongolian lamas. In terms of the relationship between the Kālacakra and skar rtsis, Tibetans made great efforts to translate and understand the abstract Kālacakra texts, and skar rtsis has been established in Tibet for centuries through incorporating many factors from observations, empirical data, debates, criticism, research into neighboring traditions, etc., while balancing itself with the Kālacakra. However, it may be assumed that

833 See Mergen gegen (1998: huang shang yi ri 79 (= 32a)). This transliteration is interim. The script is difficult to read. It seems that bančin (< T. paṇ chen) means great paṇḍita, not the Dge lugs title paṇ chen bla ma.
the Mongolians may have just imported the accumulated knowledge of skar rtsis from Tibet.

In the above debate, I pointed out that the establishment of astronomical terminology, the intended or unintended mistranslations in the Ėkīr īgei gerel-tü, and the independent development of the odun-u ğiruqai as separate from the Čaγ-un kürdün are observed in Mongolian Čaγ-un kürdün texts. More evidence may be located in the future to strengthen or repudiate these claims, but one possible counterargument is that the Mongolian texts investigated in this work may not represent astronomical research in Mongolian monasteries, simply because Mongolians used Tibetan texts and canons rather than Mongolian ones. In fact, Mergen Gegen is an exception in terms of the creation of texts in Mongolian. In other words, it may be said that Mongolians had no knowledge of the Mongolian Čaγ-un kürdün and studied the Tibetan skar rtsis / Kālacakra and that Mergen Gegen’s attempts to use Mongolian were merely restricted to his particular monastery, Mergen süm-e is not entirely in Mongolia. My response would be thus: the aforementioned Mongolian materials are important in that they accurately show how Mongolians understood Indo-Tibetan terms, concepts, ideas, and theories. It may be the case that the Čaγ-un kürdün translations were not used or Mergen gegen’s writings just reflect a local tradition, but Mongolians spoke Mongolian, even if they used Tibetan texts. Their understanding can be better grasped by their writings that are written in their mother tongue, Mongolian, and the terms, concepts, ideas, etc. that were described in the Mongolian texts may be common to Mongolian lamas with limited or less common
religious experiences. In that sense, the Mongolian texts I used in the above are the best evidence for showing Mongolian understanding.

All in all, based upon my observations, it may be assumed that the knowledge of the Mongolian lamas, who are the Rgya rtsis chen mo translators, functioned under or were as least related to the aforementioned circumstances. Of course, at present, we do not know how good their understanding on the Čay-un kürdün and odun-u jiruqai was.

Next, how did the Mongolian lamas in Beijing and Ulaγanbaγatur, who were equipped with knowledge of the Čay-un kürdün / odun-u jiruqai, translate the Tngri-yin udq-a, which is based upon modern astronomy? With a focus on the relationship between the Čay-un kürdün and the Tngri-yin udq-a in terms of terms and concepts, I will attempt to answer this question. The basis of my answer is as follows: knowledge of the Kālacakra could have been used for the parallel concepts and terms in the Tngri-yin udq-a if the translators understood the Tngri-yin udq-a.

Let us briefly discuss this point by using the following passage in the Ch. Yuelibiao yongfa (月離表用法) / M. saran-u tuyulqu-yin bodurul-un kereglekū jiruly-a / T. zla ba bragl ba’i ngos ’dzin gyi dgos pa’i ri mo:

<table>
<thead>
<tr>
<th>諸表皆用以求月離宮度分也</th>
<th>凡步月離有二法</th>
<th>皆先求月平行度分</th>
<th>次一法用三角形法</th>
<th>推求均度以加以減</th>
<th>又一法用加減立成表查均數</th>
<th>834以加以減</th>
<th>但正朔望時止用一均數</th>
<th>一加減表</th>
<th>餘日皆用二均數</th>
<th>835二加減表</th>
</tr>
</thead>
</table>

834 To understand junshu (均數, inequality), lunar inequalities (= irregularities), which change the Moon’s position, thus the calculations for these are necessary for eclipse calculation, and should be understood. They were discovered over a long period of time in Western astronomy. Roughly, let us begin with the Ptolemaic lunar model. In it, the first inequality C (defined as equation of the center), which was already known in Hipparchus’s time, was applied. It reflects that moon’s slow motion from apogee to perigee and
fast motion from perigee to apogee and the influence of the longitude of the moon. For more information, see Jacobsen (1999: 53). The second inequality, evection, was discovered by Ptolemy himself. It depends on the distance of the moon from the sun and moon’s mean anomaly. See Pedersen (1974: 182–4). After significant time had passed, Tycho Brahe refined the Ptolemaic lunar theory by means of observations. He added three substantial discoveries: the third inequality, ‘variation,’ reflects that the moon moves faster than expected at new and full moon, and slower at the quarters. See Dreyer (1890: 337–8) and Thoren (1967: 161–4). The fourth inequality, annual inequality, is an annual effect, by which the lunar motion slows down a little in January and speeds up a little in July. The fifth inequality is the inclination of the lunar orbital plane with regard to the ecliptic. It influences lunar latitude at syzygy and quadrature. For more information on the inequalities, see Watanabe (1959: 305–5), Thoren (1989: 16–9), Thoren and Christianson (1990: 324–33, 486–96), Jacobsen (1999: 157–63), Swerdlow (2004: 3–7), and The Facts on File Dictionary of Astronomy (2006: 157, 505), etc. In fact, we are aware that the moon’s inequalities are much more complex than those disclosed by Brahe, but Brahe’s discoveries fit nicely with the Xiyang xinfa lishu, based upon Brahe’s lunar model. Of course, the differences between the earlier and later Brahe lunar models should be considered. See below in this note. In the Xiyang xinfa lishu, the inequalities are called junshu:  C (Ch. yijunshu一均數), evection (Ch. erjunshu 二均數), and ‘variation’ (Ch. sanjunshu 三均數). Let me first introduce the previous research into these concepts. During the investigation into the Yuelibiao（月離表. The Lunar Table）in the Chongzhen lishu, Hashimoto (1988: 111) pointed out that lunar theory in the Chongzhen lishu is Brahe’s: “As for Tycho’s discoveries of the third and fourth inequalities, the Chinese text reflects nothing, but giving the modified tables in the four books of the Lunar Tables (Ch. Yuelibiao) from Longomontanus’s Tabula Prostaphaeresium Lunarium and Tabula Secunda Prostaphaeresium Lunarium in the Astronomia Danica.” The lunar theory in the Xiyang xinfa lishu developed in a more elaborate way than that in the Chongzhen lishu, but because the Tychonic model in the Chongzhen lishu is basically the same with that in the Xiyang xinfa lishu, the Chongzhen lishu can be used to explain the Xiyang xinfa lishu. Regarding this, Chu and Shi (2013: 335–40) presented detailed research into the lunar model in the Yuelibiao: benlun（本輪）that was devised for C, cilun（次輪, equivalent to the first epicycle）for evection, and youcilun（又次輪 and is equivalent to the second epicycle）for ‘variation’ (Ch. erjuncha 二均差 = sanjunshu). For Brahe’s double epicycle model for the moon seen in the Chongzhen lishu / Xiyang xinfa lishu, see Rho et al. (2009: 701), Hashimoto (1988: 107–11), and Ning (2007: 25–37). In addition, Chu and Shi (2013: 331–5) suggests that the lunar theory in the Chongzhen lishu is based upon the later Tychonic model (published in the Astronomiae Insauratae Progymnasmata (1602) on the basis of Swerdlow (2009: 11–31): The earlier Tychonic lunar model (1599) includes ‘variation’ and an annual equation. However, in the later Tychonic model, added and subtracted by his assistant Longomontanus (1562–1647), C was corrected and the annual equation was deleted.

835 In the case of the Xiyang xinfa lishu, the maximum value of the yijunshu is 4°58'; see Rho et al. (2000: vol. 4, 217) [= Rho et al. (1983: 577)]. The value of the Lixiang kaocheng from which the Mā yang rgya rtsis originates is similar; the maximum value of the chujunshu （初均數）= yijunshu) is 4°58'. The values of " and below are different; see He et al. (1985: 203), (1985a: 67), and Zhang1 (2014: 100). The erjunshu and sanjunshu are given in the summation of these (defined as ersanjunshu 二三均數). The maximum value of the ersanjunshu is 2°48'; Rho et al. (2000: vol. 4, 263) [= Rho et al. (1983: 622)]. In the case of the Lixiang kaocheng, 2°48' is given; see He et al. (1985a: 237). It can be speculated that the values are closely tied to those of Tycho Brahe.

836 See Rho et al. (2000: vol. 4, 200) [= Rho et al. (1983: 560)].
The translation of the Tibetan paragraph with the help of the Chinese and Mongolian passages is as follows:

“All the tables are necessary for the khyim, zhag, and chas shas at the moon’s position (T. zla ba brgal ba). There are two methods for examining the position of the moon. Both of them firstly calculate the degrees (T. zhag) and parts (T. cha shas) of the mean motion of the moon. After that, the first method is to calculate the mean degree (T. bsnyams pa’i zhag.

837 Tngri-yin udq-a (1711: saran-u tuyulqu-yin bodurul nigeđüger, 1-2) [= Čeden et al. (1990: 86)].

838 There is a mistranslation in Tibetan. Xian (先)/ urida, which are “firstly,” are separate from yue (月)/ saran, which are “the moon.” See the English translation. The Tibetan rendering of “the preceding month” (zla ba snga ma) is wrong.

839 chas was given for the rendering of baičaǰu (Ch. cha (查), “look for,” “look up.”). This is problematic.

840 dkyil tshes / dkyil nya were given for zhengshuowang (Ch. 正朔望. “true conjunctions.”). Meanwhile, dag tshes / dag nya are given in the Mā yang rgya rtsis texts. The different terms may be evidence that the Mā yang rgya rtsis is not a continuation of the Rgya rtsis chen mo.

841 Rgya rtsis chen mo (1715/1716: (left margin) ga 1b [= (right margin) juan (卷) 3, shang (上) 1]). The shang 1 is not a match to 1b. It should xià (下) 1.
The above passage explains two methods for computing lunar anomalies.\textsuperscript{842} There are some interesting features in the above Tibetan passage. Firstly, the Tibetan paragraph is a literal translation of the Mongolian paragraph, with some misunderstandings. I do not think that when the translators rendered \textit{nigedüger tegsilel-ün toy-a} as \textit{bsnyams grangs dang po}, they knew the meaning or the astronomical background of Tychonic astronomy. Also, the Tibetan translation with new coinage of modern astronomical terms could be understood only if a Tibetan reader with knowledge of modern astronomy reads it in combination with the original Chinese and Mongolian texts. Secondly, the use of \textit{skar rtsis} terms are limited to the spatial units, such as \textit{khyim} (M. \textit{ordu}, Ch. \textit{gong} 宫), \textit{zhag} (M. \textit{qonu}, Ch. \textit{du} 度), and \textit{cha shas} (M. \textit{qubi}, Ch. \textit{fen} 分). Thirdly, the translators did not use the \textit{skar rtsis} terms, even for parallel concepts. For example, \textit{nyi rkang} was not used for \textit{naran-u kerükü} (\textit{richan} (日躔), \textit{nyi ma'i myur ba} was given in the translation), \textit{zla rkang} was not used

for saran-u tuyulqu (yueli (月離), zla ba brgal ba was given), and gza’ ’dzin was not used for solbičan bariqu (jiaoshi (交食), bsnol bar ’dzin pa was given). Of course, the Tibetan renderings of the Rgya rtsis chen mo may have worked in most cases because they did not create a large difference in meaning. Except for the case of the rendering of baiyul-un bütügegsen bodurul (lichengbiao (立成表), which means table.), the Tibetan verbatim rendering from the Mongolian term, bkod cing bsgrubs pa’i ngos ’dzin, is not understood. They could simply have used the skar rtsis term re’u mig (or ngos ’dzin as is used in the Rgya rtsis chen mo). I suggest, from these instances, that the translators did not discover a link to the Kālacakra in terms of terminology and concepts, which is caused by their ignorance of modern astronomy. Alternatively, they may have thought that the descriptions in the Tngri-yin udq-a were irrelevant to the Kālacakra. Therefore, they may have consistently tried the verbatim ac litteratim translation, even in the parts where the Kālacakra terms and concepts could have worked. In any case, I think that if they had knowledge of both the Kālacakra / skar rtsis and modern astronomy, the influence of the former on the latter and vice versa, in terms of the use of terms and concepts, would have appeared in the Tibetan translation Rgya rtsis chen mo.

Another example in the following enables me to verify that the corollary of the verbatim ac litteratim translation, without knowledge of relevant field, is a translation filled with errors and incomprehensible terms. For example, see Ch. Jiaoshibiao juan 8

843 However, it should be noted that ngos ’dzin has never been used as “tables” in the Tibetan rtsis texts, except for this translation, which is problematic.
The translation of the Tibetan passage with the help of the Chinese and Mongolian passages is as follows:

Parallax (T. blta ba'i dman pa) is the gaoxia shicha (= gaoxiacha in the Lixiang kaocheng) of the sun and moon (T. nyi zla nyid kyi mtho dman gyi blta ba'i dman pa < M. naran, saran-u öndür boyun-yin qaraqu dutayu. čüm tngri-yin orui-ača bögleüü-yin qonuy, jiči yafer-un kiusin-eč bögleüü, yafer-un qayas tursi toy-a-bar erijü, ouyayan bolai. yerü naran, yafer-ača bögleüü-yin qola oir-a-yi, yerü öndür, yerü boyun-bar quyucq bolamui, qayer quyucq-yin goyurundu-yin qola oir-a-yi toy-a-yi dumdadu ülikü üliger-in jiryü-y-a-yin yosuyar boduju bolumui.845

blta ba'i dman pa zhes pa ni / nyi zla nyid kyi mtho dman gyi blta ba'i dman pa kun gnam gyi gtsug nas rgyang ba'i zhag / slar sa'i lte ba nas rgyang ba / sa'i phyed srid grangs kyis btsal nas thob bo / spyir nyi ma sa nas rgyang ba'i nye ring spyir mthon po spyir dma' bas thun du bya ba'o / thun gnyis kyi bar gyi nye ring gi grangs / ghzal dpe dbus ma'i ri mo'i lugs bzhin dpyad par 'gyur ro /.


845 Tngri-yin udq-a (1990: 663).

846 Rgya rtsis chen mo (1715/1716: na, 1b [= juan (= vol.) 20, xia 1]).

847 See above notes 325 and 668.
The above passage explains how to calculate the diurnal parallax, one of the most important factors incorporated in the calculation of a solar eclipse. Again, Tibetan paragraph alone cannot be understood. It also shows that the translators had no knowledge of modern science and mathematics, including trigonometry. The indecipherable term gzhal dpe for Chinese bilifa (比例法) and Mongolian ülikü üliger-ün jiruly-a is given. A Tibetan reader will not be able to find how to understand this term just with the Tibetan translation. Given the Chinese and Mongolian paragraphs, calculations can be proposed to involve proportional expressions and the relevant interpolation / extrapolation. I do not think that Tibetan readers will be able to come up with these concept with only the Tibetan text. All in all, I think that the translators' knowledge of Kālacakra was impotent when being confronted with modern science.

848 The zhong bilifa (中比例法 > M. dumdadu ülikü üliger-ün jiruly-a > T. gzhal dpe dbus ma'i ri mo. lit. a calculation method by middle proportion) is certain to be a calculation method involving proportional expressions, but I do not know the exact way the values of parallax are calculated here. According to the explanation of the calculation from the dibanjingcha (地半徑差, diurnal parallax) in the Lixiang kaocheng, the “three limits” (apogee, perigee, and middle) are in accordance with the proportion between the calculated semi-diameter of the earth and the sun's distance to the center of the earth (地半徑與太陽距地心比例, 高, 卑, 中距三限) and the same these are applied in the calculation of the dibanjingcha of the moon; see Qingshigao, juan (卷) 47, zhi (志) 22, shixian (時憲) 3. The above zhong bilifa may be related to a calculation of the proportion for middle distance ("zhongju" 中距 in the Lixiang kaocheng / Qingshigao) from the "two limits" (liangxian 兩限) in the above passage. More research is needed.

849 For a understanding of this term, see Seidelmann and Urban (2012: 123-5).
In the early 18th century, there was a clear demarcation between two different astronomies among Mongolian intellectuals: secular Mongolian modern astronomers were active in the Qing court and Mongolian lamas studied the monastic astronomy, specifically Čay-un kürdün and odun-u jiruqai, in Buddhist monasteries. The former produced the Tngri-yin udq-a on the basis of the firm understanding of contemporary Qing Chinese (essentially Western) astronomy; the latter studied the Kālacakra and skar rtsis / odun-u jiruqai, for the most part in Tibetan. The clear demarcation between modern science and the monastic astronomy may not have been a favorable situation for the translation of the Tngri-yin udq-a into Tibetan. I speculate that no Mongolian scientists in the Qing court knew Tibetan, and no Mongolian and Tibetan (including the Qing court Mongolian and Tibetan) lamas knew modern astronomy. In such situation, it may be that the Tngri-yin udq-a had no choice but to be given to the lamas at Ulayanbayatur for translation into Tibetan, Or, Elhe taifin Kangxi Emperor’s political concerns may have worked. We do not know how and why these concepts travelled far away from the court. At any rate, the outcome was clear from the inception: the lamas, who are assumed to have had knowledge of the Čay-un kürdün, were not able to translate the text

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850 Some lamas in Beijing may have had a certain level of knowledge regarding modern astronomy, but because no lamas appear in Ruan (1842) and Pfister (1932-1934), it can be supposed that, if any, they were not specialists. We can leave the issue open for future research.

851 It is frustrating to trace information on how the Tngri-yin udq-a was given to the Rje btsun Dam pa I for translation. Dza ya (Jaya) PaṇḍitaBlo bzang ’phrin las (1981), a biography of the Rje btsun Dam pa I, is not helpful in that respect. There may exist some relevant information somewhere in Mongolian, Manchurian, Chinese, or Tibetan texts, but currently, the printer’s colophon of the Rgya rtsis chen mo is the only source which explains the process involved in the translation.
properly due to a lack of knowledge regarding modern astronomy. Also, knowledge of the Čay-un kürdün did not function in the translation. As a result, both the Čay-un kürdün and modern astronomy are absent in the Tibetan translation Rgya rtsis chen mo. Nevertheless, the Rgya rtsis chen mo came into being merely because of the following reason: the Mongolian in the Tngri-yin udq-a, which is very close to present-day colloquial Mongolian, made possible the creation of the Tibetan calques and renderings in the Rgya rtsis chen mo, but with many mistakes, indecipherable pidgin, and calques.

Lastly, I should restress the following fact in conjunction with one of my concerns in chapter 3, i.e. the significance of the Rgya rtsis chen mo in the history of Tibetan astronomy: it could not be used because of its strange terms, concepts and theories. There is also no evidence that it was circulated. Even if it were circulated in Tibet, it would have had no impact in the 18th century (and even today). I am quite curious about who would have been able to understand it properly! In the same vein, the argument that the Mā yang rgya rtsis was created on the basis of an understanding of the Rgya rtsis chen mo is nonsensical. The origin of the Mā yang rgya rtsis was clarified in chapter 3.
ABBREVIATIONS

anno. annotated


BJAMS Bulletin of the Japan Association for Mongolian Studies / Nihon mongorugakkai kiyō 日本モンゴル学会紀要

CAJ Central Asiatic Journal

Ch. Chinese

C.P.N. Cultural Palace of Nationalities [= Minzu wenhua gong 民族文化宮]

D. Sde dge edition Tibetan Bka’gyur and Bstan ’gyur.

ed. edited

EFEO L’École Française d’Extrême-Orient.

G. Greek

HJAS Harvard Journal of Asiatic Studies.

IIJ Indo-Iranian Journal.

JA Journal Asiatique.


JHA Journal for the History of Astronomy.

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JIABS  Journal of the International Association of Buddhist Studies.

JIATS  Journal of the International Association of Tibetan Studies.

JIBS  Journal of Indian and Buddhist Studies / Indogaku bukkyōgaku kenkyū 印度學佛教學研究

JIP  Journal of Indian Philosophy

L.  Latin

lit.  literally

Man.  Manchu

M.  Mongolian.


P.  Peking Edition Tibetan Bka’gyur and Bstan’gyur.

P.  Pāli

r.  reign

RET  Revue d’Etudes Tibétaines.

rev.  revised

SKQS  Yingyin wenyuange sikuquanshu (景印 文淵閣 四庫全書)

S.  Sanskrit
TBRC  Tibetan Buddhist Resource Center

TG  Tōhō gakuhō 東方學報

T.  Tibetan


TP  T’oung pao 通報

tr.  translated

UAJ  Ural-Altaiische Jahrbücher

XY  Xizang yanjiu 西藏研究

ZDMG  Zeitschrift der deutschen morgenländischen Gesellschaft

ZKY  Ziran kexueshi yanjiu 自然科学史研究

ZKS  Zhongguo keji shiliao 中国科技史料

ZKZ  Zhongguo kejishi zazhi 中国科技史杂志

ZS  Zentralasiatische Studien des Seminars für Sprach- und Kulturwissenschaft Zentralasiens der Universität Bonn.

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Yum pa. Bod kyi gnam rig skar rtsis rig pa’i brtsi byed ma lag.