9 Jesuit Tychonic Cosmology

By the late 1620s, the mathematicians of the College of Santo Antão had successfully integrated the Tychonic ideas into a Catholic cosmological framework. Accordingly, they maintained that celestial bodies moved according to the planetary rearrangement put forward by Tycho in his *De mundi aetherei recentioribus phaenomenis* (1588) in a universe that they divided into three regions or 'heavens'. Nevertheless, the cosmological debate had strengthened since Tycho produced *his* geo-heliocentric system. Aside from the recent issues that emerged in the aftermath of the telescope's construction, there were still the problems that Tycho left unsolved, especially the question of celestial dynamics, that is, an inquiry into the causes of heavenly motions. The celestial orbits, which Tycho conceived as being circular, also became an issue of discussion after Kepler's elliptical orbits proved to be better suited to celestial computation, somehow suggesting the superiority of the Copernican system over the geostatic ones. Crucially, there was also the need to integrate the Tychonic system into a worldview in which there was room for the Empyrean heaven, the metaphysical heaven in which God, the Saints and the Blessed were to be found,[1] even while Brahe and a large majority of the Protestant philosophers and astronomers opposed the existence of this latter heaven.[2] The Jesuit mathematicians of the College of Santo Antão, particularly Cristoforo Borri, spared no efforts to put forward a coherent cosmological view that integrated all these questions.

1 On the Empyrean heaven notion, see Maurach, *Coelum Empyreum*; Lerner, *Le Monde des Sphères*. Vol. 1, *Genèse et triomphe*, 215-21; Randles, *The Unmaking*, 133-50.

2 Randles, *The Unmaking*, 133.

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While teaching in the Class on the Sphere, in the 1627-28 academic year, Borri stressed to his students that Tycho's sudden death prevented him from offering a comprehensive account of his cosmological theories, a task that the Danish astronomer had intended to perform in a book, which probably would receive the title *Theatrum astronomicum* or *Opus astronomicum*.[3] The question of the planetary motion was a pressing one. In fact, Tycho's theory explaining planetary motion by means of a heavenly vital spirit that was supposed to animate the planets appeared to astronomers, such as Rothmann and Kepler, as the main weakness in Tycho's theory.[4] It did describe how the planets performed their motions, but it failed to identify the cause of the planetary motions.[5] This being the case, and moved by the desire to see the Tychonic astronomical system fully demonstrated and accepted, Borri felt obliged to take up the task of providing such evidence of Tychonic theory as came to hand, though in a succinct way. As he informed his Portuguese audience:

> Since death led him to pass over what he had promised in silence without proving it as this illustrious astronomer [Tycho Brahe] wished, desirous to see this excellent theory clarified and proved, we considered ourselves obliged to prove it, though in a brief and summarised way for now.[6]

Although Borri had previously endorsed a different theory regarding the cause of planetary motion – namely, the theory according to which the celestial bodies were moved by an intrinsic virtue[7] – in Lisbon, the Italian Jesuit taught his students that angels were indeed responsible for celestial motion. As he explained in his *Collecta astronomica*, a book upon which he relied heavily in his Lisbon lectures, the constancy of the celestial order required the planets and the stars to be governed by superior entities. Being thought of as purely intellectual entities, and therefore superior to other beings in ontological terms, angels were assumed to be charged with this role of perpetually maintaining the exact distances and proportions between the celestial bodies.[8] As he put it rhetorically: Is there a better and more suitable extrinsic cause to explain the complexity, perpetualness and certainty of celestial motions than the angels?[9]

This understanding of the cause of celestial dynamics was consistent with the Thomist conception of providence that the Jesuit hierarchy supported

3 Dreyer, *Tycho Brahe*, 180; Thoren, *The Lord of Uraniborg*, 312.

4 Brahe, *Avthor Lectori svo de praecentibvs Rothmanni litteris et ad eas responsione* in Brahe, *Tychonis Brahe Dani Epistolae Astronomicae*, 221: "Cum et Coelum animatum esse, ipsaque coelestia corpora animantia quaedam Coeli vitali spiritu praedita, non abs re sensisse videatur Divina illa Platonicorum Philosophia".

5 Schofield, *Tychonic and Semi-Tychonic*, 100, 222 ff.; Granada, "The Defence of the Movement", 100-1.

6 Borri, *Nova astronomia*, BGUC, MS 44, f. 117v: "Como a morte lhe foi occasião de ficar em branco sem provar o que prometeu e deseiava levar ao cabo tão insigne astronomo[Brahe]. Nos pello deseyo que tinhamos de ver aclarada e provada huma doutrina tão boa nos demos por obrigados provala ainda que breve e recopiladamente por agora". Borri also made this point in his *Collecta astronomica*, 187-8.

7 Carolino, "The Making of a Tychonic Cosmology", 327. This theory was developed by Medieval Oxford Aristotelians, such as John Blund and Robert Kilwardby, who later influenced John Buridan's notion of celestial *impetus*. Weisheipl, "The Celestial Movers", 164-9.

8 Borri, *Collecta astronomica*, 235-6.

9 Borri, *Collecta astronomica*, 172.

and reaffirmed in the Order's statutes and in the *Ratio studiorum*.[10] According to this view, God governed the created world through the mediation of secondary causes. In proportion to the different roles that they assumed in the Creation, secondary causes received a transient influx from God, which enabled them to move other causes responsible for lower effects, thus preserving the order of the Creation.[11] A good example was precisely the angelical action of moving the planets according to divine intentions. Angels moved the planets and indirectly brought about planetary influence over the terrestrial region, upon which life on earth was thought to depend. Alluding to Jean Buridan's concept of *impetus*, Borri stated:

> I do not mention that force (*virtute*) which God, if He would have wanted to, could have impressed to the planets and the remaining celestial bodies, through which they could carry out those proper, numerous and certain movements. In fact, as theologians assert and philosophers corroborate, God did not wish these things to be moderated by Him, but instead, for proper employment, love and connection amongst things, He endowed secondary causes with such a power in order that the humblest beings are governed by the noblest, these by the sublime beings – which the angels are – and successively the angels by God.[12]

Borri therefore put forward the notion of a universe provided with an internal order corresponding to the different degrees of being and levels of perfection. It was against this theological and metaphysical background that Borri maintained that angels moved the planets. Though assigned a vast sphere of action, the power of the angels was limited, so a single angel could move various stars but was unable to move all the celestial bodies.[13] A certain number of angels were, therefore, required to drive the planets and stars in their complex and precise motions through the heavens.[14]

This understanding of celestial dynamics was shared by Borri's fellow mathematician, the Jesuit Simon Fallon, who taught in Lisbon a decade after Borri. Although not delving into details like his Italian confrère, the Irish mathematician asserted that "it is right that the planetary bodies do not move by themselves, but are moved by angels, who carry them like torches in their hands to illuminate the world".[15]

10 It is a well-known fact that the regulations of the Society of Jesus recommended that Jesuits follow the doctrines of Thomas Aquinas on theological matters. As Ignatius of Loyola put it in the founding *The Constitutions of the Society of Jesus*: "in theology there should be lectures on the Old and New Testaments and on the scholastic doctrine of Saint Thomas". de Loyola, *The Constitutions*, 220. See also "Ratio atque institutio", 386.

11 For details of Thomas Aquinas's account, see Aquinas, *Summa Theologica* 1a, q.105, a.5.

12 Borri, *Collecta astronomica*, 172-3: "Neque hic mentionem facimus de virtute illa, quam Deus, si voluisset poterat Planetis, reliquisque corporibus caelestibus imprimere, cuius beneficio suos illos, et multiplices, certosque cursus conficerent. Nam ut habent Theologi, Philosophique assentiuntur, Deus per se ista moderari noluit, sed ut occupatio amorque ac rerum nexus esset inter se, causis secundis imperium commisit, ut humiliora ab maioribus, et haec a summis, qui Angeli sunt, Angeli tamen a Deo regerentur".

13 Borri, *Collecta astronomica*, 243, 246.

14 Hence, Borri rejected the thesis that, because angels were spiritual entities, a single angel was able to move all the celestial bodies by itself. See Borri, *Collecta astronomica*, 244-5.

15 Fallon, *Compendio Spiculativo*, BNP, cod. 2258, f. 109*r*: "Contudo he certo que os Astros senão mouem de sy, senão por Anjos, que os leuão, como tochas na mão para ilumiar o mundo".

By explaining celestial motion by means of angelical agency, Borri and Fallon discarded the understanding that celestial bodies were endowed with an intrinsic virtue that gave them an inclination to their natural movements. This sort of understanding, which commonly identified the intrinsic principle of planetary motion with the planets' 'substantial form', in the way that the Mertonians theorised in the fourteenth century, was most likely the view supported by Ignace Stafford.[16] Furthermore, the theory of angelical agency allowed them, at the same time, to reject Gilbert's and Kepler's concepts of a *virtus magnetica* by which the Sun was held to cause the planets to move round it at speeds proportional to their distance from it. According to Borri, the Keplerian *virtus magnetica* did not successfully explain the motion of all the celestial bodies, especially that of the Moon.[17] The postulate of the centrality of the Earth therefore remained unquestioned.

Nevertheless, providing a consistent explanation for the cause of celestial motion was not enough to impose Tychonism as the leading cosmological model. Further explanation of the shape of planetary orbits was needed. Brahe, like Ptolemy and Copernicus before him, maintained that the orbits described by the planets and stars had a circular shape.[18] Nevertheless, while studying Mars, Kepler came up with the idea that planets performed elliptical orbits. He used this new idea to (re)calculate the positions of planets, the computations being printed, in 1627, in his *Rudolphine Tables*. These tables proved to be more accurate than any previous ones based on the principle of the circularity of planetary orbs. They, therefore, presented a challenge that the Jesuit professors of the Class on the Sphere could not escape.

They did not adhere to the Sun-centred elliptical hypothesis. Instead of the Keplerian suggestion, Cristoforo Borri – and all the mathematics professors who followed him – put forward a theory according to which the planets perform a single motion in helicoidal form (or spiral form, as he named it).[19] With this single motion, it was possible to explain not only the 'direct' motion of the planets but also the 'retrograde' motion and their periodic stationary state.

Borri provided a detailed account of this theory in the *Collecta astronomica*. Retrieving an idea that originated with the medieval Arab astronomer al-Bitruji (Alpetragius in Latin),[20] Borri argued that all the celestial bodies perform one single motion from east to west with different veloci-

In his *Tratado sobre a Theorica dos Planetas*, Fallon also argued that celestial bodies were most likely moved by angels. Fallon, *Tratado*, BNP, cod. 2127, f. 219*r*.

16 Stafford indeed criticised the theory of angelical agency. Stafford, *Tractado das Theoricas*, BNP, cod. 4323, f. 82*v*. Taking into account the Jesuit scholastic constraints with respect to the animate nature of celestial bodies (see Grant, *Planets, Stars, and Orbs*, 469-87 and Dales, "The De-Animation of the Heavens"), it is most likely that the English Jesuit endorsed the Mertonian understanding of celestial dynamics.

17 Borri, *Collecta astronomica*, 173; Fallon, *Compendio Spiculativo*, BNP, cod. 2258, ff. 62*v*-63*r*.

18 On Tycho's defence of the circularity of the celestial orbs, see Granada, *El debate cosmológico*, 31-59 and Thoren, *The Lord of Uraniborg*, 236-64.

19 Before Borri, Gall had already argued, in his astronomical thesis of 1621, that the fixed stars performed a spiral shape motion, which was the outcome of the two circular motions over the pole plus the trepidation movement. No reference was made there to the shape of planetary orbits. Gall, *Assertationes astronomicae*, 2.

20 al-Bitruji, *De Motibus Celorum*, 97-8; Lerner, *Le Monde des Sphères*. Vol. 1, *Genèse et triomphe*, 104-10; Samsó, *On Both Sides*, 529-45.

ties.[21] Celestial bodies that are placed farther away from the Earth move faster than those that are closer to the Earth. For this reason, the planets move more slowly than the fixed stars in such a way that they actually seem to perform a west-east motion.[22]

As in other cases, Borri remained silent with respect to his sources on this matter, mentioning neither al-Bitruji nor any other philosopher involved in the revival of the notion of the 'unidirectionality' of celestial motions at the turn of the century. The notion of a helicoidal motion path of the planets was particularly widespread among neo-Stoic philosophers. The Portuguese astronomer Manuel Bocarro Francês, for example, in his treatise on the comet of 1618 (published in 1619), based his work on "the entire School of the Stoics" (*toda a escola dos Stoicos*), maintaining that the planets and the stars progress according to a spiral path (*por caracol e espiras*) by themselves, without any external mover.[23] Borri did not cite Bocarro Francês's *Tratado dos cometas*, a book that he was certainly acquainted with as it existed in the Lisbon Jesuit libraries, such as the *Casa de São Roque*'s public library.[24]

Borri explained the helicoidal planetary motion using the analogy of the spiral flight of a bird of prey attacking a fowl. As he put it in his *Collecta astronomica*, a planet performs a three-dimensional motion, namely (1) by orbiting around the sun, as the centre of the circumference that the planets describe; (2) by progressing along with the sun from east to west in a daily motion around the Earth; and finally (3) by descending from the apogee to the perigee of the eccentric.[25] Because of this helicoidal motion, planets sometimes appear to slow down their motions, stop and initiate a backward motion.

Thus, having established the variance of velocities according to the distance of the planets from the Earth and stating that the planets progress according to a three-dimensional motion, Borri was eventually in a position to explain all the 'celestial appearances' by means of a single motion. The helicoidal motion of the planets accounted not only for the proper motion of the planets and the fixed stars but also for the west-east motion, the direct, stationary and retrograde planetary motions, the eccentricities of the orbits and, finally, trepidation.[26]

Furthermore, the theory of the helicoidal motion of the planets could most significantly provide a hypothetical explanation for all the 'celestial appearances' without having to take into account heliocentric theory and particularly Kepler's theory of the solar system and elliptical orbs. It is thus not surprising that the Jesuit mathematicians who followed Borri in teaching astronomy in Lisbon endorsed this explanation of the celestial motion. As Stafford put it, around 1633:

21 Borri, *Collecta astronomica*, 175-81.

22 Borri, *Collecta astronomica*, 181.

23 Bocarro Francês, *Tratado dos cometas*, ff. 4*r*-5*r*. On the cosmology of Bocarro Francês, see Randles, *The Unmaking*, 100-1; Carolino, "Manuel Bocarro Francês".

24 A copy of Bocarro Francês's *Tratado dos cometas*, preserved in the Biblioteca da Ajuda (50/X/47), includes an explicit reference to its former owner: "Da livraria publica de S. Roque".

25 Borri, *Collecta astronomica*, 211-12. A description of Borri's theory can be found in Schofield, *Tychonic and Semi-Tychonic*, 227-9.

26 Borri devoted a substantial part of section III to proving this point. Borri, *Collecta astronomica*, 189-212.

> No celestial body presents a circular motion but a spiral one, with which its declinations vary; even if we admit that the stars have a motion from west to east, they cannot yet perform a circular motion according to Aristotle's definition *motus circularis est qui circa medium est*.[27]

The strict Aristotelians rejected this notion on the grounds that a natural body such as a planet could not move simultaneously in two distinct directions. Probably considering the sort of analogy of the flight of a bird of prey with which Borri explained the helicoidal path, Fallon argued that the "spiral motion [...] is not and cannot be considered two motions, but it comprises one simple movement, even if it is a mixed and composite one".[28]

Alongside the Lisbon mathematicians, this conception that celestial bodies moved according to a helicoidal orbit became popular among the Jesuit community of astronomers throughout the seventeenth century, being endorsed by figures such as Giovanni Battista Riccioli and Valentin Stansel.[29] These Jesuits also agreed on the existence of the Empyrean heaven. Although Tycho Brahe and the large majority of Protestants denied the existence of this metaphysical heaven, engaged in putting forward a coherent cosmology based on Tycho's geo-heliocentric system and consistent with the Catholic dogmas, the Jesuits argued that the universe was sealed by this resplendent heaven, where God, the Saints and the Blessed were supposed to live for eternity.

No physical evidence proved the existence of the Empyrean heaven; it was a central tenet of the Catholic Church. As Borri argued, "it must be acknowledged that it is a generally accepted and completely certain truth in the Church that there is the Empyrean heaven, the beautiful home of the Blessed".[30] Nevertheless, because of its nature and the lack of physical evidence, mathematicians refrained from discussing its characteristics. "In this treatise – John Rishton warned – we do not discuss the Empyrean heaven because its existence depends purely on the principles of faith and not on the natural sciences".[31]

The exception was Borri, who aimed to provide a comprehensive view of the 'machina mundi' consistent with Catholic theology in his *Collecta astro-*

27 Stafford, *Tractado das Theoricas*, BNP, cod. 4323, f. 81*v*: "nenhuma estrella tem mouimento circular, senão espiral com que varia [de] declinação, [a]inda que admitamos que as estrellas tem mouimento de occidente para oriente, não podem ter mouimento circular conforme a definição de Aristóteles, motus circularis est qui circa medium est". See also Stafford, *Tractado das Theoricas*, BNP, cod. 4323, ff. 90*r* ff.; *Elementos*, BA, cod. 49-II-80, ff. 18*v*,20*r*; *Elementos*, BNP, cod. 4256, f. 16*r*.

28 Fallon, *Compendio Spiculativo*, BNP, cod. 2258, 108*v*: "Respondemos que não, Spira não são, nem se podem dizer dous mouimentos, senão hum só, ainda que mixto e composto". See also Fallon, *Tratado*, BNP, cod. 2127, ff. 119*v*-120*r*.

29 Riccioli, *Almagestum novum*, Pars posterior, 253; *Astronomia reformata*, prolegomena, ff IV-V; Stansel, *Uranophilus*, 164. There has been recent interest in Riccioli. See, among others, Gambaro, *Astronomia e tecniche di ricerca*; Borgato, *Giambattista Riccioli*; Dinis, *A Jesuit Against Galileo?*; Marcacci, *Cieli in contraddizione*. On Stansel, a less studied yet no less interesting character, see above all Camenietzki, "Esboço Biográfico"; "Baroque Science"; "The Celestial Pilgrimages".

30 Borri, *Collecta astronomica*, 268: "Dicendum est veritatem esse communiter in Ecclesia receptam et omnino certam dari caelum empyreum pulcherrimum Beatorum domicilium".

31 Rishton, *Curso de Mathematica*, BNP, PBA. 54, f. 12*r*: "Advirtasse que neste tratado não desputamos do ceo impireo: porque a noticia deste depende puramente dos principios da fee, enão de sciencias naturaes".

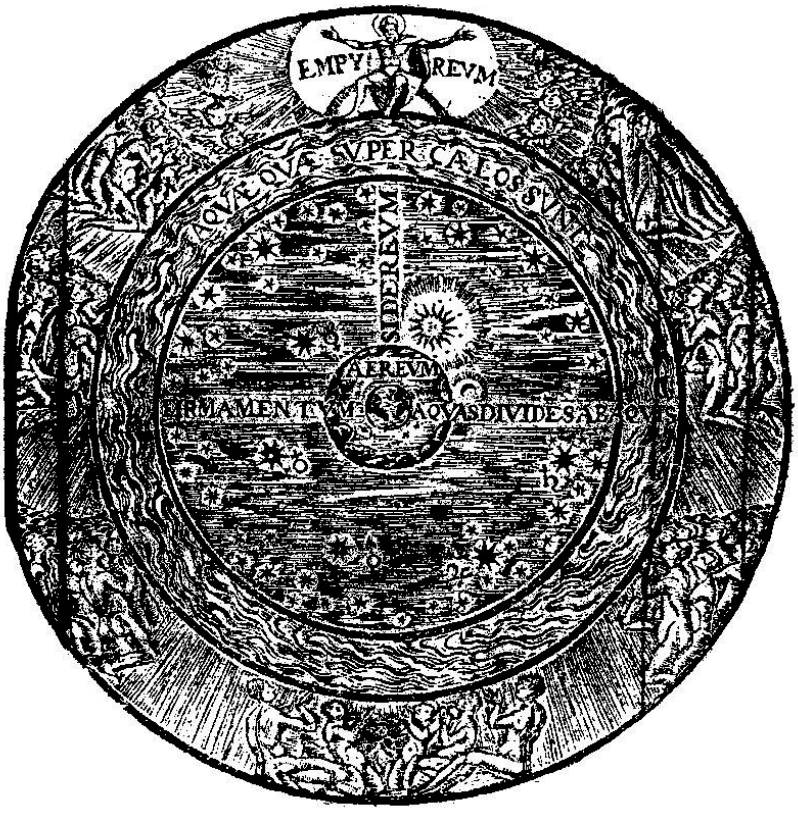

Figure 10 Cristoforo Borri's tripartite universe, sealed by the Empyrean heaven (Borri, *Collecta astronomica*, 293)

nomica and, therefore, entered into details on the nature of the Empyrean heaven.[32] According to the Italian Jesuit, God created the Empyrean heaven on the first day of Creation. Although imperceptible to human senses, it was supposedly the most perfect, incorruptible and luminous heaven. This superior heaven was most likely provided with a spherical shape and solid nature **[fig. 10]** and devoid of motion.[33]

Below the Empyrean heaven stood the sidereal and airy heavens, according to Borri. As already mentioned, he conceived the *caelum sidereum* as a fluid environment comprising the planets and fixed stars. Stafford and Fal-

32 Borri's purpose is clear in the front of his book, since the subtitle describes the *Collecta astronomica* as an "opus sane mathematicum, philosophicum et theologicum sive scripturarium". Randles (*The Unmaking*, 175-6) has considered this work to be "one of the last thorough attempts by a Catholic astronomer to integrate astronomy with the Bible".

33 Further details about Borri's conception of the Empyrean heaven can be found in Carolino, "O paraíso do astrónomo".

lon also endorsed the tripartite division of the universe.[34] Nevertheless, Fallon distinguished between the planetary heaven and the heaven of the fixed stars. According to the Irish astronomer, planets moved in a fluid inferior heaven, corresponding to the space extending between the Earth and Saturn (the planetary heaven). Above it, there was a solid heaven, wherein the fixed stars moved (the sidereal heaven) and, finally, the Empyrean heaven.[35]

In short, Stafford and Fallon shared basically the same sort of astronomical and cosmological ideas that had already been developed by Borri in his efforts to establish a Tychonic cosmology. Nevertheless, they introduced some variations of the initial outline proposed by Borri. The Santo Antão professors agreed to divide the cosmos into three heavens; however, whereas Borri and Stafford distinguished between the airy heaven, the sidereal heaven, wherein planets and the fixed stars moved, and the Empyrean heaven, Fallon preferred to allocate the planets to the heaven that extended from the Earth to Saturn, to which he added a solid heaven where fixed stars moved and, finally, the Empyrean heaven.[36] Nevertheless, Fallon agreed with Borri in sustaining that celestial bodies were pushed by angels, while Stafford argued that planets and fixed stars were moved by their own intrinsic nature. Both Stafford and Fallon maintained that celestial bodies followed a spiral path in their motion, an idea elaborated in detail by Borri in his *Collecta astronomica*.

As for the planetary rearrangement, Stafford and Fallon endorsed the Tychonic system, just as Gall and Borri had done before them. What is more, they unanimously considered the Tychonic system to be the accurate representation of the world.[37] As Fallon put it: "the order according to which the planets and the stars move, and therefore the constitution of the universe (*mundo*) that we follow as true, is that of Tycho Brahe".[38]

34 Stafford did not discuss this topic in detail. Nevertheless, since he argued, in his *Elementos astronomicos e geographicos*, that the planets as well as the fixed stars moved in a fluid heaven, he most likely assumed that all the celestial bodies move in the same heaven (the sidereal heaven). Stafford, *Elementos*, cod. 49-II-80, ff. 18*r*-18*v*; *Elementos*, BNP, cod. 4256, f. 16*r*.

35 Fallon, *Compendio Spiculativo*, BNP, cod. 2258, f. 107*r*.

36 Fallon, *Compendio Spiculativo*, BNP, cod. 2258, f. 107*r*. Stafford did not discuss this topic in his course on planetary theory.

37 Nevertheless, Santo Antão's Jesuits maintained that the Ptolemaic planetary system should serve as an instrument for planetary computations. Gall, *Tratado sobre a e*[*s*]*phera*, BNP, cod. 1869, f. 65*v*; Stafford, *Tractado das Theoricas*, BNP, cod. 4323, f. 100*v*.

38 Fallon, *Compendio Spiculativo*, BNP, cod. 2258, f. 105*v*.

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Capítulo 5. Poense a nossa e verdadeira hypothesi, que he a Tichoniana. Simon Fallon, *Compendio Spiculativo*, BNP, cod. 2258, ff. 105*v*-107*r*

Diguo em primeiro lugar, que do que dissemos nestes dous capítulos passados se colhe claramente ser fluido todo o espaço do concauo da Lua até Saturno inclusiuamente, porque de outro modo não he intelligiuel saluarense as apparencias, principalmente modernas.

Preguntará alguem, de que materia será este espaço? Respondemos que da mesma materia do ar, en que uiuemos, ainda que mais tenue, e defecado, porque a elle não chegão as exhalações e vapores, que condensão o nosso Ar: e por isso para distincão deste nosso ar, que diuidimos comumente nas três regiões, infima, mea e suprema, se pode chamar aquelle espaço Aura Etherea, ou Planetaria, por andatem por elle os Planetas.

Diguo en segundo lugar, que os Planetas não andão nesta aura etherea, liure, e irregularmente, como os pexes na agoa, e Aves no ar, senão com grande ordem e regularidade, descreuendo seus Periodos no Zodiaco, en tempos certos e determinados, como na hypothesi Ptholomeica.

Diguo en terceiro lugar, que a ordem porque se mouem os Planetas e estrellas, e conseguintemente a constituição do mundo, que seguimos como verdadeira he a seguinte de Tichobrahe. A terra A no centro do Vniuerso, ao redor o circulo BCD reprezenta o caminho da Lua, e a este se segue EFG caminho do Sol: do Sol como de centro, se descreuem os caminhos de todos os [f. 105*v*] mais Planetas, porque he certo que sempre guardão igual distancia delle, e assy o circulo HIK he o caminho de Mercurio: LMN o de Venus: o PQ o de Marte: o qual corta o caminho do Sol: RST o de Júpiter: VXZ o de Saturno: sobre o qual se seguem as estrellas fixas como tudo representa esta figura **[fig. 11]**:

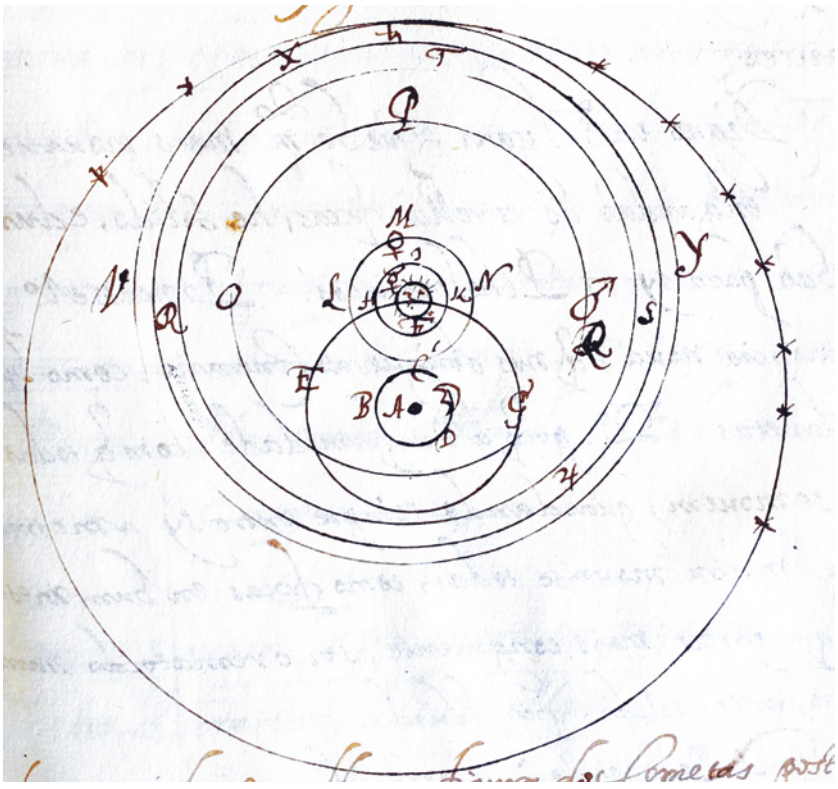

Figure 11 The Tychonic system according to Simon Fallon

Com a qual se entenderá melhor a figura dos Cometas posta no capítulo atraz.

Diguo en quarto lugar: que he prouauel, que o espaço, que occupão as estrellas fixas, he tambem da mesma materia fluida e tenue, como a Aura planetaria, sem distinção alguma, mais que serem as estrellas superiores no sitio, e ordem dos Planetas. Prouasse primeiro porque se não pode facilmente dar maior rezão de huma cousa, que da outra. Segundo, aquella estrella da Cassiopeia, de que falamos no capítulo passado, proua ser tambem fluido o espaço, en que ella andou, porque a materia della, ou forão varios corpos luminosos; que se poserão em conjunçam per modo de cometa digno, conjunção per modo de cometta, e depois se forão desunindo: ou foi na verdade estrella que sobio continuamente [f. 106*r*] a maior distancia, ate que de todo desappareceo. Terceiro, porque a Via Lactea he huma continua reuolução de estrellas mais meudas, que os semi-planetas de aura Planetaria.

Diguo en quinto lugar, que he muito mais prouauel que o espaço en que andão as estrellas fixas, he solido, e duro, na forma en que tinhão para sy os Ptholemaicos. Prouasse primeiro porque não há apparencia noua, que nos obrigue ao contrario, como há no espaço dos Planetas. Segundo porque a uniformidade, com que todas as estrellas se mouem, guardando sempre entre sy a mesma distancia, e ordem mostra mouerse todas, como fixas en hum mesmo corpo. Terceiro porque parece mais congruente ser o remate do mundo de parte conuexa, antes solido, que fluido.

Nem obstão as resões da opinião contraria, porque a primeira fica solta ex dictis. A segunda da estrella da Cassiopeia, diguo, que acerca de sua altura, ou distancia da Terra, somente [?] podia demonstrar, estar ella sobre Saturno (de Saturno para sima diremos adiante, não se poder saber certeza, por não auer Paralaxes) e como he prouauel, que o spaço fluido, e planetario não acaba onde está o corpo de Saturno, ainda quando em maior distancia, podiasse formar a dita estrella de varios semiplanetas, per modo de Cometa no espaço fluido, que há sobre Saturno, sem ser ainda na distancia, que tem as estrellas fixas da Terra. A terceira resão da Via Lactea, por ser confirmação da nossa opinião, a saber que consta não de semiplanetas, mas de semistrellas, que por guardarem sempre uniformidade, mostrão bem serem fixas [f. 106*v*] em algum corpo: Assy que por remate deste capitulo se auerigua que alem do Ceo Empireo, que Deos fez para seus Predistinados, não há outro ceo duro, e solido, tirando o en que estão as estrellas fixas, que pella conta tem o lugar do primeiro mouel: abaixo deste todo o espaço que há, não só até o concauo da Lua, mas ainda até a suprema superficie conuexa do nosso ar, que demonstramos no segundo tratado, ser en distancia de 52 milhas da Terra, he huma Aura Etherea, ou Planetaria, pella qual se mouem os Planetas, semiplanetas e cometas, com muita regularidade, na forma que reprezentão os circulos atraz e assy se pode dizer que são três ceos, Planetario, e Fluido, e Ethereo: o segundo sydereo, e fixo, o terceiro Empyreo. [f. 107*r*]

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English translation. Chapter 5. Our and the true hypothesis is proposed, which is the Tychonic one. Simon Fallon, *Compendio Spiculativo*, BNP, cod. 2258, ff. 105*v*-107*r*

I declare, in the first place, that we conclude, based on what we have said in the two preceding chapters, that the whole space from the concave of the Moon to Saturn, including it, is fluid because otherwise, it is not clear how the [celestial] appearances, especially the modern ones, could be saved.

Some may ask, what is this space made of? We answer that it is made of the same matter as the air in which we live, although it is more subtle and purified because the exhalations and vapours that condense our air do not reach it. And for this reason, in order to distinguish it from our air, which we commonly divide into three regions [i.e. the airy region], the lowest, the middle and the highest region, we may call that superior air *Aura Aetherea* or Planetary Aura, because the planets move in it.

I declare, in the second place, that the planets do not move freely and irregularly in this *Aura Aetherea*, like fishes in water and birds in the air, but move with perfect order and regularity, describing their motions in the Zodiac, in precise and determined periods, as in the Ptolemaic hypothesis.

I declare, in the third place, that the order in which the planets and stars move, and consequently the constitution of the world that we follow as the true one, is that of Tycho Brahe. The Earth A [is] in the centre of the universe; around it, the circle BCD represents the Moon's path; then follows the Sun's orbit, EFG; all the planets describe their paths [f. 105*v*] having the Sun as the centre of their orbits because there is no doubt that they are always at the same distance from it. Thus, the circle HIK is the path of Mercury; LMN, that of Venus; PQ, that of Mars, which cuts the orbit of the Sun; RST, that of Jupiter; VXZ, that of Saturn, upon which the fixed stars follow, as the figure represents **[fig. 11]**.

With this figure, it will be easier to understand the orbits [*figura*, 'figure'] of the comets referred to in the preceding chapter.

I declare, in the fourth place, that it is likely that the space occupied by the fixed stars is also of the same fluid and tenuous matter as the planetary *aura*, with no distinction apart from the fact that they stand in a superior position and order of the planets. This is proved, firstly, because one cannot easily give stronger arguments in favour of one rather than of the other position. Secondly, the star of Cassiopeia, about which we have spoken in the last chapter, proves that the space in which it moved was also fluid because its matter was either several luminous bodies, which were placed in conjunction in the manner of a comet (I say, in conjunction in the manner of a comet) and dissolved afterwards, or it was in truth a star that ascended continually [f. 106*r*] to the greatest altitude until it disappeared completely. [We prove it], because the Milky Way consists of a continuous revolution of stars, which are finer than the semi-planets of the planetary aura.

I declare, in fifth place, that the space in which the fixed stars move is much more likely a solid and hard body, as the followers of Ptolemy stand for themselves. This is proved, firstly, because no new appearance compels us to admit the opposite, as it occurs in the planetary area. Secondly, the uniformity with which all the stars move, always keeping the same distance

and order, shows us that they all move as fixed in the same body. Thirdly, it seems more appropriate for the limit of the world, in its convex part, to be solid rather than fluid.

Nor do the reasons in favour of the contrary opinion stand, because the first is resolved *ex dictis*. The second reason, on the star of Cassiopeia – I mean the reason based on its height or distance from the Earth – could only prove that it was placed above Saturn (above Saturn – we shall say later – it cannot be known for sure, because there is no visible parallax) and since it is probable that the fluid and planetary space does not finish where the body of Saturn is, even if is at a greater distance, the said-star could be formed from several semi-planets as a comet in the fluid space above Saturn, without being in the space of the fixed stars towards the Earth. The third reason, on the Milky Way, is a confirmation of our opinion that it does not consist of semi-planets but rather of semi-stars. The fact that they keep the same regularity indicates that these semi-stars are well fixed in some body. Thus, in closing this chapter, it is held that, beyond the Empyrean heaven, which God made for his Predestined, there is no other hard and solid heaven than that in which the fixed stars are found, occupying the place of the first mobile. Below this, the whole space that exists, not only down to the concave of the Moon, but still down to the supreme convex surface of our air – which we have shown in the second treatise to have a distance of 52 miles from the Earth – is made of an *Aura Aetherea* or Planetary Aura, in which the planets, semi-planets, and comets move, with much regularity, in the way represented above. Thus, one must argue that there are three heavens, the planetary heaven, fluid and aethereal; the second, the sidereal heaven, fixed; the third, the Empyrean heaven. [f. 107*r*]