

ASTROLOGY

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As is well known, astrology finally disappeared from the domain of legitimate natural knowledge during the seventeenth and eighteenth centuries, although the precise contours of this story remain obscure. It is less well known, albeit clearly documented, that astrology was taught from the beginning of the fourteenth century as an important part of the arts and science curriculum at the great medieval and Renaissance universities, including Padua, Bologna, and Paris. There, astrology was studied within three distinct scientific disciplines – mathematics, natural philosophy, and medicine – and served to integrate several highly developed mathematical sciences of antiquity – astronomy, geography, and geometrical optics – with Aristotelian natural philosophy. This astrologizing Aristotelianism provided fundamental patterns of interpretation and analysis in pre-Newtonian natural knowledge. Thus, the history of astrology – and, in particular, the story of its protracted criticism and ultimate rejection as a source of what the learned considered legitimate natural knowledge – is central for understanding the transition from medieval and Renaissance natural philosophy to Enlightenment science. The role of astrology in this transition was neither obvious nor unproblematic. Indeed, astrology's integration of astronomy and natural philosophy under the aegis of mathematics had much in common with the aims of the "new science" of the seventeenth century. Thus it becomes necessary to explain why this promising astrological synthesis was rejected in favor of a rather different mathematical natural philosophy.

Some historians have claimed that Giovanni Pico della Mirandola's extensive attack on astrology, *Disputationes adversus astrologiam divinatricem* (Disputations against Divinatory Astrology), convinced the astrologers to stop practicing upon its publication in 1496. Others have stressed the role of Copernicus's *De revolutionibus orbium coelestium* (On the Revolutions of the Celestial Spheres, 1543) in completing astrology's undoing. Both claims are belied, however, by the fact that two of the most important warriors for the Copernican cause, Galileo Galilei (1564–1642) and Johannes Kepler

(1571–1630), were both practicing astrologers. Indeed, influenced by Pico's *Disputationes*, Kepler set out to reform astrology on a sounder natural philosophical and mathematical foundation, and the English natural philosopher Francis Bacon (1561–1626) proposed his own reform of astrology in one of his last scientific works, the *De augmentis scientiarum* of 1623.

This evidence suggests that the role of astrology in the learned culture of the sixteenth and seventeenth centuries and the story of its ultimate fall from intellectual grace are more complex and important than generally thought. This chapter will sketch that role and that story. In it, I set the historical stage by describing astrology's place on the map of knowledge of the years around 1500 – its relationship to mathematics, natural philosophy, and medicine – and summarize the ideas that structured astrological theory and practice, situating them in their primary institutional location, the university. I then describe astrology's place in the work of major figures of the Scientific Revolution, including Galileo, Bacon, and Robert Boyle (1627–1691). Finally, I ask how, when, and ultimately why astrology came to be removed from its central place in the premodern understanding of nature over the course of the seventeenth and eighteenth centuries.¹

ASTROLOGY CIRCA 1500: INTELLECTUAL AND INSTITUTIONAL STRUCTURES

In 1474, Galeazzo Maria Sforza, Duke of Milan, wrote a threatening letter to Girolamo Manfredi, professor of astrology, philosophy, and medicine at the University of Bologna. Desist from publishing negative prognostications about me or my realm, he insisted, or I will send two of my men to cut you into pieces.² The annual prognostication was in fact a normal part of Manfredi's job description, although it rarely elicited such extreme reactions. In addition to teaching the standard curriculum, the professor of astrology was also required by statute to participate in at least three public astrological disputations per year and to supply the prognostication, together with other astrological services – free and in a timely manner – to the university community. By 1474, annual prognostications regularly appeared in print,

¹ For various useful but incomplete discussions of this topic, see, among others, Keith Thomas, *Religion and the Decline of Magic: Studies in Popular Beliefs in Sixteenth and Seventeenth Century England* (New York: Scribners, 1971); Patrick Curry, *Prophecy and Power: Astrology in Early Modern England* (Princeton, N.J.: Princeton University Press, 1989); Mary Ellen Bowden, "The Scientific Revolution in Astrology," Ph.D. dissertation, Yale University, New Haven, Conn., 1975; and Elide Casali, *Le spie del cielo: Oroscopi, lunari e almanacchi nell'Italia moderna* (Turin: Einaudi, 2003). For a fuller discussion (with bibliography) of this and many other issues in this chapter, see H. Darrel Rutkin, "Astrology, Natural Philosophy, and the History of Science, c. 1250–1700: Studies Toward an Interpretation of Giovanni Pico della Mirandola's *Disputationes adversus astrologiam divinatricem*," Ph.D. dissertation, Indiana University, Bloomington, 2002.

² Ferdinando Gabotto, "L'Astrologia nel Quattrocento in rapporto colla civiltà: Osservazioni e documenti storici," *Rivista di filosofia scientifica*, 8 (1889), 373–413.

allowing them to reach a broader audience, which undoubtedly sharpened Galeazzo Maria's concern.³

Like medicine, one of Manfredi's other subjects, astrology had both a theoretical and a practical dimension. For the definition and outlines of this discipline as it was taught and practiced in the years around 1500, we can look to the Hellenistic astronomer-mathematician Ptolemy (ca. 100-ca. 170) and the German natural philosopher Albertus Magnus (ca. 1200–1280), arguably the two most influential authorities in the field. According to Ptolemy's *Tetrabiblos*, there were two primary kinds of what he called “foreknowledge through the science of the stars.” The first – what we would call astronomy – studied the motions of the heavenly bodies mathematically and was an exact science. The second – astrology – investigated the influences of the heavenly bodies on the earth; because of the perturbing interaction with matter, its knowledge was not exact.⁴ Although the terminology became increasingly differentiated during the early modern period, the Latin terms *astronomia* and *astrologia* (and their vernacular variants) were often used interchangeably to refer to *both* sciences of the stars. For the sake of clarity, however, I will follow modern usage, except when I use “the science of the stars” to refer to both together.⁵

Building on Ptolemy's distinction, Albertus Magnus described the four types of astrological praxis in his *Speculum astronomiae* (Mirror of the Science of the Stars, ca. 1260s):⁶ “Revolutions” were concerned with large-scale changes, primarily in the weather but also in state affairs. This was the major feature of the annual prognostications found in almanacs and elsewhere, and it was what ruffled Galeazzo Maria's feathers.⁷ “Nativities,” on the other hand, involved the astrological configuration at a person's birth. “Interrogations” entertained questions on matters of concern, including personal, medical, and business affairs. Finally, “elections” determined the most propitious moment to begin an enterprise or perform an activity, such as crowning

³ Albano Sorbelli, “Il ‘Tacuinus’ dell’ università di Bologna e le sue prime edizioni,” *Gutenberg Jahrbuch*, 13 (1938), 109–14; Alberto Serra-Zanetti, “I pronostici di Girolamo Manfredi,” in *Studi riminesi e bibliografici in onore di Carlo Lucchesi* (Faenza: Fratelli Legov, 1952), pp. 193–213.

⁴ Claudius Ptolemaeus, *Apotelesmatike*, 1.1, ed. Wolfgang Hübner (Stuttgart: Teubner, 1998). Claudius Ptolemaeus, *Tetrabiblos*, trans. Frank E. Robbins (Cambridge, Mass.: Harvard University Press, 1940), is still useful.

⁵ For discussions of terminology, see the index to Lynn Thorndike, *A History of Magic and Experimental Science*, 8 vols. (New York: Columbia University Press, 1923–58); and Brian P. Copenhaver, “Astrology and Magic,” in *The Cambridge History of Renaissance Philosophy*, ed. Charles B. Schmitt, Quentin Skinner, and Eckhard Kessler, with Jill Kraye (Cambridge: Cambridge University Press, 1988), pp. 264–300. All translations are mine unless otherwise indicated.

⁶ I accept Albertus's authorship of the *Speculum astronomiae*; see Paola Zambelli, *The Speculum astronomiae and Its Enigma: Astrology, Theology, and Science in Albertus Magnus and His Contemporaries* (Dordrecht: Kluwer, 1992).

⁷ For annual prognostications primarily as printed in yearly almanacs, see Casali, *Le spie del cielo*, for Italy, and Bernard Capp, *Astrology and the Popular Press: English Almanacs, 1500–1800* (London: Faber, 1979), for England and America.

a ruler, passing the baton of command to a general, or laying the cornerstone of an important building.⁸

Albertus wrote the *Speculum astronomiae* to distinguish between legitimate and illegitimate forms of astrological practice. For Christians such as Albertus, elections in particular raised sensitive issues because they related to the science of images, which occupied the borderlands between what we would call magic, science, and religion. What Albertus considered the legitimate science of images, which included the making of talismans, belonged to the realm of astrological magic. This science was developed by the Arabs, based in part on Greek sources, and the relevant texts were translated into Latin during the twelfth and thirteenth centuries. It worked by means of natural astrological mechanisms and was presumably included among elections because talismans needed to be made at astrologically propitious times.⁹ Bad image magic, on the other hand, worked only because it had traffic with demons and thus crossed the line into execrable and theologically suspect practices.¹⁰

Established in the thirteenth century as a legitimate branch of natural knowledge by Albertus Magnus, among other European scholars, this astrol-ogizing natural philosophy was developed by Pietro d'Abano (1257–ca. 1316), professor of medicine at the University of Padua, into a coherent and systematic educational program with a medical purpose.¹¹ In his influential textbook, the *Conciliator* – published several times in the late fifteenth and sixteenth centuries – Pietro stated, following Hippocrates and Galen, that

⁸ See, for example, Mary Quinlan-McGrath, “The Foundation Horoscope(s) for St. Peter’s Basilica, Rome, 1506: Choosing a Time, Changing a *Storia*,” *Isis*, 92 (2001), 716–41. Keith Thomas’s chapters on astrology in his *Religion and the Decline of Magic*, pp. 283–385, are probably still the best introduction to the subject in English. Good general scholarly accounts of astrology are: Tamsyn Barton, *Ancient Astrology* (London: Routledge, 1994); Jim Tester, *A History of Western Astrology* (Woodbridge: Boydell Press, 1987); and J. C. Eade, *The Forgotten Sky: A Guide to Astrology in English Literature* (Oxford: Clarendon Press, 1984). Important contributions on Renaissance astrology include Anthony Grafton, *Cardano’s Cosmos: The Worlds and Works of a Renaissance Astrologer* (Cambridge, Mass.: Harvard University Press, 1999), and Steven vanden Broecke, *Limits of Influence: Pico, Louvain, and the Crisis of Renaissance Astrology* (Louvain: E. J. Brill, 2003), both with rich up-to-date bibliographies.

⁹ See Charles Burnett, “Talismans: Magic as Science? Necromancy among the Seven Liberal Arts,” in Burnett, *Magic and Divination in the Middle Ages: Texts and Techniques in the Islamic and Christian Worlds* (Aldershot: Variorum, 1996), pp. 1–15; David Pingree, “The Diffusion of Arabic Magical Texts in Western Europe,” in *La diffusione delle scienze islamiche nel Medio Evo europeo* (Rome: Accademia Nazionale dei Lincei, 1987), pp. 57–102; and Frank Klaassen, “English Manuscripts of Magic, 1300–1500: A Preliminary Survey,” in *Conjuring Spirits: Texts and Traditions of Medieval Ritual Magic*, ed. Claire Fanger (University Park: Pennsylvania State University Press, 1998), pp. 3–31.

¹⁰ There is much excellent scholarship on demons and demonology in the early modern period. See, for example, Stuart Clark, *Thinking with Demons: The Idea of Witchcraft in Early Modern Europe* (Oxford: Clarendon Press, 1997), and the volumes in the Routledge series *Witchcraft and Magic in Europe*, all with rich bibliographies. I have avoided configuring astrology within the so-called occult sciences because this category is fundamentally anachronistic and dependent on too many misleading assumptions to be conceptually or historically useful.

¹¹ See Nancy G. Siraisi, *Arts and Sciences at Padua: The Studium of Padua before 1350* (Toronto: Pontifical Institute of Medieval Studies, 1973). For a similar process with physiognomy, see Jole Agrimi, *Ingeniosa scientia nature: Studi sulla fisiognomica medievale* (Millennio Medievale 36, 8) (Florence: Sismel, 2002).

the complete physician must be well versed in astrology.¹² Thus, at Padua, astrology was taught not only in the mathematics course with mathematical astronomy and in the natural philosophy course with Aristotle but in the medical course as well.¹³

In 1464, the influential mathematician and astronomer Johannes Regiomontanus (1436–1476) praised astrology as the queen of the mathematical disciplines in his inaugural oration for a course in mathematical astronomy at Padua¹⁴ (see Donahue, Chapter 24, this volume). Evoking Padua's distinguished tradition of teaching the sciences of the stars, Regiomontanus located himself in the same tradition as his fellow German Albertus Magnus, a student at Padua in the 1220s,¹⁵ and Pietro d'Abano himself. Regiomontanus was also an important early figure in scientific publishing; while based in Nuremberg, between 1472 and 1475, he composed and printed ephemerides, calendars, and the *Novae theoricæ planetarum* (New Theories of the Planets) of Georg Peurbach, his teacher at Vienna, as well as an ancient Latin astrological text, Manilius's hexameter *Astronomica*.¹⁶ After Regiomontanus's death, the German printer Erhard Ratdolt continued this tradition of scientific publication at Venice and Augsburg, but with a more explicitly practical astrological orientation, publishing a variety of fundamental ancient and medieval texts.¹⁷

Although Padua was in some sense the wellspring of academic astrology, it was taught at other universities as well. As prescribed in the 1405 statutes for the study of arts and medicine at the University of Bologna, still the foundation of instruction in the late fifteenth century, the four-year course in mathematics and astrology began with two years of prerequisites in arithmetic, geometry, and astronomy, including lectures on Euclid, the *Sphere* of Sacrobosco, and the Alphonsine tables.¹⁸ With this background, students

¹² Pietro d'Abano, *Conciliator*, diff. 10. I used the facsimile of the Venice, Giunta edition of 1565; Pietro d'Abano, *Conciliator*, ed. E. Riondato and L. Olivieri (Padua: Editrice Antenore, 1985).

¹³ See Rutkin, "Astrology, Natural Philosophy, and the History of Science," chaps. 3 and 7. For related issues, see also Robert S. Westman, "The Astronomer's Role in the 16th Century: A Preliminary Study," *History of Science*, 18 (1980), 105–47; and Mario Biagioli, "The Social Status of Italian Mathematicians, 1450–1600," *History of Science*, 27 (1989), 41–95.

¹⁴ Noel M. Swerdlow, "Science and Humanism in the Renaissance: Regiomontanus' Oration on the Dignity and Utility of the Mathematical Sciences," in *World Changes: Thomas Kuhn and the Nature of Science*, ed. P. Horwich (Cambridge, Mass.: MIT Press, 1993), pp. 131–68. See also Paul L. Rose, *The Italian Renaissance of Mathematics: Studies on Humanists and Mathematicians from Petrarch to Galileo* (Geneva: Droz, 1975).

¹⁵ Regiomontanus considered Albertus the author of the *Speculum astronomiae*.

¹⁶ See Ernst Zinner, *Regiomontanus: His Life and Work*, trans. E. Brown (Amsterdam: North Holland, 1990).

¹⁷ See G. R. Redgrave, *Erhard Ratdolt and His Work at Venice* (London: The Bibliographical Society, 1894–5).

¹⁸ See Lynn Thorndike, *University Records and Life in the Middle Ages* (New York: W. W. Norton, 1975), pp. 279–82. For a fuller discussion, see Graziella Federici Vescovini, "I programmi degli insegnamenti del Collegio di medicina, filosofia e astrologia dello statuto dell'università di Bologna del 1405," in *Roma, magistra mundi: Itineraria culturae medievalis, Mélanges offerts au Père L. E. Boyle*, 2 vols. (Louvain: La Neuve, 1998), 1: 193–223.

began their study of astrology proper in the third year with Alcabitius's influential textbook the *Liber isagogicus* and (pseudo-)Ptolemy's *Centiloquium*, a fundamental astrological text for medical practitioners. In the fourth year, the student moved on to more advanced works in both astrology and astronomy – Ptolemy's *Tetrabiblos* and *Almagest* – and the *De urinis non visis* (On Unseen Urines), an astrological treatment of medical questions. This curricular framework informed Regiomontanus's and Ratdolt's publication program.

Astrology was also taught in the natural philosophy course at Bologna, which involved studying the core texts of Aristotelian natural philosophy, including those that provided astrology's natural philosophical foundations: Aristotle's *De caelo* (On the Heavens), *De generatione et corruptione* (On Generation and Corruption), and the *Meteorologia*. Finally, the four-year medical course focused on medical texts. This included some with a strongly astrological character, notably Galen's *De criticis diebus* (On Critical Days), which was studied during each of the first three years. As at Padua under Pietro d'Abano, medical training was the primary end toward which the arts and medicine curriculum at Bologna was oriented.¹⁹

As taught in Italian universities in the years around 1500, the astrological system focused on three main aspects of the topic: natural philosophy, cosmography, and a geometrical-optical model of planetary influences.²⁰ According to Aristotle, the movements of the heavens, especially the sun, were fundamental to life on earth. In *De generatione et corruptione*,²¹ Aristotle argued that the sun, as it moved around the ecliptic in the course of the year, was the universal efficient cause, ontologically prior to and necessary for generation and corruption; that is, for things to come into being and pass away. Thus, processes of generation, human and otherwise, required the sun (as efficient cause); the male, who provided the formal cause in his seed; and the female, who supplied the material cause in the menses of her womb. In his commentary on this passage, Albertus Magnus expanded the realm of the efficient cause to include the rest of the planets in addition to the sun.

In this understanding of celestial action, natural philosophical structures were fitted onto a fundamentally Ptolemaic cosmographic framework composed of mathematical astronomy calibrated with mathematical geography. This framework allowed the planetary motions to be uniquely determined

¹⁹ See Nancy G. Siraisi, *Taddeo Alderotti and His Pupils: Two Generations of Italian Medical Learning* (Princeton, N.J.: Princeton University Press, 1981).

²⁰ For a much fuller reconstruction, see Rutkin, "Astrology, Natural Philosophy, and the History of Science," chap. 2, where I also discuss important contributions to this system by al-Kindi, Robert Grosseteste, and Roger Bacon. For different interpretations of astrology's relationship with Aristotelian natural philosophy, see Edward Grant, *Planets, Stars, and Orbs: The Medieval Cosmos, 1200–1687* (Cambridge: Cambridge University Press, 1994), pp. 569–617; John D. North, "Celestial Influence: The Major Premiss of Astrology," in *"Astrologi hallucinati": Stars and the End of the World in Luther's Time*, ed. Paola Zambelli (Berlin: Walter de Gruyter, 1986), pp. 45–100; and vanden Broecke, *Limits of Influence*, index s.v. "astrological physics."

²¹ *De generatione et corruptione*, 2.9–10.

for any time at any place by means of the horizon. This is important because place was essential for analyzing the role of celestial influences in generation, as Albertus made clear:

If anyone wished to understand all the natures and properties of particular places, he would know that there is not a point in them that does not have a special property from the virtue of the stars, . . . for the circle of the horizon is varied in relation to each point of the habitation of animals, plants and stones; and the entire orientation of the heavens . . . is varied in relation to the varying circle of the horizon. From which cause their natures, properties, customs, actions and species, which seem to be generated in the same perceptible place, are varied, to such an extent that diverse properties and customs are attributed to twins' seeds, both for brute animals and for men, from this different orientation. And this is reasonable because it has been learned that the heavens pour forth formative virtues into everything that exists. Moreover, it mostly pours them forth by means of rays emitted by the lights of the stars, and therefore it follows that each pattern and angle of rays causes different virtues in things below.²²

Once the planets' motions were mapped in this way and related to each place on earth, their influences could then be analyzed using the other primary feature of this system, a geometrical-optical model of planetary influences. These irradiating influences were thought to act in straight lines on the model of the planets' other mode of influence, light. The angular relationship of the planets to each other – the planetary aspects – and their collective relationship to each place on earth could then be fully articulated. When the different qualitative natures of each planet – in themselves and as modified by each sign of the zodiac – were taken into account, as well as the variation in effect from their varying angular relationships, the result was an integrated mathematical natural philosophy of richness and sophistication.

ASTROLOGICAL REFORMS

Despite its elegance and power, this explanatory system was not without its critics. The most famous fifteenth-century attack on astrology was that of Giovanni Pico della Mirandola (1463–1494) in his extensive *Disputationes adversus astrologiam divinatricem* (Disputations against Divinatory Astrology, composed in 1493–4 and published posthumously in 1496).²³ This seems to have been at least partially directed against Marsilio Ficino's influential *De*

²² *De natura locorum*, in Albertus Magnus, *Opera omnia* . . . (Cologne: Aschendorff, 1951–), vol. 5, pt. 2, p. 8, ll. 43–62.

²³ Giovanni Pico della Mirandola, *Disputationes adversus astrologiam divinatricem*, ed. and trans. Eugenio Garin, 2 vols. (Florence: Vallecchi, 1946–52). For their heavy editing, see Paola Zambelli, "La critica dell'astrologia e la medicina umanistica," in her *L'Ambigua natura della magia: Filosofi, streghe, riti nel Rinascimento*, 2nd ed. (Venice: Marsilio, 1996), pp. 76–118 (orig. publ. 1965). See also Stephen

vita (On Life, 1489), which included a summa of astrological magic as part of its third book.²⁴ Pico aimed to remove – or radically redefine in a cabbalistic direction – the astrological superstructure that was traditionally erected on the Aristotelian-Ptolemaic foundation that he accepted as sound. By excising what he saw as outdated Arabo-Latin accretions, Pico hoped to restrict celestial influences to the realm of universal efficient cause, as originally in Aristotle, thus removing the possibility of particular predictions.²⁵

In many respects, however, Pico's voice was an isolated one, and the astrological system elaborated by Albertus Magnus and Pietro d'Abano continued to flourish in early modern Europe throughout the sixteenth century and into the seventeenth century at the universities of Bologna, Pisa, Padua, and Louvain (among others).²⁶ Indeed, Philip Melanchthon (1497–1560) used precisely this astrologizing Aristotelianism to reform the German Lutheran universities, which produced many practicing astrologers, including Tycho Brahe (1546–1601) and Johannes Kepler.²⁷ Moreover, reacting partly to Pico's

A. Farmer, *Syncretism in the West: Pico's 900 Theses* (1486) (Tempe, Ariz.: Medieval and Renaissance Texts and Studies, 1998), pp. 151–76, whose reconstruction should be treated with caution.

²⁴ It is striking to note that both works use *spiritus* as the physiological quasi-material substance that connects the heavens to life on earth. See Marsilio Ficino, *Three Books on Life*, ed. and trans. Carol V. Kaske and John R. Clarke (Binghamton, N.Y.: Medieval and Renaissance Texts and Studies, 1989), with an important introduction and commentary. For the classic discussion of this work, see Daniel P. Walker, *Spiritual and Demonic Magic from Ficino to Campanella* (London: Warburg Institute, 1958).

²⁵ For an excellent orientation to the complexities of Pico's thought, see Anthony Grafton, "Giovanni Pico della Mirandola: Trials and Triumphs of an Omnivore," in his *Commerce with the Classics: Ancient Books and Their Renaissance Readers* (Ann Arbor: University of Michigan Press, 1997), pp. 93–134, with a useful bibliography.

²⁶ For Bologna, see Angus Clarke, "Giovanni Antonio Magini (1555–1617) and Late Renaissance Astrology," Ph.D. dissertation, University of London, 1985. For Pisa, see Charles B. Schmitt, "The Faculty of Arts at Pisa at the Time of Galileo," and "Filippo Fantoni, Galileo Galilei's Predecessor as Mathematics Lecturer at Pisa," in his *Studies in Renaissance Philosophy and Science* (London: Variorum Reprints, 1981), pp. 243–72 and 53–62. For Padua, see Antonio Favaro, "I lettori di matematiche nella università di Padova dal principio del secolo XIV alla fine del XVI," *Memorie e documenti per la storia della università di Padova*, 1 (1922), 1–70. For Louvain ca. 1450–1580, see vanden Broecke, *Limits of Influence*, and his "Dee, Mercator, and Louvain Instrument Making: An Undescribed Astrological Disc by Gerard Mercator (1551)," *Annals of Science*, 58 (2001), 219–40. There is excellent scholarship reconstructing astrological culture in particular locations. For Vienna, see Helmut Grössing, *Humanistische Naturwissenschaft: Zur Geschichte der Wiener mathematischen Schulen des 15. und 16. Jahrhunderts* (Baden-Baden: Valentin Koerner, 1983); and Michael H. Shank, "Academic Consulting in Fifteenth-Century Vienna: The Case of Astrology," in *Texts and Contexts in Ancient and Medieval Science*, ed. Edith Sylla and Michael R. McVaugh (Leiden: E. J. Brill, 1997), pp. 245–71. For France, see Jean Patrice Boudet's important introduction to his edition of Simon de Phares, *Le recueil des plus célèbres astrologues de Simon de Phares*, ed. J.-P. Boudet, 2 vols. (Paris: H. Champion, 1997–99); Pierre Brind'Amour, *Nostradamus astrologue: Astrologie dans la vie et l'oeuvre de Nostradamus* ([Ottawa]: Presses de l'Université d'Ottawa, 1993); and Hervé Drevillon, *Lire et écrire l'avenir: Astrologie dans la France du Grand Siècle, 1610–1715* (Seyssel: Champ Vallon, ca. 1996).

²⁷ See Sachiko Kusukawa, *The Transformation of Natural Philosophy: The Case of Philip Melanchthon* (Cambridge: Cambridge University Press, 1995). Melanchthon was deeply influenced by his esteemed teacher at Tübingen, Johannes Stöffler, who played an important role in the predictions concerning the flood of 1524; see Zambelli, ed., "Astrologi hallucinati." Stöffler himself was deeply influenced by Albertus Magnus and his astrologizing Aristotelianism; see Wilhelm Maurer, *Der junge Melanchthon zwischen Humanismus und Reformation*, 2 vols. (Göttingen: Vandenhoeck and Ruprecht, 1967–69), 1: 136.

critique and partly to their own experience, Tycho and Kepler devoted much of their labors to reforming the astronomical and natural philosophical foundations of astrology in order to improve the system.²⁸

In August 1563, while studying at the University of Leipzig, a German Lutheran university reformed under Melancthon's guidance, the sixteen-year-old Tycho had observed an astrologically significant great conjunction of Saturn and Jupiter. Finding it fully a month off from the predictions in the tables, he resolved to establish more firmly the observational basis of the science of the stars, which he ultimately did by founding his famous observatory at Hven. In Tycho's view, a more accurate observational foundation would produce more accurate tables, which would lead in turn to locating the planets more accurately in annual ephemerides. On this basis, more accurate horoscopes could be constructed, which could then be more accurately interpreted. Tycho also proposed a reform of the mundane houses, a central feature of astrological interpretation, moving from a square figure with twelve house divisions to a round figure with eight. This reform, however, found limited acceptance.²⁹

Although Kepler is better known for his *Astronomia nova* (New Astronomy) of 1609, which used Tycho's observations of Mars to introduce elliptical planetary orbits, he was also an avid astrologer (see Donahue, Chapter 24, this volume). Indeed, his dedication of this epoch-making text to his patron, the Holy Roman Emperor Rudolf II (1552–1612), associated Mars with Rudolf's natal horoscope. Following Kepler's lead six months later in his *Sidereus Nuncius* (Sidereal Messenger, 1610), Galileo dedicated his equally epoch-making telescopic discovery of Jupiter's four moons to his own patron, Cosimo II de' Medici, by emphasizing the exalted placement of Jupiter in Cosimo's natal horoscope.³⁰

Although astrology had long been a key instrument in a courtier's toolkit,³¹ these dedications were not merely isolated gestures of courtly compliment. As imperial mathematician (and in other less distinguished roles), Kepler engaged in various sorts of astrological practice, from weather prediction to providing counsel for the emperor.³² In addition to reforming astronomical

²⁸ For fuller treatments, see Rutkin, "Astrology, Natural Philosophy, and the History of Science," chap. 7; and Bowden, "The Scientific Revolution in Astrology."

²⁹ Victor Thoren, *The Lord of Uraniborg: A Biography of Tycho Brahe* (Cambridge: Cambridge University Press, 1990). On Tycho's reforms, see John D. North, *Horoscopes and History* (London: Warburg Institute, 1986), pp. 175–7; and vanden Broecke, *Limits of Influence*, pp. 263–9.

³⁰ See Mario Biagioli, *Galileo, Courtier: The Practice of Science in the Culture of Absolutism* (Chicago: University of Chicago Press, 1993), pp. 127–33; and H. Darrel Rutkin, "Celestial Offerings: Astrological Motifs in Galileo's *Sidereus Nuncius* and Kepler's *Astronomia Nova*," in *Secrets of Nature: Astrology and Alchemy in Early Modern Europe*, ed. William R. Newman and Anthony Grafton (Cambridge, Mass.: MIT Press, 2001), pp. 133–72.

³¹ See, for example, Frederick H. Cramer, *Astrology in Roman Law and Politics* (Philadelphia: American Philological Association, 1954), for imperial Rome.

³² Max Caspar, *Kepler*, trans. C. D. Hellman (New York: Dover, 1993); Gérard Simon, *Kepler astronome astrologue* (Paris: Gallimard, 1979); and Barbara Bauer, "Die Rolle des Hofastrologen und

theory, Kepler also worked to shore up astrology's natural philosophical foundations, inspired in part by Pico's critique. Indeed, Kepler's rejection of the traditional astrological signification of the zodiacal signs and the mundane houses – and thus their panoply of derived doctrine, including planetary rulerships – was every bit as radical a move in astrology as his rejection of uniform circular motion in the realm of mathematical astronomy.³³

Like Kepler, Galileo was active in astrology during most of his career as a student, teacher, and practitioner of the mathematical disciplines, though he does not seem to have shared Kepler's interest in fundamental astrological reform.³⁴ Most of our evidence for his astrological practice comes from his period as professor of mathematics at the University of Padua, where he constructed and interpreted horoscopes for both patrons and students.³⁵ One of his manuscripts contains twenty-seven autograph horoscopes, including ones for Giovanfrancesco Sagredo, one of his principal patrons, as well as for his own now famous daughters, Virginia and Livia, and for himself.³⁶ Indeed, Galileo had his first brush with the Inquisition at this time for supposedly practicing a *deterministic* astrology out of his house in Padua – a charge the Venetian authorities summarily dismissed.³⁷

Francis Bacon proposed a serious reform of astrology in the *De augmentis scientiarum* of 1623, a Latin enlargement and reworking of his *Advancement of Learning* (1605), written during the forced retirement that followed his impeachment as Lord High Chancellor. Bacon began by identifying the many superstitions and lies that needed to be removed from its domain, including the individual planetary rule of each hour of the day and the astrological figure constructed for precise points of time. Reviewing the four principal divisions of astrological practice – revolutions, nativities, elections, and interrogations – he argued that the last three had little if any foundation, whereas he described revolutions as much more sound, though nonetheless in need of attention.³⁸

Hofmathematicus als fürstlicher Berater,” in *Höfischer Humanismus*, ed. August Buck (Weinheim: VCH, 1989), pp. 93–117.

³³ Judith V. Field, “A Lutheran Astrologer: Johannes Kepler,” *Archive for History of Exact Sciences*, 31 (1984), 189–272; and Sheila J. Rabin, “Two Renaissance Views of Astrology: Pico and Kepler,” Ph.D. dissertation, City University of New York, 1987.

³⁴ Galileo's interests in this area seem to have been confined to his discovery of Jupiter's four moons and his brief but persuasive arguments to establish their influence. See his letter to Piero Dini, dated 21 May 1611, in Galileo Galilei, *Le opere di Galileo Galilei*, 20 vols. in 21 (Florence: Giovanni Barbéra, 1890–1909), II: 105–16.

³⁵ H. Darrel Rutkin, “Galileo, Astrologer: Astrology and Mathematical Practice in the Late-Sixteenth and Early-Seventeenth Centuries,” *Galilaeana*, 2(2005), 107–43. See also Noel M. Swerdlow, “Galileo's Horoscopes,” *Journal for the History of Astronomy* 35(2004), 135–41.

³⁶ Biblioteca Nazionale Centrale, Florence, *Galilaeana* 2(2005), 107–43. MS Galileiana 81.

³⁷ Antonino Poppi, *Cremonini, Galilei e gli inquisitori del Santo a Padova* (Padua: Centro Studi Antoniani, 1993).

³⁸ Francis Bacon, *De augmentis scientiarum*, in *The Works of Francis Bacon*, ed. J. Spedding et al., 14 vols. (London: Longmans, 1857–74; repr. Stuttgart: Frommann, 1963), I: 554–60.

To make the doctrine of revolutions optimal in practice, Bacon prescribed five general rules: most notably, that the operation of the heavens is not strong on all kinds of bodies but only on finer ones, such as humors, air, and *spiritus*; and that every operation of the heavens extends more to the mass of things than to individuals, and only to larger spaces of time, not points of time or precise minutes. Retaining the traditional doctrines of planetary natures and aspects (the astrologically significant angular relationships between planets) – and affirming the principle that the heavenly bodies have in themselves other influences beyond heat and light³⁹ – Bacon turned to predictions. His considered views, after a lifetime as courtier and politician, are striking: Astrological predictions can profitably be applied to both natural and political domains, including weather, epidemics, and war, but only within a prescribed degree of specificity. Bacon made two important points in this regard, noting that the domain in which astrological predictions may be applied is virtually infinite, but that knowledge of the celestial configuration (the active – meaning efficient – causes) does not suffice.⁴⁰ One must also have a deep knowledge of the subjects at issue, the recipients of the active planetary influences. This knowledge seems to be precisely what Bacon's broader natural-historical research program was intended to provide.

In the final section of his discussion of astrology, Bacon responded to a hypothetical challenge by indicating how this research program should be instituted to develop and clarify his earlier claims. Rejecting the collection of future experiences as futile, he suggested historical research to investigate precisely those features already mentioned as legitimate subjects of astrological prediction and election. In particular, astrologers should comb the best histories to locate important events, which should then be compared with the heavenly situations at those times in accordance with his reforming precepts. Where there is a clear correlation, a rule of prediction may be inferred, he concluded, thus applying his inductive procedure to astrological reform.

I have seen no discussion of Bacon's own use of astrology, but given the tenor of his statements, his ever-precarious situation at court, and his passionate political ambitions, it seems likely that he would have pursued this avenue of possible insight – and thus advantage – in the many areas in which he actively participated.⁴¹ Given his breadth and depth as a scholar, it also seems likely that he would have ventured his own historical investigation of these matters so clearly and forcefully advocated. At the very least, it is clear that Bacon, whose writings would have so much influence on the research of the Royal Society of London, provided strong encouragement for a program

³⁹ Ibid., I: 556: “. . . quod nobis pro certo constet, Coelestia in se habere alios quosdam influxus praeter Calorem et lumen. . . .”

⁴⁰ In this he followed Ptolemy in his *Tetrabiblos*, 1.2–3.

⁴¹ See Lisa Jardine and Alan Stewart, *Hostage to Fortune: The Troubled Life of Francis Bacon* (New York: Hill and Wang, 1999), for a lively account, albeit with no reference to astrology.

of scientific research in a reformed astrology with a broad range of practical utility.

Bacon's vision of a reformed astrology was further developed by the English natural philosopher and alchemist Robert Boyle (1627–1691), one of the founders of the Royal Society of London.⁴² In his “Suspensions about some Hidden Qualities of the Air” (1674), Boyle adapted Bacon's position, declaring that the luminaries, planets, and fixed stars likely emit subtle but corporeal emanations beyond light and heat, which reach to our air. Developing this idea in the appendix, “Of Celestial and Aerial Magnets,” Boyle suggested experiments to test apparently good magnets by varying the air in which they were located according to different times, temperatures, and aspects of the planets. In this way, the different natures of the air could be discovered along with possible correspondences between the terrestrial and celestial realms.⁴³

Another text long attributed to Boyle, a letter printed in his *General History of the Air* (1692) entitled “Of Celestial Influences or Effluvia in the Air,” addressed to Samuel Hartlib, provided a fuller treatment of astrology's natural philosophical foundations. After stating that the purpose of accurate astronomical theory is to support accurate astrological practice, the author of this text – now accepted as Boyle's associate Benjamin Worsley (ca. 1620–1673) – discussed celestial influences that descended along with light to the thin and subtle air of earth's atmosphere.⁴⁴ Even more like light than the air, he argued, human spirits were all the more impressed and moved by celestial influences, which then affected human bodies. As I will show, these views continued to circulate under Boyle's name in Ephraim Chambers's vastly influential *Cyclopaedia* (1728).

THE FATE OF ASTROLOGY

Although astrology received robust proposals for reform from major astronomers and natural philosophers throughout the sixteenth and seventeenth centuries, these ultimately were of no avail, and the field lost its intellectual legitimacy during the eighteenth century. This process is not yet fully

⁴² See in general Rose-Mary Sargent, *The Diffident Naturalist: Robert Boyle and the Philosophy of Experiment* (Chicago: University of Chicago Press, 1995); and Lawrence Principe, *The Aspiring Adept: Robert Boyle and His Alchemical Quest* (Princeton, N.J.: Princeton University Press, 1998).

⁴³ [Benjamin Worsley], *Tracts: containing I. Suspensions about Some Hidden Qualities of the Air . . .* (London: W. G., 1674).

⁴⁴ The *General History of the Air* was published posthumously and edited by John Locke. Antonio Clericuzio has shown that this essay was in fact written in 1657 by Benjamin Worsley and that Boyle endorsed Worsley's views: See Clericuzio, “New Light on Benjamin Worsley's Natural Philosophy,” in *Samuel Hartlib and Universal Reformation*, ed. Mark Greengrass, Michael Leslie, and Timothy Raylor (Cambridge: Cambridge University Press, 1994), pp. 236–46. This letter was republished under Boyle's name in his collected works of 1744: *Works of Honorable Robert Boyle*, ed. T. Birch, 5 vols. (London: A. Millar, 1744), 5: 124–8.

understood. One promising approach is to examine changing disciplinary patterns and their reflection in university curricula. Thus, in this section I will examine continuities and ruptures in this domain, focusing primarily on mathematics and natural philosophy, with a quick glance at medicine, in which astrology seems to have survived longest.

For mathematics, similar patterns may be observed in Italy and England. An important moment in astrology's separation from astronomy was astrology's explicit removal from mathematics instruction by the primary developer of and textbook writer for the mathematics curriculum of the vast Jesuit educational empire, Christoph Clavius (1537–1612), who discussed his decision to exclude astrology in his influential textbook version of Sacrobosco's *De sphaera* (first edition, 1570, with many later editions).⁴⁵ It should be noted that although Clavius eliminated astrology from the mathematics course, this does not imply that he thereby wholly rejected it. In addition, his action by no means indicated astrology's overall demise in mathematics education, even in Italy. For example, Giovanni Antonio Magini (1555–1617) taught astrology and wrote influential textbooks for mathematics and medical courses at the University of Bologna until his death in 1617, and Andrea Argoli taught astrology at the University of Rome, *La Sapienza*, from 1622 to 1627, and then at the University of Padua from 1632 to 1656, where he also wrote mathematical textbooks and compiled ephemerides.⁴⁶

These conflicting patterns also appear in England, where the 1619 Savilian statutes of Oxford University expressly forbade the newly established professor of astronomy from teaching the construction of nativities or judicial astrology.⁴⁷ There is significant evidence, nevertheless, that astrology was studied and taught at English universities up to and beyond this time.⁴⁸ Astrology was also found in non-university mathematics textbooks, including those of Charles II's hydrographer, Joseph Moxon, whose *A Tutor to Astronomy and Geography* (1674) taught the easy construction of horoscopes.⁴⁹

These contradictory impulses were embodied in the activities of John Flamsteed (1646–1719), the first Astronomer Royal and Regius Professor of

⁴⁵ See James M. Lattis, *Between Copernicus and Galileo: Christoph Clavius and the Collapse of Ptolemaic Cosmology* (Chicago: University of Chicago Press, 1994).

⁴⁶ See Clarke, "Giovanni Antonio Magini." For Argoli, see the article, s.v., *Dizionario biografico degli Italiani* (Rome: Treccani, 1960–), 4 (1962), pp. 132–4.

⁴⁷ Mordechai Feingold, "The Occult Tradition in the English Universities," in *Occult and Scientific Mentalities in the Renaissance*, ed. Brian Vickers (Cambridge: Cambridge University Press, 1984), pp. 73–94, at p. 78 (with n. 25).

⁴⁸ See, for example, Hilary M. Carey, *Courting Disaster: Astrology at the English Court and University in the Later Middle Ages* (Houndsmill: Macmillan, 1992); and Mordechai Feingold, *The Mathematicians' Apprenticeship: Science, Universities, and Society in England, 1560–1640* (Cambridge: Cambridge University Press, 1984).

⁴⁹ Joseph Moxon, *A Tutor to Astronomy and Geography* (London: Thomas Roycroft, 1674). I use the reprint: New York: Burt Franklin, 1968, pp. 122–35. In 1682–3, Moxon, who became a Fellow of the Royal Society in 1678, briefly revived the Society of Astrologers, which had become moribund since its heyday in the Interregnum. See Curry, *Prophecy and Power*, p. 77.

Astronomy at the newly erected Royal Greenwich Observatory.⁵⁰ Soon after completing an intensive critique of astrology in 1673 – which he conspicuously never published – Flamsteed constructed a horoscope for the foundation of the Greenwich Observatory (1675). Indeed, he and Edmund Halley both provided the most accurate astronomical data available for the tables printed in George Parker's popular astrological almanacs in the 1690s.⁵¹

We can also trace the removal of astrology from the mathematical disciplines through an important printed genre, ephemerides: multiyear collections of planetary tables. Because sixteenth- and seventeenth-century ephemerides were overwhelmingly astrological – including (inter alia) extensive astrological introductions, horoscopes for the year (useful for making annual prognostications) and tables of planetary aspects – one may ask when this astrological component disappeared?⁵² The several Bolognese ephemerides I have examined through 1666 are all astrological, as are Argoli's for Rome and Padua, which provide tables with horoscopes through 1700.

In the first quarter of the eighteenth century, however, there are signs of change. In the introduction to his *Ephemerides motuum coelestium* (Ephemerides of Celestial Motions) for 1715 to 1725, Eustachio Manfredi stated that he was deliberately removing the stain, astrology, from his ephemeris, unlike his predecessors Regiomontanus, Magini, and Kepler. Only tables of planetary aspects remained.⁵³ Once again, this does not mean that astrology was finished at Bologna, as we can see in Antonio Ghisilieri's *Ephemerides motuum coelestium* for 1721–56, drawn from the tables of de la Hire, Streete, and Flamsteed (1720).⁵⁴ Ghisilieri's ephemerides provided horoscopes for eclipses and the four cardinal points of the year (namely, the two solstices and equinoxes), as well as full tables of planetary aspects. Of most interest, however, is Ghisilieri's extensive introductory letter to the reader, wherein he outlined his own reform of astrology, discussing, among others, Descartes and Newton. By 1750, the only remaining astrological vestiges in the Bolognese ephemerides I have examined were the planetary aspects,⁵⁵ whereas the first English naval ephemerides (1767) have nothing astrological

⁵⁰ Flamsteed's complex and ambivalent relation to astrology has been studied in Michael Hunter, "Science and Astrology in Seventeenth-Century England: An Unpublished Polemic by John Flamsteed," in *Astrology, Science, and Society: Historical Essays*, ed. P. Curry (Woodbridge: Boydell Press, 1987), pp. 261–300.

⁵¹ Hunter, "Science and Astrology," pp. 250–1.

⁵² I focus here on Italian ephemerides, primarily from Bologna. Other ephemerides that I have examined from France, Germany, England, and elsewhere in Italy corroborate this picture. I used the collections of the Houghton Library of Harvard University, the Burndy Library of the Dibner Institute, and especially Owen Gingerich's private collection. My sincere thanks to Professor Gingerich for granting me access to his important collection of astronomical and astrological publications.

⁵³ Eustachio Manfredi, *Ephemerides motuum coelestium* (Bologna: Constantinus Pisanus, 1715).

⁵⁴ Antonio Ghisilieri, *Ephemerides motuum coelestium* (Bologna: apud successores Benatti, 1720).

⁵⁵ Eustachio Zanotti, *Ephemerides motuum coelestium ex anno 1751 in annum 1762: ad meridianum Bononiae ex Halleii tabulis supputatae . . . ad usum Instituti* (Bologna: C. Pisarri, 1750); Eustachio Zanotti, *Emphemerides motuum coelestium ex anno 1775 in annum 1786: ad meridianum Bononiae ex Halleii tabulis supputatae . . . ad usum Instituti* (Bologna: Laelius a Vulpe, 1774).

in them whatsoever.⁵⁶ Further research should clarify the chronological outline indicated here.

Astrology's removal from the natural philosophy curriculum was also complex, as we can see from popular textbooks by the Protestant Johannes Magirus (first edition, 1597) and the Jesuit Coimbra Aristotle commentaries, especially the *De caelo* (first edition, 1592), both of which discussed celestial influences at the appropriate Aristotelian loci. These works were influential throughout the seventeenth century. Magirus's *Physiologia peripatetica* (Aristotelian Natural Philosophy) came out in sixteen editions through 1642, and the Coimbra commentary on *De caelo*, taught within and beyond the Jesuit educational network, saw thirteen editions by 1631.⁵⁷ Major figures such as René Descartes (1596–1650) and Marin Mersenne (1588–1648) learned their natural philosophy in this manner at the Jesuit college of La Flèche.⁵⁸ Moreover, as an undergraduate at Trinity College, Cambridge, in 1661, Newton began his study of Aristotelian natural philosophy by reading Magirus, before turning to Descartes.⁵⁹ Magirus continued to be read at Cambridge into the 1670s, at Harvard into the 1690s, and at Yale into the 1720s.⁶⁰

Descartes and Newton, however, lead us into a new phase in the history of science and philosophy, with the systematic formulation of competing traditions of inquiry that would ultimately complete the uprooting and replacement of the Aristotelian-Ptolemaic worldview. Although Newton was a devoted alchemist, he and Descartes were both antiastrological, or, perhaps more accurately, nonastrological,⁶¹ even though there came to be Cartesian astrologers (for example, Claude Gadrois)⁶² and Newtonian ones, at least after a fashion, as we will see with Richard Mead. This raises an important question: Because mechanisms that stressed the impact of celestial influences on subtle effluvia should have worked well for both Descartes and Newton, why did they not embrace a reformed astrologizing natural philosophy along

⁵⁶ *Nautical Almanac and Astronomical Ephemeris for the Year 1767* (London: Commissioners of Longitude, 1766).

⁵⁷ See Charles H. Lohr, *Latin Aristotle Commentaries II: Renaissance Authors* (Florence: Leo S. Olschki, 1988), pp. 235–6 (Magirus) and pp. 98–9 (Conimbricensis Collegii Societatis Jesu commentarii). For their influence, see P. Reif, "Natural Philosophy in Some Early Seventeenth-Century Scholastic Textbooks," Ph.D. dissertation, St. Louis University, St. Louis, Mo., 1962; in general, see Charles B. Schmitt, "The Rise of the Philosophical Textbooks," in Schmitt et al., eds., *The Cambridge History of Renaissance Philosophy*, pp. 792–804.

⁵⁸ Peter R. Dear, *Mersenne and the Learning of the Schools* (Ithaca, N.Y.: Cornell University Press, 1988); and Stephen Gaukroger, *Descartes: An Intellectual Biography* (Oxford: Clarendon Press, 1995).

⁵⁹ J. E. McGuire and Martin Tamny, *Certain Philosophical Questions: Newton's Trinity Notebook* (Cambridge: Cambridge University Press, 1983), pp. 15 ff.

⁶⁰ Samuel E. Morison, *Harvard College in the Seventeenth Century*, 2 vols. (Cambridge, Mass.: Harvard University Press, 1936), 1: 226–7. Astrology was finally removed from Harvard disputations in 1717; *ibid.*, 1: 214.

⁶¹ For Descartes, see Bowden, "Scientific Revolution in Astrology," pp. 197–8. The references for Newton are given in note 68. For the unexpected disjunction between alchemy and astrology, see William R. Newman and Anthony Grafton, "Introduction: The Problematic Status of Astrology and Alchemy in Premodern Europe," in *Secrets of Nature*, pp. 1–37, at pp. 14–27.

⁶² Bowden, "Scientific Revolution in Astrology," pp. 198–202.

the lines laid down by Bacon and Boyle? Perhaps the effluvial mechanisms did not work at the great distances now understood to exist in the solar system.⁶³ Unfortunately (as far as I know), neither Descartes nor Newton explicitly discussed their views on astrology – a fact significant in its own right.

An important figure in the acceptance of the antiastrological stance of Descartes – and also, ironically, of Newton – was the influential textbook writer Jacques Rohault (1620–1675), who published his Cartesian *Traité de Physique* in 1671, with at least ten editions in Paris alone by 1730. He explicitly rejected astrology in a chapter entitled “Of the Influences of the Stars, and of Judicial Astrology,”⁶⁴ where he asked “whether the stars act as the cause of or contribute to effects we see produced on earth.” Because he granted causal efficacy to the sun’s light and heat (as did Pico), the question applied only to the other stars, whose light moves only our optical fibers and elements in the air. Because the sun’s light is infinitely greater than all the stars put together, Rohault argued, also echoing Pico, it should be understood as the sole cause of all these effects. Rohault noted further, thus dissenting from the views of his contemporary Robert Boyle, that if the air is different at different times, we should not look for the cause of this in the heavens but in the air itself or the earth.

After this brief natural-philosophical critique, Rohault addressed judicial astrology, simply asserting that it cannot be proved by any reason. Turning to experience, he argued that astrological rules cannot be based on one-time experiences because it would take many thousands of years for the same celestial configuration to recur to test the rule. This is impracticable, as Bacon had also understood. Furthermore, even if it were possible, the rule would apply only to the country where the experience happened, not universally. Finally, even if the astrologers are sometimes correct in their predictions, this is attributable only to luck. Rohault’s conclusion leaves no doubt about his definitive rejection of astrology: “Not to insist any longer upon this Subject, which does not deserve to have any more said of it, and which is not worth being seriously treated by any Philosopher.”

Rohault’s Latin translator and Newton’s disciple, Samuel Clarke (1675–1729), appended only one explanatory footnote to this entire section; namely, to clarify the nature of the moon’s influence:

But as to the real Power of the Moon; since it is evident, that it causes a greater Flux and Reflux in the Air than in the Sea, it must certainly produce some

⁶³ Albert Van Helden, *Measuring the Universe: Cosmic Dimensions from Aristarchus to Halley* (Chicago: University of Chicago Press, 1985).

⁶⁴ The references are to John Clarke’s English translation of Samuel Clarke’s Latin translation with Newtonian commentary of Rohault’s *Treatise; Rohault’s System of Natural Philosophy* . . . , 2 vols. (London: James Knapton, 1723), reprinted in Jacques Rohault, *A System of Natural Philosophy*, 2 vols. (The Sources of Science, 50) (New York: Johnson Reprint Co., 1969), with an informative introduction by Larry Laudan. The chapter (*System*, 2.27), appears in 2: 86–91. My thanks to Domenico Bertoloni Meli for insisting on Rohault’s importance.

Alterations in the Temperature of the Heavens, and this may make some Alteration in the Bodies of Animals. But as to any other Effects commonly ascribed to the Moon and Planets, beyond what are owing to these Causes, they are meer Trifles.⁶⁵

Rohault's textbook had an extraordinary influence both in its original French editions and in the Clarke brothers' Latin (1697) and English (1723) annotated translations.⁶⁶ Samuel Clarke's three later Latin editions, culminating in 1713, became increasingly Newtonian as he augmented his apparatus of critical explanatory notes, attacking Rohault's Cartesian exposition from the foot of the page. The English translation, which incorporated these notes, served at least into the 1740s as a natural philosophy textbook with an antiastrological bent at Cambridge, as well as Harvard and Yale.⁶⁷

Beyond Rohault's textbook, Newton himself contributed to astrology's undoing, although this was not necessarily his intent. Although few contemporaries actually read his *Philosophiae naturalis principia mathematica* (Mathematical Principles of Natural Philosophy, 1687), Newton's synthesis seems to have undercut the natural-philosophical foundations of astrology in two fundamental and interrelated ways, one natural-philosophical and the other heuristic. First, he did away with the entire hylemorphic fourfold causal framework with Aristotle and his followers' characteristic views of substance, accidents, and change (see Joy, Chapter 3, this volume). Without this causal structure, the natural-philosophical foundations for astrology simply disappeared. Heuristically, Newton radically reoriented the nature of legitimate scientific questions, focusing first of all on what can be observed, quantified, and measured.⁶⁸

Astrology seems to have persisted in medicine longer than in any other branch of learning. Richard Mead (1673–1754), Newton's and Halley's personal physician, a graduate of the University of Padua, wrote *De imperio solis et lunae* (Concerning the Influence of the Sun and Moon upon Human Bodies and the Diseases thereby Produced) in 1704, with a revised edition in 1748 after forty years of medical practice.⁶⁹ In this work, Mead grafted a Newtonian iatromechanical explanatory framework onto traditional astrologically informed Galenic praxis, but without the usual emphasis on natal

⁶⁵ Rohault, *Rohault's System*, 2: 90, n. 1.

⁶⁶ Laudan, introduction to Rohault, *Rohault's System*, 1: ix–x.

⁶⁷ Ibid., 1: x–xiii.

⁶⁸ This can be seen clearly in query 31 of the *Opticks*. See Isaac Newton, *Opticks; or, a Treatise of the Reflections, Refractions, Inflections and Colours of Light* (based on the fourth edition, London, 1730; repr. New York: Dover, 1952), pp. 401–2. Newton assiduously promoted this reoriented research program as president of the Royal Society from 1703 to 1727. See John L. Heilbron, *Physics at the Royal Society during Newton's Presidency* (Los Angeles: William Andrews Clark Memorial Library, 1983); and Richard S. Westfall, *Never at Rest: A Biography of Isaac Newton* (Cambridge: Cambridge University Press, 1980).

⁶⁹ It was also published posthumously in his collected works (1775).

horoscopes or medical interrogations.⁷⁰ One of his principal authorities in this area was John Goad, who published the rich results of his extensive astrologically informed meteorological observations in his *Astro-Meteorologica* (1686).⁷¹ Later still, Franz Anton Mesmer (1733–1815), who received his medical degree from the University of Vienna in 1766, wrote a dissertation analyzing the influences of the heavens on the health of human beings. Inspired primarily by Mead's treatise, this dissertation was informed by the latest theories of gravitation, magnetism, and electricity and discussed Newton's views in the *Principia*.⁷²

THE EIGHTEENTH CENTURY AND BEYOND

In the preface to his popular *Cyclopedia* (1728), Ephraim Chambers declared that he would treat astrology because, in addition to its erstwhile popularity, it still contained something worth preserving:

The heavenly Bodies have their Influences: The Foundation, therefore, of Astrology is good: but those Influences are not directed by the Rules commonly laid down, nor produce the Effects attributed to 'em: so that the Superstructure is false. Astrology, therefore, ought not to be exploded, but reformed.⁷³

He concluded the prefatory statement with a sympathetic nod to Bacon's astrological reform as an *astrologia sana*.

In his article on astrology, which he defined as "the Art of foretelling future Events, from the Aspects, Positions, and Influences of the Heavenly Bodies," Chambers clearly distinguished natural from judicial astrology.⁷⁴ In discussing the former, he argued for fundamental features of astrology's natural philosophical foundations. Noting that planetary configurations affect the weather, Chambers cited John Goad. Noting that heavenly bodies affect all physical bodies, in both their rarefaction and condensation and their generation and corruption (the old Aristotelian categories), he drew on Robert

⁷⁰ Anna Marie Roos, "Luminaries in Medicine: Richard Mead, James Gibbs, and Solar and Lunar Effects on the Human Body in Early Modern England," *Bulletin of the History of Medicine*, 74 (2000), 433–57.

⁷¹ On Goad, see Curry, *Prophecy and Power*, pp. 67–72; and Bowden, "Scientific Revolution in Astrology," pp. 176–87.

⁷² See the introduction to Franz Anton Mesmer, *Mesmerism: A Translation of the Original Scientific and Medical Writings of F. A. Mesmer*, trans. G. Bloch (Los Altos, Calif.: W. Kaufmann, 1980); and Robert Darnton, *Mesmerism and the End of Enlightenment in France* (Cambridge, Mass.: Harvard University Press, 1968). Much additional research is needed to complete the story of the fate of astrology in learned medicine during the Enlightenment.

⁷³ Ephraim Chambers, *Cyclopedia; or, An Universal Dictionary of Arts and Sciences* . . . (London: J. and J. Knapton, etc., 1728), 1: xxviii. My thanks to Richard Yeo for directing me to this material; see in particular his *Encyclopedic Visions: Scientific Dictionaries and Enlightenment Culture* (Cambridge: Cambridge University Press, 2001).

⁷⁴ Chambers, *Cyclopedia*, 1: 162–4.

Boyle's *History of the Air*. Finally, Chambers argued that each planet has its own specific quality of light and that the angular relationship of the planets to each other, and to the Earth – the astrological aspects – thus have a particular qualitative effect on sublunary things.

Chambers's treatment of judicial astrology, on the other hand, was wholly dismissive: "Judiciary, or Judicial ASTROLOGY, which is what we commonly call Astrology, is that which pretends to foretell moral Events; i.e. such as have a Dependence on the Will and Agency of Man; as if they were directed by the Stars." Referring to it as superstition, he declared that "the chief Province now remaining to the modern Professors, is the making of Calendars or Almanacks."⁷⁵ Chambers's treatment of astrology remained exactly the same at least through the revised edition of 1741, and his discussion, translated into French, was taken over whole in the *Encyclopédie*'s first edition of 1751 by Denis Diderot and Jean d'Alembert.⁷⁶ By 1786, however, in Abraham Rees's posthumous edition of Chambers's *Cyclopaedia*, the treatment had changed significantly. Although the prefatory discussion remained the same, the description under the term was significantly reduced. Chambers's three original authorities, Boyle, Goad, and Mead, were reduced to Boyle alone.⁷⁷

Chambers's reforming treatment should be sharply contrasted with the abruptly dismissive definition in the *Encyclopaedia Britannica*'s first edition of 1768, which I quote in full:

ASTROLOGY, a conjectural science, which teaches to judge of the effects and influences of the stars, and to foretel future events by the situation and different aspects of the heavenly bodies. This science has long ago become a just subject of contempt and ridicule.⁷⁸

Taken as a group, these eighteenth-century encyclopedias illustrate, albeit with some delay, the various trends already visible in more specialized seventeenth-century discussions of astrology: its severing from astronomy among the mathematical disciplines and its elimination from the mathematical curriculum; the gradually widening fissure between natural and judicial astrology, together with attempts to incorporate natural astrology into the new sorts of natural philosophy; and a concomitant rejection of judicial astrology's panoply of rules and aims. These are fundamental transformations in the transition from premodern to modern disciplinary configurations.

⁷⁵ Ibid., I: 163.

⁷⁶ Denis Diderot and Jean d'Alembert, *Encyclopédie, ou Dictionnaire raisonné des arts et des métiers* (Paris: Briasson, etc., 1751), I: 780–3.

⁷⁷ Ephraim Chambers, *Cyclopaedia . . . with the Supplement, and Modern Improvements . . . by Abraham Rees* (London: J. F and C. Rivington, 1786).

⁷⁸ *Encyclopaedia Britannica; or, a Dictionary of Arts and Sciences . . .*, 3 vols. (Edinburgh: A. Bell and C. Macfarquhar, 1771), I: 433.

These patterns of rejection and reconfiguration do not, however, appear to extend to lay culture. From 1640 on, even as learned writers increasingly limited astrology's claim to explanatory power, translation of astrological texts into English made in-depth knowledge of astrology accessible to a much broader social spectrum than before.⁷⁹ Thus, what remained of judicial astrology in the mid-eighteenth century seems to have found a home primarily within popular culture, especially in almanacs, many of which retained their astrological character.⁸⁰ This situation changed again in the nineteenth century, when astrology was integrated into a new configuration of the so-called occult sciences (which included magic, alchemy, witchcraft, and the kabbalah), where we still find it today.⁸¹

Although I have traced the outlines of the process whereby astrology disappeared from the domain of legitimate natural knowledge as defined by the learned, some of the biggest questions still remain. In particular, why was such a promising astrological synthesis uprooted during the seventeenth and eighteenth centuries? In addition to natural philosophical motivations, part of the answer must also lie in the political domain, where the role played by astrology – still vital in the seventeenth century – lost its importance in the eighteenth.⁸² Likewise, astrology increasingly became the brunt of biting satire at this time, as in Jonathan Swift's vehement attack on the real astrologer John Partridge under the fictional guise of another astrologer, Isaac Bickerstaff.⁸³ This seems to have reflected and reinforced the increasing vulgarization of astrology and its demotion from the world of elite to popular culture.⁸⁴

Although finally severed from its intellectual and institutional roots in Aristotelian-Ptolemaic-Galenic natural knowledge and university culture, astrology continued to exist as a system of thought, even after the middle of

⁷⁹ See Curry, *Prophecy and Power*, pp. 19 ff.

⁸⁰ Capp, *Astrology and the Popular Press*, pp. 238–69. For the somewhat different situation in Italy, see Casali, *Le spie del cielo*, pp. 203–70.

⁸¹ This configuration is reflected in Wayne Shumaker, *The Occult Sciences in the Renaissance: A Study in Intellectual Patterns* (Berkeley: University of California Press, 1972).

⁸² For the astrological political think-tank run by Orazio Morandi in Rome in the 1620s, see Brendan Dooley, *Morandi's Last Prophecy and the End of Renaissance Politics* (Princeton, N.J.: Princeton University Press, 2002), which must be treated with caution. For France, see Drevillon, *Lire et écrire l'avenir*. For the great role astrological prophecy played in the English Civil War and Interregnum of the 1640s and 1650s, see Ann Geneva, *Astrology and the Seventeenth Century Mind: William Lilly and the Language of the Stars* (Manchester: Manchester University Press, 1995). For Elias Ashmole and William Lilly as Charles II's court astrologers in the 1660s and 1670s, see C. H. Josten, *Elias Ashmole (1617–92)* . . . , 5 vols. (Oxford: Clarendon Press, 1966). For the eighteenth century, see Curry, *Prophecy and Power*, pp. 95–137.

⁸³ For this episode, see Curry, *Prophecy and Power*, pp. 89–91. For the general movement “from popular to plebeian,” see Curry's section under this title, pp. 109–17.

⁸⁴ For a parallel discussion of this process as it concerned prodigies and natural wonders, see Lorraine Daston and Katharine Park, *Wonders and the Order of Nature, 1150–1750* (New York: Zone Books, 1998), chap. 9.

the eighteenth century, as it still does today.⁸⁵ Nonetheless, the sixteenth and seventeenth centuries marked a crucial turning point in learned attitudes toward astrology and in its role in learned understandings of the natural world. The exclusion of astrology from these understandings was intimately connected with the undermining and removal of Aristotelian natural philosophy itself and its eventual replacement by Newtonian science.

⁸⁵ For a contemporary example of astrological practice in the highest corridors of power, see Joan Quigley, *What Does Joan Say?: My Seven Years as White House Astrologer to Nancy and Ronald Reagan* (Secaucus, N.J.: Carol Publishing, 1990). People still try to justify astrology scientifically, perhaps most famously Michel Gauquelin, who has written such books as: *Birthtimes: A Scientific Investigation of the Secrets of Astrology*, trans. S. Matthews (New York: Hill and Wang, 1983); *Cosmic Influences on Human Behavior*, trans. J. E. Clemow (London: Garnstone, 1974); and *The Scientific Basis of Astrology*, trans. J. Hughes (New York: Stein and Day, 1969).