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STARS, CRYSTALS AND COURTS:
JOHANNES KEPLER AND ANSELMUS BOËTIUS DE BOODT

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The new star of 1604 twinkled marvelously. Kepler devoted a chapter to its scintillation in *De stella nova* (1606). Two centuries later, François Arago reviewed the opinions of his predecessors in the course of his own exposé on stellar scintillation. He did not mince words about Kepler's account:

> In several passages, he compares the stars to carved diamonds, in which the slightest movement gives birth to the colors of the rainbow. He imagines that the stars can have angular sections and regions that are unequally luminous, and he explains in this way how they do not need to make one complete revolution for each scintillation. Analyzing the explanation of Scaliger, Kepler places the action of the air among the secondary causes without importance. All this, let's frankly admit, hardly seems worthy of Kepler's genius.[1]

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[1] François Arago, *Oeuvres complètes*, ed. J. A. Barral, v. 4 (Paris: Gide, 1858), p. 67: "Dans plusieurs passages, il compare les étoiles à des diamants taillés à facettes, dans lesquels le moindre mouvement fait naitre les couleurs de l'arc-en-ciel. Il imagine que les astres peuvent avoir des parties anguleuses, des régions inégalement lumineuses, et explique ainsi comment il n'est pas nécessaire qu'elles fassent une

Arago does not even bother mentioning that Kepler had these crystalline stars pulsing with heat and life. What makes Kepler's view even more fascinating was his presence at the court of one of Europe's most passionate aficionados of gems and precious stones, Rudolf II, whose collection was built on pillars of beauty, rarity, exoticism, and medical utility. Rudolf's personal physician, Anselmus Boëtius de Boodt (1550-1632), wrote a major early-modern treatise on mineralogy, the *Gemmarum et lapidum historia* (Hanau, 1609). This work, which happened to appear the same year as the *Astronomia nova*, harbors a vision of nature bearing striking resemblance to that of Kepler. Their natural philosophies seem to share a root system, as if they both participated in a common project or institution—*which indeed they did*. This is important because it suggests how Kepler, who spent an intellectually fertile period in Rudolf's Prague, was shaped by Rudolfine culture. In what follows, I will look at a few tantalizing similarities. The point is not to claim any direct transfer of ideas between the two scholars. As far as I know, they never mention one another by name, although Robert Halleux has suggested that Kepler might allude to de Boodt in his New Year's gift on the six-cornered snowflake.[2] At the moment, it suffices to examine how the two echo one another. Kepler's activity was about prediction, calculation and explanation, his material experimentation limited to lenses and light. Understandably, matter theory is one of the sketchiest aspects of his natural philosophy. On the other hand, de Boodt made his career studying, evaluating, and experimenting on, earthly matter. He

révolution totale à chaque scintillation. En analysant l'explication de Scaliger, Kepler range l'action de l'air au nombre des causes secondaire et sans importance du phénomène. Tout cela, avouons-le franchement, semble peu digne du génie de Kepler."

[2] Johann Kepler, *L'étrenne ou la neige sexangulaire*, trans. Robert Halleux (Paris: Vrin, 1975), pp. 56 and 91, n. 31.

marshaled that knowledge toward the accumulation of wealth, the restoration of health and the protection against disease. In short, reading de Boodt may provide us additional clues about how Kepler's philosophy meshed with the wider intellectual enterprise of Rudolf's court, beyond astrology and astronomy.

1. Kepler and Gems

Kepler opens his discussion on stellar scintillation by referencing Julius Caesar Scaliger's *Exotericarum exercitationum liber XV* (Paris, 1557), a work that he had esteemed highly in his youth. Scaliger embraced a variety of causes.[3] Kepler lists them as "magnitude, brightness, sidereal motion, the medium of air, and the motion of light in the star."[4] Kepler is especially convinced that scintillation should be attributed to changes within the star itself. The inner force that causes light must have its own proper motion.[5] Kepler admits to difficulties in knowing exactly how this is so. First, he draws a comparison with the beating of the heart and arteries, where the heart is like the Sun and the light is like life. But it cannot be, he concedes, that the star squeezes light throughout its body like *spiritus*. Light is so pure that it needs no impulsion. The motion inside the stellar body must not be a change of place—a local motion—but a qualitative change rendering the body luminous.[6] Here, Kepler hits on a better example, that of "live coals" (Kepler adds that they acquired

[3] Julius Caesar Scaliger, *Exotericarum exercitationum liber xv* (Frankfurt: Andreas Wechel, 1582), Exercise LXIII, especially pp. 240-242.

[4] *JKGW*, 1, p. 241.9-11: "J.C. Scaliger *Exotericarum Exercitationum* 63. causas affert ad scintillationem concurrentes quinque: Magnitudinem, Claritatem, Motum sideris, Medium aeris, et Motum luminis in sidere."

[5] Ibid., 241.24-25: "Placet Scaligero et, ipse vehementer approbo, naturalem esse in sideris corpore vim luminis sese spargentis non sine motu."

[6] Ibid., 241.33-35: "Sed tamen analogus aliquis intelligatur in stella motus, non localis, sed alterationis, secundum eam qualitatem, qua stella lucidum est corpus."

the name of "live" from this alternating vigor). If we could speed up the wavering of hot coals, he continues, they would look a lot like the twinkling of Venus.[7] On just a visual level, Kepler says, the most apt comparison with stars is the flickering of torches, as the poets tell us. But the wavering of firelight is caused by the conflict of flame and air: air saps the fire; fire is renewed by its fuel and dissipates the surrounding vapor. Where are any of these effects to be found in the super-rarified environment of the fixed stars? So, he concludes, twinkling must be internal to the bodies, which are eternal and transparent.[8]

Kepler then introduces another cause of scintillation.[9] He suggests that the stars turn on their axes and shimmer diamond-like with the passage of their facets and angles. This would be a secondary cause, explaining differences in flashing and color. It would require some eternal faculty in the stars (presumably an animal faculty). Kepler prefers this reason to others because it is clean and simple: differences in twinkling and color are reduced to the optical characteristics of the body. Kepler preempts a question from some of his more Aristotelian readers. If the stellar body has surface differences, as well as differences in interior density, such as we see in diaphanous rocks, that may suggest stars to be impermanent. Kepler recalls that gems in the Earth—though sometimes spotted, fissured, cloudy—are for all intents and purposes eternal, too.[10]

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[7] Ibid., pp. 241.35-242.3: "Imo vero vivum propono huius alterationis exemplum, in vivis carbonibus; qui ab hoc ipso motu, et quasi vigore alternante, nomen vivorum sunt adepti. Etsi hoc exemplum, si et celeritatem ei maiorem affingas, Veneris scintillationi magis respondet."

[8] Ibid., p. 242.27-32: "Itaque sint ista exempla non substantiae, sed luminis: de fixis vero maneat sententia Scaligeri; vim inesse in corpore perenni, adde et pellucido, luminis reciprocantis, analogon deflagrationi nostrarum flammarum. Nostro vero sideri, vel idem corpus, vel eandem vim luminis tribuemus, prout postea videbitur."

[9] Scaliger had himself criticized Cardano for attributing scintillation uniquely to the extreme speed of the stars, whose whirling carries them a vast distance around the Earth in one day. While Scaliger seems to accept that this movement results in some twinkling, it cannot be the only cause. Kepler rejects any translational motion among stars, unnecessary in Copernican astronomy.

[10] *JKGW*, 1, p. 243.18-23: "Quare non metuo, ut perpetua esse non possint corpora stellarum, si angulosa, aut si intus inaequaliter densa sunt, ut solent Uniones, partibus aliis aliter pellucidi. Nam et hostis illinc

In the chapters that follow his account of scintillation, Kepler covers the conception of the star. These chapters are notable for their view of nature as generative and suffused with animal faculties.[11] The new star was created by a vital faculty in the aether operating much like the Earth's vital faculty when the latter fashions new stones, insects, or plants. Kepler speaks here about bodily heat, humidity, fats and humors, and he makes little distinction between the stony and fleshy:

> It is clear enough that the Earth operates through such an inner faculty that engenders some metals in other parts, that fosters heat in the interior, that absorbs sea water, digests it and makes it evaporate at the surface, provides matter for rivers and rains, and, relying on none other than some hidden impression responding to the animal imagination, introduces incredible geometric shapes in fossils […]. For this is that faculty which, whenever it finds some superfluous matter, converts it into a small animal that serves the nature of things […] Vapor appears to be a certain instrument of both [the Earth and the human body] that is generated within the body. The exhalation envelops the exterior, filling with its humidity the hidden cavities of bodies where its heat can persist. Once this faculty has entered the outside body (attracted, in kind, to heat or the effusion of its vapor), it begins to

abest, qui vim inferat; et sunt nobis in hac Tellure gemmae, si vim auferas, aeternae; et eae tamen partim maculosae, partim fissae, partim nubilae."

[11] For an overview and extended analysis of Kepler's vitalism, see Patrick J. Boner, *Kepler's Cosmological Synthesis: Astrology, Mechanism and the Soul* (Leiden: Brill, 2013). On Kepler's vitalism in a medical context, see Jonathan Regier, "Kepler's Theory of Force and His Medical Sources," *Early Science and Medicine*, 2014, 19: 1–27.

> fashion those marvelous things through a divine impulse received at creation and retained down to the present time, charged with ordering every part to an end goal.[12]

To summarize, the vital faculty of the Earth was installed at creation and tasked with conservation and perfection. It is similar to the vitality of the human body, or of the celestial reaches. It manifests as a creative and industrious heat acting on oily and fatty humors, matter ripe for life and transformation. Regarding this latter point, it bears mentioning that life, as Kepler understands it, generally requires heat and humidity, which the celestial bodies produce to varying degrees (more on this point below). Kepler also describes in more detail how this vital faculty behaves on a daily basis: wherever it finds some kind of unused or degenerated matter, it transforms the matter into a higher form of being, whether a small animal, insect, or plant.[13] Finally, it is worth noting that Kepler was aware of the concept of seminal reasons—the formal seeds (*logoi spermatikoi*) of Stoic origin present in a variety of sixteenth century contexts, including Paracelsian. Earlier in the *De stella nova*, noting the patterns of color in flowers, Kepler had suggested that the vital faculty of all living things was equivalent to the "*rationes seminariae*."[14]

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[12] *JKGW*, 1, p. 268.11-269.7: "Satis constat de Terra, pollere illam intus huiusmodi facultate; quae aliis partibus alia gignit metalla; quae calorem intus fovet; quae marinas aquas absorbet, digerit, sublimes evaporare facit, fluviis et pluviis materiam sufficit; quae mirabiles figuras geometricas fossilibus indit, non alia re, nisi quadam impressione occulta, quae respondet imaginationi animalium, subnixa […] Haec nempe est illa, quae quoties invenit superfluam aliquam materiam; convertit eam in animalculum tale, quod rerum naturae serviat [...] Utriusque organon quoddam vapor esse videtur, qui in corpore genitus, id forinsecus circumdat exspiratus, implens madore suo sinus corporum occultiores, ubi calor inclusus durare potest. Hoc enim facto statim in eum egressa facultas haec, corporis incola (utique prolecta [prolectata] calore, et effluvio sui vaporis), ista mira machinari incipit: instinctu divino per creationem accepto, hactenusque retento, de singulis membris ad finem ordinandis admonita."

[13] Cf. Boner (ref. 11), p. 31.

[14] *JKGW*, 1, p. 185.35-37. For more on this passage and the chapter in which it appears in *De stella nova*, see Patrick J. Boner, "Kepler on the New Star: *De stella nova*, Chapters 7–9," *Culture and Cosmos*, 2010, 14: 209–234.

In the above, we encounter a complex of ideas well represented throughout Kepler's corpus. One is that nature operates via souls and their faculties or instruments. The other is that gems and metals are produced by life forces and sometimes contain those forces within themselves. There are many possible sources for Kepler's ideas here. Gems, minerals and precious metals were frequently associated with vegetative and animal bodies in the Renaissance. They could be thought to grow in the Earth like plants, expanding in branch-like or root-like formations, and they often showed up in the human body, in the kidney and bladder, with extremely painful and life-threatening implications.[15] Cicero writes of the formative powers of the Earth's womb in Book II of the *De natura deorum*.[16] In the *Naturales quaestiones*, Seneca compares the fluids of the human body to the many fluids of the earth, all these fluids serving different purposes (metals, according to Seneca, are a kind of terrestrial fluid that hardens).[17] Cardano writes that gemstones are not simply alive but also undergo a lifecycle of disease, old age and death.[18] Kepler, familiar with all the above authors, would have had to look no further than Gilbert's *De magnete* (London, 1600) for a vital theory of metal formation.[19]

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[15] There is an extensive, if somewhat scattered, secondary literature on early-modern body stones. See, for example, Margaret Healy, "A Most Troublesome and Dangerous Ailment: Encounters with the Stone in Early Modern Europe," *Journal de La Renaissance*, 2005, 3: 207–16.

[16] Cicero, *De natura deorum. Academica.*, trans. H. Rackham, Loeb Classical Library (Cambridge, MA: Harvard University Press, 1933), 2.33, pp. 203–205.

[17] Seneca, *Natural Questions*, trans. Harry M. Hine (Chicago: University of Chicago Press, 2010), 3.15, p. 34.

[18] Girolamo Cardano, *The De Subtilitate of Girolamo Cardano*, trans. John M. Forrester (Tempe, Arizona: Arizona Center for Medieval and Renaissance Studies, 2013), 1.7, pp. 366–67. Cardano devotes Book VII of *De subtilitate* to gemstones.

[19] Gilbert accepts only one true element in the universe, true earth, which possesses a pure magnetic capability and an innate tendency to rotate around a fixed axis. The rest of the matter we see around us—non-magnetic, heterogeneous, perpetually changing—is "a kind of veil," a shallow and corrupted covering to the essential sphere of the earth. William Gilbert, *On the Magnet (De Magnete)*, trans. Silvanus Phillips Thompson (New York: Basic Books, 1958), p. 120. Hence, Gilbert must explain how everything else comes to be: air, water and other metals. The answer is that condensed vapors travel upward from the center of the Earth, becoming trapped just below the surface or inside mountains. Here, as in a womb, they

A link between stones and celestial bodies was also widely accepted. Ficino has celestial bodies and constellations presiding over gemstones and metals.[20] Agrippa systematically lists metals and stones under the planets and signs presiding over them.[21] Yet in Kepler we find something altogether different—planets and stars are said to have a composition materially comparable to stones. Kepler discusses stones in his *De fundamentis astrologiae certioribus* (Prague, 1602), a first systematic account of his astrology written early in his Prague period while he was engaged in securing his position at Rudolf's court.[22] Here, he defends astrology as a natural philosophical enterprise, a study of the effects of celestial bodies, via their light, on earthly bodies. The chief powers of celestial light are to heat and moisten. Ptolemy's *Tetrabiblos* remains the example of how to think of planetary influence, yet whereas Ptolemy assigned the planets a range of influence corresponding to the four elements, Kepler reduces the causal palette to heating and moistening. Every planet provides either a deficiency or an excess of each of these two powers. When Kepler imagines the material constitution of planets, he thinks of gems and rocks. So Saturn, which "[…] has an excess of humidity and is deficient in heat […]," is like ice. Jupiter is like a ruby, "[…] so that it may be very transparent, to account for its abundant intrinsic light, and even and red to account for its brightness and colour." Mars

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cool and congeal into humors that are the proximate causes of metals, "like the blood and semen in the generation of animals." Ibid., pp. 20-21.

20 See, for example, the first two chapters of the *Liber de vita coelitus comparanda* in Marsilio Ficino, *Three Books on Life*, ed. Carol V. Kaske and John R. Clark (Binghamton, NY: Renaissance Society of America, 1989), pp. 243–255.

21 See Book I, Chapters 22-32, in Henry Cornelius Agrippa of Nettesheim, *Three Books of Occult Philosophy*, ed. Donald Tyson, trans. James Freake, Llewellyn's Sourcebook Series (St. Paul, MN: Llewellyn Worldwide, 1993).

22 See J. V. Field, "A Lutheran Astrologer: Johannes Kepler," *Archive for History of Exact Sciences*, 1984, 31: 189–272, especially p. 195: "*De Fundamentis Astrologiae Certioribus* was written after the death of Tycho Brahe. Kepler's desire to obtain the now vacant post of Imperial Mathematician no doubt contributed to his decision to write the work at this particular time. One can, nonetheless, trace other, older and more intellectually respectable, origins for the work."

is dry and hot like coal. Venus is like amber because of its brightness, and like amber, Venus must also have a soft body since it humidifies more than it warms. Mercury is like sapphire, given its transparency and heat.[23] The above shows that Kepler considered both planets and stones to imbue light with powers deriving from their physical constitution and to operate on living bodies in a similar, possibly identical, manner.[24] Moreover, although heating and moistening are the main astrological effects of planetary bodies, a range of powers might also be transmitted from planet and stone alike: "[…] for any power a Planet shows in its effect there will be some analogous disposition in the body of the Planet."[25]

Stones and metals were also, of course, socially operative as embodiments of wealth and class. Kepler exploited their multivalent functionality when as an ambitious young mathematician, he sought to create a precious astronomical sculpture in order to further his standing in Wurttemberg. In early 1596, he was finishing his first book, the *Mysterium cosmographicum* (Tubingen, 1596), which he believed would unveil a discovery of historic importance. An advantage of Copernican astronomy was that it neatly established planetary distances as ratios of the Earth-Sun distance. Kepler, having exhausted the summer of 1595 in search of what lay behind those distances, had found what he believed to be the divine motive. God, it seems, had established the universe based on the Platonic solids, five figures that are mathematically unique (maximally symmetrical) and textually unique (they are the subject of Euclid's *Elements* Book XIII). In a word, Kepler thought he had hit on the divine idea behind the world's architecture. He also

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[23] Ibid., p. 247.

[24] To illustrate how light can transmit chemical properties of objects, Kepler uses the example of sunlight reflected off a cement wall. When the light is strong, he says, it receives and transmits the corrosive effects of lime in the cement and poses a danger to people standing nearby. Ibid., p. 246.

[25] Ibid.

viewed the *Mysterium* as an opportunity to elevate his professional status[26] and as an occasion to make inroads with local nobility. Hence, in February 1596, he wrote to Duke Friedrich I of Württemberg announcing his great *inventum*. His letter, hardly touching on astronomical and philosophical details, was brief and to the point, as would be expected from a relatively unknown supplicant. Writing in German with a sprinkling of Latin technical terms, Kepler proposed a large, decorative silverwork that "fittingly and charmingly" (*füeglich und zierlich*) captured his new cosmography. Kepler's project was a lavish liquor bowl.[27] The bowl, he wrote, would be the Duke's very own *scyphus Nestoris*, a reference to King Nestor's cup in the *Iliad*, a cup so heavily decked-out that few men but old Nestor could easily lift it. Kepler's bowl would feature the planetary orbs set at their polyhedral distances, with each orb serving as a reservoir for a particular kind of alcohol, which would flow via hidden pipes to spigots on the outer rim of the bowl. The strength and cost of the alcohol would vary with distance from the sun, presumably to represent the solar virtue diminishing with distance.[28] The body of the sun would hold a precious *aqua vitae*, to be delivered to the solar spigot; the Sun-Mercury orb would hold *branntwein*, and so on until the "old bad wine or beer" contained in the Jupiter-Saturn orb.

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[26] Kepler would send copies to leading mathematicians, including Tycho Brahe, Nicolaus Reimers Ursus, and Galileo.

[27] Johannes Kepler to Duke Friedrich of Wurttemberg, 17 February 1596, *JKGW*, 13, no. 28. An account of this episode can be found in Walther von Dyck, *Nova Kepleriana: Wiederaufgefundene Drucke und Handschriften von Johannes Kepler. Vol. 8. Die Keplerbriefe auf der Braunschweigischen Landesbibliothek in Wolfenbüttel. II. Teil. Zusammen mit zugehörigen Aktenstücken der Landesbibliothek in Stuttgart*, (Munich: Bayerische Akademie der Wissenschaften, 1934), pp. 4-6. A slightly expanded account can be found in Arthur Koestler, *The Sleepwalkers* (New York: Macmillan, 1959), pp. 268–271. Adam Mosley examines the liquor bowl and the later clockwork design in "Objects of Knowledge: Mathematics and Models in Sixteenth-Century Cosmology and Astronomy," in *Transmitting Knowledge: Words, Images, and Instruments in Early Modern Europe*, ed. Sachiko Kusukawa and Ian Maclean (Oxford: Oxford University Press, 2006), pp. 193-216, and 201-209.

[28] An exception is the shell of the Earth (including the moon), which holds water. Mosley sees the bad wine or beer in the Saturn orb as a reminder of the decay that Saturn represented.

Meanwhile, Kepler wanted the planets to be depicted by precious stones: Saturn as diamond, Jupiter as hyacinth, Mars as ruby or spindle, Earth as turquoise or lodestone, Venus as amber, Mercury as crystal, the Sun as carbuncle, and the Moon as pearl.[29] Kepler does not offer reasons for this selection, appealing only to the work's importance and to the Duke's taste. Yet the latter was a major benefactor of alchemy and would have immediately recognized the general relationship between mineral, alcohol and the heavens, well-established as this relationship was in a wide swath of natural philosophy. The distillation of alcohol was probably the most important of all chemical-medical activities, and the distillation process itself was imbued with profound philosophical significance. The highly refined elixirs, produced by instruments pioneered during the late-medieval period and early Renaissance, were frequently likened to celestial aether.[30] (Years later, Kepler's peppery exchange with Thomas Harriot led him to consider liquor under a different light: as a counterexample to atomism. In their discussion on optics, Harriot, an atomist, maintained that transparency required vacuum spaces.[31] Kepler asked how liquor, eminently transparent, could maintain within itself pockets of vacuum when compressed. How would these pockets, filled with nothing, support themselves against the pressure? If

[29] Kepler (ref. 27), ll. 74-79.

[30] For the range of chemical and medical meaning attached to distillation, see Sergius Kodera, "The Art of the Distillation of 'Spirits' as a Technological Model for Human Physiology. The Cases of Marsilio Ficino, Joseph Duchesne and Francis Bacon," in *Blood, Sweat and Tears: The Changing Concepts of Physiology from Antiquity into Early Modern Europe*, ed. Manfred Horstmanshoff, Helen King, and Claus Zittel (Leiden: Brill, 2012), pp. 139–170. For Renaissance "distillation manuals," see Allen G. Debus, *The Chemical Philosophy: Paracelsian Science and Medicine in the Sixteenth and Seventeenth Centuries* (New York: Science History Publications, 1977), pp. 21–22.

[31] *JKGW*, 16, no. 497, ll. 28-30: "Fateor meam sententiam fundari in doctrina de vacuo vt rectè collegisti. Nullam Dyaphanitatem agnosco nisi ratione vacui."

liquor cannot support vacuum spaces, Kepler concluded, no diaphanous material can: "All diaphanous things derive from liquor."[32])

Kepler could not have chosen a better target for his budding courtly ambitions than Duke Friedrich, a passionate collector and patron. Friedrich sought to elevate his lands through discovery and cutting-edge industry: mining, alchemy, textiles. In 1608, the year of his death, his alchemical laboratory "accommodated a team of twenty-one people operating fourteen portable copper furnaces and four ovens."[33] He also had a propensity for extravagance and symbol.[34] Once the Duke received Kepler's letter, he immediately asked for a copper model, which Kepler fashioned in paper because he could afford no better. The Duke then asked for a report on the proposal from Michael Maestlin, Kepler's mentor and professor of mathematics at the University of Tübingen. Maestlin enthused over the project. The Duke accepted. But this was only the beginning of a long ending. The Duke asked that the model take the form of a globe rather than a liquor bowl.[35] Kepler oversaw the initial stages in Stuttgart but soon after had to leave for home and work in Graz. Well over a year later, around October 1597, Maestlin anxiously asked Kepler for news about the *opus argenteum*. Maestlin admitted to Kepler that he had entertained worries at the outset but had thought enough about Kepler's competence and honor, and of the project, to remain silent. Now his fears had come to pass. "I dread terribly," he wrote,

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[32] *JKGW*, 16, no. 536, ll. 41-42: "Jam si liquor non recipit vacua, nihil quod sit diaphanum, recipit. Ex liquore enim omnia diaphana existunt."

[33] Ulinka Rublack, *The Astronomer and the Witch: Johannes Kepler's Fight for His Mother* (Oxford: Oxford University Press, 2015), p. 49.

[34] Duke Friedrich famously waged an embarrassing five-year campaign of charm on Queen Elizabeth to be named a Knight of the Garter, and so was immortalized as a punch-line in Shakespeare's The Merry Wives of Windsor. In 1599, he oversaw a sumptuous parade filled with New World decor and had himself decked out as Lady America. Ibid., p. 46.

[35] Johannes Kepler to Duke Friedrich of Wurttemberg, 28 May 1596, *JKGW*, 13, no. 42.

"that the illustrious Duke will be offended."[36] The main problem, as he understood it, was rising cost, and he wished to communicate the best course of action to the court, once Kepler had provided a best course of action. His and Kepler's reputations were at stake. Kepler responded in January 1598 with a long and at times angry letter.[37] Most of the blame, by his account, belonged to the goldsmith, whom he portrayed as uniquely incompetent. To be fair, it seems that the goldsmith from the outset had never really understood what was expected. In any case, the work was being done in Stuttgart, while Kepler lived in Graz, a distance requiring days of travel. Kepler had expected his voice to be heeded among the Duke's counselors, and his orders to be passed along to the goldsmith, but the councilors had ignored his frequent complaints. They were now, he thought, trying to drop all the blame on his shoulders:

> I have not renounced my home. Even if I am absent, I am still under the protection of the Prince, and I have a small patrimony in Wurttemberg. And what man of any standing would endure having his reputation torn to pieces in that illustrious city [Stuttgart]? I will not bear having my good name destroyed in the Duke's eyes by unjust accusations. If I cannot at the same time maintain the grace of the Duke *and* his counselors, then I will thus demonstrate my innocence most clearly to him concerning those other indignant [counselors].[38]

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[36] Michael Maestlin to Johannes Kepler, 30 October 1597, *JKGW*, 13, no. 80, ll. 80-81: "Etenim lllustrissimum principem offensum iri vehementer metuo."

[37] Johannes Kepler to Michael Maestlin, 6 January 1598, *JKGW*, 13, no. 85.

[38] Ibid., ll. 305-311: "Ego vero patriam meam non abjuravi: et quid tum, si absens sum, qui nihilominus in fide sum principis, qui patrimoniolum habeo in Wirtembergia. Et quis ingenuus ferat lancinari famam suam in illustri urbe. Itaque mihi ferendum non est, ut iniqua criminatione principi deferar. Si non possum simul retinere gratiam et principis et consiliariorum: ergo iratis his innocentiam meam illi demonstrabo luculentissime."

Kepler's foray into the realm of precious materials—in this case, gems and silver—was also a foray into the courtly sphere of power. Intellectually, he could instrumentalize the nobility of these precious materials by integrating them into his natural philosophy. Yet he lacked the leverage—social and material—required to organize them into an actual object. Kepler's letter to Maestlin amounted to an admission of failure and a request to abandon the project entirely in favor of something new, a planetarium built from cheaper material, either copper or brass, that would display movement around the sun along with planetary distances. As Walther von Dyck notes, this second project would soon dissolve. Kepler would be exiled from Graz, begin working with Tycho Brahe, and enter into another, much greater, sphere of power at the court of Rudolf II in Prague. Nevertheless, the episode demonstrates Kepler's eagerness to connect his celestial research to the chemical projects popular at European courts.

2. Kepler and de Boodt

Kepler had had a number of personal contacts who could have influenced his thinking about stones and metals. His first employer in Prague, Tycho Brahe, was an experienced chemical practitioner, oriented largely toward medical application. Tycho's *pyronomic* or *spagyric* activities[39] have been well documented, from his laboratory at Uraniborg, to the remedies and elixirs that he produced, to his personal relationship with Petrus Severinus, the Danish royal physician and one of the most influential Paracelsian philosophers in all

[39] For Tycho's aversion to the "alchemical" and preference for the "pyronomic" or "spagyric," see John Robert Christianson, *On Tycho's Island: Tycho Brahe, Science, and Culture in the Sixteenth Century* (Cambridge: Cambridge University Press, 2000), p. 91.

of Europe.[40] Brahe expected to continue his chemical activities in Prague when he left Denmark amid scandal and took up the post of Imperial Mathematician. At the time of his death, a laboratory was being built for him at the castle in Benátky nad Jizerou that Rudolf had given him for his new residence.[41] It is even possible that Kepler witnessed some of Brahe's experimentations in Prague or at the Benátky castle.[42]

After Tycho's death, Rudolf's court at Prague likely remained for Kepler a source of information about material productions of the Earth and heavens. Rudolf is remembered by historians for his passionate interest in alchemy. His castle was the site of several laboratories, where he was personally involved in experimentation. Over large stretches of time, he seems to have been more available to his alchemists and philosophers of nature than he was to certain functionaries and dignitaries of state.[43] Rudolf's fascination with stones and gems was not only alchemical in the strict sense. He was one of Europe's great collectors of precious stones and a major patron of glyptic works—decorations including vases and rich inlays. Following the example of Ferdinando I de' Medici, Rudolf commissioned works of *pietre dure* from the best craftsmen in Milan, sending them

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[40] For the laboratory, see Jole Shackelford, "Tycho Brahe, Laboratory Design, and the Aim of Science: Reading Plans in Context," *Isis* 84, 1993, 84: 211–30. On Tycho and Severinus, see Jole Shackelford, "Providence, Power, and Cosmic Causality in Early Modern Astronomy: The Case of Tycho Brahe and Petrus Severinus," in *Tycho Brahe and Prague: Crossroads of European Science*, ed. John Christianson et al. (Frankfurt: Verlag Harri Deutsch, 2002), pp. 46–69. For an overview of Tycho's chemical activities, see Vladimír Karpenko and Ivo Purš, "Tycho Brahe: Between Astronomy and Alchemy," in *Rudolf II and Alchemy: Exploring the Secrets of Nature in Central Europe in the 16th and 17th Centuries*, ed. Ivo Purš and Vladimír Karpenko (Prague: Artefactum, 2016), pp. 459–88. Various information on Tycho's chemical practices can also be found throughout Victor E. Thoren, *The Lord of Uraniborg: A Biography of Tycho Brahe* (Cambridge: Cambridge University Press, 1990).

[41] Shackelford, "Tycho Brahe" (ref. 40), p. 220.

[42] Kepler describes in his *Tertius interveniens* (1610) how he tasted a strong brandy that Brahe had distilled from roses. Karpenko and Purš (ref. 40), p. 488.

[43] The classic work on Rudolf and his occult interests is R. J. W. Evans, *Rudolf II and His World: A Study in Intellectual History, 1576-1612* (Oxford: Oxford University Press, 1984), especially Chapter 6, pp. 196-242. See also Ivo Purš, "Rudolf II's Patronage of Alchemy and the Natural Sciences," in *Alchemy and Rudolf II* (ref. 40), pp. 139–204.

Bohemian stones to be cut and set, and managed to entice a Milanese master craftsman to join his court in 1588.[44] We should also note that the expansion of trade and voyage in the sixteenth century brought a surge of exotic stones from the Americas and Asia, especially India and China.[45]

At Rudolf's court, the chief authority on precious stones was the Bruges-born Anselmus Boëtius de Boodt, who hailed from an aristocratic, Catholic family.[46] After training in law, de Boodt studied with the physician-philosopher Thomas Erastus in Heidelberg, then took a doctoral degree in medicine at the University of Padua. From 1588 to 1604 de Boodt served as court physician in Prague. The year 1604 saw him promoted to Rudolf's personal physician, a post he retained until the latter's death in 1612. His main function at court was mineralogical work, much of it devoted to classification and verification, and some of it of an alchemical nature. De Boodt's personal views on alchemy and the possibilities of transmutation remain ambiguous, although Nicolas Barnaud reported that he had had some luck transmuting mercury into gold.[47] De Boodt's role as physician was not ancillary to his mineralogical work. On the contrary, the two activities were closely connected, as can be seen from his *Gemmarum et lapidum historia*, first published in 1609. The *Historia* is an encyclopedic treatise on gems and stones, and one of

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[44] Anna Maria Giusti, *Pietre Dure: The Art of Semiprecious Stonework*, trans. Fabio Barry (Los Angeles: Getty Publications, 2006), pp. 109–16.

[45] Donald F. Lach, *Asia in the Making of Europe*, Volume 2, *A Century of Wonder* (Chicago: University of Chicago Press, 1970), pp. 113-122.

[46] For a recent overview of de Boodt's education and career, see Ivo Purš, "Anselmus Boëtius de Boodt: Physician, Mineralogist and Alchemist," in *Alchemy and Rudolf II* (ref. 40), pp. 535-537. For an analysis of de Boodt's philosophy of nature, specifically his use of *spiritus* and seminal reasons, see Hiro Hirai, *Le concept de semence dans les théories de la matière à la Renaissance: de Marsile Ficin à Pierre Gassendi* (Turnhout: Brepols Publishers, 2005), 375–99. Also see, Robert Halleux, "L'œuvre minérologique d'Anselme Boèce de Boodt (1550-1632)," *Histoire et Nature*, 1979, 14: 63–78; and Lynn Thorndike, *A History of Magic and Experimental Science*, vol. 6 (New York: Columbia University Press, 1941), pp. 318–24.

[47] Ibid., pp. 549-552.

the most influential early modern books on mineralogy.[48] Not only does it treat all manner of mineralogical topics—from the generation of stones, to their identification, decorative use, classification, falsification, and valuation—, it is an exhaustive compendium of known stones, with chapters devoted to their faculties and powers. These chapters focus on how a given stone can protect and heal the body, to such an extent that a contemporary reader might come to see gemstones as a kind of wearable technology of the Renaissance. So we learn that, "as the authors tell us" ("*tradunt authores*"), the carbuncle or true ruby strongly resists venom, protects against plague (a leitmotif of stone powers), chases away melancholy and terror, and generally keeps the body safe from sickness. Rubies can also darken in the presence of misfortune and return to their original color once the danger has passed. However, they shorten sleep and agitate the blood, so that wearers will be quick to anger.[49] In de Boodt's chapter on the faculties and powers of pearl, he writes that pearls can strengthen the heart and vital spirits. Hence, they resist venoms, plague and corruption, and cure cardiac problems, melancholy and fainting. De Boodt continues with a list of afflictions that can be soothed with pearl, then insists on a complex manner of preparation (a kind of cleaning and purifying) to be completed before mixing the pearl into medicines that achieve a variety of effects. De Boodt assures us that the best remedy, far and away, against venoms and animal bites is a precise mixture of powdered pearl, powdered intestinal stones, powdered unicorn horn, and the powdered horn or heart bone of a stag.[50]

[48] The only scholar of whom I am aware to note similarities between Kepler and de Boodt is Robert Halleux in his 1975 French translation of *Strena seu de nive sexangula.* In particular, he underlines the similar appeals to a vital faculty. See, Kepler, *L'étrenne* (ref. 2), pp. 21-22.

[49] Anselmus Boëtius de Boodt*, Gemmarum et lapidum historia* (Hanover: Claudius Marnius, 1609)*,* 2.14, p. 73.

[50] *Historia* 2.38, p. 87. For more on unicorn horns as a remedy for poison, see Joan Evans, *Magical Jewels of the Middle Ages and the Renaissance, Particularly in England* (Oxford: Clarendon Press, 1922), pp.

All of this might seem distant from Kepler, and here we might signal a major difference between the two: de Boodt is an atomist, whereas Kepler is a dedicated anti-Epicurean.[51] But de Boodt and Kepler have much in common, especially when we turn to de Boodt's understanding of natural cause and generation, as well as a few other assorted themes. Early in the *Historia*, de Boodt grounds generation—animal, plant and mineral—in a terrestrial spirit acting via heat and light.[52] When God created the universe from nothing, says de Boodt, he established earth and water as the fundamental matter. At first, the Earth was deserted and sterile, with neither ornament nor seed. On the third day of creation, God made the Earth participate in a formative and seminal faculty, so that it could produce trees, herbs and everything benefiting from a vegetative soul. This faculty is described as the terrestrial vehicle of the creative spirit that, as *Genesis* recounts, first dwelt above the waters. Aided by celestial light and heat, this spirit assures the generation, alteration and change of all things. The spirit is hot in potential, and its heat is made active through the effect of light.

> […] it thus seems to be the author of all movement and the efficient cause of all things. Reposing on things and setting in them a seminal and formative faculty, it is like the architect that fashions trees and plants, that paints them and multiplies

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176–77. Thorndike reports that de Boodt elsewhere expresses skepticism about the unicorn's existence; Thorndike (ref. 46), pp. 323-324.

51 Although de Boodt's atomism is unnoticeable through most of the *Historia*. However, he does invoke atoms to account for the transparency of stones. Transparency is caused, he says, by the tight assemblage of very small atoms. *Historia*, 1.14, p. 21. Transparency, in turn, is one of the most important features of stones. His system of classification is based on a hierarchy where the most transparent occupy the highest rung, the least transparent the lowest. See Ibid., *Ad lectorem*.

52 Also see Purš, "Anselmus Boëtius de Boodt" (ref. 46), pp. 540-541; and Hirai Hirai (ref. 46), pp. 378-382.

them to infinity. God, good and great, created this same spirit in animals, so that they could fulfill their functions, conserve their life and propagate their species. He also infused this same spirit in man, as the nearest instrument of the soul, by which he could conserve his life and posterity. This spirit is therefore author of all things after God and is the first instrument of God present in the entrails of the Earth and in water and air. It is never idle. But by its innate heat, and roused by the external heat of the heavens, it stirs up and forms the matter with which it meets, and transforms this matter into various species according to the variety of the seed joined to it or the matter mixed within it. This variety is the reason why, in addition to animals, insects and vegetables, there is such a variety and multitude of mixed things that are generated. […] For when it encounters a good amount of matter that has already undergone multiple alterations [already is sufficiently mixed], it shapes it into nobler mixtures, such as imperfect animals, and insects, herbs, trees, and vegetables. When it encounters rude matter with little alteration, it produces metals, minerals, rocks or gems, as if it were their proximate, efficient cause. Either the matter or the spirit itself must contain the seed of future form. Were this not so, nothing would be produced or generated.[53]

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[53] *Historia* 1.8, p. 8: "[…] ita motus omnis autor, & efficiens rerum omnium causa videatur. Rebus enim insidens rerumque seminalem, & formatricem facultatem in se ferens, tanquam architectus quidam, plantam seu arborem fabricat, pingit, ac tandem in infinitum multiplicat. Similem Spiritum ubi animantia crearet. D. Opt. Max. illis ad varia officia obeunda, vitamque custodiendam, ac speciem multiplicandam dedit. Homini etiam eundem inspirauit tanquam animae proximum instrumentum quo vitam & posteritatem conseruare posset. Hic ut rerum omnium fere autor post Deum est, ac proximum quasi eius instrumentum terrae visceribus, aquae & aeri insidens, ociosus nunquam manet: Sed perpetuo materiam quam nanciscitur calore, qui illi innatus est, ac ab externo coelesti excitatur, exagitat, format, ac in varias species, pro seminis sibi adiuncti aut materiae immixti varietate mutat. Haec varietas efficit ut praeter animantia, insecta, & vegetabilia; tam varia, & multa mixtorum sint genera. Nam ut pictores ex albo, nigro, rubro, ceruleo, & flauo colore omne colorum genus facere possunt, ita ex rebus a Deo prius formatis & diuersis, licet paucioribus infinitas res componere, & efficere potest hic Spiritus formatrice facultate instructus. Dum enim materiam multas alterationes passam nanciscitur, ac ipse copiosus est, nobiliora mixta ut animantia imperfecta, insecta, herbas, arbores, & vegetabilia efformat. Dum rudem ac parum passam, metalla,

In short, de Boodt's formative spirit is more or less identical to Kepler's terrestrial spirit. Both are instruments of God in nature and were established at creation. Both are specifically purifying, with a similar transformative activity. Both are identified as a kind of heat that provides form. Both are said to be equivalent to seminal reasons.[54] And both are celestial and animal, such that the Earth's generative faculty is of the same kind as those of the celestial region and human body. And, as seen in the above quotes, Kepler and de Boodt describe them in very similar ways.

There is another point of similarity relating to the Earth's vital faculty, specifically the question why crystals are hexagonal. Kepler actually asks this question about snowflakes, assuming an analogous mechanism at work between ice and crystals. Kepler tackles the snowflake question in his *Strena, seu de nive sexangula* (Frankfurt, 1611), a gift of charm and erudition to his friend and loyal patron in Prague, the diplomat Johann Matthäus Wacker von Wackenfels (1550-1619). As the title indicates, the work was a New Year's gift for 1609-1610 and published in 1611. That year, Rudolf would abdicate the throne to his brother Matthias. Kepler, amid political uncertainty and terrible personal loss, would begin plans to relocate to Linz, where he lived from early 1612. The *Strena*, then, marks the end of Kepler's decade in Prague. Robert Halleux, in his French translation of the work, has pointed out a compelling similarity between Kepler and de Boodt: both attempt a material explanation for the manifestation of hexagons before throwing up their hands and appealing to their architectural world spirits. "De Boodt's process is exactly

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mineralia, lapides, aut gemmas tanquam proxima earum efficiens causa, producit. Verum vel materia Seminarium futurae formae, vel ipse Spiritus continere debet. Id si non fuerit nihil generatur, aut producitur."

[54] For de Boodt's account of generation and the activity of the vital spirit, see *Historia* 1.8, pp. 8-9.

parallel to Kepler's," writes Halleux, "with the same hesitation between a purely mechanical explanation and an explanation that is animistic and Neoplatonic."[55] Here would be an opportune moment to compare their respective arguments more closely. De Boodt and Kepler both begin their respective examinations by considering what Andrea Cesalpino (1519-1603) had to say about hexagonal crystals in his *De metallicis libri tres* (Rome, 1596). Cesalpino's argument runs roughly as follows: crystals form together in a mass before they begin to separate into individuals; due to the purity of their sap, they form identical figures that fill the space without gaps; there are only three such figures available: the triangle, square and hexagon; of these, the hexagon approaches closest to the circle, particularly as it can be divided into six equilateral triangles sharing the same center; hence, crystals are hexagonal.[56] Both Kepler and de Boodt disagree with the above account. Crystals do not form side-by-side in a consistent mass, says de Boodt: they grow freely in clusters, as if from a common root. Kepler, for his part, writes that snowflakes are not connected during their formation, so no material reason exists why they would adopt a plane-filling shape. De Boodt explains the production of angles chemically, but this does not help him to answer for the number of angles.[57] Why six? "I esteem," he writes, "that this is because nature never does more when it can more easily do less. Nature acts more easily [with the hexagon]: because the hexagon holds and brings together the circular with

[55] Kepler, *L'étrenne* (ref. 2), pp. 21–22. "La démarche de Boèce de Boodt est exactement parallèle à celle de Kepler, avec la même hésitation entre une explication purement mécaniste et une explication animiste et néoplatonicienne."

[56] Cesalpino, *De metallicis libri tres* (Rome: Aloysius Zanetti, 1596), 2.19, pp. 96-99. Halleux provides a summary of Cesalpino's account in Kepler, *L'étrenne* (ref. 2), pp. 19-20. De Boodt accurately summarizes Cesalpino's account in *Historia*, 1.13, p. 18. Kepler responds to Cesalpino in *L'étrenne*, pp. 79-80. Cf. *JKGW*, 4, pp. 278-280.

[57] If salt is not present in high quantity, the stone will take on a round form; cf. *Historia*, 1.13, pp. 19-20.

more order, proportion, and equality."[58] In fact, de Boodt agrees with Cesalpino that the hexagon is the most noble of polygons. But his demonstration of this nobility takes a different turn. The hexagon, writes de Boodt, "divides the circle at its center by three lines such that there form six equilateral triangles."[59] Pentagons and heptagons, he continues, cannot divide the circle equitably. Squares and octagons can, but their constituent triangles are not equilateral. De Boodt's demonstration is rudimentary, and somewhat awkward, but the point is clear. The hexagon's simplicity originates from how it divides the circle via inscription. To put it another way, the nobility of a polygon can be ascertained by inscription. Certainly, such an idea does not originate with Kepler, although it is one of the most prevalent of all Keplerian themes.[60] In any case, de Boodt concludes by noting his displeasure with his own purely material-mathematical account:

> The hexagonal figure is therefore the most perfect of polygons, and most apt for the circle to be contracted into it, and so the crystal hardens into a hexagon. But if I may confess sincerely, I am not entirely satisfied with this. I think that nature has given the hexagonal shape [to the crystal], so that by this outward mark [the crystal] is differentiated, not otherwise than how nature gives to the leaves of trees and the

[58] Ibid., p. 20: "[…] hexagonam figuram oriri, quae rotundae quam proxima est, ac aliis omnibus figuris angularibus perfectior, quia ex sex triangulis rectilineis aequalium laterum constat, habetur. Fieri a. potius sex angulos quam plures puto ob id quod natura per plura nunquam faciat quod per pauciora commodius facere potest. Facit autem commodius, quia rotundum citius, ordinatius & aequalius contrahit."

[59] Ibid.: "Dividit enim circulum per centrum tribus lineis tali modo, ut sex inde fiant trianguli aequilateri, ac quilibet centrum habeat ab omni angulo & a cuiusque lateris medio aequidistans; quod in nulla alia figura plurium angulorum vel pauciorum contingit."

[60] See Jonathan Regier, "An Unfolding Geometry : Appropriating Proclus in the Harmonice Mundi (1619)," in *Unifying Heaven and Earth: Essays in the History of Modern Cosmology*, ed. Miguel A. Granada, Patrick J. Boner, and Dario Tessicini (Barcelona: Universitat de Barcelona, 2016), pp. 217–37.

> flowers of herbs their particular figures, which are fashioned by this artisan spirit and formative faculty in an unknown manner.[61]

Thus de Boodt. Kepler, having established that snowflakes are not hexagonal because of material necessity, also settles on their creation via the Earth's vital faculty. So, he asks, is the hexagon ingrained as a privileged figure in the Earth soul? No, because the Earth knows and exercises all of geometry, meaning that it puts diverse figures into rocks and plants.[62] Kepler submits that the faculty may act differently according to the humor that it encounters.[63] And with that suggestion, he addresses his patron directly and concludes his New Year's treatise:

> Let the chemists, then, say whether snow contains any salt, and what kind of salt, and what shape it assumes at other times. As for me, after knocking on the doors of chemistry, when I see how much remains to be said in order to capture the cause of the thing, I prefer to listen to what you think, most ingenious man, than to tire myself out through further discussion.[64]

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[61] *Historia*, 1.13, p. 20: "Est itaque hexagona figura omnium figurarum perfectissima & aptissima, ut circulus in eam contrahatur, & per consequens ut Crystallus in eam coaguletur. Sed, ut ingenuè fatear, mihi non plane satisfacio, & naturam ut Crystalus hac nota ab aliis gemmis distinguatur, hexagonam figuram dedisse autumo, non secus quam arborum frondibus & herbarum floribus peculiares suas figuras dat, quae ab architectonico spiritus & formatrice facultate ignoto nobis modo fabricantur."

[62] For Kepler's most thorough account of the Earth's soul and vital faculty, see Johannes Kepler, *The Harmony of the World*, trans. E. J. Aiton, A. M. Duncan, and J. V. Field (Philadelphia: American Philosophical Society, 1997), pp. 358–385.

[63] *JKGW*, 4, 279.40-280.1: "Itaque verisimile est hanc facultatem formatricem pro diuerso humore, diuersam fieri."

[64] *JKGW*, 4, 280.2-6: "Dicant igitur Chymici, an in Niue sit aliquid salis, et quod nam salis genus, et quam illud alias induat figuram. Ego namque, pulsatis Chymiae foribus, cum videam, quantum restet dicendum, vt causa rei habeatur: malo abs te, Vir solertissime, quid sentias, audire, quam disserendo amplius fatigari." Cf. Johannes Kepler, *The Six-Cornered Snowflake: A New Year's Gift*, trans. Jacques Bromberg (Philadelphia: Paul Dry Books, 2010), pp. 112–113.

But what is the sense in rejecting a purely mechanical or chemical explanation—based entirely on the movement of salts or other materials—in preference for a terrestrial spirit? De Boodt and Kepler's skepticism begins with acknowledging the complexity of the chemical phenomenon. This complexity signals to both that a simpler cause can be found by focusing on the agent.[65] The similarity in the appeal to an agent, and the similarity in the nature of said agent, point us to the theoretical grounding shared by de Boodt and Kepler. The sixteenth century saw many "*spiritus mundi*" schemes, where a world soul was said to act via a corporeal spirit, its first instrument. I would argue that a hallmark of these schemes, from Ficino onward, is that they support a medicalized view of nature: the human body forms a causal continuum with the rest of nature, meaning that natural forces can be channeled, *détournées*, and the like, in order to protect or conserve the body. Robert Westman, noting the incredible cast of artisans and intellectuals at Rudolf's court, has observed that, "although they shared many common concerns and competences, the court figures who contributed under the emperor's aegis to the theory of the heavens were not the emperor's mechanicians but […] his physicians."[66] This seems to me an accurate conclusion to draw. We might take it a step further. Considering Evans's classic account of Rudolf's favorites among the alchemists and chemists at his court, it is clear that de Boodt was not the exception: Rudolf's most trusted practitioners in these arts were also physicians, by and large.[67]

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[65] As Halleux notes in ref. 2.

[66] Robert S. Westman, *The Copernican Question: Prognostication, Skepticism, and Celestial Order* (Berkeley and Los Angeles: University of California Press, 2011), p. 238.

[67] "Behind the legends and against the background of imposters and simpletons there were at Rudolf's court significant representatives of alchemy in its widest sense, and several of them lived as members of the

Another way to examine the similarity between de Boodt and Kepler is through the prism of cause or force. After all, what is the vital faculty if not a universal ensemble of formal and efficient cause? In turn, we might refine this question by asking about celestial forces in particular. To begin with, I am unaware of a moment in the *Historia* where de Boodt compares planetary bodies with metals or gemstones. De Boodt would have considered unfounded the sympathies seen in Ficino and Agrippa, a point we will touch upon momentarily. As for whether there might be an actual material likeness between planets and certain stones, such as Kepler believes there to be, de Boodt says nothing. In the *Historia* 1.26, he covers in detail the kinds of powers that stones can have. The brief answer is that they can only possess powers based on their form, essence or matter (i.e., mixture of elements). In short, they can only act as what de Boodt calls "natural causes." They cannot produce supernatural effects, the domain of supernatural beings. Moreover, de Boodt does not think that these forces are placed in stones by the celestial bodies; God was Himself more than capable of ascribing to stones their respective powers for the use of mankind.[68] Ivan Purš and Hiro Hirai have highlighted a wonderful passage later in *Historia* 1.26, where de Boodt criticizes the belief that stones, by their shapes or by characters engraved on them, can be in "sympathy" with stars or astrological aspects. The meaning of such shapes and characters is human convention only, he writes, just like astrological signs, which were invented by astrologers to aid them in teaching.[69] Purš indicates that de Boodt seems to embrace Pico della Mirandola's disputations against

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Emperor's permanent establishment in the capacity of court physician (*Leibartz*)." Evans (ref. 43), p. 203. See Ibid., pp. 203-208, for the roll call of physician-alchemists at the service of Rudolf.

[68] *Historia*, 1. 26, p. 47.

[69] Purš, "Anselmus Boëtius de Boodt" (ref. 46), pp. 548-549. Hirai (ref. 46), pp. 397-398. Thordike has also drawn attention to this passage: Thorndike (ref. 46), pp. 320-321.

astrology. If so, it is a qualified embrace. De Boodt does not reject astrology outright; he asks for natural causes. He is open to the possibility that celestial aspects and states can influence terrestrial matter, via real forces acting upon entities materially disposed to receive them.[70] All this signals another correspondence between him and Kepler. In Chapters 8 and 9 of the *De stella nova*, Kepler undertakes a discussion with Pico over what is and is not natural in astrology, and he accepts the lion's share of Pico's criticism.[71] The difference is that Kepler does not reject everything, especially not the efficacy of astrological aspects, which he holds to be empirically irrefutable and explicable via natural causes. Hence, both Kepler and de Boodt are open to some form of astrology—what we might term a natural-philosophical astrology. And unlike Pico, who acknowledged only three types of celestial cause—heat, motion and light—, de Boodt and Kepler both admit that forces other than these can be transmitted. As de Boodt argues:

> The sky and the celestial bodies as common and universal causes govern this inferior world and transmit forces by their rays and by their heat: but the effects that follow always result from this, and are neither stimulated nor impeded by figure or character [inscribed on rocks]. Such effects are easily recognized by experience

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[70] *Historia*, 1.26, pp. 53-54.

[71] *JKGW*, 1, pp. 184-194. See, for example, ibid., p. 184.8-16, where Kepler thoroughly agrees with Pico that there is nothing natural about the zodiacal signs and triplicities, nothing about the association of signs with animals, nor triplicities with elements: "Dixi hactenus, neque naturalem esse distributionem zodiaci in signa duodecim, neque perpetuam vel accuratam, hanc, quae à motibus superiorum fit, in triplicitates quatuor distinctionem, triumque distantium connexionem : Dictum etiam, neque signis proprietates ullas eorum animalium, neque signorum Triplicitatibus, qualitates eorum elementorum inesse, a quibus denominantur. Quae omnia cum centum amplius annis ante me docuerit Joannes ille Picus, Mirandulae comes: iure videri possim totus in eius sententiam de Astrologiae vanitate concedere." See also Sheila J. Rabin, "Kepler's Attitude Toward Pico and the Anti-Astrology Polemic," *Renaissance Quarterly*, 1997, 50: 750–770. On the role of "natural" elements in the astrology of Kepler, see the following contribution by Aviva Rothman.

and offend neither nature nor intellect, even if the reason perhaps cannot be understood. Thus the northern zone of the sky always turns the piece of iron rubbed by the magnet and placed in equilibrium toward it, even though the reason why may not be known […][72]

Conclusion

By way of the above quotation, we come to a surprising difference between our two subjects, and one that leads us to our concluding remarks. As an example of celestial force, de Boodt adopts a magnetic theory common from the medieval period until the seventeenth century: that the lodestone is attracted by the polestar or, rather in this case, by the "northern zone of the sky." Yet nearly a decade before the *Historia*'s publication, William Gilbert had offered profound evidence that the Earth was itself a magnetic body, thereby explaining the behavior of compasses. Indeed, I can find no mention of Gilbert in the *Historia*. If we assume some form of dialogue or discourse between Kepler and de Boodt, this lacuna is particularly difficult to explain. Kepler made Gilbert's magnetic philosophy a centerpiece of his physical astronomy, to be laid out in the *Astronomia nova*. Why would de Boodt not have entertained Gilbert's opinions even if he disagreed, as he seemed ready to do with other contemporaries or near contemporaries?[73] Yet it is perhaps less important to ascertain whether de Boodt and Kepler discussed their work with one another. The fact

[72] *Historia*, 1.26, p. 56: "Coelum & astra tanquam causae communes & universales regunt quidem ista inferiora ac vires per radios & calorem rebus immittunt: sed effectus qui inde proueniunt semper inde proueniunt, nec propter figuram aut charaterem promouentur aut impediuntur. Qui autem inde proueniunt facile experientia deprehenduntur, nec contra naturam aut rationem esse deprehenduntur, etiamsi ratio fortassis intelligi non possit. Sic coeli plaga septentrionalis ferrum magnete tactum & in aequilibrio positum ad se respicere cogit semper, etiamsi ratio cur id fiat ignota […]"

[73] For de Boodt's citation of authors, see Thorndike (ref. 46), pp. 318-319.

is that they share a theoretical grounding or hard core, even if their research and output cover different subjects. And we are not discussing two secondary figures at Rudolf's court. One was a personal physician to Rudolf and his chief mineralogist. The other was his chief mathematician and astrologer. Between the two, heaven and Earth were nicely covered—and heaven and Earth meshed together coherently. The similarities we find between de Boodt and Kepler strongly suggest that Kepler successfully adapted his work to the wider Rudolfine philosophical institution. His celestial physics and astrology lent themselves to a matter theory specifically directed toward the use and renewal of terrestrial substances for the preservation of health and well-being.