<CT>Astrology and Science: A Renaissance Problem<CT>

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From the standpoint of many thinkers in the Renaissance, astrology was science.[1] It comprised a body of knowledge that fit the criteria of verification commonly accepted for confirming information and establishing certitude about the natural world. It derived from authoritative traditions rooted in admired ages and places, illuminated by ancient wisdom. The most respected intellects had set great store by it from time immemorial. It made sense according to prevailing ideas about how the world and human nature worked. Its language was embedded in the very discourse whereby the results of scientific investigations were expressed. It seemed to conform to observations and experiences accumulated over time. Its methods were the methods of all knowledge-gathering. It used an experiential, not an experimental approach; and as such it belonged to Renaissance science and only partly to ours. And to the extent that Renaissance thinkers began to invent modes of knowledge-testing to which it could not conform, it gradually lost its grip on Renaissance minds and was superseded by other approaches.[2]

Thus the story of astrology and science in the Renaissance is largely the story of science in general. No wonder Giovanni Battista Riccioli included both astrologers and astronomers together in the list he compiled at the end of the seventeenth century of experts on celestial matters from ancient to modern. And no wonder that, well into the seventeenth century and beyond, it kept its position among the studies associated with "mixed mathematics" as taught in the medical schools. And the works and days of its practitioners deserve all the attention that, for instance, the *Cambridge History of Early Modern Science*, or indeed the *Cambridge History of Renaissance Philosophy* have devoted to them. To these anthologies we also refer for a fuller discussion of the problematic term "science" in this context, adding only that for the sake of convenience "science" and "natural knowledge" will be used interchangeably in deference to historical usage when referring to our period, and clear indications will be given when anything specifically relating to the notion of "modern science" is in play.

To understand the full implications of the theme of astrology and science, therefore, is to understand a basic episode in the formation of humanity's outlook on nature, and perhaps, to throw more light on the complex pedigree of a category of experience, "science," that since the Renaissance has loomed ever larger in human life. In this exploration, we will take three well-known and deeply contrasting interpreters of natural knowledge to epitomize the relation between astrology and science in the Renaissance. For our purposes, Gerolamo Cardano exemplifies how astrology was bound up with other natural knowledge, Francis Bacon shows how other knowledges could lead to innovations in astrology, and Johannes Kepler shows how astrology could lead to innovations in other branches of science. All three were highly controversial when they wrote and their writings subsequently spawned intense debates among scholars attempting to appraise their contributions. We will mention rather than engaging fully with the scholarship on each one, as we focus on the aspects of their work that elucidate our topic.

Gerolamo Cardano wrote, according to his own last count in 1575, nearly a hundred books on almost every field of human endeavor in his time (*On Water*, *On Dialectics*, *On the Studies of Socrates*, *On Civil Prudence*, *In Praise of Nero*, are some of the less known), although he is remembered in science history textbooks mainly for contributions to algebra, game theory, and machine construction. Most recently attention has been drawn to his voluminous medical works, which summarized theory and practice in an age to some degree torn between Galen and Hippocrates, and he is now studied for his (not unrelated) astrological works—also because of his having produced the last great commentary on Ptolemy's astrological manual, which he entitled, *Claudii Ptolemaei Pelusiensis libri quatuor, De Astrorum Iudiciis cum expositione Hieronymi Cardani*. Though he referred to himself in print mostly as a "Milanese" in virtue of his origin or as a "medicus," in view of his profession, he would have considered that his breadth of knowledge qualified him as a "philosophus." He attempted not once but twice to conceive of a unified theory of all things. His massive *De subtilitate* (in twenty-two books), later reworked into *De rerum varietate* (in seventeen books) contains the substance of his thinking about humans within the natural world, and the heavens above, problems which he and his contemporaries

regarded as the highest form of natural knowledge. It was not, he said in his autobiographical writings, his greatest work, but likely the one that would be most widely read.[3]

Cardano conceived of *De subtilitate* and its sequel as a kind of encyclopedia of natural knowledge (at one point he calls the later installment a "history of the universe and the world"), organized around the concept of "subtlety." This concept embodied his basic view of the universe as a dense web of occult connections full of arcane meanings forming patterns which humans might endeavor to understand in order to achieve mastery over nature, themselves, and history. "Subtlety," in his definition, referred to "sensible things that are difficult to comprehend by the senses, and intelligible things difficult to comprehend by the intellect." Amplifying this, he says, "it is the science of some things that are and some that only seem to be; some which are seen with us sleeping, others with us awake." Characteristic of his effort to use hidden capacities as well as discover hidden meanings, he asserted the concept for the work came to him in a dream; and the method of compilation appears to give equal space to inspiration and pattern-recognition. Although he intended the work to be systematic, like those of his ancient models Aristotle and Pliny, and he divided it into categories like "1: On beginnings," "2: On the Elements," "3: On the Heavens," "5: On Metallic Things," "11: On the Necessity of Man," "13: On the Senses," "16: On the Sciences" and "17: On the Arts," nevertheless his inclusion of material in each of these categories was subject to the meanderings of his own mind over entire ranges of ancient and modern sources. He provided answers to major questions and minor: why the sea is salty as well as "why asses are stupid."[4] Where he is not satisfied with the accepted schemes of organization he invents his own: the four excellent things in nature, the five kinds of stone, the seven human calamities, the nine kinds of animals.[5]

He avoids a unilateral approach, and endeavors rather to proceed back and forth between universals and particulars. Laws come from experience and return to organize the results of yet other experience. Everyday observations form the basis for weighty conclusions, as when the presence of salt in the sea goes to prove that the world is eternal. The work is as much an essay on a method of inquiry as on the matter at hand. He subjects his hypotheses to tests, and draws more hypotheses from his tests. Sometimes he thinks the best answer is no answer. Gold should taste better than silver because it is higher

on the scale of excellence; however, it has no taste at all. He also uses particular and sometimes rather homely tests to demonstrate this or that much more weighty point. To explain the effect of tides on the surface of water he suggests pinching the skin to form a "tumor" and observing what this does to the surrounding skin. The approach seemed to engage enough readers for numerous reprintings, although it also gained him the ridicule of Joseph Scaliger—damagingly or innocuously, according to different modern interpretations.

The main force in the universe is celestial heat, which causes motion and change by action in varying degrees on the living souls existing in all matter, including animals and humans. It seems to take the place of the peripatetic notion of substantial form and introduce a hylozoic position closer to Plato, the Neoplatonists and even Averroes—whose ideas about unity to some degree inspired his own, expounded in a particular treatise *De uno*. In a posthumously published treatise on nature, he remarks, "whoever has written about the soul says it is either the author of nature, or else is nature itself."[6] At one point in *De subtilitate*, he says natural heat and the soul are also the same thing.[7] The sun and the other heavenly bodies possess this heat and communicate a generative force to the world. This is evidently the basis of astrology. Indeed, "no one may deny" that such forces exist, he said; because "they rule all mortal things," in spite of any assertions to the contrary by "the ambitious and the impious."[8]

Cardano's scheme of natural philosophy challenged the astrological tradition as described by Ptolemy, by removing fire from the list of elements, because of its special role in the universe, leaving only water, air, and earth, so there could be no four-part division of the constellations according to their relation to the elements; and he overturned the division of the planets according to their relation to the four qualities by removing cold and dry and leaving only hot and moist. Moreover, he was able to demonstrate that the *Centiloquium*, widely used by practitioners and long thought to be an astrological work by Ptolemy, was actually a later forgery. In his commentary on the *Tetrabiblos*, he attempted to restore ancient astrology to its former splendor. He identified symptoms, in his source, of the earlier, and in his mind unreliable, Chaldean and Egyptian traditions, so these could be expunged. Instead, he would place before the public a purified version, fit to silence the skeptics and restore the prestige of current

practice. He expanded upon Ptolemy's comments regarding where astrology was more reliable (say, in dealing with the weather) or less (say, in predicting the exact course of a person's life). He drew out to greater length (in passages later carefully read by Kepler) Ptolemy's conjectures concerning the rapport between the chief aspects and the harmonies in music. Where Ptolemy had merely mentioned the significance of comets, he added a whole section, based on the wide-ranging literature on the topic in his own time, by Regiomontanus, Pontanus, and Nifo. To the astrologer's toolkit, he confirmed the modern addition of conjunction theory in relation to the fates of nations, drawing upon medieval, and especially Islamic, traditions subsequent to Ptolemy. And as part of his set of demonstrations of astrological technique, he introduced and explicated the geniture of Jesus Christ, answering definitively, so he hoped, the questions raised by a debate that had begun practically with the Renaissance. If astrology could even illuminate theology, the queen of the sciences, its value was secured.

Bacon belonged to the next generation (d. 1626); and as one of the paradigmatic intellectual innovators of the Renaissance, he considered a purely mathematical approach to celestial matters to be highly defective.[9] "Astronomy, as it now stands, loses its dignity by being reckoned among the mathematical arts, for it ought in justice to make the most noble part of physics."[10] He agreed with the division of tasks between astrology and astronomy, with the first comprising knowledge about the significance of the movements, and the second about the movements themselves; but he considered the two approaches to be worthy of study together. He thought astrological knowledge was real, but its use and practice needed to be reformed. "Astrology is . . . so full of superstition that scarce anything can be discovered in it, though we judge it should rather be purged than absolutely rejected." The basic principle of stellar influences upon which astrology was based he found to be unimpeachable, and likewise the notion of a rapport between the microcosm of human affairs and the macrocosm of celestial ones. He said, whoever understood the connection "between terrestrial and celestial things, and well understands the more general appetites and passions of matter, which are powerful in both, may receive a clear information of what happens above from that which happens below; and from what passes in the heavens,

he may become acquainted with some inferior motions hitherto undiscovered, not as these are governed by those, but as they both have the same common passions."[11]

Stellar forces were not only heat and light, in Bacon's view, but included "certain other influences," which varied in kind and strength according to the planet or star in question, and according to the relation between the planet or star and the earth. He did not venture to pronounce on the precise character of these other influences; it was enough to know they existed and worked observable effects in the world, and to understand something of the dynamics. He outlined the studies that might be done in this connection. Mixtures of rays (conjunctions, oppositions, and other aspects) were to be taken into account, as well as the passage of the wandering stars through the zodiac. Angles were fundamental, and so were apogees and perigees, acceleration and retardation. The particular essence of a star was important—whether fixed or wandering, whether one color or another, whether twinkling or not, large or small. Tradition could be a help where observation was lacking, in terms of the ages-old agreed-upon characters of the stars (the beneficence of Jupiter and Venus, the maleficence of Saturn and Mars). When all of these features were calibrated and described, the result, in Bacon's view, would be a "sane astrology," founded upon the same "physical reasons" as a "living astronomy."

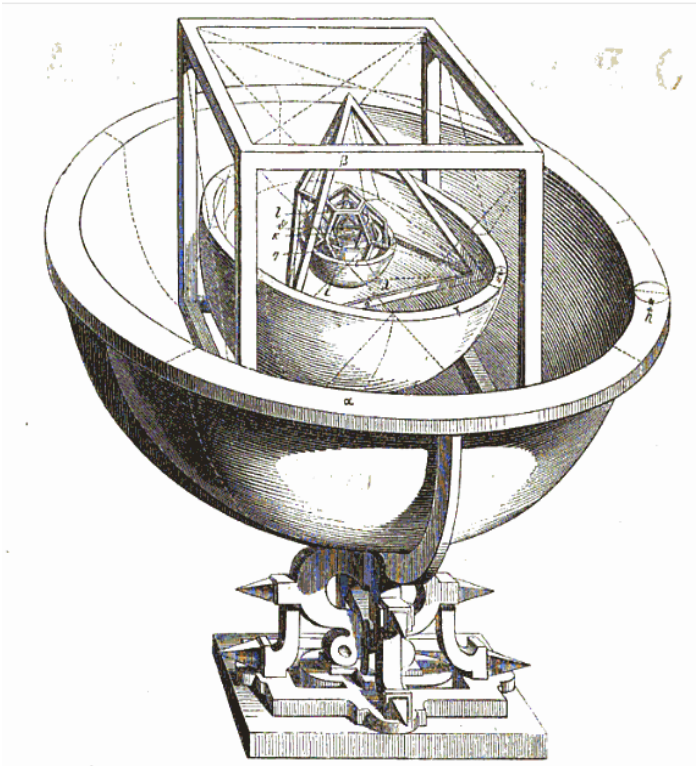
The trouble with astrology, according to Bacon, was not the principles per se, but the astrologers and their traditional practices for judging of the future. In other words, events and characters were the products of a network of cosmic connections governing the great body of the world. However, "we reject, as an idle figment, the doctrine of horoscopes, and the distribution of the houses, though these are the darling inventions of astrology, which have kept revel, as it were, in the heavens."[12] Instead, in the spirit of the Great Instauration, of which *The Advancement of Learning* formed a part, that is, Bacon's project for a "total reconstruction of sciences, arts and all human knowledge, raised upon the proper foundation,"[13] he would reform astrology by expunging the uncertain and the patently false and collecting what could be verified. There were, in his mind, four routes to truth in this science. The first two were by "experiments" past and future, by which he meant experiences of predictions gone right; next came traditions, and finally "physical reasons." He proposed a collaborative effort of hitherto unimagined

proportions, to proceed from the mass of evidence to the formulation of new laws. “The astrologers may, if they please, draw from real history all greater accidents, as inundations, plagues, wars, seditions, deaths of kings, etc., as also the motions of the celestial bodies . . . to . . . erect a probable rule of prediction.” Such information was of course to be carefully scrutinized. “All traditions should be well-sifted, and those thrown out that manifestly clash with physical reasons, leaving such in their full force as comport well therewith.” This, he avowed, “we take for the surest guide to astrology.”[14]

If such thoughts did not exactly fit the picture, propounded in the Enlightenment, of Baconianism as the incubator of modernity, they nonetheless make perfect sense in the context of the early modern culture we are examining. No modern edition of *The Advancement of Learning* can afford to simply leave them out entirely, as Basil Montagu did in the early nineteenth century; nor can any manual on history of science pass over them in silence as was the practice of George Sarton and other early twentieth-century writers. In fact, Bacon’s diffidence with regard to contemporary astrological practice, combined with his acceptance of the principle of stellar influences, fit a pattern shared among other figures who have been considered to be leading innovators in a period of rapid intellectual change.

Kepler contrasted sharply with Bacon, ten years his senior, in terms of method as well as intellectual proclivities.[15] He tended toward a priori explanations, which he attempted to defend first on a priori grounds (elegance, aesthetic, mystical) and only then by empirical data. Number mysticism, drawn from Platonic neopythagoreanism, informed the world picture he first presented in the *Mysterium Cosmographicum*, where the heliocentric model, derived from Copernicus, was based on the existence of six planets and six geometrical figures including the five regular solids nested one inside the other, plus the outermost sphere. Plato, in those pages of the *Timaeus* which contained so much of the natural knowledge he ever transmitted, had coordinated four of the solids with the four elements (cube: earth; tetrahedron: fire; octahedron: air; icosahedron: water). Kepler ordered all five by importance from a mathematical viewpoint (cube, tetrahedron, dodecahedron, followed by octahedron and icosahedron), and related them to the planets, with the three most important ones including the earth and outward toward the fixed stars, and the two remaining ones toward the sun. He found a peculiar confirmation for this

arrangement in the relation, explained by Plato, between the study of harmony and the five regular solids, pointing out that just as the solids were ordered in a hierarchy, there were three chief intervals (octave, fourth, fifth) and two subordinate ones (third and sixth). His calculation of hypothetical distances of each planet from the sun on the basis of the related polyhedron seemed to coordinate with the latest planetary distances calculated by Michael Maestlin, his mentor.



α Sphaera Saturni. β Cubus. γ Sphaera Jovis. δ Tetraëdron. ε Sphaera Martis. ζ Dodecaëdron. η Orbis Terrae. ϑ Ikosaëdron. ι Sphaera Veneris. ϰ Octaëdron. λ Sphaera Mercurii. μ Sol, Medium sive centrum immobile. (Comp. Fol. 214.)

Figure 2.1 Kepler's Polyhedric Model *Opera omnia*, ed. Ch. Frisch (Frankfurt: Heyder u. Zimmer, 1858), p. iv.

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The question for Kepler was not whether planetary influences existed or could be measured, but whether the well-known characteristics agreed upon by generations of astrologers could be predicted by his geometrical model. The results were striking. Mercury's famed inducements to celerity referred to its octahedron, which could be turned cleanly on two angles, whereas the other figures, in his view, could not. Jupiter and Venus were supposed to indicate cause and effect, or fertility and offspring: and indeed, the pyramid (tetrahedron) of Jupiter, presumably, impregnated, whereas the icosahedron of Venus received the impregnation. In addition, "the female is always various and mutable," he said, and this was confirmed by the polyhedron of Venus. Jupiter's beneficence was noted already by Ptolemy. Kepler saw the same, but transposed to the heliocentric universe; and he found an explanation once again in its related pyramid. Although generally beneficent, Jupiter was hostile to the other two superior planets, Saturn and Mars, a fact apparent in their three solids: the cube, the tetrahedron, and the dodecahedron:

> <Extract>Also among their three solids absolutely none of their observable properties agrees, though Mars conspires with Saturn in malice alone. To this I relate the variability of their angles, which is peculiar to them, and common to both.<Extract>

The beneficent planets could also be explained by their solid geometry: "the constancy of the angles between their edges alone, is evidence of benignity."[16]

In 1606, he finished his key work on the orbit of Mars, the *Astronomia nova*, where he announced his first two laws of planetary motion, stating equal areas and elliptical orbits, the latter of which posed serious difficulties for his earlier concentric spheroid model involving the polyhedrons. In this work, he tended more toward an empirical approach than in his previous productions, collecting and interpreting the observations of Tycho Brahe and Maestlin, modifying his model in tandem with what he saw. The reason for the form of the orbits still eluded him, but he liked the neoplatonic concept of an *anima mundi* or world soul capable of making judgments. The planets, he suggested, have a "mind," whereby they steer this way and that, always according to a pattern—in this case, a non-circular one. The new discoveries

made no contribution to astrology, he said; although everyone knew (and he clearly implied an autobiographical reflection here) the chief reason for doing astronomy was to further astrological interests.[17]

In his later work, Kepler kept the polyhedrons in his cosmology, but used them less dogmatically and more heuristically, also in view of the new discoveries. A new idea began more and more to take hold of his imagination: the relation between planetary calculations and the harmonic series. Hints of this idea, elaborated from a theory of Ptolemy, already appeared in the *Mysterium*, but the mature version emerged in the *Harmonice Mundi* of 1618. He found a striking correspondence between the series and the planets' angular velocities at perihelion and aphelion, and calculated the harmonies of all of them beginning with Saturn at aphelion, taken to be the lowest note, "G." That the chromatic scale had twelve tones he found to be particularly significant in light of the twelve houses of the zodiac. Here too he elaborated on the cause of motion in the universe, based on the *anima mundi* or world soul, drawing upon the animal analogy used by Giordano Bruno and other neoplatonists, an approach that led him far away from geometry and mathematics, and toward a general philosophy of matter. "Just as other animate beings consume food and drink, so the Earth also must take some kind of material from definite channels, to brew from it such a multiplicity of substances, because nothing is made from nothing."[18] Indeed, "as the bladder pours out urine, so the mountains pour out rivers; as the body produces excrement of sulphurous odor and farts which can even be set on fire, so the Earth produces sulphur, subterranean fires, thunder and lightning."[19] And so forth. As to the type of soul the Earth had, "it seems plainly to be a sort of flame."[20]

Within this view of nature there was plenty of room for astrology, and Kepler applied what he knew in various prognostications and in the composition of nativities for the court, as part of his employment by Emperor Rudolph II. He never doubted that the planetary aspects powerfully influenced the world ("for I saw with great consistency that the state of the atmosphere was disturbed whenever planets were either in conjunction or configured in the aspects commonly spoken of by the astrologers"[21]) or that this influence was transmitted to the *anima mundi*. Individual souls responded, much as the Earth

itself, to the stellar influences, and the collective impact of these effects could influence mass actions: hence the coincidence of wars and other major human events with the major conjunctions. Furthermore, souls received at birth an impression of the zodiac, which created dispositions of character. “For since the vital faculty, lit in the heart, and burning as long as life persists, is a kind of zodiac circle, since its essence consists in activity, and in a flow of flame, as it were, the result is that the whole sensible shape of the zodiac flows into it when it has been freshly lit at birth.”[22] The planets, the ascendent house, the descendent 180° away, the mid-heaven or cusp of the tenth house, all sent particular harmonies to the soul, forming predispositions, inclinations, and shades of character. The study of a nativity was a key element in judging and understanding a human being. For instance, he hypothesized, “those who are born at a time of many aspects among the planets generally turn out hard-working and industrious.”[23] His own nativity he adduced as an example.

Also in the *Harmonice*, Kepler engaged in the nearly obligatory practice of denouncing the naïve strain of working astrology, as he had done already in his annual predictions of 1598 and 1599. Rereading Giovanni Pico della Mirandola’s by now classic diatribe, he said he was led “to confirm my condemnation of a great many superstitions,”[24] and attempted to find ways of restoring the conceptual foundations. Experience showed no presumed celestial effects to be ineluctable, and no planetary dispositions to be determining. The space of predictions obviously had to be redefined and circumscribed. Too often, he said, the planets were regarded as omnipotent gods, inexorable and capable of creating effects at will, although few observers of those effects had considered exactly what might be the physical causes, that is, the actual mechanisms that brought them about from the standpoint of current natural knowledge. The polyhedron theory was one way to do this, but this was only one portion of a multi-level project. In fact, he began the work of reforming astrology in 1602 with the publication of his *De fundamentis astrologiae certioribus*. True to its title, there he proposed to demote the zodiac from its primary role, for the same reasons that Pico had poured scorn on it: because the precession of equinoxes across the centuries had put the actual positions of the stars out of phase with the positions supposed in the traditional view. He would consider the names of the houses to be irrelevant and put much more

emphasis on the Ptolemaic aspects, to which he added three new ones: the quintile (72°), bi-quintile (144°), and sesqui-quadrate (135°). He would also follow the contemporary trend, influenced by Arab astrology, in giving greater attention to conjunctions.

Kepler thought he saw his views spectacularly vindicated by the appearance of a new star in the constellation Serpentarius in 1604, close to where a Great Conjunction of Jupiter and Saturn had occurred the year before in Sagittarius, signaling the beginning of the Fiery Trigon or triplicity of Sagittarius, Aries, and Leo, whose slowly gyrating 30° of arc it would continue to traverse for the next 200 years. Such events, he was convinced, were obviously significant—although interpreting the significance was (he opined) probably beyond the abilities of any of the observers. In one work dedicated to the phenomenon, he insisted, "The star's significance is a difficult matter to establish and we can be sure of only one thing: that either the star signifies nothing at all for Mankind or it signifies something of such exalted importance that it is beyond the grasp and understanding of any man."[25] In his definitive work on the topic, the *De stella nova*, published in 1606, he indicated his hope that the event signaled a "beautiful and lasting ending" to human suffering, but he reiterated his doubts about humans' ability to interpret the signs in any way that might be useful to them.[26] The best option for humankind, in his view, was to take the occasion as a prompting to turn more piously to the things of faith, and repent before it was too late.

Later in the *Tertius interveniens* of 1610, he assumed the role of a mediator between the naïve astrologer and the skeptic, with a "warning, to true Theologians, Physicians and Philosophers . . . when simply rejecting the stargazing superstitions, not to throw the baby out with the bathwater and thereby ignorantly act in contravention of their Professions."[27] The study of astrology, he pointed out, was no more uncertain than, say, the study of simples in medicine: both were arts of practice as much as bodies of knowledge, and both relied on the skill of the practitioner in applying the knowledge to the case. Moreover, "in the beginning there are also many failed experiments."[28] Any attempt to forbid even the silliest forms of astrology, such as the various imperial injunctions in the ancient world and the recent Bull of Sixtus V, would cancel an important road to physical and theological truth, and made no more sense than forbidding the study of anatomy. After all, he knew well what recent scholars have now

discovered, that without astrology, he himself might not have been drawn in the direction of his major accomplishments.

For each of these three figures, astrology was at once more and less than science. It was more because it involved a particular outlook on the world as well as a way of doing knowledge. It was less than science because its practitioners in all ages, no differently from Ptolemy himself, believed that many of its propositions had not yet been verified, and had simply been received on the strength of the tradition and their evident plausibility. Ptolemy asked:

> <Extract>If, then, a man knows accurately the movements of all the stars, the sun, and the moon, so that neither the place nor the time of any of their configurations escapes his notice, and if he has distinguished in general their natures as the result of previous continued study, even though he may discern, not their essential, but only their potentially effective qualities, such as the sun's heating and the moon's moistening, and so on with the rest; and if he is capable of determining in view of all these data, both scientifically and by successful conjecture, the distinctive mark of quality resulting from the combination of all the factors, what is to prevent him from being able to tell on each given occasion the characteristics of the air from the relations of the phenomena at the time, for instance, that it will be warmer or wetter? Why can he not, too, with respect to an individual man, perceive the general quality of his temperament from the ambient at the time of his birth, as for instance that he is such and such in body and such and such in soul, and predict occasional events, by use of the fact that such and such an ambient is attuned to such and such a temperament and is favourable to prosperity, while another is not so attuned and conduces to injury? (*Tetrabiblos* I,2)<Extract>

In Ptolemy's view, as in the view of the Renaissance thinkers so far analyzed, and others besides, astrology was a faith as much as a science: a faith that eventually better data-gathering would make real astrological knowledge possible, so that this knowledge could be used effectively to improve human life. In the absence of any single conceivable decisive proof, the value of astrology would be attested by the

continuing commitment of its admirers and the accumulating evidence of its successes, which progress guaranteed would be more impressive in the future than in the past.

In an emerging world where celestial motion was to be explained by other means, and the claims of science were to be reduced to what could be verified by tests reproducible in a laboratory, and the mysteries of the cosmos no longer demanded an immediate explanation, astrology came to be pushed to the outer edges of the intellectual world, into the area occupied by theology and other speculative arts. And when Louis de Jaucourt, in his article on "Influences" in the French *Encyclopédie*, labeled astrological knowledge "pretendu" and submitted it to a withering critique, there was no one left to defend it. The spell it had long cast over European minds had finally been broken.

<H1>Notes<H1>

1. So was magic. Here I side with Cesare Vasoli in his Introduction to *Magia e scienza nella civiltà umanistica* (Bologna: Il Mulino, 1976). In particular relation to astrology and science, see the special issue, edited by Lauren Kassell, of *Studies in History and Philosophy of Biological and Biomedical Sciences,* vol. 41 (2010). In addition, Eugenio Garin, *Astrology in the Renaissance: The Zodiac of Life* (Boston, MA: Routledge, 1983, Italian original Laterza 1976); Patrick Curry, ed., *Astrology Science and Society: Historical Essays* (Wolfeboro, NH: Boydell Press, 1987); Idem, *Prophecy and Power: Astrology in Early Modern England* (Princeton, NJ: Princeton University Press, 1989); Paola Zambelli, ed., *"Astrologi hallucinati": Stars and the End of the World in Luther's Time* (New York: Walter de Gruyter, 1986); Idem, *The "Speculum Astronomiae" and Its Enigma: Astrology, Theology, and Science in Albertus Magnus and his Contemporaries* (Boston, MA: Kluwer Academic, 1992); Idem, *L'apprendista stregone: astrologia, cabala e arte lulliana in Pico della Mirandola e seguaci* (Venice: Marsilio, 1995); articles in *Horoscopes and Public Spheres*, ed. Günther Oestmann, H. Darrel Rutkin, and Kocku von Stuckrad (Berlin and New York: Walter de Gruyter, 2005).

2. Concerning the waning of astrology note H. Darrell Rutkin, "Astrology," in *The Cambridge History of Science,* vol. 3: *Early Modern Science*, ed. Katherine Park and Lorraine Daston (Cambridge: Cambridge University Press, 2008), 542–63.

3. All citations are from the *Opera omnia*, 10 vols. (Lyons: Jean Antoine Huguetan/Marc Antione Ravaud, 1663). Here, vol. 1, p. 70, from his *De Libris Propriis.*

4. *Opera omnia*, vol. 3, book 10.

5. On these features see Ian Maclean "The Interpretation of Natural Signs: Cardano's De Subtilitate Versus Scaliger's Exercitationes," in *Occult and Scientific Mentalities in the Renaissance*, ed. Brian Vickers (Cambridge: Cambridge University Press, 1984), 242.

6. *De Natura* (op. vol. ii, chap. 3).

7. *De subtilitate*, lib. 2, de elementis.

8. *De rerum varietate*, II: xiii.

9. Concerning Bacon and his project, Stephen Gaukroger, *Francis Bacon and the Transformation of Early-Modern Philosophy* (Cambridge and New York : Cambridge University Press, 2001). Concerning the impact, consider Nicholas Popper, "'Abraham, Planter of Mathematics': Histories of Mathematics in Early Modern Europe," *Journal of the History of Ideas* 67 (2006), 87–106.

10. Francis Bacon, *Advancement of Learning*, vol. 3 of *The Works of Francis Bacon*, ed. James Spedding and Douglas Denon Heath, 14 vols. (London: 1857-74), book III, chap iv.

11. *Advancement of learning*, book III, chap iv.

12. *Advancement of Learning*, Proemium.

13. *Advancement of learning*, book III, chap iv.

14. *Advancement of Learning*, ed. Edward Creighton (New York: Colonial Press, 1900), III: 4 (p. 90 in this edition). Not in the least Whiggish of course is Paolo Rossi, *Francesco Bacone: Dalla magia alla scienza*, 2nd edn. (Turin: Einaudi, 1974); and especially see D. P. Walker, "Spirits in Francis Bacon," in *Francis Bacon: Terminologia e fortuna nel secolo XVII* (Rome: Edizioni dell'Ateneo, 1984), 315–27. Of course, I am not confusing Bacon's empiricism with the "empirics" whom he condemns. See Didier Deleule, "Experientia-experimentum chez F. Bacon," in Ibid., 59–72.

15. Concerning Kepler, consider Sheila J. Rabin "Kepler's Attitude Toward Pico and the Anti-Astrology Polemic," *Renaissance Quarterly* 50 (1997): 750–70; as well as Gérard Simon, *Kepler: Astronome,*

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Astrologue (Paris: Gallimard, 1979), there is Fernand Hallyn, *Structure poétique du monde: Copernic, Kepler* (Paris: Seuil, 1987) and J. V. Field, "A Lutheran Astrologer: Johannes Kepler," *Archive for the History of the Exact Sciences* 31 (1984): 189–272, all to be compared with Bruce Stephenson, *Kepler's Physical Astronomy* (New York: Springer-Verlag, 1987).

16. Modified from Kepler, *The Secret of the Universe*, tran. A. M. Duncan (New York: Abaris, 1981), 115–6. In addition, here, Mary Ellen Bowden, *The Scientific Revolution in Astrology: The English Reformers, 1558–1686*, PhD dissertation, Yale University, 1974, 112.

17. John North, *The Fontana History of Astronomy and Cosmology* (London: Fontana Press, 1994), 309–26~~, k wouldn't have produced his astron such if no astrologer~~.

18. ~~tr. field, p.~~Kepler, *The Harmony of the World*, tr. and notes by E. J. Aiton, A. M. Duncan, J. V. Field (Philadelphia: 1997), p. 363.

19. *The Harmony of the World*, p. 364

20. *The Harmony of the World*, p. 366

21. *The Harmony of the World*~~, Ibid.~~, p. 360.

22. *The Harmony of the World*, p. 374

23. *The Harmony of the World*, p. 375

24. *The Harmony of the World*, p. 360

25. , *Opera Omnia*, ed. Christian Frisch, 8 vols. (Frankfurt: 1858-71), vol. 1, *Bericht vom neuen Stern, 1604*, ~~Bericht,~~ p. 396— M. A. Granada, "The Discussion between Kepler and Roeslin on the Nova of 1604," in M. Turatto, S. Benetti, L. Zampieri, and W. Shea, eds., *1604–2004: Supernovae as Cosmological Lighthouses*, ASP Conference Series, Vol. 342 (Provo, UT: 2005), ~~Granada,~~ p. 37

26. Granada, "The Discussion between Kepler and Roeslin," p. 41.

27. ~~*Title page.*~~*Tertius interveniens*, title page, in *Opera omnia*, vol. 1.

28. *Opera omnia*, vol. 1, ~~Opera 1;~~ p. 630, thesis 111.

Comment [r3]: AU: Some text is missing in note 17. Please check.

Comment [r4]: AU: Please provide complete note details (author name, year of publication, and publisher name and location) for the notes 18–28.

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