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palgrave advances in renaissance historiography

edited by
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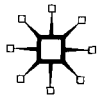

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68. This is truer still of a much more recent collection than Smith's: *English Renaissance Literary Criticism*, ed. Brian Vickers (Oxford, 1999).
69. See Loewenstein and Mueller, *Cambridge History of Early Modern English Literature* and James Simpson, *The Oxford English Literary History*, II: *1350–1547, Reform and Cultural Revolution* (Oxford, 2002).
70. John Skelton, *The Complete English Poems*, ed. John Scattergood (New Haven, 1983), pp. 319–31.
71. Spanish is once again an interesting exception, at least in the United States, but the resurgence in Hispanic studies has brought Golden Age studies to the forefront of Renaissance or early modern studies.
72. Helgerson, *Forms of Nationhood*, p. 38.
73. John Nichols, *The Progresses, Processions, and Magnificent Festivities of King James the First, His Royal Consort, Family, and Court*, 4 vols (London, 1828), I, pp. 121, 93–4; Smith, *Elizabethan Critical Essays*, II, p. 356.
74. Weisinger, 'Who Began the Revival of Learning?', p. 627.
75. See Anthony Grafton, *Defenders of the Text: The Traditions of Scholarship in an Age of Science, 1450–1800* (Cambridge, MA, 1994), pp. 94–101; Donald R. Kelley, *Foundations of Modern Historical Scholarship: Language, Law and History in the French Renaissance* (New York, 1970); Ginzburg, *No Island*, p. 31.
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77. Richard T. Spence, *Lady Anne Clifford, Countess of Pembroke, Dorset and Montgomery (1590–1676)* (Stroud, 1997), pp. 181–99.
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79. Nichols, *Progresses*, I, pp. 32–3, 128–32.

12
science

brian w. ogilvie

For historians of science, the Renaissance has long been the neglected stepchild, standing in the shadow of the Middle Ages and the seventeenth-century Scientific Revolution.[1] Historians have written about scientific developments in the period from 1400 to 1600, but by and large they have had little interest in whether the Renaissance forms a coherent period in the history of science distinct, on the one hand, from developments in late medieval natural philosophy and, on the other, from the 'new science' of seventeenth-century figures like Galileo, Descartes, Boyle, and Newton.

When writing about the historiography of science in the Renaissance, there are thus two issues to address. First, what was science like in the Renaissance, and on what have modern historians of Renaissance science focused? What approaches have they taken, how do those approaches differ from earlier historical approaches to Renaissance science, and what are their fruits? Underlying these questions about recent and contemporary historical research is a second, deeper – though not necessarily more important – question: is the Renaissance a coherent period in the history of science?

In the following pages, I chart a path from the first to the second of these questions. I begin by sketching briefly the historiography of Renaissance science from Jacob Burckhardt's *Civilization of the Renaissance in Italy* (1860) through the following century. I then address the substance of historical research on science during the Renaissance, emphasizing the shift from study of scientific theories and institutions, with an eye on the origins and development of modern science, to an interest in science as practice and culture done by historians who are less concerned with explaining how Renaissance science contributed to modern science

than with understanding what role science played in Renaissance culture and society.

Historians have only occasionally reflected on the Renaissance as a category in the historiography of science. My own views of the subject have been informed not only by my reading in the literature but also by four of these reflections: Eric Cochrane's 1976 article on 'Science and Humanism in the Italian Renaissance'; Antonio Beltrán's 1985 considerations on 'El Renacimiento en la historiografía de la ciencia' ('The Renaissance in the Historiography of Science'), Pamela O. Long's 1988 essay on 'Humanism and Science', and Brian Copenhaver's 1992 article, 'Did Science have a Renaissance?'[2]

As these historians point out, history of science has rarely addressed the Renaissance as a distinct period. Beltrán notes that historians in the 1960s and 1970s – Frances Yates, D. P. Walker, Allen Debus, P. M. Rattansi, and Margaret C. Jacob – acknowledged the importance of the mystical or hermetic tradition on the development of modern science, but they framed the issue not in terms of Renaissance science but, rather, in terms of contributions to the Scientific Revolution. Paolo Rossi emphasized in his study of Francis Bacon the specifically Renaissance elements in Bacon's thought: his logic was an offshoot of Renaissance logic, while his notion of the natural philosopher as 'interpreter of nature' drew heavily on the Renaissance idea of the magus.[3] But more commonly, historians of science either neglected the Renaissance or treated it as only an indirect influence on the history of science. As Beltrán portrays developments through the 1970s, there were three main approaches to the question of Renaissance science and its relation to the history of science more generally. One strand pointed to the indirect importance of later fifteenth- and sixteenth-century humanism for recovering ancient Greek scientific knowledge, which stimulated seventeenth-century developments. A second strand, dating back to the work of Pierre Duhem in the early twentieth century, stressed the theoretical and methodological continuities between medieval physical science and its seventeenth-century successor, treating the Renaissance as an irrelevant or retarding interlude. A third strand emphasized the continuity between the seventeenth-century scientific revolution and the mystical-magical Hermeticism of the Renaissance.[4] Peter Damerow and Jürgen Renn have recently suggested that the last two approaches are not so much opposed as complementary: the body of scientific knowledge of the Scientific Revolution shows many continuities with medieval science, but the 'image of science' of the Scientific Revolution – with its grand claims to remake man and society – is a Renaissance innovation. Moreover, Renaissance and seventeenth-century 'scientist-engineers' confronted new 'objects of knowledge' that led to significant changes and refinements in the theoretical and methodological inheritance of the Middle Ages.[5]

Damerow and Renn's approach is fruitful for understanding the historiographical state of study on Renaissance science. But the very title of the article in which they state their position is revealing: 'Scientific Revolution, History and sociology of.' Scholars who explicitly address the overall character of science in the Renaissance have been interested almost exclusively in relating the Renaissance to the subsequent Scientific Revolution. A chief exception is the work of Michel Foucault (addressed below), which in turn explains why Copenhaver and others take Foucault to task for positing a rupture at the transition both from the Middle Ages to the Renaissance and from the latter to the 'classical age' of early modern thought (and science).

In what follows, we will consider how historians have treated the body of science, the image of science, and the object of science in the Renaissance, in the context of who was doing science and how that changed. I will emphasize the period from 1450 to 1600; as we will see, the sixteenth century has received much more attention from historians of science than the fifteenth. I have made no attempt to be comprehensive; the reader who wishes for a complete bibliography should consult the *Isis Current Bibliography* and the collections produced on its basis.[6]

background: renaissance science from 1860 to 1970

Jacob Burckhardt's powerful interpretation of the Renaissance created a historical myth that has both structured and distorted subsequent scholarship.[7] Following Jules Michelet, Burckhardt characterized the Renaissance as a period of the 'discovery of the world and of man'. A lively interest in natural phenomena was one element in Burckhardt's Renaissance picture.[8] But Burckhardt knew little and said little about science itself. The 'revolt of the medievalists' against Burckhardt's characterization of the Renaissance as the birth of modern Europe affected the history of science too.[9] Careful study of the achievements of medieval natural philosophers in the mathematical study of motion led the French physicist and historian Pierre Duhem to conclude that the birthplace of modern science lay in the thirteenth and fourteenth centuries, and that the mechanical work of Leonardo da Vinci, essentially medieval, served to transmit this mechanics to its most important student, Galileo Galilei.[10] This conception was vigorously opposed by other historians of science, who identified the late sixteenth and seventeenth centuries as

the period when modern science was born. In particular, for E. A. Burtt and Alexandre Koyré, the development of astronomy and physics from Copernicus to Newton marked not only the birth of modern scientific theories and methods but also a more fundamental shift in metaphysics, producing the infinite, mechanized, mathematically tractable universe in which we live.[11] Thus, in the early twentieth century, the most important debate about the origins of modern science was over whether it was to be found in the Middle Ages or the seventeenth century.

This emerging notion of the Scientific Revolution largely eliminated the Renaissance as a distinct period in the history of science. The Scientific Revolution began with the astronomical innovation of Nicholas Copernicus, whose 1543 *On the Revolutions* posited a heliocentric mathematical model for planetary astronomy. Copernicus began a scientific revolution that challenged the dominant Aristotelian physics and Ptolemaic astronomy of the Middle Ages. Later revolutionaries, like Galileo Galilei, Johannes Kepler, and René Descartes, strove both to justify heliocentrism against its opponents and to devise a mathematical theory of local motion that made sense in a world that no longer admitted Aristotle's fundamental distinction between celestial and terrestrial physics. Their endeavours culminated in Isaac Newton's *Mathematical Principles of Natural Philosophy* (1687), whose theory of universal gravitation tied together a century and a half of developments in terrestrial and celestial physics.

When the Renaissance did receive attention, it was generally either as a period of scientific stagnation or as a preparation for the more important developments of the seventeenth century, as in Marie Boas' 1962 survey of 'the scientific Renaissance'.[12] For Boas, the characteristic aspect of the Renaissance in the history of science was confusion and tension between the heritage of ancient science, recovered by humanist scholars, and the increasing demands of scientific empiricism, which was driven by practical needs. The result was a 'paradoxical blend':

> Striving to master Greek scientific texts, while keenly aware of later technical progress, mathematicians, botanists and physicians, like astronomers, strangely combined reverence for the literal word of the remote past with a desire for novelty. Endeavouring to see in nature what Greek writers had declared to be there, European scientists slowly came to see what really was there.[13]

Torn between the conflicting demands of recovering past texts and discovering the world, Renaissance science possessed no individual character of its own.

By the 1970s, the Renaissance had largely been written out of the history of science. Generations of scholars had emphasized the divide between the medieval scholastic tradition, with its strong scientific bent, and the rhetorical, political concerns of Renaissance humanists, who held most scientific knowledge in contempt. Moreover, by emphasizing the continuities between Galileo's work in the 1590s and that of Paduan Aristotelians two centuries earlier, J. H. Randall had effectively removed from the Renaissance its most prominent scientific light. Galileo, according to Randall, was not a product of the humanist culture of the Renaissance but, rather, of a scholastic counter-culture that had persisted in Padua.[14]

Admittedly, there were other currents. George Sarton initially dismissed the Renaissance as a retrograde period whose scholars substituted ancient texts for independent thought and personal observation of nature. But late in life, in the 1950s, Sarton came to appreciate the importance of Renaissance humanism for reviving aspects of ancient Greek science that had been neglected in the Middle Ages.[15] As will be discussed further below, the art historian Erwin Panofsky characterized the Renaissance as a period of 'decompartmentalization' during which the medieval barriers between artists, engineers, and intellectuals broke down, resulting in such universal geniuses as Leonardo da Vinci and Albrecht Dürer.[16]

Nonetheless, these were exceptions. In the middle of the 1970s, Thomas Kuhn summed up what he saw as two different traditions of early modern science. The mathematical tradition, above all astronomy and physics, achieved a true scientific revolution in the seventeenth century. The experimental tradition – chemistry, natural history – did not; their revolutions would come only in the eighteenth and nineteenth centuries.[17] The Renaissance played no role in either of Kuhn's traditions: for the mathematical tradition it was irrelevant, while for the empirical tradition it, like the Middle Ages, was a period of indiscriminate fact-collecting by artisans that began to develop seriously only in the seventeenth century. Insofar as Kuhn considered the Renaissance, he did so in the guise of neoplatonic Hermeticism, a negative force that had to be overcome by the founders of modern science in the seventeenth century.

revitalizing the renaissance in the 1970s

By the time Kuhn's article was published, though, historians were revitalizing the study of Renaissance science. The major focus of rehabilitating the Renaissance was in the history of chemistry. Allen G. Debus and Owen Hannaway took a new look at sixteenth-century

developments in the alchemical tradition from Paracelsus to the seventeenth-century experimentalists and medical chemists. Unlike Boas and other earlier historians, who distinguished sharply between progressive developments and the blind alleys of alchemy, Debus insisted that alchemy was central to scientific developments in the sixteenth century. His studies had roots in the innovative study of Renaissance neoplatonism, especially in its Hermetic varieties, conducted in the 1950s and 1960s by D. P. Walker and Frances Yates.[18] But where Yates had exaggerated the mystical element in Renaissance thought, and Walker had dismissed Paracelsus as a madman, Debus worked to domesticate Paracelsian thought and bring it into the mainstream of Renaissance science. Drawing on the work of the historian of medicine Walter Pagel, Debus first approached the subject in his 1965 *The English Paracelsians*, which established the presence in sixteenth-century England of a number of experimentally-inclined physician-alchemists who accepted Paracelsian medical chemistry despite their suspicions of his elaborate metaphysics.[19] But it was his 1977 synthesis, *The Chemical Philosophy*, that presented most forcefully the argument that a distinctly Christian, anti-Aristotelian chemical philosophy, developed in the sixteenth century out of Renaissance Hermeticism and medieval alchemy, was a vibrant area of scientific enquiry in the sixteenth and seventeenth centuries. In the early seventeenth century, this philosophy offered an alternative to the atomistic or corpuscular philosophies of Gassendi, Galileo, and Descartes.[20]

Debus' work was well received by scholars like P. M. Rattansi, Charles Webster, and Betty Jo Dobbs, who were reformulating the received view of the seventeenth-century Scientific Revolution. His work intended to show, *inter alia*, that sixteenth-century developments, even those that 'lost', were crucial to the development of modern science. Owen Hannaway took a similar approach but with a different focus in his 1975 *The Chemists and the Word*.[21] For Hannaway, the chemical philosophy – represented by the Paracelsian Oswald Croll – was the foil against which Andreas Libavius defined chemistry in the first chemical textbook.[22] Croll was caught up in a Foucauldian world of similitudes. He emphasized the immanence of the Word in the world and held that the alchemist must have ineffable experience of the world. Libavius, on the other hand, took a didactic, operational approach to chemistry. He contributed to forming the discipline of chemistry by deferring any discussion of its theoretical or metaphysical basis, grounding this exclusion in the sixteenth-century didactic method of Peter Ramus. Ramus and his followers developed a method for presenting any art or science systematically while taking for granted its fundamental axioms. Libavius applied Ramist methods to the tools, operations, and products that were part of chemistry, thus systematizing it as a set of practices and results that could be taught regardless of theoretical commitments.

In a later, influential article, Hannaway continued to contrast Paracelsian alchemy with Libavian chemistry in terms of laboratory design.[23] The astronomer and alchemist Tycho Brahe located his chemical laboratory deep in the most secret parts of his palace on the island of Hven. He pointed backwards to the medieval contemplative ideal of knowledge, while Libavius' humanistically-informed notion of science for the public good pointed the way toward the Scientific Revolution. Here as before, Hannaway integrated standard themes in Renaissance intellectual history – Ramism and the humanist praise of the active life – with the history of science.[24]

Hannaway's emphasis on humanism's positive contribution to science was echoed in studies of other disciplines. Karen Reeds' important 1976 article on Renaissance botany emphasized the role of humanist philology and sociability in reshaping the study of plants.[25] In attempting to reform medical study along the lines of the ancients, humanist physicians studied the text of the ancient pharmaceutical writer Dioscorides and revived the Greek physician Galen's programmatic call for physicians to have knowledge of plants. To understand these ancient works, they turned to direct observation of nature.[26] Humanism was thus part of the route to modern natural history, not a dead end that had to be overcome. Mathematics, too, owed much to humanists who gathered, edited, published, and commented on Greek mathematical manuscripts, as Paul Rose demonstrated in his 1975 study.[27] As in natural history and chemistry, Renaissance mathematicians contrasted the dark state of knowledge in the Middle Ages with the revival of learning in which they were taking part.

These studies demonstrated that despite disciplinary differences, Renaissance scientists shared the general attitude of Renaissance culture toward the ancients and the Middle Ages. They did not merely denigrate the Middle Ages and praise antiquity. By the sixteenth century, particularly in northern Europe, scholars recognized that medieval scientists had made positive advances that were worthy of study. Naturalists, mathematicians, and chemists drew extensively on medieval works. Nonetheless they adopted the humanist rhetoric of rebirth and renewal, the rhetoric that drove Francis Bacon's *Instauratio magna* or 'Great Renewal' of the sciences on the threshold of the seventeenth century.

The new canonical view was stated in Allen Debus' 1978 survey, *Man and Nature in the Renaissance*.[28] Despite the importance of fifteenth-century humanism, Renaissance science really began in the sixteenth century with Paracelsus, Copernicus, the anatomist Andreas Vesalius, and the botanist Leonhart Fuchs. Its *annus mirabilis* was 1543, the year in which both Copernicus' *On the Revolutions* and Vesalius' *The Structure of the Human Body* were published; Fuchs' path-breaking *Notable Commentaries on the History of Plants* had appeared the previous year, and Paracelsus' influence was just beginning to spread. From the middle of the sixteenth century through the first decades of the seventeenth, medieval Aristotelian natural philosophy was under assault from heliocentrism, the new empirical sciences of medicine and natural history, and the chemical philosophy. The Scientific Revolution would ultimately establish the mathematico-mechanical natural philosophy of Galileo, Descartes, and Newton, but their achievement would have been impossible without sixteenth-century developments. In this view, Renaissance science was important not because it comprised a unified approach to nature but because, in a time of intellectual turmoil, it tore down old certainties, leaving room for the Scientific Revolution to establish new ones.

rehabilitating the 'non-progressive' sciences since the 1980s

The work of Debus, Hannaway and others in the 1970s contributed to a historiographical trend that continues to the present: the rehabilitation of alchemy and other 'non-progressive' or dead-end sciences as legitimate subjects of enquiry for historians of science. For the founders of history of science as an academic discipline, these cul-de-sacs of knowledge were of interest only as part of the history of human folly. They had no place in the history of science itself, which they conceived as a record of intellectual progress. Lynn Thorndike's massive *History of Magic and Experimental Science* was an exception, but Thorndike was not trained as a historian of science and he treated magical procedures as a kind of unsystematic empiricism.[29] True, the journal *Ambix*, devoted to 'alchemy and early chemistry', had been founded as early as 1937, but it remained a venue for specialists. Debus, Hannaway, and their contemporaries made alchemy a key part of the history of Renaissance and seventeenth-century science, a position it has continued to hold until the present: no serious historian of Renaissance science can afford to be contemptuous of alchemy.

Contemporary work in the history of alchemy and chemistry has tended to emphasize two elements: first, its connection with princely courts, and second, its cultivation by canonical figures of the Scientific Revolution. Bruce T. Moran and Pamela Smith have emphasized the former. Moran's work on Landgrave Moritz of Hessen underscores the importance of princely support, interest, and practice for developments in alchemy.[30] Smith's study of Johann Becher emphasizes the place of alchemy, and alchemical collections, at the intersection of princely power, scientific enquiry, and economic development in the period immediately following the Thirty Years War.[31] The second aspect, though beyond the chronological scope of the Renaissance, cannot be wholly separated from it. In a series of important studies, Betty Jo Teeter Dobbs uncovered the central importance of alchemy to Isaac Newton.[32] Her pioneering work encouraged William Newman and Lawrence Principe to direct their attention to the alchemical interests of Robert Boyle, and, through Boyle, to the alchemical thought of George Starkey and other forgotten figures of the late seventeenth century.[33] Their scholarship demonstrates that some of the vital questions debated during the Scientific Revolution had been shaped by Renaissance alchemy.

No one writing on Renaissance science can avoid being struck by the attention natural philosophers gave to 'magic'. Marie Boas, in a chapter entitled 'Ravished by Magic', simultaneously acknowledged and dismissed the place of magic in Renaissance science. Since then, Michel Foucault's pioneering study of what he called the *episteme* of the Renaissance (on which see further below), and the work of historians of alchemy, have combined to make magic respectable – at least as a subject of historical enquiry. In fact, Renaissance magicians distinguished two forms of magic: one that invoked intelligent spirits or demons and another that simply drew on knowledge of the properties of things to produce unusual, but wholly natural, effects. This 'natural magic' is being written into the history of Renaissance science, in particular through studies of the 'books of secrets' in which natural magic and craft tricks were set out and of these books' authors. The work of William Eamon has played a key role in this development.

Books of secrets and their authors are humbler than the contemporary works of Latin-writing alchemists, but Eamon argues that the empiricism preached in these books, if not always practised by their authors, contributed to seventeenth-century philosophers' attacks on scholastic natural philosophy.[34] According to Eamon, 'secrets of nature' provided a powerful metaphor for understanding the relationship between common sense and the true structure of the world. Hellenistic esoteric thinkers

and their successors considered nature's secrets (*arcana naturae*) as accessible only through divine revelation; they were the province only of a religiously initiated élite. In the Latin Middle Ages, on the other hand, many of nature's secrets fell outside the realm of scholastic *scientia* because they were accessible only to experience. Eamon argues that the early modern notion of the 'secret' as the inner workings of natural processes, a notion popularized by printed books of secrets, informed the seventeenth-century idea of natural philosophy as an attempt to understand the way nature worked and the concomitant criticism of the scholastic notion of 'occult qualities' as a cover for ignorance. Although the word 'Renaissance' does not figure prominently in Eamon's book, his research illuminates an important aspect of late Renaissance intellectual life.

Artisans and natural philosophers shared an interest in natural magic with princes. The court of the Holy Roman Emperor Rudolf II in Prague was a particular focus of the promiscuous pursuit of natural knowledge by almost any path. As Richard Evans showed in a classic study of Rudolf's court, the occult arts were among those the emperor cultivated. John Dee, his medium Edward Kelly, and Giordano Bruno were only three of the magicians who passed through Rudolfine Prague, in the company of naturalists, artists, humanist scholars, and miscellaneous courtiers.[35] In a series of lapidary studies on Rudolf's court, Thomas DaCosta Kaufmann has illuminated how Rudolf's pursuits were intended to do no less than create a microcosm, a small world, through which Rudolf could exercise control over the large world, the macrocosm, in which he lived.[36] Such notions of a correspondence between microcosm and macrocosm, central to Renaissance Hermeticism and the chemical philosophy, shaped – disastrously for Rudolf himself, it must be admitted – not only the quest for scientific knowledge but also imperial policy.

Astrology, the 'irrational' and backwards-looking pseudo-science *par excellence* for historians of science through the 1960s, depended on the same assumptions about correspondences between the greater and the lesser world. Historians of medicine have long taken astrology seriously, for learned medicine in the Middle Ages and Renaissance had a strong astrological bent.[37] Historians of science have begun to take it equally seriously: an indication is Anthony Grafton's recent study of Girolamo Cardano, astrologer, physician, and shameless self-promoter.[38] Grafton is less concerned with the truthfulness of Cardano's astrology – though he points out where the astrologer went wrong according to his own techniques and theories – than in the history and contemporary meaning of astrological practice. This approach emblematizes the changes that

have occurred in the historiography of Renaissance science (and science in general) in the past two decades or so.

from theory and institutions to practice and culture

The rehabilitation of 'non-progressive' Renaissance science took place as part of a broader change in approaches to the history of science. In broadest terms, historians of science have shifted their emphasis from scientific theories and institutions to scientific practice and culture. These developments draw upon a wide range of intellectual traditions. One important strand was the work of Thomas Kuhn, whose classic *The Structure of Scientific Revolutions* undermined confidence in science as a cumulative, progressive enterprise; Kuhn emphasized instead the 'incommensurability' of competing scientific theories, insisting that choices between them had a subjective, cultural element (though the culture in question might be that of a narrowly defined professional community).[39] Kuhn's and others' work legitimated the interests of the historians of the 1970s in alchemy, astrology, and other historical dead ends.

More recently, the sociology of scientific knowledge has had a great impact on historical approaches to early modern science. This tradition, which developed out of Karl Mannheim's sociology of knowledge and the later work of the philosopher Ludwig Wittgenstein, emphasized that early modern European scientists argued not only about specific theories but, more fundamentally, about the very nature of science and the methods by which to pursue it.[40] The rules of the game could not be taken for granted; they were in the process of being worked out. The key work in the transfer of these sociological approaches to history was Steven Shapin and Simon Schaffer's 1985 book *Leviathan and the Air-Pump*.[41] In this work, the authors – a historically-minded sociologist and a historian – examined the dispute between Robert Boyle and Thomas Hobbes over the nature of air and the existence of the vacuum not as a contest between two ideas, one right and the other wrong, but as a dispute over the proper way to conduct natural philosophy. Boyle's victory helped resolve the question of what kind of science would be done in the seventeenth century and beyond, but it was not a foregone conclusion and it depended as much on Boyle's skills as a scientific politician and communicator, his ability to convince others that the 'matters of fact' he observed were true, as it did on the way things really were.

Shapin and Schaffer's book encouraged historians to take a cultural approach not only to 'bad' sciences like astrology and alchemy but also

to 'good' science, like Boyle's and Newton's physics. By emphasizing that science changes through controversy and that the old distinction between 'internal' (scientific) and 'external' (cultural) sources of change was untenable, this and similar works encouraged attention to scientific culture and practice as key aspects of the history of science. It appeared at a time when the 'linguistic turn' was at its height in the human sciences: that is, attention to the ways in which linguistic representations of the world do not merely reflect reality but shape our perceptions of it, and to the specific communities within which representational schemes were developed and contested.[42] Together, these approaches have brought new vigour and methodological richness to the study of Renaissance science.

The most obvious impact of the linguistic turn on the history of science has been in the study of scientific terminology and concepts. Hans Blumenberg's massive study of *The Genesis of the Copernican World* is concerned not with where Copernicus got his ideas but how it became possible for Copernicus to think in heliocentric terms.[43] Coming from the German tradition of *Begriffsgeschichte* (history of concepts), Blumenberg's work has not received the attention it deserves from historians of science, perhaps because it is more abstract and less attached to specific historical circumstances than Anglo-American historians prefer. Paula Findlen and Ann Moss have produced more concrete studies of the language of Renaissance science. Findlen's substantial article on *lusus naturae* (jokes of nature) and scholarly playfulness examines both the conceptual value of ideas of natural variability, of nature 'at play', and the sociological effects of scholarly jokes on the practice of Renaissance science.[44] Moss turns her attention to commonplace-books, works in which Renaissance readers jotted down classified notes from their readings. A study of printed versions of these books reveals both how the commonplaces of Renaissance pedagogy were shaped by reading practices and how they structured the way that Renaissance scholars and scientists thought about the world.[45]

As these examples suggest, Anglophone scholarship that takes a linguistic approach to the history of science tends to have a narrow chronological focus and emphasize specific communities and practices. A signal exception is Lorraine Daston and Katharine Park's 1998 study of *Wonders and the Order of Nature* from the twelfth through to the eighteenth century.[46] Daston and Park approach how Europeans thought of nature over this span of six centuries by looking at its boundary: the concept of wonders. By tracing where scholars, physicians, and scientists drew the border between natural occurrences on the one hand, and

preternatural or supernatural (wondrous or miraculous) events on the other, the authors construct a rich history of changing ideas of nature. Despite its breadth, this history is connected with specific communities: medieval university scholars scornfully neglected wonders, while medieval courts were fascinated by them; Renaissance physicians collected them; anti-Aristotelians used them to attack received theories of the world; seventeenth-century natural philosophers thought they were the gateway to knowledge; and at the end, Enlightenment scientists and *philosophes* domesticated them while scorning the emotion of wonder as an obstacle to knowledge.

One particular community whose contributions to science in the Renaissance has been fundamentally reevaluated since the 1970s is that of Renaissance humanists. Paul Rose's work, already mentioned, challenged the myth that humanists were opposed to science. Like most myths, this one had a kernel of historical truth: some humanists, above all the fourteenth-century poet Petrarch, disdained the study of the natural world. But the myth depended more on twentieth-century divisions between the humanities and the sciences than on the historical realities of the Renaissance. In the last two decades the myth has become untenable in the light of historical scholarship that has revealed how Renaissance scientists were stimulated by ancient alternatives to medieval Aristotelian natural philosophy, and how textual methods were intimately connected with the study of nature.

A case in point is the early seventeenth-century philosopher Pierre Gassendi. As Lynn Joy has shown, Gassendi became an early defender of atomism on the basis of his studies of Epicurean texts, texts that became tools to dismantle contemporary physical theories.[47] Gassendi, his contemporary and friend Fabri de Peiresc, and others saw no conflict between their antiquarian investigation of the past and the study of nature. On the contrary, one of their models was Galileo Galilei's empirical investigations of heavenly phenomena.[48] Johannes Kepler, too, was both astronomer and classical scholar, though he distinguished carefully between the methods proper to each.[49] Even Isaac Newton, at the end of the seventeenth century, devoted himself not only to physics and alchemy but also to his true passion, biblical chronology.

For seventeenth-century atomists, the support of prestigious ancient texts was indispensable; as Christoph Meinel has shown, atomism lacked sufficient empirical support, even by seventeenth-century standards, to stand on its own merits.[50] In this regard, humanist methods played a key role in the development of modern science, even at a period when scholars began to distinguish more sharply between the methods of

the 'new science' and those of the humanities. The study of sixteenth-century humanism and science thus provides a necessary foundation for understanding the Scientific Revolution.

Earlier accounts of sixteenth-century humanism and science tended to emphasize the conservative aspects of the former: for instance, Lisa Jardine's study of Francis Bacon, where the humanist method of Peter Ramus appears as a hindrance to the development of Bacon's new science.[51] More recently, Ann Blair's exemplary study of Jean Bodin sets out the intimate connections between sixteenth-century humanism and science.[52] Bodin set out to encompass the world within the covers of a book, aptly titled the *Theatre of Nature*. His method was empirical, but in a sixteenth-century sense that did not distinguish sharply between an individual's personal observations and those gathered from books. Hence Bodin's empiricism was stamped more by the study than the laboratory. Blair's study underscores that there were several competing forms of empiricism in the sixteenth century. Humanists like Bodin mined books for facts. Empirics like Paracelsus urged their followers to cast away their books and turn to nature – though in fact, Paracelsians depended heavily on the books of their master and others. Naturalists like Conrad Gesner of Zürich and Ulisse Aldrovandi of Bologna did both: by reading old books and studying natural objects in the field and the cabinet, by employing humanist methods of comparison and distinction, they attempted to catalogue the world more comprehensively than anyone before them.

Books, ancient and modern, were essential to the task of humanist science. The invention of the printing press in the middle of the fifteenth century had an undeniable impact on the development of science, an impact recognized by the traditional emphasis on publication dates as landmarks in the history of science (for example, the 1542–43 publications of Fuchs, Copernicus, and Vesalius). A bolder claim, that printing was responsible for the Renaissance, the Reformation, and the Scientific Revolution, was advanced by Elizabeth Eisenstein in 1979.[53] Printing, Eisenstein argued, allowed scholars to amass libraries far larger than had been possible in the age of manuscript. Moreover, it allowed scholars scattered across a continent to consult identical, error-free copies of the same works, thus permitting more intensive long-distance collaboration than ever before. Whereas medieval scholars had striven merely to get access to books, by the middle of the sixteenth century, scientists could compare works, sift through them for reliable information, and work to transcend them. In short, print gave ideas a fixity that they had lacked before, a fixity that was necessary for scientific progress.

Eisenstein's premises have been scrutinized critically ever since the work was published.[54] But her work was immensely stimulating to research in the connection between print culture and the development of science; directly or indirectly, it led to works like those by Moss and Blair on books and the sciences in the Renaissance.[55] Despite its historical and conceptual limitations, it remains essential for the study of Renaissance science. Eisenstein emphasized the importance of material objects, institutions (above all, printers' shops), and communications in the formation of modern science: in those respects, she was at the crest of the wave sweeping across the history of science in the late 1970s and early 1980s. And in engaging critically with her arguments, historians of science have been forced to take a new look at the role of material culture, institutions, and communications in early modern science.

Historians of medieval and early modern Europe had long studied the history of science in two institutional contexts: the universities, often seen as the bastions of outdated Aristotelian thought, and the new academies and societies of the seventeenth century, from the Accademia dei Lincei, founded in 1603, through the Royal Society of London (1660/62) and the Académie des Sciences of Paris (1666). Recent scholarship on the universities has tended to revise the earlier emphasis on their conservatism.[56] Along with this reappraisal, scholars have increasingly focused on a third institutional setting for Renaissance and seventeenth-century science: royal and princely courts. Again, Richard Evans' study of Rudolfine Prague (mentioned above) pointed the way to examining the court as a place where scientists met, exchanged ideas, and vied for the prince's attention. Beginning in the 1990s, this research has dramatically altered how we view Renaissance science. Of particular note is a collection of essays edited by Bruce Moran on *Patronage and Institutions*.[57] The contributions to that volume emphasize how the transformations in the nature of scientific knowledge and activity were intimately connected with princely politics and, above all, court patronage from the sixteenth through the eighteenth century. A particularly influential (and controversial) study of patronage and science is Mario Biagioli's book *Galileo, Courtier*.[58] Biagioli argues that Galileo sought out patronage from the Medici Grand Duke of Tuscany not only to pay his bills but also to gain the right to call himself a 'philosopher', despite his doing what university faculties considered mathematics, a discipline that in their eyes could not offer causal explanations of natural phenomena. Though many of Biagioli's specific claims have been disputed, his work has encouraged a lively debate over the question of patronage and the legitimation of new claims to knowledge. Peter Dear's study of sixteenth-

and seventeenth-century Jesuit mathematics differs greatly in spirit from Biagioli's book, but it is motivated by many of the same questions.[59]

The recent emphasis on informal institutional settings for science, like courts and academies, has encouraged attention to the intersections of science and other courtly pursuits, especially art. The great German refugee scholar Erwin Panofsky was a pioneer; his 1962 essay 'Artist, Scientist, Genius' explicitly addressed the connections between the new spirit of the Renaissance and contemporary developments in science and art, above all in the figures of Leonardo da Vinci and Albrecht Dürer.[60] Panofsky's idealist scholarship emphasized a unitary spirit of the age; at a time when historians are more likely to exorcize *Zeitgeister* than seek them, his approach is out of fashion. But (as noted above) he stimulated attention to specific links between art and science by arguing that the Renaissance was a period of 'decompartmentalization': traditional medieval distinctions between the 'liberal arts' (including science) and the 'mechanical arts' (including painting, sculpture, and architecture) had been effaced, while the modern separation between the cultures of science and humanities had not yet been constructed. Two important collections of essays from 1985 illuminate specific aspects of the connection.[61] In 1991, the art historian Samuel Edgerton revived an element of Panofsky's thesis, arguing that the key to the origins of modern science lay in the new geometrical conception and depiction of space represented by Renaissance perspective theory.[62] Other scholars, such as James Elkins, have responded that 'perspective' is a modern historian's construct, and that Renaissance artists used several different, incompatible systems to create the illusion that a two-dimensional surface had three dimensions.[63] A recent collection of essays, resulting from a 1997 conference, illuminates the continuing fruitfulness of examining such questions, which now include the cognitive role of illustrations in early modern science.[64]

Contemporary scholarship on the history of Renaissance science is epitomized in recent studies of Renaissance natural history. Natural history, Harold Cook has noted, was the 'big science' of the sixteenth and early seventeenth century.[65] Universities, princes, and private individuals collected natural curiosities, established gardens for rare and exotic plants, and stalked urban markets and dockyards for unusual specimens. Naturalists exchanged specimens and descriptions in their correspondence. They used woodcut, and later copperplate engraving, to depict plants and animals while simultaneously developing a powerful descriptive language for natural history. With a few exceptions,

Renaissance naturalists did not attempt to develop new classifications of the natural world; instead, they sought to catalogue nature's productions as exhaustively as possible. And their results were presented in large, often lavish books from Europe's finest presses.

Until recently, these developments were the province of specialists in the history of botany, zoology, and geology.[66] Some scholars did see natural history as emblematic of broader transformations in European thought: for example, Charles Raven and Michel Foucault.[67] The key development that brought natural history to the centre of the historiography of science and culture in the Renaissance was, however, a turn to the history of collecting. In 1985 and 1986, two signal collections of essays were published, resulting from conferences in France and England. The papers in *La Curiosité à la Renaissance* addressed the broad range of meanings of 'curiosity' and its connection to collecting, while *The Origins of Museums* examined more specifically the cabinets of 'curiosities' or 'wonders' that enjoyed an immense popularity beginning in the middle of the sixteenth century.[68] These studies linked natural history to other late Renaissance currents in collecting. Krzysztof Pomian and Antoine Schnapper soon followed with the first important book-length studies since Julius von Schlosser's work at the beginning of the twentieth century.[69] Sustained interest in the subject was marked by the foundation of the *Journal of the History of Collections* in 1989.

This interest in collecting came at a time when Italian scholars were revitalizing the history of natural history. In a series of articles beginning in the late 1970s, Giuseppe Olmi began a detailed study of Renaissance natural history based on the papers of the Bolognese naturalist and physician Ulisse Aldrovandi.[70] Margherita Azzi Visentini, Fabio Garbari, Lucia Tongiorni Tomasi, and Alessandro Tosi complemented this work with important studies of the botanical gardens at the universities of Padua and Pisa.[71] It is in this context that Paula Findlen produced her masterful 1994 account of natural history collecting in Renaissance and Baroque Italy.[72] Findlen examined not only collections of *naturalia* (plants, animals, and minerals) but also the extensive collections of manuscript notes and drawings gathered by Italian naturalists. Both kinds of collections were used reciprocally to understand the natural world. Renaissance scientific empiricism depended not only on examining and comparing objects but also, crucially, on notes, books, and other aids to memory: by the middle of the sixteenth century, the number and variety of species known to naturalists exceeded their unaided cognitive capacity.[73] Collections also helped define the identity of collectors, who formed networks of correspondence and patronage to enhance their

collections and their own social standing; some individuals, not collectors themselves, became important brokers in the early modern economy of scientific exchange.[74]

The historiography of natural history has also been shaped by the history of the book. Large and, by the 1540s, usually copiously illustrated, natural histories were expensive and had to be carefully marketed.[75] Laurent Pinon has traced the evolution of Renaissance zoological publications in a catalogue that is a prelude to his forthcoming study of Renaissance zoology.[76] The printed and manuscript illustrations in natural histories have attracted the attention of art historians and historians of science. William Ashworth pointed out that natural history illustrations were widely copied and plagiarized in the sixteenth century, raising the question of what it meant to have an image 'drawn from life' in a published work.[77] Claudia Swan, in a study of natural history illustrations done in the Low Countries, has underscored the pedagogical function of illustrations as well as the distinctive character of natural history illustrations in the artistic landscape of the sixteenth and early seventeenth centuries.[78] I have traced the connections between illustration, text, and the market for natural history books in the sixteenth and seventeenth centuries; illustrations and texts developed in tandem according to naturalists' cognitive needs and publishers' sense of their market.[79]

In summing up developments in the historiography of Renaissance science, natural history also points the way toward resolving the second question with which this chapter is concerned: was there some distinctive 'Renaissance science', in addition to specific developments during the Renaissance period? Natural history as we know it was invented in the Renaissance, and Renaissance natural history, from about 1490 to 1620, was motivated by a specific concern with description, unlike subsequent natural history, in which the problem of classification took on increasing prominence.[80] Nonetheless, the transition from Renaissance to seventeenth century was a matter of a gradual shift, not an abrupt change. In a detailed, magnificently illustrated study of the early seventeenth-century Accademia dei Lincei, the art historian David Freedberg has argued that these 'lynx-eyed' academicians created modern natural history through careful visual documentation of nature, aided by the newly discovered microscope. Freedberg carefully reconstructs the Linceans' painstaking efforts to study nature, but he exaggerates the novelty of their approach.[81] In the case of natural history, it is very hard to draw a line in the sand and say that the Renaissance lies on one side, the Scientific Revolution on the other. The position of the line shifts depending on whether one considers naturalists' conceptual framework, their working methods, their tools, or the nature of their publications. It is hard to escape the conclusion that Renaissance science, if it is to be defined at all, must be defined prototypically: that is, by identifying a series of characteristics that are shared by many Renaissance sciences but that do not necessarily distinguish them sharply from predecessors and successors.

did science have a renaissance? does it matter?

Nonetheless, the question has been hotly debated: significantly, in terms that hark back to the earlier historiographical notion that science is a matter chiefly of concepts and theories, not practices and culture. I have already noted that historiography before the 1970s tended to efface the Renaissance as a distinct period in the history of science. As the careful reader will have noted from the above, more recent writers also tend to elide the distinction between the sixteenth and seventeenth centuries. Connections between the period are the focus of the essays on *Renaissance and Revolution* edited by J. V. Field and Frank A. J. L. James.[82] The varied contributions to that volume share an interest in continuity, with a focus on cultural and social context and the interactions of science and practical knowledge (for example, J. V. Field on perspective theory and Frances Willmoth on military mathematics). This kind of scholarship, typical of the field at present, recognizes that science participated in Renaissance developments (humanism, exploration, printing, to name only three) but is reluctant to posit any Platonic ideal of 'Renaissance science' that distinguishes it from medieval and seventeenth-century science.

About a decade ago Brian Copenhaver raised the question explicitly: 'Did science have a Renaissance?' In an elegant article Copenhaver argued that there was no transformation in science in the fifteenth and sixteenth centuries that could be seen as equivalent to the Renaissance in art or letters, and that the period was characterized by incoherence and competition among many scientific views, not by any Renaissance scientific world view that was distinct both from the medieval science that preceded it and the mechanical, corpuscular philosophies of the Scientific Revolution that followed. As his focus on world views implies, Copenhaver had a specific target in mind: the Renaissance *episteme* (way of thinking) whose existence was brilliantly, yet ultimately unconvincingly, presented by Michel Foucault in *The Order of Things*.[83]

Foucault characterized Renaissance thought as 'the prose of the world': a metaphorical understanding of nature, in which sympathies and antipathies, resemblances and 'signatures' dominated people's way of

thinking about the world. Such a way of thinking, argued Foucault, was a 'grill' that structured people's perceptions of the world in which they lived: it was not so much a conceptual structure as the foundation that made concepts possible. In this sense, Foucault went far beyond earlier accounts of Renaissance mentalities, like E. M. W. Tillyard's version of *The Elizabethan World Picture*, which had also emphasized neoplatonic thought and metaphorical visions of the world.[84] Take the doctrine of signatures as an example: the view that certain natural things were 'signed' by God to indicate their natural sympathies. The plant liverwort bore, in its liver-shaped leaves, the signature of its efficacy against diseases of the liver. For Foucault, the meaning of this particular signature had to be determined by Renaissance thinkers, but the idea that the world was composed of signatures was an *a priori* of Renaissance thought.

Natural history played a large role in Foucault's account. He marked the transition from Renaissance thought to that of the 'classical age' in the 1660s natural histories of John Johnston, the first, he claimed, to eschew symbolic meaning in favour of naked description. In this new period, the metaphorical *episteme* of the Renaissance was succeeded by a metonymical *episteme* in which classification became the dominant approach to the world. Foucault had little interest in explaining this rupture; he considered his work to be an archaeology of knowledge, not a history. And like some archaeologists, Foucault drew grand conclusions from selective evidence. In the realm of natural history, Foucault ignored botanical and zoological works that had, a century before Johnston, no place for fables, emblems, and other symbolic forms of knowledge. And more broadly, as Ian Maclean pointed out devastatingly, Foucault neglected the Aristotelian natural philosophy that still dominated sixteenth-century thought.[85] In the end, Copenhaver concluded that science had no Renaissance, certainly not in a Foucauldian sense and probably not in any sense, due to the multiplicity of views and approaches that characterized science in the sixteenth century.

Others have not been satisfied with this negative answer. The Spanish historian Antonio Beltrán argued that the Renaissance was a coherent period, situated distinctly between the Middle Ages and the seventeenth century:

> The Renaissance constitutes a theoretical period that can be delimited even if it has not been. And only when we narrate [*historiamos*] the period from the fifteenth to the sixteenth century as the succession of the 'Aristotelian-scholastic' frame or paradigm, the 'magical-naturalist', and the 'mechanistic', will we be able to address in an appropriate fashion questions such as the topic of 'experimental' or 'scientific method', and reject the fallacious oppositions between 'recourse to experience' and 'speculation.' These conceptual frames or paradigms constitute one of the clearest objectives of the historian of 'science', insofar as he is considering the scientific revolution.[86]

Beltrán's use of the term 'paradigm' indicates his debt to Thomas Kuhn, a 'historian-philosopher' whose work, Beltrán hoped, would help explicate this frame.

Beltrán's sequence of periods and his identification of the Renaissance with a 'magical-naturalist' paradigm bears a strong resemblance to Foucault's archaeological approach. The 'magical-naturalist' frame Beltrán describes is *mutatis mutandis* the 'prose of the world' of Foucault's *Order of Things*, and like Foucault's Renaissance *episteme*, it is subject to serious faults. It takes one strand of Renaissance thought and makes it characteristic of the age as a whole, ignoring the persistent vitality of Aristotelian thought and its contributions to scientific debates well into the seventeenth century. Moreover, it perpetuates an unhealthy priority in history of science to conceptual schemas and worldviews at the expense of lower-level theories and scientific practice. It is striking that Beltrán's 1985 article makes no mention of work done after the middle of the 1970s.[87]

Though rejected by experts in Renaissance science, Foucault's work continues to be influential outside of the history of science. This alone justifies continued study of the general presuppositions of Renaissance systems of thought – with an emphasis on their plurality. James Bono has recently returned to the Foucauldian stomping-grounds, but he has done so with a refined historical sense.[88] Where Foucault posited a single Renaissance *episteme* based on metaphor that gave way to a classical *episteme* based on metonymy, Bono posits not two but three early modern approaches to reading the Book of Nature: two competing Renaissance versions and a third, radically different one that characterizes the seventeenth century. In the Renaissance, the 'exegetical' tradition that attempted to uncover the original Adamic language through study of the world competed with a neoplatonic view of hidden correspondences, sympathies, and antipathies. These competing approaches to understanding the meaning of the world were in turn challenged, from the late sixteenth century, by a radically new hermeneutics of nature. Its representatives – Francis Bacon and Galileo Galilei, among others – argued that the connection between human language and the world of nature was arbitrary; God did not inscribe the world in the same idiom

in which He produced Scripture. Empirical research, not hermeneutics, was for these thinkers the only way to understand nature; as Galileo put it, God wrote the Book of Nature not in Adam's language but in the language of geometry.

Bono's work returns to the thesis of a rupture between Renaissance and seventeenth-century modes of apprehending the world, while recognizing that all three views competed for adherents in the seventeenth century. Bono emphasizes the incontestable fact that ways of thought are connected with specific individuals located in identifiable, if intersecting, communities of thinkers, each with its own traditions and reference points – traditions and references that extend well beyond the boundaries of an anachronistic notion of 'science'. Bono epitomizes a signal, welcome development in the history of Renaissance science in the past three decades: even historians of science with an intellectual bent have become cultural and social historians. Other contemporary studies that make broad claims about transformations in thought, such as Daston and Park's study of *Wonders and the Order of Nature*, also connect patterns of thinking with identifiable groups and traditions.

This development occurred late in the history of science. Like all subdisciplines of history, history of science has its own conferences, its own points of reference, and its own traditions. These traditions have, until recently, been opposed to drawing the consequence of living in a historicist age – possibly because historians of science had been seduced by the philosopher Karl Popper's unfortunate confusion of historicism with amoral historical materialism.[89] Today, historians of science, intimately aware of subtle differences between individuals, communities, and traditions in Renaissance science, shy away from *ex cathedra* judgements about 'the Renaissance mind' and its place in the history of thought.

Where does this leave the question of Renaissance science? Ultimately, it is without an answer. In one sense, the sciences in the Renaissance participated in the great intellectual and cultural movements of the Renaissance: they were deeply humanist in their critical engagement with classical texts and, throughout the period, in the importance of Latin as a scientific language (though Latin was by no means the only language of science).[90] Renaissance naturalists and geographers engaged with new information, peoples, and objects from European voyages of discovery and conquest. Scientists were closely associated with the efflorescence of princely and royal courts in the Renaissance, and they offered their services to the emerging absolutist rulers of Europe. These cultural and social processes shaped the methods and goals of the study of nature

from 1450 to 1600. In that sense, Renaissance science was part of the Renaissance.

In another sense, though, Copenhaver is right: there was no single 'Renaissance science'. All historical periods seem to be in flux when examined closely, but science, in the period from 1450 to 1600, was more in flux than immediately before or after. From the thirteenth to the early sixteenth century, university natural philosophers dealt with natural phenomena within an agreed-upon intellectual and institutional framework that emphasized deductive reasoning and 'final causes', the purposes or reasons behind natural things. By the end of the seventeenth century, empirical, experimental, and quantitative-mathematical approaches to nature had triumphed, and final causes had been expelled from science proper, taking refuge in natural theology.[91] In between, informal institutions and petty courts supported and lent their sometimes dubious prestige to many competing approaches to the study of nature. Panofsky's notion of 'decompartmentalization' seems as good a label as any to define Renaissance science, but it is a negative label: it characterizes the scientific Renaissance by what it was not, not by what it was.

The absence of a definitive answer to this question does not bother most historians of Renaissance science. They are more interested in local contexts and in scientists' *bricolage* – their 'making do' or adaptation of the intellectual tools available to them to new problems, with consequences that might go far beyond their intentions. Ironically, this notion of *bricolage* is adopted from the French structuralist Claude Lévi-Strauss, who himself posited deep conceptual structures, far below the conscious surface, in the world views of human societies.[92] Such structures undoubtedly do exist; the error of Foucault and his followers was to see them as cultural universals. For the most part, they are more akin to habits of thinking inculcated in specific communities; the way to seek them out is by carefully investigating those communities: that is, to adopt, insofar as the historian may, the techniques of ethnographers. In adopting those methods, historians had to abandon the will-o'-the-wisp of 'Renaissance science'. But in exchange they have gained a more subtle, satisfying, and accurate account of what scientists actually thought and did in the European Renaissance.

notes

1. *Note on terminology:* The word 'science' in our modern sense is anachronistic for the Renaissance. *Scientia* and its vernacular cognates referred to any organized body of knowledge; in philosophical circles it meant, specifically, knowledge

that was derived through logical demonstration from universal principles. 'Scientist' is equally anachronistic; the word appeared in French in the late eighteenth century and entered English in the early nineteenth century. These days, careful historians tend to use specific words to designate Renaissance scientists: naturalists, natural philosophers, astronomers, alchemists and so on. The very profusion of terms suggests that no single conception of natural science reigned in the Renaissance. Nevertheless, for want of a better general term, I often use 'science' and 'scientist' to refer to the investigation of nature and its practitioners in the Renaissance when a more specific term is impossible.

Note on sources: I have concentrated on English-language scholarship. But the history of science, like other fields of Renaissance historiography, is polyglot, even though more and more European historians of science are publishing their works in English. When referring to works originally published in a foreign language, I have cited English translations if they are available.

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