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Section V.4.a.1: Natural Philosophy and the 'New Science'

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The studies by Marjorie Hope Nicolson, and others, of the impact of the 'new science' on seventeenth-century English literature assumed an unproblematic demarcation between science and literature. Since the 1950s this notion has been challenged, both by new trends in 'literature and science' (from cyberspace to the rhetoric of science) and by recent historical scholarship. In particular, as this brief sketch will suggest, the historical complexity of the relations between natural philosophy and literature in the early modern period belies not only the traditional assumption of a separate science which 'influences' literature, but also the more recent intimations that science simply is literature. In the Renaissance proper (say, until 1630) the methods, goals and individuals involved in the two clusters of disciplines overlapped in a number of ways. During the seventeenth century new developments in both science and literary criticism tended, sometimes self-consciously, to define the two fields as separate and even opposed. Although one can see in these trends the foundations for our modern sense of a gulf between science and literature, at the time such a gap was not so readily apparent.

Carrying on an ancient tradition, natural philosophy in the Renaissance searched for certain, causal knowledge about nature primarily

through the interpretation of and commentary on authoritative texts. Bookish methods promised more exciting results than ever once they could be applied beyond the writings of Aristotle and his scholastic commentators, already central to the medieval curriculum. Thanks to humanism, a vast number of newly discovered ancient works about nature became available: late antique commentaries on Aristotle (for example, Philoponus, Simplicius, and Alexander of Aphrodisias); accounts of pre-Socratic, Epicurean and Stoic, hermetic and Neoplatonic cosmologies and philosophies; and new works and better versions of old ones by still canonical figures, like Aristotle, Ptolemy, and Galen.ⁱ Until roughly the mid-seventeenth century the main practice of natural philosophy was to emend and interpret, compile and sort, reconcile and imitate such disparate texts.ⁱⁱ

In the universities, natural philosophy (one of the four branches of philosophy, alongside logic, metaphysics, and ethics) consisted in the explication of and commentary on canonical texts, starting with Aristotle's Physics on the principles of nature (space, time, motion and the like), and advancing to more specialized works on meteorology, psychology or theoretical medicine. The academic boom of the late sixteenth and early seventeenth centuries produced countless theses, professorial treatises, and textbooks on these topics.ⁱⁱⁱ For broader, non-specialist audiences authors located outside the university (often doctors, lawyers or clerics) compiled and debated the nature and causes of myriad natural (and in some cases mechanical) 'facts' garnered from the wide range of available books, ancient and modern. Although these different kinds of works

might include direct observations, secondhand reports and local lore alongside information derived from books, this traditional kind of natural philosophy created new knowledge primarily through the compilation, criticism and explication of texts.

At the same time, before 1630, a handful of works introduced the emphases identified with 'modern science': notably new claims for the applicability of mathematics to the physical world, and for the relevance of empirical observation and practical applications to natural knowledge. Although scientific by modern standards, these new concerns, too, grew in part out of the humanist methods of textual recovery and imitation. Thus current scholarship agrees with Kepler when he complained that Copernicus, in launching an astronomical revolution, 'had imitated Ptolemy rather than nature'.^{iv} Similarly, in rejecting the traditional division of labour between the learned doctors and the menials who performed dissections, Andreas Vesalius invoked the methodological precepts of his ancient model Galen.^v For Niccolò Tartaglia, an autodidact employed as military engineer to the Duke of Urbino, Euclid's Elements, newly available in the vernacular, provided the format and ideal for his attempt to mathematize and lend higher status to ballistics.^{vi} Whether mathematical, empirical or social, the scientific innovations of the sixteenth century drew from ancient texts a rich supply of models, methods, data and theories.

Although founded on the imitation of ancient models and the manipulation of textual sources, Renaissance natural philosophy did not generate

any theories of literary practices specific to its goals. In this sense it did not directly contribute to the formulation of literary critical precepts. The suggestive metaphor of reading the 'book of nature', as a companion volume to the Bible, for example, did not entail a particular interpretive method. Drawn from both biblical and ancient sources (notably St Paul, Lucretius, and the Stoics), the metaphor is a commonplace used to support contradictory attitudes toward natural philosophy. At one extreme, for example, Galileo finds that the book of nature is written in the language of mathematics, which speaks more clearly than the language of Scripture; at the other, the Protestant scientific poet Du Bartas, following Luther, believes that the book of nature can only be read through the glasses of faith.^{vii}

Instead of developing a literary method specific to their subject, natural philosophers drew from the humanist education and ambient culture shared by the educated elite. Natural philosophers did not form a separate professional group and received little formal specialized education outside medical faculties or London's new Gresham College for mathematical practitioners. Even mathematicians, whose methods and topics had been clearly delineated since antiquity, were also trained as humanists. Thus, although each author is primarily identified with one field or the other, Renaissance 'literature' and 'science' overlap in a number of canonical figures. Almost every philosophical author had occasion to compose literary exercises of some kind, especially poems, in academic gatherings or early salons, in the front matter to books, or in commemoration of political or academic ceremonies.^{viii} Galileo left two comedies and a few neo-Latin poems in manuscript and published a critique

of Tasso's style. Championing the classical simplicity and order of Ariosto, Galileo attacked the Girusalemme liberata for its excessively intricate syntax and amplifications, its distortions of Tuscan vocabulary, and for the lack of psychological coherence of its characters; while Galileo participated in this way in a general turn against mannerism in the years 1590-1615, he too shunned classical Latin in favor of an Italian style that tended toward polemical excess and a personal tone in an effort to reach out to a broader audience.^{ix} Kepler composed a 'Dream' imitated from Lucian and Plutarch, in which he imagines the earth as seen from the moon, and a serio-comic paradox on the snowflake as a new year's gift to a courtly patron. Even in a technical work like the Mysterium cosmographicum (1596), in which he develops his theory that the planets are nested between the perfect solids, Kepler displays a sophisticated authorial self-consciousness when he describes the difficulties of matching the data to his theory in the first edition and, in a later edition of 1620, adds a thorough critique of his earlier work in long, probing footnotes. Conversely, some figures central to Renaissance literary criticism were also active in natural philosophy: notably Girolamo Fracastoro (medicine), Francesco Patrizi (anti-Aristotelian natural philosophy) and Jacques Peletier du Mans (arithmetic).

Even while 'doing science', natural philosophers contributed to the development of literary languages, forms and metaphors. Galileo's Dialogue concerning the two chief world systems, for example, is considered a landmark in the development of Italian as a vernacular, as is Bacon's Advancement of learning for English; yet both authors also composed other works in Latin. Natural

philosophy was involved both in the early emergence of the vernaculars and in the late persistence of Latin. Latin continued to be used into the eighteenth century for works addressed to a specialist or academic audience, most famously Newton's Principia (1687) or Linnaeus's Systema naturae (1735). But already in the sixteenth century, artisans with little or no Latin literacy (in fields ranging from surgery to engineering and pottery) successfully laid claim to greater respectability as authors of technical treatises which offered an improved mastery of nature (Paré, Tartaglia, the English mathematical practitioners). Some self-consciously used the vernacular to challenge established academic and intellectual hierarchies, attacking, for example, the priority of theory over practice (Palissy), or of ancient learning over theosophic wisdom (Paracelsus). These calls for the vernacular to free natural philosophy from the narrow ranks of those indebted only to classical learning were also echoed by literary figures like John Rastell (c. 1510) and Sperone Speroni (1547).^x Natural historians were also among the first to introduce the vernacular, both in nomenclatures and in the composition of treatises (e.g. by Guillaume Rondelet, Pierre Belon, Leonhard Fuchs); the difficulty of identifying local vernacular terms for plant and animal species with the ancient ones was well known since the fifteenth-century controversies concerning the translation of Pliny's Natural history and remained of the utmost importance in trying to follow accurately ancient medical recipes.^{xi} At the same time, increasing numbers of translations from the Latin of ancient and Renaissance natural philosophy contributed to the development of a vernacular vocabulary on scientific topics. But the authors involved complained about the

difficulty of their task, and debates over the proper use of borrowings from Latin and other languages, versus innovative coinings, or colloquialisms from local dialects, continued long into the seventeenth century.^{xii} Indeed Thomas Sprat's famous call in 1667 for a 'plain and simple' style, which R. F. Jones saw as the origin of a new 'utilitarian' and anti-rhetorical prose, is, after many years of debate, increasingly interpreted as a reaction not against rhetoric itself, but against the crabbed Latinisms in the English prose of contemporary scholars. Particularly in the translation of scientific works, neologisms were frequently coined on Latin models, so that some English books even included glossaries explaining the new words; John Evelyn and John Wilkins were among those who, like Sprat, called for an end to the excessive use of Latinisms and of words having several meanings. Robert Boyle too complained about the ambiguity of chemical language in particular.^{xiii}

Natural philosophers also helped to develop new literary forms: the utopia (Bacon, Campanella), the cosmic voyage (Kepler, Huygens), the debate (Bruno), the essay and the aphorism (Bacon).^{xiv} Metaphors of theatres, books, and jokes of nature pepper their writings.^{xv} A more conventional form especially widespread during the Renaissance, the dialogue, surfaces in many kinds of natural philosophical works, from technical treatises of medicine or astronomy (Jean Fernel's De abditis rerum causis, Kepler's Epitome) to the simple questions and answers of textbooks for beginners, in encyclopaedic compilations (Jean Bodin's Universae naturae theatrum) and natural theologies (Lambert Daneau, Physica christiana). The didactic dialogue could be used to powerful effect, as

Galileo discovered when his Dialogue of 1632 engaged rhetoric in the battle between the cosmologies with such success that it was condemned.^{xvi}

Finally, the Renaissance was the heyday of a phenomenon which has often puzzled modern sensibilities, that loosely termed 'scientific poetry'. Throughout Renaissance Europe, newly recovered examples and reports of ancient Greek and Latin poetry about nature (for example, Manilius, Virgil, Hesiod, Columella, Oppian, Nicander, Xenophanes, Lucretius) spawned imitators: among them, George Buchanan, Sphaera and du Monin, Uranologie (1585 and 1583, astronomy); Giovanni Pontano, Urania (1480, astrology and meteorology); Girolamo Fracastoro, Syphilis (1530); Augurelli, Chrysopoeia (alchemy, 1518); Marco Vida, Bombyx (on the silkworm, 1527).^{xvii} These largely didactic poets were motivated by practical goals, to facilitate memorization of useful knowledge, or to display their virtuosity in this most difficult form of imitation. Between 1555 and 1565, the French poets of the Pléiade, who envisioned themselves as learned and inspired guides to a Christianized and often Neoplatonized universe, perceived deeper links between the poet and the natural philosopher -- for example, in a shared demonic inspiration (Ronsard), or in the recondite understanding of secret wisdom (Scève, alchemical poets); the heavens especially were valued as a suitably exalted topic for poetry which would sing the praises of the God the divine Creator.^{xviii}

Whether didactic or lyric in orientation, these poets pursued a goal common to both poetry and natural philosophy: to ally the utile with the dulce. In a close parallel to the hackneyed Horatian tag about the purpose of poetry, natural

philosophy was routinely praised in the Renaissance for both teaching the wisdom and providence of God, and delighting the reader with the varied detail of natural description (docere et delectare).^{xix} Through most of this period the scientific knowledge contained in such poetry rested on traditional knowledge transmitted from ancient sources and available in the most basic pedagogical manuals; descriptions of the heavens by the poets of late sixteenth-century France, for example, bear no traces of the knowledge or concerns current among astronomers at the time.^{xx} For that reason, poetry has served as a useful gauge of the penetration of the new scientific ideas to a broader public and of the conceptual transformations that occurred in that process. For example, many astronomers objected to Copernicanism, but never on the grounds that it displaced humans from their noble place at the center of the universe; on the contrary, the Aristotelian objection was that the earth was too crass and unworthy a body to share in the perfect motions of the heavenly bodies. But poets like John Donne, perceiving the end of a number of long-traditional notions, expressed dismay and uncertainty at a world changing its centerpoint, at the 'breaking of circles', which the natural philosophers never did.^{xxi}

As the Renaissance developed a new poetics, inspired by Aristotle's rediscovered work on the subject, over time literary theory worked to exclude natural philosophy written in verse from the purview of poetry. While some critics, like Patrizi, Fracastoro and J.C. Scaliger, still favoured scientific poetry, the strict Aristotelians like Speroni, Varchi, Vettori, and Minturno condemned it.^{xxii} By the early seventeenth century, in France, the classical rules

laid out by Malherbe sealed the oblivion of the poets of the preceding generation. In England, however, scientific poetry generally aroused less criticism. Even Sidney, one of its strongest opponents, wavered in his condemnation, praising for example its venerability.^{xxiii} A flow of original works (most notably, Abraham Cowley's De liber plantarum, 1673), of scientific passages in longer poems (Milton), of editions of classical works, and of translations of Renaissance poems continued throughout the seventeenth century. Encouraged by various members of the Royal Society at the end of the century, English nature poetry culminated in a flowering of georgic, descriptive, and natural theological poetry praising the glories of divine creation which lasted well past 1700.^{xxiv} Throughout this progressive shift in poetic topics away from natural philosophy and toward the description of nature or of husbandry, one work continuously exercised critics on account of both its philosophy and its poetry: once rediscovered in 1417, Lucretius's De natura rerum was endlessly reviled for its Epicureanism, praised for its poetry, and imitated for its descriptions of nature.^{xxv} By the end of the eighteenth century, however, the nature poem was eclipsed by the lyric poem and nature books in prose, partly under the renewed attacks of literary theorists.^{xxvi}

From the mid-seventeenth century on, the 'new science', too, contributed in various ways to a progressive separation between science and literature, although the legacy of Renaissance interrelations continued later than the programmatic statements of various 'new scientists' would indicate. Francis Bacon and René Descartes, both posthumously hailed as leaders into new (and quite different) kinds of natural philosophy, agreed at least in proclaiming the

utter uselessness of traditional bookish methods of acquiring knowledge.

Although historians have noted in their work some unacknowledged debts to earlier methods and texts,^{xxvii} these statements were effective in first spreading the notion, now commonplace, that science is antithetical to literature. To free themselves from the 'idols' which Bacon associated with received language, some projectors devised new, symbolic languages that would match reality.^{xxviii} But the 'language' which the new science successfully developed was mathematics: Isaac Newton's Principia (1687), despite being immediately lionized, soon removed the study of physics beyond the ken of the educated non-specialist. Although the life sciences still remained accessible to the lettered elite through the eighteenth century, Newton effectively drove a wedge into the kind of vast research program which he himself had undertaken, of tracing divine activity through alchemical, historical and biblical learning as well as mathematical physics.^{xxix} The foundation of the Royal Society (1662) and of the Académie Royale des Sciences (1666) also laid the foundations for the specialization of science, although for a time the Royal Society included not only the famous players in the development of the mechanical philosophy (like Boyle and Hooke), but also figures associated primarily with esthetic and antiquarian pursuits (like Evelyn, Dryden, Wren, Aubrey or Cowley).

'Literature' and 'science' had only begun by the end of this period to form distinct conceptual worlds; neither was 'literary criticism' clearly defined. The impact of scientific developments on literary criticism has more to do with a shared context than with a specific theoretical legacy. The Scientific Revolution

contributed to the general trend of the 'moderns' to reject ancient authority and rely on rational rules. While during the sixteenth century the renewal of scientific disciplines was still largely based on the imitation of the ancients and on methods of textual compilation and commentary, by the end of the seventeenth century the traditional scientific authorities (except perhaps Hippocrates) had been replaced with new systems of explanation and description supported variously by rational speculation, mathematical laws, empirical observation and experimental testing. In evolving toward this 'modern' outcome, scientific practice, both traditional and innovative, was nonetheless noticeably shaped by the literary concerns central to a humanist education. Thus literary goals, forms, methods and justifications can be detected, as I have outlined, in most natural philosophical works of this period.

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NOTES

A generation of more didactic French poets (down to 1580), such as du Monin, returned to the framework of the ancient and neolatin (especially Italian) models made available through humanism.

i

See Anthony Grafton, New worlds, ancient texts: the power of tradition and the shock of discovery (Cambridge, MA: Harvard University Press, 1992).

ii See Ann Blair, Anthony Grafton, Owen Hannaway and Lynn Joy, 'Reassessing Humanism and Science', Journal of the history of ideas 53 (1992), 535-84, and the works cited there.

iii Charles B. Schmitt, 'The rise of the philosophical textbook', in The Cambridge history of Renaissance philosophy (Cambridge: Cambridge University Press, 1988), pp. 792-804.

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v Andreas Vesalius, Epitome, tr. L. R. Lind (New York: Macmillan, 1949), preface.

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