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PROCLUS' «THEOLOGICAL» SPHERICAL
COSMIC WHOLE AND HIS SCIENTIFIC
INNOVATIVE ASTRONOMY

Proclus was an impassioned critic of the complex and highly developed astronomy of his predecessors. Armed with an extensive scientific knowledge of physics, geometry and spherics, he offered an innovative astronomy of his own to counter what he perceived to be the deficiency of former views. He did so, however, not only on the basis of his own sophisticated knowledge of science and mathematics, but with very potent nonscientific sources. When he criticised Claudius Ptolemy's *Almagest*, written in the second century C.E., the most influential book on astronomy for more than 1,200 years after its composition, he did so on the basis of his own views of space. He supported this critique, however, with appeals to a theology which he considered compatible with Pythagorean/Platonic philosophy and Neoplatonic doctrine. He particularly questioned whether epicycles (circles within which a planet moves and which has a centre that is itself carried around on the circumference of a larger circle) and eccentrics (the amount by which an elliptical orbit deviates from a circle), innovations that had been deployed by former respected astronomers to account for the apparent irregular movements of the sun, moon and the planets, were anything more than mechanical contrivances. Apollonius of Perga (265 BCE–190 BCE) and Hipparchus of Rhodes (190 BCE–120 BCE), whose work he knew well, all had held to these constructs. He particularly opposed Ptolemy. The mechanical artificiality of Ptolemy's use of these contrivances did not meet his own

demand for a causal account of motion¹. Though his own astronomy was based on physics and mathematics, he backed up his objections with theological/Platonic ideas. ‘Soul’, for example, was the force which enabled motions of all kinds. In doing so, he anticipated some of the discoveries of Copernicus and Kepler as well as those of modern physics². His ‘theological’ metaphysics, surprisingly, resulted in an astronomy with mathematical and scientific veracity and a respect for physics, a more fruitful approach than any based on the ancient astronomy of the centuries that preceded him.

Greek astronomy was given its uncontested first principles by Presocratic philosophers. Parmenides, for example, declared the universe (*to holon*) to be a «well-rounded sphere» (*eukuklon sphaires*)³. The Pythagoreans held to the notion of a central fire around which the universe revolved⁴. The conviction that the universe was spherical and that the motions of heavenly bodies must be circular, thereafter, made it imperative for future astronomers to account for the appearance of irregularity posed by the movements of the planets, the sun and the moon, as compared to the fixed stars. For Plato, perfect circular motion was displayed by the orbits of the fixed stars, a physical exemplar of «reason»⁵. Any departure from this premise was disturbing. As reported by Simplicius, it was Eudoxus, a student of Plato, who attempted a mathematical hypothesis to accomplish the goal of accounting for these anomalies⁶. Not only did they violate the presumed harmony of the celestial sphere, the figure of the perfect sphere (or dodecahedron) was the presumed shape of the universe but also a figure conceived by Theaetetus, a student of

1. Segonds 1962, 329 points out that Festugière found the expression “artificiellement machinees” or its equivalent pertaining to Ptolemy, in all the following passages: Procl. *In Ti.* III 358.22 Van Riel (= II 264.22 Diehl); IV 84.20 Van Riel (= III 65.8 Diehl); IV 123.25 Van Riel (= III 96.19 Diehl); IV 189-90 Van Riel (= III 147 Diehl); *In R.* II 223.23; II 227.27-28; II 229.9-11; II 230.8-9; II 236.11.

2. See Kutash 2008, 297-321.

3. See Parm. DK28B8.32-49, present in Pl. *Ti.* 33b1-7 as well.

4. Dicks 1970, 51.

5. See Pl. *Ti.* 46b5-9.

6. See Aiton 1981, 79.

Plato, as having the ability to contain all the other so called cosmic figures (the regular solids)⁷. The enormous and sophisticated discipline of astronomy from that time forward developed around the issue of the irregular motions of the planets, an aporia which defied strong beliefs in sphericity as a visible icon of the invisible world of noetic truth. Proclus faithfully followed Plato, for example, in *Laws* (X 898a-b) where noesis is described as an activity that resembles the sphere⁸.

Proclus argued repeatedly that attempts to commensurate the apparent irregular movements of the planets (the appearances), through both the use of concentric spheres and the use of epicycles and eccentrics, must be rejected. Further, notably, not only did Proclus object to Ptolemy's mechanical model and return to Plato's emphasis on the invisible world of reason, he argued that they are completely foreign to Plato's conviction that the fixed stars, engaging in perfect circular motion, are «divine living things» (*Ti.* 40b4-8). Proclus notes that Plato «[...] indicates the presence in them of both divine intellect and divine soul» (*In Ti.* IV 163.7-8 Van Riel = III 126.15-16 Diehl). Ascribing to Plato's attribution of divine origin, Proclus also held the conviction that the World Soul was the source of the presence of soul as it is manifest in celestial motion. Epicycles and eccentric, on these grounds, are «unworthy of the divine essence». Plato's in *Laws* (X 899b3-7), after all, had said:

Concerning all the stars and the moon, and concerning the years and months and all seasons, what other account shall we give than this very same, namely, that, inasmuch as it has been shown that they are all caused by one or more souls, which are good also with all goodness, we shall declare these souls to be gods⁹.

Epicycles and eccentrics are pointedly criticised throughout the *Commentary on the Timaeus*. They are clearly in opposition to

7. Kutash 2001, 130-31. Kepler, in his *Mysterium Cosmographicum* of 1597, retained this model as it fit the distances between the orbits of the six planets to the distances that would be obtained if the hypothetical spheres of the planets were inscribed in and circumscribed around, the five regular solids.

8. See Baltzly 2009, 207 note 49.

9. Tr. Bury 1926.

the primacy of a celestial world in which there is spatial unity and only one compelling centre for *all* the heavenly bodies, fixed stars and planets alike. This and only this is in accordance with the soul's own volition.

He claims that (*In Ti.* IV 190.2-4 Van Riel = III 147.2-5 Diehl):

It is [in fact] necessary for the very variety in their motions to be dependent upon the *souls* [that animate the stars] so that the bodies that undergo motion do so swiftly or slowly in accordance with the *will* of these souls¹⁰.

Clearly, Proclus relies on *Platonic Theology* to 'verify' stipulations based on scientific considerations.

It is notable that Plato's views on the World Soul and the belief that Soul is a purveyor of motion, enable Proclus to apply physics to astronomy. While the views of astronomers before Proclus hold to the idea that the planets are passive bodies carried along by epicycles or eccentrics, he claims that the irregular motions of the planets are self-moving entities within dimensional space. They are intermediaries between the fixed stars and things in the sub-lunary regions which display rectilinear motion (*In Ti.* IV 189.7-10 Van Riel = III 147.8-10 Diehl). These independent trajectories through dimensional fields can be erratic when escaping the influence of centric force. The universe, however, is an essentially unified whole, ultimately an eternal one being, beyond the vicissitudes of time and space. All motions will succumb to this eternal unity and deform towards circularity.

According to B. L. Van Der Waerden (1974), theological attributions are not Platonic *per se*, but characteristic of the Pythagoreans who based science on theological arguments. He raises the possibility, however, that Geminus, Proclus and Simplicius were following the widespread practice of attributing every discovery to the Pythagoreans (he cites Sir Thomas Heath). Geminus' (10 BCE-60 CE) *Introduction to Astronomy* was well known to Proclus, who quotes him twenty times in his *Commentary on Euclid's Elements*. Geminus claimed that the Pythagoreans

10. Tr. Baltzly 2013.

knew about stationary points and retrogradations but still declared that the true motion of the planets must be uniform and circular, because the planets are eternal and divine. The mandate to explain the phenomena by assuming circular and uniform motions, was a stipulation that was likely to have originated by the Pythagoreans, particularly Philolaus¹¹. Uniform circularity, from the Pythagoreans through to Plato and to the Neoplatonists, was commended as endemic to being. In *Timaeus* the universe is deemed to be «[...] One single Whole, compounded of all wholes perfect and ageless and unnailing» (*Ti.* 33a7) and revolving in a circle. For Proclus, the unity commended in *Timaeus* demanded that Plato's view of being as one extends to the celestial sphere in the form of the circular motion exhibited by the motion of the fixed stars. Proclus, in his treatise on astronomy, *Hypotyposis Astronomicarum Positionum*, asserts that «The hypotheses of eccentrics and epicycles commended themselves also, so history tells us, to the famous Pythagoreans as being more simple than all others [...]»¹².

For Proclus, however, they are not simple at all but in fact, complicate the unity that Platonists ascribe to celestial being. The «vision of the whole», as a spherical or dodecahedral configuration of a bounded or limited universe, was a standard conceptual icon for Greek astronomers. Plato (*Ti.* 33b1-8), posited, following Pythagorean geometry, that the fitting shape to hold within itself all shapes (*schematon*) is spherical (*sphairoeides*), perfect and self-same (*homoiotaton*). This paradigmatic case of containment was thought to represent all that is and equivalent to 'being'. All change and motion had to be accounted for by reference to true being and, since the universe is a spherical whole, motion in the celestial realm must be subject to sphericity as well.

Zeno's paradoxes regarding motion brought to the attention of the ancient philosophers the fact that any kind of successive motion in the form of a purely rectilinear course, motion, in time, could potentially go on ad infinitum. In Zeno's race between the tortoise and Achilles, Achilles can never overtake

11. Van Der Waerden 1974, 176-78.

12. See Heath 1981, 271 and note 2 citing Proclus' *Hyp.* 34.18.

the tortoise because there is a one-to-one correspondence between the infinite set of points run by the tortoise and run through by Achilles. Motion that is unidirectional and occurring across segments of space and time with no limiting parameter, could result in a potential infinite iteration. In the celestial expanse, the Platonic vision of an invisible noetic unity is actualised by the perfect circular motion of the fixed stars. This orbital sphericity, at the outermost point of the celestial space, was not a material sphere, but a spherical boundary enunciated by the orbits of the stars. The possibility of never-ending seriated infinity in rectilinear progression could never become a reality. Commandeered by the force of the «centre», a physical placeholder for noetic unity, all sorts of motions ultimately comply with circularity.

A Commanding Centre

Copernicus did not ignore his debt to the long and sophisticated history of Greek astronomy. He knew that his revolutionary innovations were predicated upon the posit of a ruling «centre» and that the circular or elliptical pathways of the heavenly bodies orbited around it. Copernicus cites Aristarchos of Samos, as Sir Thomas Heath points out, and also alludes to the central fire of the Pythagoreans¹³. One of Proclus' objections against epicycles and eccentrics was that motions in circles that move opposite to the direction of the spheres on which they are located destroy the continuity of the spherical space. This «does away with the common axiom of the physicists, namely that every simple movement is either round the centre of the universe or to or from that centre»¹⁴. Explaining Plato's conviction that the Demiurge ordained that the planetary circles would go in opposite directions from the fixed stars (*Ti.* 39b1) Proclus claims they did so (*In Ti.* III 358.18–359.1 Van Riel = II 264.18–25 Diehl):

13. Heath 1981, 95–97.

14. Lloyd 1991, 261 note 39 citing *In Ti.* IV 189.9 ff. Van Riel (= III 146.14 ff. Diehl).

[...] since they are moved by their own individual motion as well as that of the sphere of the fixed stars. Nor did Plato here or elsewhere make any mention of eccentrics or epicycles. Rather the seven circles all determine a single centre, without the addition of any other centres. [...] [further] the hypothesis of epicycles or concerns about the rising of the planets are in no way appropriate to the subject of the circles within the soul¹⁵.

According to Helen Lang, Aristotle's account of motion, is fully teleological because it rests on a full specification of the relation of moved to mover¹⁶. For Proclus, the isometric circular universe is subject to a force which operates like an unmoved mover, not at the limits of the universe but at its centre. Proclus claims in his *Commentary on Euclid's Elements*, the centre «[...] represents the principle of Limit [...]. The rest of the universe converging upon it, striving to be the centre and become one with it»¹⁷. The trajectories of celestial bodies, then deform toward the circular under the influence of a centric position at rest. Neoplatonic doctrine regards rest as the superior state of being over motion. Immobility rules in the higher hypostases. In the centre of the celestial space, then, there is a placeholder for noetic unity in situ. Motion is commandeered centrifugally rendering all motions to conform to circularity. For Proclus, all space within the universe is constant given the fact that the outer limit is spherical and the earth, (as good as any other body), is to be at its centre. Earth, for Proclus, functions as a centrally located organizer embodying the rest/centeredness that is an analogue to noetic truth. Kepler recognised the implications of Proclus' model and speculated that Proclus actually envisaged the sun as the centre of power of the system composed of the earth and planets¹⁸. Unity and rest characteristic of higher hypostases is present in the celestial sphere, itself subject to both rest and motion. Notably, Proclus remarks that some commentators «[...] say that the middle is the centre of the earth, but

15. Tr. Baltzly 2013.

16. Lang 1996, 259.

17. *In Eucl.* 154 tr. Morrow 1970.

18. Siorvanes 1996, 308–11 elaborates the case for Proclus' heliocentrism. See also *In Ti.* III 67.27–68.10 Diehl (= IV 87.22–88.9 Van Riel).

others say that the moon is the middle [...] Still others say that the Sun is established in the place of the heart (*in Ti.* IV 134.4-9 Van Riel = III 104.17-24 Diehl)». In the following quote, theology and Pythagoreanism are co-present along with mathematical and physical considerations (*In Ti.* III 147.21-148.5 Van Riel = II 106.15-22 Diehl):

By virtue of its guardian powers it holds together the centre. For the whole sphere is steered from thence and converges in the centre. Moreover all the troubles in the world have been corralled in its middle and it is necessary that there should be a divine guardian who is capable of marshalling them and keeping them within their proper bonds. It is for this reason that theologians and [...] the Pythagoreans call the middle, «the tower of Zeus» or «the guard post of Zeus»¹⁹.

Perfect circular movement, then, is commanded by a centre at rest. Irregular or rectilinear motion will always succumb to its overrule. The superior ontological status of circular motion over rectilinear motion receives its imprimatur by command of the compelling centre. Anomalous motions will ultimately revert, therefore, in deference to circularity, the closest physical reflection of rest. Plato, after all, asserts that «Motion does not consent to exist in uniformity» (*Ti.* 57e3-4). The stars, then, are the exemplary case of the presence of reason *in* the universe. They are subject to the hybrid nature of the celestial sphere – rest, characteristic of *noesis*, and motion, enabled by soul. For a Neoplatonist both the celestial sphere, and the world of nature are subject to higher hypostases. Proclus' threefold hierarchy of grounding principles – One Beyond Being, One Being – and Existence is a multi-leveled hierarchy in the continuum from the One to existence. On the level of Existence (generated being) there is a variety of motions but on higher levels, these motions are subject to the One Being and grounded in a transcendent unity (One beyond Being)²⁰. In the material world (existence), spatiotemporal intervals (*diastema*) are possible. In the celestial region motion is accountable to the standards of unity/rest and only circular motion achieves similarity to higher hypostases.

19. Tr. Baltzly 2009.

20. Kutash 2008, 298-89.

Proclus had a strong interest in Aristotle's physics and Stoic theories of motion and focused his commentary on Aristotle's *Physics* on motion. He rejected, however, the *Primum Mobile* as a First Cause. For Aristotle the *Primum Mobile* is connected to the outermost sphere of the heavens and is considered to impart motion to the other celestial spheres. For Proclus, rest is the transcendent eternal principle and the celestial sphere's centre is the unmoved mover, the originator of eternal circular motion. In celestial space transcendent principles and spatial and temporal unfolding are both operative. Rest, rather than motion, is the ultimate determinate of being and perfect circular motion is the material exemplar closest to rest and to noetic truth. Remarkably, this framework enabled Proclus to endorse an idea of curvilinear space, the equivalence of mass and energy, the limiting role of light, and a physics of motion.

Curvilinear space

For twentieth century physics, the concept of «field» is, in principle, a replacement of the idea of a particle or material point in the concept of space and presumes a space that is a continuum²¹. When light came to be regarded as a wave field, the field concept that gradually won greater independence. The cosmological theories then follow from Einstein's work such as the work of E. A. Milne, in 1932, describe all events as contained within a sphere, all intervals between two events (points in space-time) are regarded as homogeneous, with all places alike and isotropic²². For Proclus, a spherical limit determines the ultimate configuration of the celestial space which displays both unfolding in intervals of time and space and at the same time continuity as a simultaneous whole. Celestial space, however, is curvilinear; rectilinear unfolding anomalous. Proclus, in his *Commentary on Euclid*, and in many other of his texts, makes laudatory comments on the powerful influence of circularity (*In Eucl.* 149.9-13):

21. Einstein 1961, 163-65.

22. See Kutash 2008, 302.

On the heavenly bodies the circle confers their likeness to Nous, their homogeneity and uniformity, their function of enclosing the universe within limits, their fixed and measured revolutions, their eternal existence without beginning or end, and all such things²³.

The One beyond being is the ultimate source of the One Being in the Neoplatonic hierarchy and the celestial space embodies its image in its own simultaneous unity. The One is itself, «[...] without beginning and without end»²⁴ and sphericity is iconic. The fixed stars, then, as eternally circular in motion enacts a situated reflection of the One Being while anomalous motions appear to escape its overrule. In Euclidean geometry the dodecahedron or sphere potentially contains all other figures. This is a paradigm case for containment for celestial sphericity, as well as containment marked by the orbits of the fixed stars. Physical or celestial entities assume a rectilinear trajectory in the interval structure of time and space but in the «field» which is curvilinearly structured, curvilinear dominance will have a commensurating effect on rectilinear movement and force a reverting trajectory. All displacement will cease (*In Ti.* III 17.1 Van Riel = II 12.13 Diehl):

[...] That every simple body, when in its proper place either remains immovable, or is moved in a circle, in order that it may by no means relinquish its proper place. For if it is moved in a different manner it will either no longer being its own place or will not yet be in it. A celestial body therefore being fiery is necessarily moved in a circle. Earth also, if it were moved without leaving the place about the middle, would be moved in a circle. For when fire is moved to the upper region it is so moved in consequence of being in a foreign place. For the same reason likewise, a clod of earth is moved downward. In short, the local motions of the elements are in a right line, [...] it is false to say that fire is moved naturally in a right line [...] when it tends to its proper place it is not yet in a condition conformable to nature [...] in its natural place it will either be immovable or moved in a circle²⁵.

23. Tr. Morrow 1970. In *El. Theol.* 11.14 Proclus mentions that circularity forecloses the possibility of an infinite regress.

24. In *Eucl.* 149.12–13.

25. Tr. Baltzly 2013.

For Proclus, temporality and spatiality must be considered from the perspective of an eternal being and beyond being rest. «All that is eternal is a simultaneous whole [...] without diminution and without serial extension»²⁶. Time in the material universe is an image of eternity but temporality (when time passes toward the future from the past it in the material or celestial space) it does so within an interval (*diastema*) sequence. Essentially, however, it is immovable, invisible and immaterial and from a panoptic perspective all time is a degraded form of an eternal Now. Proclus calls *to en* and *to estai*, «what was and what will be», «species» (*eidai*) of time generated by the Demiurge (*In Ti.* IV 48.7-9 Van Riel = III 37.15-17 Diehl). Temporal intervals like rectilinear motions are part of times progression (*In Ti.* IV 44.14-15 Van Riel = III 34.15 Diehl). Eternal unity holds all physical manifestations in the grip of eternal rest, ultimately ruling over it and grounding it in what is permanent, continuous and uniformly self-same. Time and space then, just as in modern physics, are inseparable. The life of the heavens displays its hybrid nature by these features, the heavens move according to time, but the intelligible nature (*noeta physai*) fixes these movements in the larger scheme of things. According to the whole of itself it is eternal and analogous to a breadth rather than a series²⁷. The celestial sphere, is both material and can exhibit processive expansion, but it is an image in extension of the essentially extensionless whole. The simultaneous whole is transcendent and eternal, but the celestial sphere is concomitantly eternal and subject to its regional situations. Time and space are inseparable in the sense that unfolding in space is unfolding in temporality. For Proclus, within an interval structure all motions, temporal and spatial, in material existence are potentially commensurate to an overriding whole. Time and times, are a moving image of image of eternity and interval sequences in space are a moving image of rest (*In Ti.* II 41.2-6 Van Riel = I 233.1-4 Diehl):

Only the intelligible realm is fully eternal in virtue of itself. For this reason some of the ancients describe (a) the noetic realm in its full

26. *El. Theol.* 52.51.

27. See Kutash 2009, 45; 55.

extent as «truly extent» [...], b) the psychic realm as «not truly existent», (c) the sense perceptible realm as a «not truly existent» and (d) matter is «truly non-existent»²⁸.

I would amend the phrase translated above as «noetic realm in its full extent» to correspond to the Greek *noeton platos*, «intelligible breadth». For Proclus, for whom the celestial universe is an exemplar of spherical wholeness, and also entails spatial extension, curvilinear space allows both. The celestial world can display both time (becoming) and eternity (being), motion and rest. Platonic metaphysical premises, once again, result in an astronomy of the physical world which is both scientific *and* onto-theological. Modern astronomy, of course, is based in physics and mathematics *per se*.

Proclus references to the primacy of the Circle of the Same in Plato's *Timaieus* (*Ti.* 37b6-c2), as opposed to the Circle of the Different, are a good example of his reliance on Platonic principles to advance his astronomy. Under the Circle of the Same, eternal unity dominates and will triumph over the possible aporias that stem from a potential endless dispersion and divisibility. Difference, such as is displayed by anonymous motions, participates in the One as well. The terminal point of a progression in time or space is not infinitely postponed in a curvilinear space as the spherical limit contains all the potentially infinite motion that appears as spatial progressions. Proclus celestial curvilinear space like that of modern physics, is the occupant of an unbounded but finite universe. All trajectories in space will be curvilinear or deform to a naturally curvilinear influence. In a homiletic universe, all objects in space must conform to its ruling parameters of a spherical limit. Proclus calls the circular figure «[...] the very highest of intelligibles» and the centre resembles the principle of Limit. Though the lines from the centre typify Boundlessness (*In Eucl.* 155.12-19),

[...] the line which bounds their indefinite extendedness and gathers it back to the centre is like the hidden cosmic order they constitute, which Orpheus describes as follows:

28. Tr. Runia – Share 2008.

[...] The Boundless in a circle
Was moving unweariedly [...] ²⁹.

Astronomy, then, recapitulates ontology. This model extends all the way to living souls which are illuminated by autonomous life and motion which enables them to revert to Nous and circle about it, enjoying self-renewal through the special periodic revolutions which unfold the partlessness of Nous, as Soul «[...] traverses a circle in her desire to embrace the Nous in herself» ³⁰. All motion and apparent motion is subject to noetic predetermination. All astronomical anomalies such as the irregular motions of the planets ultimately fall prey to its dominating truth and correct under the ruling symmetry.

Einstein's vision of a finite but unbounded space as Max Born pointed out is, «one of the very greatest ideas about the nature of the world which ever has been conceived» ³¹. When Einstein considered the problem as to whether the space and matter of the universe were finite or infinite, he followed De Sitter's suggestion that the universe might possess a finite volume but no finite boundaries ³². Finite unboundedness would fit the case of a space that was a three-dimensional expanse with a definite area but no actual material boundary. For Proclus, the celestial region in analogue to the spherical geometrical shape that would encompass all the shapes within itself (*Ti.* 33b1-8), is a visionary construct of a finite but unbounded space. Proclus comments extensively on the gift to the universe of spherical shape and its ability to contain all shapes within its limits ³³.

The Irregularity of the Planets

Dirk Baltzly points to a passage in the *Commentary on the Timaeus* which views the universe as diminishing levels of *homoi-*

29. Tr. Morrow 1970.

30. In *Eucl.* 149.7-8 tr. Morrow 1970.

31. Born 1956, 200.

32. Mason 1954, 567-69 discusses this.

33. Baltzly 2007, 124-40, elaborates Proclus' views on the gift of sphericity to the universe (from III 94.8-112.10 Van Riel = II 68.6-81.10 Diehl). See also Kutash 2011, 115 ff.

tatus in the continuum from the fixed stars to the irregular motion of the planets³⁴. The planets are (*In Ti.* IV 73.13–16 Van Riel = III 56.31–57.6 Diehl):

[...] like an intermediary between things that undergo motion that is entirely regular [*scil.* the fixed stars] and things that undergo motion that is entirely irregular [*scil.* things in the sub-lunary], for [the planets] have been allotted a motion which is regularly irregular or irregularly regular³⁵.

When circular motion is the true reflection of noetic principles and sphericity is the true shape of the celestial sphere, planetary irregularities present a troubling inconsistency. The seventh book of Plato's *Republic* (*Resp.* VII 529–531), after all, asserted that astronomers and scientists must conform to true reality and understood it by pure reason alone. The word planet (*planetes*), notably, is the word for «wanderer». Proclus, who had a vast knowledge of astronomy in the centuries before him, understood that the use of eccentrics and epicycles made use of superimposed circular orbits, attributing their origin to the Pythagoreans. Proclus was particularly familiar with the astronomy of Apollonius of Perga and Hipparchus of Rhodes (who developed trigonometry and accurately measured the sizes of the sun and the moon). Ptolemy however was his prime target. On Platonic terms alone, the contrivances of all three of these astronomers, were unacceptable. More sophisticated than the celestial spheres of Eudoxus, Callippus and Aristotle, they attempted to preserve uniform circle motions. Ptolemy's *Syntaxis*, argued against the idea of aethereal spheres as well. Ptolemy did consider each planet to possess a «vital force» and moved itself and this was the source of planetary motion. Still, he attributed the irregularity to eccentrics and epicycles³⁶. Proclus repeatedly argued that eccentrics and epicycles were limited and too mechanical. Curvilinear space and a spherical «limit» were the true reflections of the commanding centre (a place holder for eternal unity), therefore the ultimate influence on all motions.

34. Baltzly 2013, 7.

35. Tr. Baltzly 2013.

36. Sambursky 1962, 144 citing Ptol. *Syntax. Mathem.* II 7.119.21.

Proclus allowed the planets a self-moving motion (away from rest/centre). The ultimate reversion, however, would commensurate with circular wholeness. The continuity of curvilinear spacing left no room for intervening epicycles or eccentrics, which would destroy its unity. In any number of passages in his *Commentary on the Timaeus* (IV 73.20 Van Riel = III 56.28 Diehl; III 134.22 Van Riel = II 96.27 Diehl, for example), Proclus criticizes Ptolemy's account. His own explanation for the observed irregularities, emphasised the physics of motion over geometry. In his *Commentary on the Republic* (II 216.5-13), he advocated a continuous celestial expanse precluding spherical interference:

For there is no vacuum at all between the whorls which fit into one another so that there is one continuous surface from the convex surface of the innermost (*endolatoi*) of all spheres as far as to the outermost (*exotatoi*), for the whole of this depth is called the celestial expanse and not only the surface of the greatest of them³⁷.

In *Hypotyposis Astronomicarum Positionum* (236.15 ff.) Proclus asserts that the spheres may be mere artifacts of theory:

For what are we to say about the eccentrics they go on about and the epicycles? [...] that they are merely contrivances [objects of thought] or that they also have existence in the spheres in which they are fixed³⁸?

This would make them a result of mathematical concepts and not physical entities that exist in nature. Epicycles and eccentrics, moving in opposite directions, further, do not support the ruling principle that all celestial bodies ultimately, move around or toward the centre of the universe (*In Ti.* IV 189.10 Van Riel = III 146.17 Diehl). The perceived anomalies must be accounted for by the rule of central attraction. The result is a spiral—a mean between purely circular and rectilinear movements (*In Ti.* IV 164.5-165.20 Van Riel = III 127.31-128.16 Diehl):

37. Tr. Siorvanes 1996, 281.

38. Lloyd 1991, 238, Lloyd translated Manutius' text *Hyp.* 236.15 ff. The *Hypotyposis Astronomicarum Positionum* with Introduction, Text, Translation and Commentary by Lithari 2025 is now available.

[...] when the planets make their journey through the heavens, they have their «turnings», for this is what has been said about the planets (39d8) those that make a turn. It is therefore clear that Plato means that the planets themselves [perform] these turnings, that they make their journeys – coming to be closer or further from the Earth or changing in latitude—on their own. It is not the case that they are carried by other things, [...] [counter-rotating] spheres or epicycles. Possessing a single yet varied motion thanks, as it were, to their own single nature, the planets exhibit progression or retrogradation in a helical manner after the configuration of their own orbit in all sorts of ways. As a result, the motion that belongs to each one is triple. First there is the one that happens when they are turned as they undergo motion with respect to latitude (*platos*) and depth (*bathos*) in conjunction with each planet being moved around its own centre. Then there is that which take place when each one is led around its individual circle to the left [i.e., west or east]. Then there is the one [from east to west] which takes place due to the fact that the motion of the Same dominates the entire motion of the Different³⁹.

Proclus' analysis of motions is complex. In Proposition 14 of *Elements of Theology*, he states that «[...] everything is unmoved (*akineton*), intrinsically moved (*autokineton*), or extrinsically moved (*heterokineton*)»⁴⁰. In *Platonic Theology* (I 14), Proclus also provides a multifaceted account as well: motions are *kinoumena monon*, *kinoumena* and *kinounta*, *autokineta* and *akineta*. The *akineton* is the prime mover and circular movement is its closest material image. The self-moved (as are the planets), though moving erratically are nevertheless under the command of an unmoved mover⁴¹. Siorvanes (1996) explains that «while the fixed stars traverse the heavens in one direction only, the planets do so in all six, longitude, forwards and backwards [...] in latitude up and down, in depth, closer and further (from earth)» (*In Ti.* IV 190.5–12 Van Riel = III 147.6–10 Diehl)⁴²:

And this [difference or irregularity] comes about in regular temporal periods when the stars themselves undergo motion around their own

39. Tr. Baltzly 2013.

40. See Dodds 1963, 16–17.

41. See Procl. *El. Theol.* 201 citing *Theol. Plat.* I 14.32 ff.

42. Siorvanes 1996, 295.

centres and also variously undertake journeys through their own spheres. [This happens] in order that they might have motion that is mixed, since they are intermediates between the fixed stars [that have only regular circular motion] and the things [in the sub-lunary realm] that undergo motion in a straight line⁴³.

Anomalies are due to self-volition on the part of the planetary bodies, their anomalous trajectories, therefore, need no supporting circles to explain their rectilinear motion. Copernicus subsequently employed one of his theorems of combined motions, citing Proclus.

Platonic and Neoplatonic Ontology in Scientific Astronomy

Moritz Schlick stated that for twentieth century scientists it is impossible to speak of a determinate geometry of space without taking into account physics and the behavior of natural bodies⁴⁴. For Proclus the anomalous planar movements of the planets (their behavior) and perfect circular containment (geometry) marked by the circular motion of the fixed stars, are co-present in the celestial region, just as in modern astronomy, geometry and physics are not separate matters. When Proclus resorts to supporting these ideas with conceptual oppositions, like Being and Becoming, Sameness and Difference, however, it is clear that ontology is as powerful an explanatory tool as physics and mathematics. Proclus, at every turn, roots his astronomy in basic Platonic ontology. Plato's Circle of the Same and the Circle of Difference, Not Being and Being, as coexistent, are all brought to bear on the issues in astronomy discussed above. The basic opposition Limited (*Autoperas*) and Unlimited (*Auytoapeiron*), are present immediately beneath the One in Proclus' ontological hierarchy. This opposition is consequential for the binaries which Proclus deploys, for example, The Circles of Same and Other (*In Ti. IV 157.25-158.1 Van Riel = III 122.11-14 Diehl*):

But since the heavens are as immaterial as possible for sensible things, the opposites are not in conflict with it, nor is there faction

43. Tr. Baltzly 2013.

44. Schlick 1929.

among them. Instead they coexist (*synyparchein*) with one another and at the same thing is moved with respect to the two revolutions⁴⁵.

Being and Becoming, as well, coexist in the celestial realm. Becoming is operative in anomalous movements: Being is reflected in the perfect circular motion of the fixed stars. As a result of the dominance of being, rectilinear motions will revert and exhibit a spiral path (*In Ti.* IV 103.12–19 Van Riel = III 80.5–13 Diehl):

The spiral shape is not an empty coincidence but rather fills in the intermediate status between bodies that have rectilinear motion and those that are carried around in a circle. The circle, as has been said [79.14], is only for the fixed stars, while the straight line is for Becoming. The spiral, then, is for the planets, since they have a mixture of both rotation and straightness. Their motions with respect to latitude and proximity to the Earth are proximate causes and paradigms of the motions of things down here – that is of motions upward, downward and along the diagonal⁴⁶.

Limit and Unlimited are the ultimate source of opposition that appear in lower hypostases. They are discussed at length in Proclus' texts. As Proclus contemplates the finite and/or infinite possibilities in a universe which is encircled by an immaterial spherical limit wherein beginning and end are one and a space/time that could unfold in potentially infinite sequences, this pair of opposites are always in play. Limit, in Platonism, guarantees that the danger of potential dissipation into nonbeing through iterative seriality does not occur. Serial infinities, like incommensurable magnitudes, irrational lines, temporality or demiurgic ceaseless productivity are potentially, actual infinities: possibilities which must be brought under the rule of unity. The Circle of the Same and the Circle of the Other, Limit and Unlimited pertain to the fixed stars and the orbits of the planets, respectively⁴⁷. Rectilinear motions of the planets, like infinities, present the prospect of limitlessness, foreign to a Platonic vision of the

45. Tr. Baltzly 2009.

46. Tr. Baltzly 2013.

47. Kutash 2011, 100–1.

whole. The simultaneous whole, that is envisioned, bounded only by the fact of circularity wherein end and beginning are identical, forecloses the possibility of a bad infinity of limitless rectilinear unfolding. Sphericity provides a terminal point wherein all seriated potential infinities reach a limit. It is, in the celestial region, a mark of finitude, finite and at the same time unbounded. Limit is the sign that noetic unity is present⁴⁸. Proclus' spherical cosmos is both unbounded and finite (limited) at the same time.

A considerable portion of Proclus' *Commentary on Plato's Parmenides* is devoted to the Unlimited Limited binary. Proclus alludes to the spherical shape in this Commentary quoting Parmenides' fragment on the well-rounded sphere (*In Prm.* VI 1129). What is *unlimited* is only what is transcendent in the ultimate sense. Intellect is unlimited (*In Prm.* VI 1120) Eternity is unlimited (*In Prm.* VI 1121). Soul is unlimited. Proclus' astronomy allows that «the celestial sphere [...] through the continuous infinite power of Time, [...] makes the same thing to be beginning and end [...] in respect to its unlimited circular limit. It is an image of noesis (Intellect is unlimited). When Intellect «possesses a life [which it does in the celestial sphere through the presence of soul] the danger of an unlimited dispersion in rectilinear motion, the celestial circular orbits present a remediating Limit to avert a 'bad infinity'. In the *Commentary on the Parmenides* (VI 1122.10-12) Proclus mentions the «circuits of the Soul and its cycle as uniformly completed».

At VII 1162, Proclus engages in apophatic theology (a negative theology which stipulates what the One is only properly spoken about by enumerating what it is not). The One has no shape, no centre or parts and does not undergo circular motion. The «divine Soul», however, is capable of both motion in a straight line and circular motion» (VII 1166.7-8). This is a good example of applied ontology as Proclus' astronomy, rejecting material spheres and peculiar innovations such as epicycles and eccentrics, conceives of a celestial sphere commandeered by the centre, along with a physics which relies on Soul as possessing the

48. Morrow - Dillon 1987, 470.

powers to preserve «rest» through its relation to noetic unity and to enact motion and change. The fixed stars provide Limit while honoring its source in the unlimited unity of the centre as a placeholder for Intellect.

Theology is never absent from Proclus' priorities. Proclus ability to favor physics over pure geometry implicates the involvement of Soul but Soul is present by *divine* bequest. «Soul» a hypostasis beneath Intellect in the hierarchy of being was given to the cosmos according to Plato (*Ti.* 34b5-9):

In the centre of the body of the cosmos, the everlasting God, [...] set Soul, which He stretched throughout the whole of it, and therewith He enveloped also the exterior of its body: and as a Circle revolving in a circle established one sole and solitary Heaven [...]⁴⁹.

It is ultimately Soul that imbues the centre of the celestial sphere with its ability to assimilate all varieties of motion to a dominant curvilinear space. The circumnavigation of the fixed stars and ultimately the irregular motions that appear rectilinear upon observation, will fall under the Soul's sway. Divinity is ever present in Proclean Platonism. Plato asserted in *Timaeus* that the fourth gift of the Demiurge was to give the universe the gift of spherical shape: «it's body; and as a circle revolving in a circle [...] needing no other beside [...] He generated it to be a blessed God» (34b). Plato concludes *Timaeus* proclaiming, «Our cosmos is a visible Living Creature embracing the visible creatures, a perceptible God (*zoon oraton* [...] *eikon tou noetou theos aisthetos* [...]) made in the image of the Intelligible (*tou noetou*) [...]». (*Ti.* 92c6-9). Following Plato's vision it is clear that for Proclus the celestial sphere as a work of divine Creativity. Proclus mentions Plotinus as a support for his theology by his idea that the demiurge «in some sense [...] is the same as the cosmic intellect»⁵⁰. Proclus addressed him with the name Zeus, citing *Ennead* III 9 [13], 1.23-27 (*In Ti.* II 147.7-12 Van Riel = I 305.23-28 Diehl)⁵¹:

49. Tr. Bury 1968-89.

50. See Procl. *In Ti.* III 410.23-411.1 Van Riel (= II 305.17-20 Diehl).

51. Runia - Share 2008, 160 note 629 about *In Ti.* III 411.1 Van Riel (= II 305.18 Diehl).

[...] he is also the transcendent Father and Creator, whom he posits as existing in the Intelligible, calling the entire realm between the One and the cosmos intelligible. There in his view the true Heaven and the kingdom of Kronos and the Intellect of Zeus, just as if someone would say that in heaven there is the sphere of Kronos and of Zeus and of Ares⁵².

In instances such as these, theological attributions are artfully and curiously interchangeable with scientific and mathematical analyses. E. R. Dodds, commenting on Propositions 128, and 129 of Proclus' *Elements of Theology*, points out that the terms *Theois* and *Theos* were used by the Greeks in all periods in a wide and loose sense. Plato himself spoke of a *Theios Nous* of soul (*Phlb.* 22c) and of the soul and the cosmos as gods (*Lg.* V 726; *Ti.* 92c)⁵³. It is clear, then, that the Greek theological tradition, enabled Proclus to endorse, with divine sanction, his conviction that the universe could be both finite and unbounded, a vision of the whole that had to await Einstein's conviction that space is curvilinear and that space/time, «does not claim existence on its own but only as a structural quality of the field»⁵⁴. The space/time in Proclus' celestial expanse, was a divine bestowal to a universe through the agency of Soul and the transcendent noetic unity of Intellect allowing the perfect circular motion which could hold the universe in both time and eternity simultaneously.

Some Consequences of Proclus 'Astronomy'

Proclus regarded light as the limit of one of the four elements, the one most prevalent in celestial space, where the four elements earth, air, fire and water, are at their «summits» (*akrotetes*). Siorvanes (1996) explains that matter has many states for Proclus and light is the limiting case of matter as it is for modern physics⁵⁵. Thus in the celestial sphere the continuity of matter expresses itself in gyrations of energetic states (*In Ti.* IV 166.12-23 Van Riel = *In Ti.* III 128.29-129.7 Diehl):

52. Tr. Runia - Share 2008.

53. Dodds 1963, 268.

54. Einstein - Infeld 1967, 176.

55. See Siorvanes 1996, 251.

[...] The spheres [in the heavens] have a substance that is finer and more diaphanous, while the stars are more solid. However fire predominates everywhere and the entire heaven is characterised in accordance with the power of this [element]. The fire up here is not caustic since the [region just] below the Moon [...] contains nothing caustic [...]. Neither is [the fire in the heavens] something destructive or opposed to earth. Rather [the celestial gradation of fire] shines with life-generating heat, the power to illuminate and translucency [...] Therefore the fire up there is light [...]⁵⁶.

Simplicius' *Commentary on Aristotle's Physics* provides a summary of the late Neoplatonist position. Where the claim is that place is a body that is immobile, indivisible and immaterial (place should be light), accordingly Proclus says (*Simpl. In Ph.* 612.24–613.1):

We should envisage two spheres, the one of light, the other consisting of many bodies, equal to each other in bulk. Situate the one about the centre and put the other inside it, and you will see the whole universe within place, moving within that immobile light being itself immobile as a whole, in imitation of place, but having moving parts. In order to be in that way inferior to place [Proclus] confirms his account from Plato, who says light, akin to the rainbow, which is mentioned in the *Republic* [616b] is place⁵⁷.

For Einstein the speed of light is the crucial variable which mediates mass and energy. The more general principle under which the idea of conversion of mass to energy and the limiting role of light is the conviction that there is a unified cosmos and terrestrial and celestial regions are not isolated. For Proclus, this means that the material and celestial worlds, though in diminished states of being, still mirror the invisible paradigm. This view is contrary to Ptolemy, who had declared in *Almagest* XIII 2, following Aristotle, that the physics of the terrestrial world did not hold in the superlunary realm and visa versa. The principle of Oneness (*homoitaten*, i.e., self-similarity), supports the idea that rest is the truth of motion, the ruling principle of all things celestial and terrestrial. Anomalies that appear to depart from

56. Tr. Baltzly 2013.

57. Tr. Urmson in Sorabji 2004, 234.

continuity, are manifestations of a lower state of being. They seem to depart from continuity and appear to be *anomoitaten* but ultimately the basic principle of continuity will prevail.

Another consequence for Proclus and for modern physics is the primacy of curvilinear space has consequences for planar geometry. Hans Reichenbach recognised that the criticism of Euclid always centered around the parallel postulate⁵⁸.

While all great circles as straight lines share properties with plane straight lines, they are distinct from the latter with respect to the axiom of the parallels. All great circles of the sphere intersect and there are no parallels among these straight lines. When the plane then, is meant as the surface of the sphere, Euclidean geometry holds with the exception of the formulation of the axiom of the parallels.

The parallel postulate is a defining characteristic of linear space but fails to be characteristic of a nonlinear space. Like his twentieth century counterparts, Proclus was troubled by the parallel postulate and stated clearly that it «[...] ought to be struck out of the postulates altogether»⁵⁹. So intrigued was he by this postulate that he insisted on the need for proof and made his own attempt to prove it.

A further consequence regarding the universe as unified and all forms of material reality subject to similar underlying principles, supports the curious idea that objects can deform their geometry in accordance with limiting parameters outside themselves. Reichenbach describes rigid bodies as solid bodies which are not affected by differential forces by definition [...] *if universal forces are disregarded*⁶⁰. In a world that bends and shifts everything with time, however, static structures are impossible.

The concept of rigidity loses its meaning in this world [...] solid bodies [...] no longer define a unique coordinate system as internally at rest, due to differences in their elastic properties. We [...] lose the possibility of defining a geometrical state as rigid in terms of solid bodies, since this definition was based primarily on the uniform behavior of different materials. There is no longer geometry of rigid bodies⁶¹.

58. Reichenbach 1958, 2-3.

59. *In Eucl.* 191.21-22 tr. Morrow 1970. See also Heath 1956, 202.

60. Reichenbach 1958, 22.

61. Reichenbach 1958, 264.

Proclus ascribes to the conviction that as the tetrahedral pyramids of sublunary fire approach the heavens their faces become convex by the celestial binding of the curvature of the celestial orbs (*kyrtoutai sphiggomena*). Siorvanes (1996) discusses the fact for Proclus the elements, because they are the images of the perfect spherical figures of self-substantiated and «self-sufficient» entities in the sensible world, namely the celestial objects, «[...] seek to curve in a convex manner in order to fit and ‘unite’ with heaven [...]»⁶². For Proclus, deforming in order to assimilate to the contours of sphericity is possible. Just as the triangle in Riemannian space can have angles greater than 180, planar forms, deform to assimilate to the contours of sphericity. This idea applies to the rectilinear pathways of the planets. Proclus comments on 36b of *In Timaeus*, where Plato says that the right lines are bent into circles in the formation of the universe, «[...] as the continuous is simultaneous with the discrete, thus also the circular with the rectilinear [...]» (*In Ti.* III 142.3 Van Riel = II 102.5 Diehl). This oddity suggests that rectilinear motions are unnatural, a product of the disarrangement which time and motion can bring into the cosmos. Since rest is the ideal and transcendent «truth» of being, geodesic conformity will prevail. Bodies in celestial space will deform in conformity to a limit which is round; rectilinear pathways will deform to the curvilinear. In modern physics, geometrical figures have been acknowledged to have different properties on different surfaces. On a sheet of paper the sum of the three angles of a triangle is equal to two right angles, on the egg, or the sphere it is larger, on a concave surface it would be smaller etc. Proclus was able, entirely on different grounds, to understand the subtleties of non-planar geometry in a way that was unprecedented for his time⁶³.

Conclusion

Einstein had this to say about ‘fanatical atheists’. They were, he said, «creatures who cannot hear the music of the sphere»⁶⁴. He

62. Siorvanes 1996, 222 quoting from Proclus’ reply to Aristotle’s objection six (*Simpl. In Cael.* 650.18–657.8).

63. Kutash 2008, 316–17.

64. Fox 2025, 45.

could not say that about Proclus. Proclus' «heavens» are a simultaneous whole encapsulated by a spherical limit marked by the perfect circular notion of the fixed star. It is not bounded by a material celestial sphere as conceived by Eudoxus, Callippus, and Aristotle. It is not limited either by the internal presence of either eccentrics or epicycles. A noetic totality, the celestial space subsumes all anomalies under the rule of a commanding centre at rest, making them subject to a deforming reversion toward the curvilinear space to which they are ultimately commensurate. Like Einstein, Proclus, found the most elegant solution of his time to the problem of motion. Like Einstein, he wanted to know the mind of God. Both figures resorted to notions of Infinity and panoptic perspectives to solve regional mechanical problems. Both scientist philosophers maintained a vision of the whole from a panoptic view wherein rest allowed, motion, light, and matter to follow a principle of continuity. Proclus, like Einstein, rejected all previous assumptions regarding astronomy. Both eschewed the obvious logic of time and space as it was known before them. For Proclus, the physical world was ultimately ordered by the One beyond Being, manifesting diminishing reflections of its transcendent source. For the celestial world, Proclus' mission was to amend an unholy astronomy and apply his Neoplatonist «logic» in a manner that allowed for scientific innovation. Einstein had stressed that «[...] there *is* no logical path [...] between theory and observations – their concordance is to be understood extra logically»⁶⁵. For Proclus and the Pythagorean/Platonic tradition, this «extra» was theology.

65. Kutash 2008, 120–21; 297; Davies 1992, 80 note 2.

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Emilie Kutash, *Proclus' 'Theological' Spherical Cosmic Whole and His Scientific Innovative Astronomy*

Proclus rejected the traditional celestial spheres of Eudoxus and Aristotle and also rejected Ptolemy's mechanical attempts to model irregular planetary movements using epicycles and eccentrics. Instead, he returned to Plato's emphasis on the invisible world, allowing his science to be governed by his Platonic theology. He envisioned a limited space that everywhere conforms to the cosmic spherical whole, thus requiring all motion to entail a circular trajectory in ultimate reversion to the One Being (a placeholder for Eternal Unity). Anomalies were due to 'self-moving motion' away from the center. Crucially, Proclus viewed the planets not as passive bodies, but as self-moving entities with independent trajectories through dimensional space. Their erratic movements were complex, occurring in longitude, latitude, and depth, ultimately resulting in a spiral – a mean between purely circular and rectilinear movements. This unique theory, based on higher theological principles, accounted for the anomalies that troubled other astronomers and resulted in an innovative physical account. Copernicus later employed one of Proclus' theories of combined motions. Proclus even questioned the parallel postulate, which is characteristic of linear space, in a way that suggests analogies to Einstein's curved space and space-time continuum, highlighting his innovative scientific foresight.

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