The German Hercules's Heir: Pierre Gassendi's Reception of Keplerian Ideas

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I. INTRODUCTION

Pierre Gassendi (1592–1655) is often considered a reviver of Epicurean atomism, a determined opponent of René Descartes (1596–1650) or a founder of modern empiricism.[1] Some historians also qualify him as an accomplished astronomer. But in connection with his crucial role in the promotion of the "new philosophy," which is now widely acknowledged,

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[1] These three aspects of his philosophy are explored in the following studies, respectively: Bernard Rochot, *Les travaux de Gassendi sur Épicure et sur l'atomisme, 1619–1658* (Paris: Vrin, 1944); Antonia LoLordo, "Flesh vs. Mind: A Study of the Debate between Descartes and Gassendi" (PhD. diss., Rutgers University, 2001); Saul Fisher, *Pierre Gassendi's Philosophy and Science: Atomism for Empiricists* (Leiden: Brill, 2005). On Gassendi, see also Olivier R. Bloch, *La philosophie de Gassendi: nominalisme, matérialisme et métaphysique* (The Hague: Nijhoff, 1971); Howard Jones, *Pierre Gassendi, 1592–1655: An Intellectual Biography* (Nieuwkoop: Graaf, 1981); Barry Brundell, *Pierre Gassendi: From Aristotelianism to a New Natural Philosophy* (Dordrecht: Reidel, 1987); Lynn S. Joy, *Gassendi the Atomist: Advocate of History in an Age of Science* (Cambridge: Cambridge University Press, 1987); Margaret J. Osler, *Divine Will and the Mechanical Philosophy: Gassendi and Descartes on Contingency and Necessity in the Created World* (Cambridge: Cambridge University Press, 1994); Sylvia Murr, ed., *Gassendi et l'Europe (1592–1792)* (Paris: Vrin, 1997); Antonia LoLordo, *Pierre Gassendi and the Birth of Early Modern Philosophy* (Cambridge: Cambridge University Press, 2007).

his contributions to astronomy have attracted less attention from scholars than his criticism of Aristotelianism or his atomistic interpretation of Galileo's (1564–1642) physics.[2]

Astronomy was by no means of small importance to Gassendi. He devoted as much energy to his astronomical pursuits as to his Epicurean project. Over thirty years, he carried out meticulous observations of various celestial phenomena, including solar and lunar eclipses, comets, and parhelia.[3] The results of his survey were widely circulated among his colleagues through his personal letters, parts of which were separately published on various occasions.[4] Gaining recognition in the Republic of Letters by these activities, he was appointed professor of mathematics at the Collège Royal in Paris, to lecture on astronomy. The history of this discipline also stimulated his interest to write the biography of four famous early modern astronomers: Georg Peurbach (1423–61), Johannes Regiomontanus (1436–76), Nicholas Copernicus (1473–1543), and Tycho Brahe (1546–1601).

The present paper has two main objectives. The first is to examine this undeservedly dismissed aspect of Gassendi's intellectual endeavors. For this purpose, I shall focus on one particular aspect of his wide-ranging astronomical activities, that is, his reactions to Johannes Kepler's (1571–1630) astronomy. The imperial mathematician's achievement is often considered to have aroused little attention before the publication of *Principia mathematica*[5] by Isaac Newton (1642–1727). In reality, a number of astronomers before Newton not only carefully read his works but also often accepted the so-called Kepler's laws.[6] But how his astronomy was disseminated in continental countries is still waiting to be explored. Gassendi was one of the leading minds in France who pursued astronomical activities under the influence of Kepler. In this connection, valuable investigations have been

[2] Some exceptions are: Pierre Humbert, *L'œuvre astronomique de Gassendi* (Paris: Hermann, 1936); Bloch, *Gassendi*, 326–34; Brundell, *Gassendi*, 30–47.

[3] Humbert, *L'œuvre astronomique*, 12–25.

[4] See Sylvie Taussig, *Pierre Gassendi (1592–1655): introduction à la vie savante* (Turnhout: Brepols, 2003).

[5] *Philosophiae naturalis principia mathematica* (London, 1687).

[6] John L. Russell, "Kepler's Laws of Planetary Motion: 1609–1666," *British Journal for the History of Science* 2 (1964): 1–24; Wilbur Applebaum, "Kepler in England: The Reception of Keplerian Astronomy in England" (PhD. diss., State University of New York at Buffalo, 1969); Applebaum, "Keplerian Astronomy after Kepler: Researches and Problems," *History of Science* 34 (1996): 451–504.

made into his use of Keplerian ephemerides and the *Tabulae rudolphinae*[7] as well as into his observation of the transit of Mercury in 1631, predicted a year earlier by the imperial astronomer.[8] But the previous studies have neglected the impact of the most characteristic novelty of Keplerian astronomy: the emphasis on physical causality. It is well-known that, distinguishing himself from other astronomers, Kepler insisted on the quest for physical causes underlying planetary motions.[9] Although some historians have pointed out traces of Keplerian ideas in Gassendi's work, their observations have remained superficial. For example, they treat only Gassendi's theory of celestial revolution, neglecting Kepler's influence on his notion of rotation.[10] To what extent did Kepler's physical astronomy affect Gassendi's theories? This is our first question.

The second objective of the present study is to show the religious motivations that led Gassendi to adopt Keplerian ideas. Kepler's cosmology was built on several characteristic principles concerning theology. This theological aspect offers a key to understanding his explanation of both celestial and sublunar phenomena.[11] If Gassendi's idea was influenced by Kepler's astronomical theories, is it likely that the former neglected the fundamental principles for the latter's entire activity? By exploring this issue, I shall reevaluate the role played by the theological dimension in his physical theories.

The present paper, therefore, aims to examine how Gassendi reacted to Kepler's ideas, both in the astronomical and theological spheres. I shall first treat the Keplerian theory of physical causes underlying planetary mo-

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[7] *Tabulae rudolphinae* (Ulm, 1627).

[8] Humbert, *L'œuvre astronomique*, 10–11; Albert van Helden, "The Importance of the Transit of Mercury of 1631," *Journal for the History of Astronomy* 7 (1976): 1–10.

[9] Nicholas Jardine, *The Birth of History and Philosophy of Science: Kepler's* A Defense of Tycho against Ursus *with Essays on Its Provenance and Significance* (Cambridge: Cambridge University Press, 1984), 225–57.

[10] Alexandre Koyré, *La révolution astronomique: Copernic, Kepler, Borelli* (Paris, 1961; repr., Paris: Hermann, 1961), 364; William H. Donahue, *The Dissolution of the Celestial Spheres* (New York: Arno, 1981), 272–75; Martha Baldwin, "Athanasius Kircher and the Magnetic Philosophy" (PhD. diss., Chicago University, 1987), 207. Only Donahue has dealt with the rotation, but his arguments are not developed enough.

[11] On the theological dimension of Kepler's ideas, see especially Jürgen Hübner, *Die Theologie Johannes Keplers zwischen Orthodoxie und Naturwissenschaft* (Tübingen: Mohr, 1975). These principles are often called "animistic." See Harald Schwaetzer, "Si nulla esset in terra anima:" *Johannes Keplers Seelenlehre als Grundlage seines Wissenschaftsverständnisses* (Hildesheim: Olms, 1997); Patrick J. Boner, "Kepler's Living Cosmology: Bridging the Celestial and Terrestrial Realms," *Centaurus* 48 (2006): 32–39.

tions and Gassendi's reactions to it. I shall then discuss how Gassendi inherited important theological principles from the imperial astronomer.

II. KEPLER'S THEORY ON CELESTIAL MOTIONS IN *EPITOME*

Kepler expounds his theory of planetary motion in his work *Epitome astronomiae copernicanae*, a treatise on theoretical astronomy widely read from 1630 to 1650.[12] Gassendi also reads this very systematic work. I shall first examine Kepler's explanation of solar and planetary rotation and then that of celestial revolution.

Taking the earth as an example, Kepler posits three causes for its rotation: 1) the first "impulse" (*impressio*) given by God; 2) the circular "fibers" (*fibrae*) running around the earth; and 3) the "soul" (*anima*) of the earth. He thinks that God gave the earth an initial impulse at the creation of the world. This impulse caused the earth to begin to move, and enables it to keep its motion. For Kepler, the direction of rotation confirms the existence of this external cause. One cannot understand why the earth rotates in the present direction, rather than the opposite, unless the initial impulse imposed by the Creator is taken into account.[13]

Next, Kepler introduces the idea of "circular fibers." He says:

> It is probable that this unbroken *species* of the first rotation was itself transformed in the earth, or coalesced into such a corporeal faculty, and thus developed into fibers of earth arranged in line with the direction of the earth's movement [. . .].[14]

To these circular fibers, Kepler adds rectilinear fibers running parallel to the earth's axis, which keep the direction of the axis stable.[15] Thus, for him, the earth's rotation results from a combination of these two types of fibers. However, he thinks that the earth's fibers alone are insufficient to keep its

[12] *Epitome astronomiae copernicanae* (Linz and Frankfurt, 1618–21).
[13] Johannes Kepler, *Epitome astronomiae copernicanae*, in *Gesammelte Werke* [hereafter *GW*], ed. Max Caspar (Munich: Beck, 1953), 7: 89.
[14] *GW*, 7: 89–90: "Verisimile est, hanc ipsam primae rotationis continuatam speciem in terra, transformatam esse, seu coaluisse in talem facultatem corpoream, et sic in fibras terrae, dispositas secundum ductum motus ipsius, inolevisse; [. . .]."
[15] *GW*, 7: 87.

rotation, for they are not the cause of its movement but the instruments used by the cause, just as an animal's nerves, muscles and bones are used by its soul, the ultimate cause of its movement. Thus, he concludes that there is a soul residing in the earth, which uses the fibers as its instruments to preserve rotation.[16]

As for revolution, Kepler thinks that there are "magnetic fibers" (*fibrae magneticae*), both in the sun and in the planets, different from those used for rotation. For him, the magnetic fibers stretching from the sun's center to its surface emit "enmattered species" (*species immateriatae*).[17] While the sun rotates, these *species* also turn around and carry the planets by their circular movement to cause planetary revolutions.[18] Next, through the magnetic fibers in the planets, Kepler explains why the circular motion of the *species* produces the elliptical orbits to these planets. Claiming that William Gilbert (1544–1603) discovered magnetic fibers running from the South Pole to the North Pole in the earth, he affirms that there are two magnetic poles in all the planets.[19] He adds that these planetary poles interact with the *species* emanating from the sun. One of the two poles has a "friendship" (*amicitia*) with the *species*, the other a "hostility" (*inimicitia*) toward them.[20] Thus, between the planets and the sun, attraction and repulsion take place simultaneously, and as a result of their mutual interaction, the elliptical orbits of the planets are brought into existence.[21] This is the mechanism of revolution.

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[16] *GW*, 7: 91. See Hübner, *Die Theologie Keplers*, 232; Gérard Simon, *Kepler: astronome astrologue* (Paris: Gallimard, 1979), 186–92; Schwaetzer, "Si nulla esset in terra anima," 221–39; Patrik J. Boner, "Soul-Searching with Kepler: An Analysis of *Anima* in His Astrology," *Journal for the History of Astronomy* 36 (2005): 7–20; Boner, "Kepler's Living Cosmology." On the earth's soul, see Hiro Hirai, "Âme de la terre, génération spontanée et origine de la vie: Fortunio Liceti critique de Marsile Ficin," *Bruniana & Campanelliana* 12 (2006): 451–69. For Cornelius Gemma's *De naturae divinis characterismis* (Antwerp, 1575) as Kepler's source, see Fernand Hallyn, "A Poem on the Copernican System: Cornelius Gemma and His Cosmocritical Art," in *Cornelius Gemma: Cosmology, Medicine and Natural Philosophy in Renaissance Louvain*, ed. Hiro Hirai (Rome: Serra, 2008), 13–31.

[17] On the term *immateriatus* taken as "enmattered," see Sheila J. Rabin, "Was Kepler's *Species Immateriata* Substantial?" *Journal for the History of Astronomy* 36 (2005): 49–56. This notion can be traced back to Jacob Schegk at the University of Tübingen, where Kepler studied theology. Cf. Hiro Hirai, "The Invisible Hand of God in Seeds: Jacob Schegk's Theory of Plastic Faculty," *Early Science and Medicine* 12 (2007): 377–404.

[18] *GW*, 7: 302–3.

[19] *GW*, 7: 334.

[20] *GW*, 7: 300.

[21] *GW*, 7: 337–38.

III. GASSENDI'S THEORY ON CELESTIAL MOTIONS

In his main work *Syntagma philosophicum*, Gassendi takes up Kepler's theory.[22] For Gassendi, there are two types of theories for the cause of celestial motions: one considers it to be external to heavenly bodies, the other internal.[23] Those which postulate the souls of stars, of course, belong to the latter. Classifying Kepler's theory in this group, Gassendi says:

> [. . .] I note only the fact that Kepler made stars animate in this way: Just as the fibers distributed throughout the muscles function as the instruments of movement in animals, there are, he thought, certain huge fibers both in the earth and in the other planets in proportion to the mass of each, through which their souls exert their own motive force. He also thought that, besides the special souls and forces which reside in the other planets, there is in the sun itself the noblest and the most powerful soul, which, while rotating the sun on its own axis (which therefore does not move away from the center of the world), pours out the enmattered *species* (he calls them so) around itself by irradiation. The planets, as if they were caught by these *species*, are led around the sun. The closer the planets are to the sun and the more abundantly they receive of its power, the more rapidly do they move [. . .].[24]

This explanation comes from Kepler's *Epitome*, for it is only in that work that he develops his notion of planetary fibers for rotation. According to Gassendi, Kepler attributes the cause of rotation to the fibers running through the heavenly bodies. The cause of revolution, on the other hand, is assigned to the enmattered *species* emanating from the soul of the sun. Comparison of this summary with Kepler's own explanation shows that

[22] *Syntagma philosophicum* (Lyon, 1658).
[23] Pierre Gassendi, *Syntagma philosophicum* [hereafter *SP*], in *Opera* (Lyon, 1658; repr., Stuttgart: Frommann, 1964), 1: 631a.
[24] *SP*, 1: 635a: "[. . .] adnoto dumtaxat Keplerum ita sidera fecisse animata; ac ut instrumenta motus in animalibus sunt fibrae digestae per musculos; sic censuisse illum esse et in terra, et in planetis ceteris ingentes fibras aliquas pro ratione molis cuiusque, per quas anima vim suam motricem exerceat. Censuit vero etiam, praeter speciales animas, et vires, quae insunt in ceteris, esse in ipso sole animam nobilissimam, potentissimamque, quae dum solem circa proprium axem (a centro mundi propterea non discedentem) circumagit, immateriatas species (sic enim appellat) irradiando circumfundit, quibus planetae velut correpti, ipsi soli circumducantur; et quisque quidem tanto velocius, quanto soli propinquior, illius virtutem excipit uberius [. . .]."

Gassendi's understanding is exact for rotation but inaccurate for revolution, as Kepler teaches that the *species*, which cause revolution, come from the magnetic fibers, not from the sun's soul itself.

Now let us see how Gassendi reacts to Kepler's theory. He assigns the cause of rotation to the internal structure of the planets, which he calls "the native form or contexture" (*nativa forma contexturave*) or "the soul particular [to these celestial bodies]" (*anima sui generis*).[25] But he does not think that this celestial soul is identical to that residing in plants or animals. It is only by analogy that he calls the form or contexture of a celestial body "the soul."[26] In fact he does not see the celestial soul as incorporeal, but composed of indivisible atoms arranged in a circle like fibers. According to him, a "propulsion" (*compulsio*) inherent in one atom is transmitted to its neighboring atom, and this second atom further transmits the received propulsion to the third one. Because of the circular arrangement of atoms, this process of transmission gives endless rotation to the planets and the sun.[27] But since he thinks these circular fibers alone are insufficient to rotate the heavenly bodies, he adds rectilinear fibers running parallel to the rotational axis as their assistants.[28]

Gassendi argues that the ultimate cause of these propulsions is God. At the beginning of the world, the Creator distributed to each atom its own internal propulsion, which is also called "gravity" (*pondus*).[29] This is why the direction of rotation is the current one, rather than the opposite. There cannot be any other factor than the will of God that imposed it.[30]

Gassendi's theory of rotation is very close to that of Kepler. Both suppose God to be its initial and ultimate cause and posit two types of fibers for the cause of rotation. They also commonly refer to the souls of the celestial bodies. It is thus hardly surprising to see Gassendi acknowledge his debt to Kepler as follows:

> Therefore, it seems that we can call these [parts of rotating stars] "fibers" with Kepler. Because, by doing so, we retain the same analogy which permits us to call the form of the stars "the soul" and the stars themselves "animals." In fact, when we move our hands, legs or heads in circles, or turn our whole bodies around,

[25] *SP*, 1: 638a.
[26] *SP*, 1: 522a–b, 1: 638a.
[27] *SP*, 1: 638b.
[28] *SP*, 1: 638b–639a.
[29] *SP*, 1: 273b.
[30] *SP*, 1: 638b.

> we [are able to] perform these actions only through the service of the fibers, by which the muscles are woven together and are driven successively in circles. In the same way, one might think that, when the globe of a star turns in a circle, this happens because its soul or form and its interior energy use some parts [of the star] as if they were fibers and muscles or organs suitable for movement.[31]

But Gassendi's theory is not identical to that of Kepler, for the latter thinks that the purpose of the fibers parallel to the rotational axis is only to stabilize this axis. In contrast, Gassendi supposes that this second type of fiber is necessary to make the circular fibers work properly. In addition, the celestial soul, which is an incorporeal entity for Kepler, is made of the corporeal and fibrous structures composed of atoms for the French atomist.

As for revolution, Gassendi also discusses it in his treatise *De motu impresso a motore translato*.[32] In this work, Gassendi expounds his theory of gravity under the heavy influence of Kepler.[33] In explaining the mechanism of revolution, Gassendi again refers to Kepler's theory:

> Moreover, in his attempt to show why [planetary] motion occurs in an elliptical form, [Kepler] took note of the following point: There are two poles in a single magnet, one of which seeks one of the poles of another magnet, while the other flees from the same pole. The same phenomenon could occur with the earth (which would be like a magnet and could be compared with the sun as with a larger magnet). There could be some sun-seeking parts and sun-fleeing parts [in it], because of which, when being rotated, the earth is sometimes pulled towards the sun, and is sometimes turned away from it. For this reason, the earth does not trace a circle but an ellipse by its motion.[34]

[31] *SP*, 1: 639a: "Idcirco autem videmur posse eas dicere cum Keplero fibras, quod inde servetur eadem analogia, qua et siderum forma anima, et sidera ipsa animalia conceduntur dici. Quippe, ut dum ipsi aut manum, aut pedem, aut caput ducimus in orbem, aut nosmet etiam totos gyramus, id agimus solum beneficio fibrarum, quibus contexti musculi succedenter, inque orbem aguntur: sic censere licet, dum globus sidereus se in orbem versat, idcirco id fieri, quod ipsius anima, seu forma, energiaque interior aliquibus partibus, quasi fibris, et musculis, congruisve organis ad motum utatur."

[32] *De motu impresso a motore translato* (Paris, 1642).

[33] Alexandre Koyré, *Études galiléennes* (Paris: Hermann, 1939), 304–17.

[34] Gassendi, *De motu impresso a motore translato*, in *Opera*, 3: 515b: "Quin etiam, ut diceret causam, ob quam motus fiat elliptica forma, animadvertit, ut in uno magnete sunt duo poli, quorum unus appetit alterum polorum alterius magnetis, alius eundem refugit; ita esse posse in terra, (quae sit quasi magnes, et ad solem, quasi ad maiorem magnetem comparetur) esse, inquam, posse partes aliquas solipetas, solifugasque, ob quas dum cir-

In *De motu impresso* and *Syntagma philosophicum*, what Gassendi presents as Kepler's theory of revolution is limited to a condensed form of summary like this.[35] The detailed and mathematical arguments deployed in *Epitome* are omitted altogether, along with the ideas of the magnetic fibers. Moreover, he does not provide his own judgment on Kepler's theory. Indeed, he neither rejects it nor interprets it after his atomism as he does for rotation. Despite this neutral attitude, Gassendi in reality espouses Kepler's idea of revolution. In *De motu impresso*, he explains Galileo's theory of tides. His explanation supposes that the earth rotates around the sun in an elliptical orbit. But Galileo himself considers the planetary orbits to be circular, not elliptical. Thus, Gassendi modifies the Galilean notion of tides, basing his ideas on the Keplerian theory of revolution.[36]

But why does Gassendi not publicly support Kepler on the cause of revolution? The reason seems to lie in the religious context of the time. The defense of Kepler's revolution theory, totally based on heliocentricism, would directly lead one to reject geocentricism altogether. This was, however, very dangerous after Galileo's condemnation in 1633. Although Gassendi shows his espousal of heliocentricism in his private letters, in his published works he repeatedly declares that he will respect the decision of the Catholic Church. Thus, in his *Syntagma philosophicum*, he recommends the Tychonic system for pious Christians.[37] In contrast, the situation is fairly different for rotation. First, from the observed movement of sunspots, it is possible to admit the sun's rotation without accepting the earth's revolution.[38] Second, Kepler's rotation theory is not itself based on heliocentricism. Consequently, Gassendi can give his own views on rotation by interpreting Kepler's theory in his atomistic framework.

IV. THE FORMATION OF SNOW CRYSTALS

We have seen that Gassendi bases his ideas about celestial motions on Kepler's theory. But is his influence confined to the realm of astronomy? While studying Kepler's astronomy attentively, did Gassendi entirely ne-

cumducitur, nunc ad ipsum magis alliciatur, nunc ab eodem magis avertatur; eaque ratione motu suo non circulum, sed ellipsin describat."

[35] *SP*, 1: 639a

[36] About this point, see Carla Rita Palmerino, "Gassendi's Reinterpretation of the Galilean Theory of Tides," *Perspectives on Science* 12 (2004): 212–37.

[37] *SP*, 1: 149a.

[38] *SP*, 1: 638b.

glect the other aspects of his work? To find the key to this problem, I shall take up one of Kepler's small works, *Strena seu de nive sexangula*.[39] In this treatise, he inquires into the cause of the regular and well-ordered formation of hexagonal snow crystals. For him, the real cause of this phenomenon lies in the soul that the Creator gave to the earth in the beginning of the world. Taking God as a great geometer, Kepler considers that this earth's soul has "an animal faculty" (*facultas animalis*) or "a formative faculty" (*facultas formatrix*), which is "skilled and well-versed in the entire geometry."[40] In addition, certain vapors are told to be formed in the bowels of the earth as the vehicles of this forming power. Since snow crystals are made from these vapors, they share the formative faculty coming from the earth's soul. That is why particular geometrical structures appear in the snow crystals.[41]

In *Syntagma philosophicum*, Gassendi refers to Kepler's *Strena*. According to Gassendi, no ancient philosopher noticed the well-defined form of snow crystals, and Kepler's little work is the first record to have made him aware of their structures.[42] Having acknowledged his debt to *Strena*, he introduces a list of theories on the cause of the geometrical shape of snowflakes, the first of which is as follows:

> Should we here make recourse to a certain soul of the earth, or the world, which, having learned geometry from the supreme Artificer, would make this admirable contexture [. . .]?[43]

Although there is no explicit reference to his source, this idea comes close to Kepler's. But Gassendi himself does not support this option, since he clearly denies the soul either in the earth or in the world, claiming that such a soul can be admitted only by analogy.[44] In contrast, one of the theories enumerated by Gassendi ascribes the geometrical organization of snow-

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[39] *Strena seu de nive sexangula* (Frankfurt, 1611). On this work, see Cecil Schneer, "Kepler's New Year's Gift of a Snowflake," *Isis* 51 (1960): 531–45; Robert Halleux, "De la *Strena* de Kepler à la naissance de la cristallographie," in Johann Kepler, *L'étrenne ou la neige sexangulaire* (Paris: Vrin, 1975), 109–37.

[40] Kepler, *Strena seu de nive sexangula*, in *GW*, ed. Max Caspar and Franz Hammer (Munich: Beck, 1941), 4: 279 = Johannes Kepler, *The Six-Cornered Snowflake*, trans. Colin Hardie (Oxford: Clarendon, 1966), 43.

[41] *GW*, 4: 275 = Kepler, *The Six-Cornered Snowflake*, 33.

[42] *SP*, 2: 80b–81a.

[43] *SP*, 2: 81a: "An hic vero est recurrendum ad animam quandam telluris, seu mundi, quae a supremo opifice γεωμετρεῖν edocta, mirabilem hanc contexturam faciat [. . .]?"

[44] *SP*, 1: 160b–61a, 1: 522a–b, 2: 3a–4a.

flakes to "a certain reason proper to them" (*ratio illa sibi propria*). For him, this "reason" has a close relationship with a "seminal principle" (*principium seminale*), which he thinks to have been given by God to the seeds of animals and plants. As seen in his frequent appeal to the seminal principle to explain the regularity observed in nature, he admits the existence of a particular principle, similar to the seminal one, which organizes the snowflakes' geometrical structures.[45] But does Gassendi reject Kepler's theory altogether? Is this particular principle not really similar to the formative faculty of Kepler? It should be noted that Gassendi owes much of his notion of seminal principle to the theory of Anselmus Boethius de Boodt (1550–1632), the mineralogist of the emperor Rudolf II at Prague. De Boodt explained the cause of the geometrical structure of crystals and living beings by his theory of seminal principle, although he did not explain in detail how it works geometrically.[46] It was his imperial colleague, Kepler, who went further in the development of this idea. Kepler's formative faculty and Gassendi's seminal principle, both given by God, work in a geometric way. Unlike the theory of the earth's soul, Gassendi did not reject this main feature of Keplerian theory, that is, the idea of the Creator as a great geometer. A further examination of divine geometry is required.

V. THE 1645 INAUGURAL ORATION

1. God as a Geometer

In 1645, Gassendi was appointed mathematics professor at the Collège Royal in Paris and lectured on astronomy until his retirement in 1648. This appointment could have caused some problems for him because of his former profession as a priest. He could be accused of abandoning his holy duty to pursue a secular one, since he had been engaged in ecclesiastical activities for over thirty years.[47] To avoid possible accusations, he vindicated his religious piety by his inaugural oration, published as *Oratio inauguralis*.[48]

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[45] *SP*, 2: 81a–b.

[46] See Hiro Hirai, "Les *Paradoxes* d'Etienne de Clave et le concept de semence dans sa minéralogie," *Corpus: revue de philosophie* 39 (2001): 45–71; Hirai, *Le concept de semence dans les théories de la matière à la Renaissance: de Marsile Ficin à Pierre Gassendi* (Turnhout: Brepols, 2005), 375–99.

[47] On Gassendi's fear for accusations, see his letter in *Opera*, 6: 230a = Pierre Gassendi, *Lettres latines*, trans. Sylvie Taussig (Turnhout: Brepols, 2004), 1: 427.

[48] *Oratio inauguralis* (Paris, 1645). On this oration, see Pierre Magnard, "La mathématique mystique de Pierre Gassendi," in *Gassendi et l'Europe*, 21–29.

Gassendi begins his oration by affirming that the goals of theology and natural philosophy are one and the same, for there are two types of sacred book, the Bible and the Book of Nature. Each of these requires its own interpreters, specifically theologians and natural philosophers.[49] For him, theologians receive the knowledge of God through revelation. In contrast, it is through demonstration that natural philosophers seek the truth, which is nothing but God himself. Thus, the disciplines do not differ in their goal, but only in their method. Accordingly, natural philosophers can be called "natural theologians" (*theologi naturales*).[50]

To confirm this sameness, Gassendi explains how God created the world and now administrates it. He says:

> [. . .] as I begin my lectures on cosmography, or on the world, let me start with a hymn of the Creator of the world. For, seeing that Plato, who is considered divine among the philosophers, when asked what God does, famously answered that God does geometry, there seems to be nothing that I can do that is more suitable for the present subject, more in tune with my way of life, and more worthy of your attention and that of the whole of this most illustrious audience, than to try to say how I believe God does geometry, having placed myself in the position of answering as if I were Plato even though I bear the mask of a Christian philosopher.[51]

Gassendi's oration focuses on the very idea that God does geometry. For him, to explain this divine geometry is to prove that nature always works under the rational principle imposed by the Creator-administrator of the world. Hence, natural philosophy is necessarily a theological pursuit. But Gassendi does not make clear his source for this idea. Although he attributes the phrase to Plato, in reality the phrase comes from the dialogue of

[49] On the Book of Nature, see Heribert M. Nobis, "Buch der Nature," in *Historisches Wörterbuch der Philosophie* (Basel: Schwabe, 1971), 1: 957–59; James J. Bono, *The Word of God and the Languages of Man: Interpreting Nature in Early Modern Science and Medicine* (Madison: University of Wisconsin Press, 1995).

[50] Gassendi, *Oratio inauguralis*, in *Opera*, 4: 66a–b.

[51] *Oratio*, 4: 67a: "[. . .] praelectiones habiturus cosmographicas, seu de mundo; ab hymno exordiar conditoris mundi. Siquidem, cum Plato, qui habitus est inter philosophos divinus, quaerenti quid ageret deus, celebre illud responderit, γεωμετρεῖν τὸν θεὸν, *exercere geometriam deum*; nihil videor facere posse, aut argumento accommodatius, aut generi vitae meae consonantius, aut tua, totiusque consessus celeberrimi attentione dignius; quam si, cum ipse quoque personam philosophi Christiani gerens, haud secus, quam ille fuero responsurus, dicere adnitar, qui deum exercere geometriam putem."

Plutarch, where the middle Platonist introduces it as a Platonic idea, noting that the phrase itself never appears in his master's corpus.[52] Why does Gassendi assign this phrase to Plato, not to Plutarch? Gassendi could be dismissing philological accuracy for the sake of the simplicity of argument. But there is another possibility, for which the work of Kepler provides a clue. Indeed, in his first published work, *Mysterium cosmographicum*,[53] Kepler introduces the idea of God as a geometer:

> We have orbit thanks to motion, and bodies thanks to number and magnitude. What more is there left to us other than to say with Plato that "God always does geometry"[?][54]

Here, Kepler ascribes the phrase to Plato without referring to Plutarch, just as Gassendi will do.[55] Does this not strongly suggest that Gassendi's use of the Platonic phrase comes from his reading of Kepler's work?

After explaining God's role as a geometer, Gassendi takes up the problem of the Trinity. According to him, a geometrical structure is observed in the relationships among the three divine hypostases: the Father, Son and Holy Spirit. He says:

> Shall we therefore reconsider this mystery of the Trinity as a sphere [in the following way]?: Its center is, as it were, the eternal Father, who is aptly called the fountain, origin and principle of the divinity as a whole; its circumference is the Son, in which the fullness of the divinity, [the Scripture] says,[56] inhabits; and the radii interposed

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[52] Plutarchus, *Moralia*, *Quaestiones convivales*, 8.2 (718B–C) = Plutarch, *Moralia*, trans. Edwin L. Minar, Jr. et al. (Cambridge, Mass.: Harvard University Press, 1961), 9: 119. For the importance of the Middle Platonists in early modern intellectual history, see my "Eclecticism as Seneca's Heritage: Evil and the Cosmic Cycle in Justus Lipsius," in *Justus Lipsius and Natural Philosophy*, ed. Hiro Hirai (Brussels: Royal Academy of Belgium, forthcoming).

[53] *Mysterium cosmographicum* (Tübingen, 1596; Frankfurt, 1621).

[54] Kepler, *Mysterium cosmographicum*, in *GW*, ed. Max Caspar (Munich: Beck, 1938), 1: 26 (= Johannes Kepler, *The Secret of the Universe*, trans. Alistair M. Duncan [New York: Abaris, 1981], 97): "Habemus orbem propter motum, et corpora propter numerum et magnitudines: quid restat amplius, quin dicamus cum Platone, θεὸν ἀεὶ γεωμετρεῖν [. . .]."

[55] Kepler also assigns the phrase to Plato in his *Harmonice mundi*, in *GW*, ed. Max Caspar (Munich: Beck, 1940), 6: 299 = Johannes Kepler, *The Harmony of the World*, trans. Eric J. Aiton et al. (Philadelphia: American Philosophical Society, 1997), 407. See Hübner, *Die Theologie Keplers*, 175–76.

[56] *Col.*, 1:19.

> between the center and the circumference [of the sphere] are the Holy Spirit, which is common to the Father and the Son, and a kind of intervening heat just like a bond or mutual chain.[57]

Thus, in God's geometry, each of the divine three persons occupies its specific position in the sphere. Gassendi does not specify whether this assimilation of the Trinity with the spherical structure is his own idea. But a passage from Kepler's *Mysterium cosmographicum* helps us to elucidate this problem:

> [. . .] but another much more important thing was also added: the image of triune God [exists] in the spherical surface, that is, the image of the Father in the center, that of the Son in the surface and that of the Spirit in the evenness of relationship between the [central] point and the circuit.[58]

This analogy resembles that of Gassendi with the single exception of the role of the Spirit.[59] In Kepler, the third hypostasis is symbolized by the "evenness" between the sphere's center and its surface. This evenness is also called "the intervening space" (*intermedium* or *intervallum*).[60] In contrast, in Gassendi, the Spirit is represented by the radii that connect the sphere's center to its surface. But this difference is very slight.

Regarding the circle as a symbol of the holy union, Nicolaus Cusanus (c. 1401–64) taught that the Trinity has a geometrical structure.[61] Francesco Giorgio (1466–1540), in his turn, advanced a similar analogy in

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[57] *Oratio*, 4: 68b: "Anne proinde hoc adorandum trinitatis mysterium habebimus rursus ut sphaeram, cuius quasi centrum sit pater aeternus, qui totius divinitatis fons, origo, principium accommodate dicitur; circumferentia filius, in quo legitur habitare plenitudo divinitatis: et radii centro, circumferentiaeque intercedentes spiritus sanctus, qui est patris, et filii communis, et quasi intercedens ardor; ac veluti nexus, vinculumve mutuum?"

[58] *GW*, 1: 23 (= Kepler, *The Secret of the Universe*, 93): "[. . .] accessit tamen et alterum longe maius: dei trinuni imago in sphaerica superficie, patris scilicet in centro, filii in superficie, spiritus in aequalitate σχέσεως inter punctum et ambitum."

[59] On Kepler's symbolism of the Trinity, see Wolfgang Pauli, "The Influence of Archetypal Ideas on the Scientific Theories of Kepler," in Carl G. Jung and Wolfgang Pauli, *The Interpretation of Nature and the Psyche* (New York: Pantheon, 1955), 147–240, esp. 159–60, 167–72; Hübner, *Die Theologie Keplers*, 188–92.

[60] *GW*, 7: 258, 7: 287.

[61] Nicolaus Cusanus, *De theologicis complementis*, in *Nicolai de Cusa opera omnia*, vol. 10, bk. 2, fasc. 2, a (Hamburg: Meiner, 1994), 30. For a historical survey on this symbolism, see Dietrich Mahnke, *Unendliche Sphäre und Allmittelpunkt* (Halle, 1937; repr., Stuttgart: Frommann, 1966), 106–8, 142–43.

his *Harmonia mundi* (Venice, 1525), with a notable modification in comparing the Trinity with a "sphere" instead of a "circle."[62] Although Kepler accepted the same modification, he never named Giorgio as his source, referring only to Cusanus.[63] Thus, it remains unclear whether Kepler knew about Giorgio's idea or made the modification independently. The situation is the same with Gassendi, who supported the modified version. Since he remains silent over his real sources, the possibility of Giorgio as his source cannot be eliminated at this point.

Let us continue to collect still more pieces of evidence to confirm his reliance on Kepler. Gassendi calls "natural theologians" the interpreters of the Book of Nature. In *Epitome,* Kepler also considers this created world as the Book of Nature, through the study of which God should be rightly recognized and admired by human beings.[64] Both men thus admit similar theological dimensions in the duty of natural philosophers. In this connection, Gassendi justifies his idea of God as a geometer by referring to one Biblical passage:

> [. . .] it is totally evident that not only philosophy but also the Holy Oracle teaches that God does geometry, since that phrase "[God] makes all things in number, weight and measure" does not mean any other thing.[65]

This Biblical quotation comes from *The Book of Wisdom*, 11.20.[66] Kepler also takes up the same passage in his *Harmonice mundi* (Linz, 1619), as follows:

> [. . .] for me and for all the Christians who hold with a firm faith that the world, because it had no previous existence, was created by God in weight, measure and number, that is, in accordance with the Ideas coeternal with Him [. . .].[67]

[62] Francesco Giorgio, *De harmonia mundi totius cantica tria* (Venice, 1525), 40.
[63] *GW*, 1: 23 = Kepler, *The Secret of the Universe*, 93.
[64] *GW*, 7: 25.
[65] *Oratio*, 4: 69a: "[. . .] perspicuum est sane, non philosophiam modo, sed sacra etiam oracula edicere γεωμετρεῖν τὸν θεὸν, *exercere geometriam deum*; quando non aliud sonant ea verba, quibus dicitur omnia facere in numero, pondere, et mensura."
[66] On the significance of this passage, see Natacha Fabbri, *Cosmologia e armonia in Kepler e Mersenne: contrappunto a due voci sul tema dell'*harmonice mundi (Olschki: Firenze, 2003), 156–70.
[67] *GW*, 6: 81 (= Kepler, *The Harmony of the World*, 115): "[. . .] mihi, Christianisque omnibus, qui fide tenemus, mundum, cum antea non esset, a deo creatum esse, in pondere mensura et numero, scilicet ideis ipsi coaeternis [. . .]."

Since divine geometry works through the "Ideas" coeternal with God, Kepler thinks under the authority of *The Book of Wisdom* that the Creation itself was realized according to geometrical principle.[68] Thus, Kepler and Gassendi rely on the same Biblical passage for the same purpose to show the existence of the geometry of God.

Gassendi's 1645 oration contains several important theological ideas that also appear in the work of Kepler: the idea that God does geometry; the theological dimension of natural philosophy as the interpretative pursuits of the Book of Nature; the use of the same Biblical passage; the sphere symbolism for the interpretation of the Trinity. Under this circumstance, is it really natural to see Kepler and Gassendi as independently adopting each of these ideas? It should be mentioned again that the latter was an attentive reader of the former. It is thus fair to conclude that, in the composition of his oration, Gassendi made use of these theological ideas, which he found in the work of Kepler.

One might suspect that Galileo's famous passage in *Il Saggiatore* leads Gassendi to use the metaphor of the "Book of Nature."[69] Of course this is possible. But is it possible to consider Galileo to be the main source of the 1645 oration? In the works read by Gassendi, the Italian natural philosopher does not speak of God as a geometer, at least not explicitly.[70] What is more, the sphere symbolism for the Trinity does not appear in his works. Consequently it is reasonable to consider that Kepler's work, not Galileo's, inspired the ideas developed in the 1645 oration. We can at best say that the Galileo's statement reinforced Gassendi's belief in the "Book of Nature" metaphor.

2. *The Divine Geometry and Providence*

Among the theological ideas Gassendi shares with Kepler, the belief that "God does geometry" is of particular importance, since it epitomizes the relationship between the Creator and the created world. Let us examine

[68] On the coeternity of geometry with God, see Hübner, *Die Theologie Keplers*, 176.

[69] Galileo Galilei, *Il Saggiatore*, in *Le Opere di Galileo Galilei*, ed. Antonio Favaro (Florence: Barbera, 1896), 6: 232.

[70] On Gassendi's reading of *The Starry Messenger*, *Letters on Sunspots*, and *Dialogue Concerning the Two Chief World Systems*, see his *Opera*, 6: 4a–6b, 6: 53b–54a = Gassendi, *Lettres latines*, 1: 6–9, 1: 94–95. On his reading of *Two New Sciences*, see especially Gassendi, *De motu impresso*, 3: 483a–b.

Gassendi's application of this idea to the explanation of natural phenomena in his inaugural oration.

Discussing natural things subject to generation and corruption, Gassendi calls attention to some meteorological phenomena and minerals. Snowflakes take star-like shapes and salt crystals hexahedral or cubic figures. From these geometrical constructions observed in nature, he asserts:

> [. . .] to those who direct neither their mind nor attention to these things, everything appears to be figured randomly rather than geometrically. And it is not made clear to them how truly it has been said: "At every moment nature is not believed in" and "All the works of nature are the works of the intelligence."[71]

According to Gassendi, these two maxims fully explain the geometrical figurations in nature. The former comes from Pliny's *Naturalis historia*, and the latter is of medieval origin.[72] Although we find neither the idea of God as a geometer nor the first maxim in *Syntagma philosophicum*, the second maxim appears in a section entitled "Of the efficient principle of things." For Gassendi, the exemplary cause exists in nature, as Plato insisted against atomists such as Leucippus or Democritus. As a manifestation of this type of cause, Gassendi uses the example of a spider, which seems to make its nest according to a certain plan, and consequently to recognize what should be built. He thinks it is reasonable to admit in the spider's instinct a kind of "Idea," an exemplary cause. He says:

> To be sure, those philosophers are better [than others like Leucippus], from whom the following dictum is derived: "The work of nature is the work of the intelligence." Because, in reality, every

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[71] *Oratio*, 4: 71a: "[. . .] mentem, oculosque ad haec non advertentibus omnia esse temere potius, quam geometrice figurata appareant, neque manifestum fiat illico quam vere dictum fuerit, et fide carere momentis singulis naturam, et opera omnia naturae, opera esse intelligentiae."

[72] Plinius, *Naturalis historia*, 7.1.7 = Pliny, *Natural History*, trans. Harris Rackham (Cambridge, Mass.: Harvard University Press, 1942), 2: 511. On the second maxime, see James A. Weisheipl, "The Axiom 'Opus naturae est opus intelligentiae' and Its Origins," in *Albertus Magnus, Doctor universalis: 1280/1980*, ed. Gerbert Meyer and Albert Zimmermann (Mainz: Grünewald, 1980), 441–63; Adam Takahashi, "Nature, Formative Power and Intellect in the Natural Philosophy of Albertus Magnus," *Early Science and Medicine*, 13 (2008): 451–81.

> effect of nature testifies that its cause knew what it was going to do.[73]

In the 1645 oration, the spider example is taken up again. Gassendi, in accordance with Kepler's arguments in his *Strena*, claims that animals like spiders and bees make geometrically structured nests according to their instincts, and thus God, the originator of those instincts, should be considered a geometer.[74] These cases in his *Syntagma* and oration show that the maxim "the work of nature is the work of the intelligence" plays an important role in connecting the idea of God as a geometer to the exemplary cause in nature.

Gassendi again refers to this maxim in discussing the final cause. In his *Syntagma philosophicum*, Gassendi accepts the Aristotelian idea that the finality should be admitted in nature. But, for him, this finality results from a kind of "cognition" (*cognitio*) or "wisdom" (*sapientia*) in nature. This cognition and wisdom can be evidenced by the fact that the parts of animals, plants or minerals are all formed according to their specific functions. Gassendi claims that since all beings, including minerals, are generated from their own seeds, the cognition, wisdom or finality imprinted on nature must be admitted in their seeds, too.[75] Inquiring further into the origin of these seeds, he takes into account the Creation of the world. Interpreting *Genesis* 1.12 and 1.24, he argues that the invisible seeds were created by God in the beginning of the world and distributed to the earth.[76] It is precisely in this context that Gassendi interprets the maxim "the work of nature is the work of the intelligence." For him, the invisible seeds created by God possess a kind of cognition and wisdom and therefore recognize how they should act when they are set under suitable conditions. This explains why the work of nature is considered intelligent. Here, Gassendi connects the medieval maxim to a concept developed in Renaissance "chymical" (alchemical/chemical) philosophy. Recent studies have shown that his notion

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[73] *SP*, 1: 285b (= Pierre Gassendi, *Du principe efficient, c'est-à-dire des causes des choses:* Syntagma philosophicum, *physique, section I, livre 4*, trans. Sylvie Taussig [Turnhout: Brepols, 2006], 45–46): "Melius sane philosophi ex quibus derivatum est, quod dicitur *opus naturae esse opus intelligentiae*; quia revera nullus naturae effectus non testatum facit causam suam id intellexisse, quod factura fuit."

[74] *Oratio*, 4:72a. Cf. *GW*, 4: 269 = Kepler, *The Six-Cornered Snowflake*, 17.

[75] *SP*, 1: 286a = Gassendi, *Du principe efficient*, 46–47. On his concept of seeds, see Hiro Hirai, "Le concept de semence de Pierre Gassendi entre les théories de la matière et les sciences de la vie au XVII[e] siècle," *Medicina nei Secoli* 15 (2003), 205–26; Hirai, *Le concept*, 463–91.

[76] *SP*, 2: 262b.

of seeds owes much to the Danish Paracelsian Petrus Severinus (1540/42–1602). It should be added that the interpretation of the first chapter of *Genesis* with invisible seeds was advanced above all by Kepler's colleague de Boodt, whose work Gassendi knew well.[77]

The concept of seeds reappears in Gassendi's 1645 oration. His arguments are basically the same as those of *Syntagma philosophicum*. For him, because of the power of the invisible seeds, plants and animals are generated in their own species and endowed with various bodily parts designed for their own functions. The origin of this power is again attributed to Creation by interpreting the same passages of *Genesis*.[78] What is more characteristic in his oration is the fact that the seminal power is said to work geometrically. Quoting *Genesis* 1:11, he says:

> As for the vegetables, the seminal power is without doubt geometrical, which God in the beginning impressed [on the earth], when He ordered the earth to sprout verdant and seed-making plants and trees bearing its own fruits according to their species. For, no commander can arrange soldiers or draw up military units or lines more geometrically and skillfully than this power distributes the parts of plants and their functions as if [he were handing out] chores.[79]

To his arguments in *Syntagma philosophicum*, Gassendi adds here that the power of seeds possesses a geometric nature, which is given by God the geometer. Thus, Gassendi's concept of seeds is linked to the idea of God as a geometer, which he shares with Kepler.

Gassendi supposes the active involvement of God in various natural processes. This point is intimately tied to the problem of divine providence, a matter of great importance for him.[80] Since antiquity, the negation of divine providence by Epicurus had been deemed one of the most irreligious philosophical doctrines.[81] Gassendi needed to eliminate this aspect from

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[77] See Hirai, *Le concept*, 484–91.

[78] *Oratio*, 4: 71a–b.

[79] *Oratio*, 4: 71a: "Ad vegetabilia quod spectat; geometrica sane est seminea vis, quam deus initio impressit, dum iussit terram germinare herbam virentem, et facientem semen, et lignum pomiferum faciens fructum, iuxta genus suum, cuius semen in semetipso esset. Non enim potest imperator geometrice, ac scite magis milites componere, ordinesque, et aciem instruere, quam haec vis partes plantae omnes earumque functiones, quasi pensa quaedam distribuit."

[80] See Osler, *Divine Will*.

[81] Howard Jones, *The Epicurean Tradition* (London: Routledge, 1989), 97–98.

his Epicureanism to make it acceptable for the Christians.[82] It is thus not surprising that the problem of divine providence is amply treated in the 1645 oration. Now let us see by what kind of idea Gassendi links God's geometry to this crucial issue and, consequently, how he achieves the ultimate goal of his oration.

In his *Syntagma philosophicum*, Gassendi adopts several ways to prove the existence of divine providence. Among them, the "argument from design" is particularly relevant to natural philosophy. For him, the regularity of celestial motions, the variety of sublunar bodies and the extreme subtlety observed in plants and animals show that everything in nature is produced by a certain wisdom, which he conceives to be divine providence.[83] This issue is further elucidated in his discussions on the Creation, addressed to the question of how God daily administrates the created world. According to *Genesis* 1.2, the first thing created by God was "chaos." For Gassendi, this is composed of atoms, to which the Creator gave "moving force" (*vis motrix*). He says:

> Next, [what is permitted to philosophers to investigate is] through what kind of force it is proper to God to organize [matter]. This matter, left to itself only with the general concourse of God, is able to exert this force so that it can shape and arrange itself into this appearance of the world. For, as we know, the matter, thus shaped and arranged, is conserved with the same concourse and it is admitted that conservation is nothing but continuous production.[84]

The ideas of God's "general concourse" (*concursus generalis*) and "continuous production" (*productio continens*) are of medieval origin.[85] Gassendi integrates these traditional ideas into his atomistic system. The second idea

[82] *SP*, 1: 5a.
[83] *SP*, 1: 324a.
[84] *SP*, 1: 485a–b: "Deinde qua vi consentaneum fuerit deum illam instruere, ut sibi cum solo generali dei concursu relicta, eam vim sic exsereret, ut posset in hanc mundi speciem se componere, atque conformare; quippe, cum ita composita, conformataque, ut cernimus, cum eodem concursu servetur, et admittatur conservationem nihil aliud, quam continentem productionem esse."
[85] On God's ordinary concourse, see Étienne Gilson, *Index scolastico-cartésien* (Paris: Alcan, 1913), 49–50. On God's continuous creation, see Gilson, *Index*, 62–64: Christian Link, *Die Schöpfung: Schöpfungstheologie in reformatorischer Tradition* (Gütersloh: Mohn, 1991), 1: 34–38; Charlotte Methuen, *Kepler's Tübingen: Stimulus to a Theological Mathematics* (Aldershot: Ashgate, 1998), 107–9.

also appears in the 1645 oration where he explains how God created the world and thereafter administers it:

> Since, as Plato himself argues, God reigns the world by the same principle by which He founded the world (from this fact it becomes known that the conservation of the world and things is nothing but a certain continuous production), it is sufficient for us to touch briefly on the very divine geometry, about the origin of the world and its principle parts, which constantly remain the same, as well as about the series, instituted [by God], of continuously generated things.[86]

To the discussion on God's general concourse in his *Syntagma philosophicum*, this passage adds that the Creator's continuous production is made through the geometric principle, by which the world was created. For Gassendi, to assert that God does geometry is to confirm the existence of divine providence, which works geometrically in nature. That is precisely why Gassendi claims the essential equivalence between natural philosophy and theology. Since nature is directed by God without interruption under the geometric principle, investigations into nature inevitably lead to the elucidation of the activity of the Creator-administrator of the world. It is in this theological context that we must understand the following passage of the oration:

> Finally you made me realize that there are two temples, where God demands priests or divines [to fulfill their duties]: one is the Church herself, in which [God] is adored according to the revelation of the divine word; the other is this [universal] system of things, in which [God] is recognized and worshiped according to the signs of His ineffable wisdom.[87]

[86] *Oratio*, 4: 69a: "Et quoniam deus non alia ratione, vel ipso Platone authore, mundum regit, quam condidit (ex quo efficitur, ut mundi, rerumque conservatio intelligatur nihil esse aliud, quam continens quaedam productio) ideo sufficit pauca attingamus de ipsa divina geometria, tam circa originem mundi, praecipuarumque eius partium, quae constanter eaedem perdurant; quam circa institutam seriem suborientium continuo rerum."

[87] *Oratio*, 4: 66b: "Denique effecisti, ut intelligerem duplex esse templum, in quo deus mystas, sacerdotesve exigat; alterum nempe ipsam ecclesiam, in qua iuxta divini verbi revelationem adoretur; alterum systema hoc rerum, in quo agnitus iuxta characteres ineffabilis sapientiae colatur."

VI. CONCLUSION

We have so far examined Gassendi's theories of celestial motions and the formation of snow crystals, as well as his theological ideas related to the created world. This survey has shown that he is under the strong influence of Kepler. We can thus consider Gassendi to be a philosopher who reacted very positively to the achievements of Kepler's intellectual pursuits before the publication of Newton's *Principia*. However, he was not Kepler's uncritical-minded follower, as is testified by his atomistic interpretation. The contemporary religious context also played a crucial role for his reactions to Kepler. As for Kepler's theory of revolution, the condemnation of Galileo prevented him from supporting it publicly. But some religious motivations drove him to adopt various theological arguments inherited from Kepler in the 1645 oration; these penetrate into the very core of even Gassendi's natural philosophy. Indeed, in Gassendi, the theological idea of God as a geometer is closely tied to his notion of exemplary and final causes, his concept of seeds and his understanding of divine providence.

One crucial limitation in Gassendi's reactions to Keplerian ideas is his relatively poor mastery of mathematics. This limitation is clearly seen in his omission of the detailed mathematical arguments that Kepler advances in his *Nova astronomia* (Heidelberg, 1609) and *Epitome*.[88] It should be admitted that Gassendi's incompetence in mathematics resulted in his failure to make a substantial contribution to theoretical astronomy. However, because of this limitation, Gassendi's reactions to Kepler are all the more interesting for historians. Thus, after having heard of the imperial mathematician's death, he writes:

> Namely, whenever someone pays attention to the Herculean labors and incomparable genius of that man, [Kepler] will cause astonishment. Why not? [. . .]. If it is not that man, I do not see who it is to whom Minerva is said once to have taught all the arts and whom the supreme Jupiter is said to have permitted to enter the assembly of the gods.[89]

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[88] Koyré, *La révolution astronomique*, 364.

[89] Gassendi's letter to Wilhelm Schickard in his *Opera*, 6: 44a (= Gassendi, *Lettres latines*, 1: 77): "Videlicet stuporem creabit, quoties quis labores Herculeos, incomparabilemque genium viri animadverterit. Quidni? [. . .]. Nisi profecto de illo verum, non video, quem unquam Minerva artes omnes docuisse dicatur; et Iupiter optimus maximus admisisse in concilium deorum."

For Gassendi, Kepler is the contemporary Hercules, whose labors would strike everyone with admiration for generations to come. Gassendi inherits these Herculean labors in developing his natural philosophy. When tracing the subsequent "astonishment" created by these labors, we should not ignore the French atomist as the heir of the German Hercules.

Tokyo.