3 The Celestial Novelties

João Delgado taught his students in the Class on the Sphere that the heavens were perfect bodies and, therefore, devoid of any process of generation and corruption. Nevertheless, several celestial novelties seemingly indicated otherwise. In the period that spanned from 1572 to late 1618, a series of bright *novae* (namely those of 1572, 1600 and 1604) and great comets (particularly those of 1577 and 1618) appeared in the skies around the world, drawing the attention and curiosity of astronomers, scholars, *virtuosi* and countless readers of the popular booklets and astrological almanacs that overstocked the European markets and piazzas at the time. These celestial novelties tore down the traditional worldview. They showed that the process of coming to be and passing away also took place in the heavens, demolishing the ontological divide between the celestial and the terrestrial region that structured the Aristotelian worldview. In addition, the movement of comets proved that celestial spheres could not exist, challenging the principle of celestial solidity that Clavius, Delgado and the Jesuit mathematical community keenly advocated at the turn of the seventeenth century.[1]

The astronomical observations carried out by Galileo around 1610 using a brand-new instrument – the telescope – not only corroborated these events but also posed new challenges. As astronomers quickly realised, the observations of Venus's phases, the four satellites of Jupiter and the apparent three-bodied Saturn denied celestial solidity. They suggested furthermore that celestial bodies could revolve around centres other than the

1 On the overwhelming impact of the celestial novelties on the astronomical and cosmological debate, see, among many others, Granada, *Novas y Cometas* and Tessicini, Boner, *Celestial Novelties*.

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Earth. This being the case, Christoph Clavius urged his fellow mathematicians to work out a solution. As he mentioned in the last edition of his celebrated *Commentarius in sphaeram Ioannis de Sacro Bosco*, published in Mainz in 1611, shortly before his death:

> Quae cum ita sint, videant Astronomi, quo pacto orbes coelestes constituendi sint, ut haec phaenomena possint salvari.
>
> As this is so, astronomers ought to see how the celestial orbs may be arranged in order to save the phenomena.[2]

The professors who taught astronomy at the College of Santo Antão in the 1610s and the 1620s were in an excellent position to respond to Clavius's plea. This was particularly the case with Giovanni Paolo Lembo, who taught in the Class on the Sphere between 1615 and 1617. Born in Benevento, in Campania, Southern Italy, Lembo, upon completing his philosophical studies at the Jesuit College of Naples moved to Rome in 1607, probably on the suggestion of his Naples mathematics professor, Giovanni Giacomo Staserio (1565-1635), to study theology and mathematics with Clavius.[3] At that time, the 'Academy of Mathematics' run by Clavius at the Collegio Romano gathered a group of advanced students, which included Christoph Grienberger, Odon van Maelcote (1572-1615), Paul Guldin (1577-1643) and a few others.

At the Collegio Romano, Lembo became one of Clavius's closest collaborators.[4] He was indeed the first to attempt to produce a telescope for the use of the Roman Jesuit mathematicians between 1610 and 1611. As Christoph Grienberger revealed in his well-known letter addressed to Galileo on 22 January 1611, in which he made a case for the independence of the early Jesuit telescopic observations from those of Galileo, Lembo had produced the first rudimentary telescope by the spring or summer of 1610, even though this first effort did not enable him to observe Jupiter's moons. As Grienberger informed Galileo:

> before hearing anything about [your instrument], [Lembo] had made some spyglasses himself; not by imitation of others, but rather by the power of inference. He observed both the lunar irregularities and the multitude of stars in the Pleiades, Orion, and other [constellations], but he did not see the new planets.[5]

A few months later, by late October or early November of 1610, Lembo, with the help of Grienberger, managed to produce a superior instrument that did enable them to observe the satellites of Jupiter whenever optimal viewing conditions prevailed. Nevertheless, in late November, the Jesuits in Rome received a much better telescope, sent to them by Antonio Santini, a mer-

2 Clavius, *Opera mathematica*. Vol. 3, *In sphaeram* (1611), 75.

3 A biography of Lembo, with detailed description lecture notes for the course that he gave at the College of Santo Antão, features in Baldini, "Giovanni Paolo Lembo's Lessons in Lisbon", 126-45.

4 On Lembo's involvement in the astronomical observations carried out in Rome, see also Bucciantini, Camerota, Giudice, *Galileo's Telescope*, 208, 210-11. See also Reeves, van Helden, "Verifying Galileo's Discoveries".

5 Galilei, *Le Opere*, 11: 33-4, translation by Lattis, *Between Copernicus and Galileo*, 185.

chant in Venice. Apart from allowing better observations of the satellites of Jupiter, this instrument enabled the Collegio Romano Jesuit mathematicians to start studying Venus.[6]

On the night of 17 January 1611, after a systematic series of observations, Lembo and the Collegio Romano Jesuits observed Venus in conjunction with the Moon. As Grienberger mentioned, the observation conditions were particularly favourable as Venus seen through the telescope appeared quite similar to the Moon viewed with the naked eye.[7] In Lisbon, Lembo's College of Santo Antão lecture notes would provide additional details on the Jesuit Venus observation programme. In reference to this specific observation, Lembo reported that "the masters of theology, philosophy and mathematics of the Collegio Romano, who were almost all there, did ingenuously confess to seeing two Moons".[8]

In April 1611, Clavius would himself acknowledge the central role played by Lembo in the Collegio Romano telescopic saga. On 19 April, Cardinal Roberto Bellarmino sent a letter to the Collegio Romano mathematicians asking for their opinion on the new celestial phenomena observed through the telescope, some of which Bellarmino had already seen for himself. Aware of the different views on the physical reality of these appearances (*perché ne sento parlare variamente*),[9] Bellarmino wanted specifically to know whether they agreed on the existence of a multitude of fixed stars invisible to the naked eye and, particularly, whether the Milky Way and nebulas were made up of very dim stars; whether Saturn was not a single star but rather a unit of three stars; whether Venus waxed and waned like the Moon; whether the Moon had a rough and uneven surface; and, finally, whether there were actually four stars moving differently around Jupiter.[10]

In conjunction with Grienberger and Maelcote, who would deliver the famous oration *Nuntius Sidereus Collegii Romani* when Galileo paid a visit to the Roman Jesuit College in May, Clavius made Lembo sign the letter of response to Bellarmino, dated 24 April. In this missive, the four Jesuit astronomers responded affirmatively to each of the five queries. They thereby recognised how telescope observations had revealed that there were indeed a great number of stars in the nebulas of Cancer and Pleiades, though it remained not entirely clear whether the Milky Way was made up of minute stars; that Saturn was not round like Jupiter and Mars, although they were unable to see three distinct stars clearly; that Venus did actually wax and wane, although they said nothing about its potential cosmological implications; that the Moon's surface did appear to be uneven, even though Clavius attributed this appearance to variations in the density of the Moon's body; and, finally, that there were four stars moving quickly and almost in a straight line around Jupiter.[11]

Thus, apart from being the Collegio Romano's principal telescope maker, Lembo was one of the *Clavisti* who first observed the celestial novelties re-

6 Galilei, *Le Opere*, 11: 34.

7 Galilei, *Le Opere*, 11: 34

8 Lembo, *Tratado da Esfera*, ANTT, MS Liv. 1770, f. 33*v*.

9 Galilei, *Le Opere*, 11: 88.

10 Galilei, *Le Opere*, 11: 87.

11 Galilei, *Le Opere*, 11: 92-3.

vealed by Galileo. Having started these astronomical observations in Rome, in October 1610, with recourse to two telescopes – as he informed the Portuguese audience[12] – he continued his astronomical programme while in Lisbon in 1615.[13] In the Portuguese capital city, the Campanian Jesuit replicated some of these observations, particularly those of the phases of Venus and, to a lesser extent, Mercury. There, according to him, he "showed [the phases of Venus] not only to my students (*ouvintes*), but also to several other *virtuosi* (*pessoas curiosas*)".[14] Lembo also wished to continue his observational programme by studying Mars in greater detail. In 1615, he had already started observing Mars but wished to carry out further observations later that year. As he informed his students, "we will see later [the orbit of Mars with regard to the Sun] after a few observations of this very same planet [Mars] that we aim to carry out with a greater diligence this year if God wishes".[15] No documentary evidence exists of these later telescopic observations of Mars. In 1617, Lembo became seriously ill and, upon finishing his lessons in Lisbon, he returned to Italy. He died in Naples in May 1618, most likely from tuberculosis.[16]

In the Class on the Sphere, Giovanni Paolo Lembo was succeeded by a couple of professors who were also particularly suited to approaching Clavius's plea to work out an astronomical solution to the Galilean challenging discoveries of 1610: Johann Chrysostomus Gall and Cristoforo Borri. Although there is no concrete evidence that these Jesuits performed astronomical observations while living in Lisbon, they were both experienced astronomical observers.[17] Apart from presenting exhaustive descriptions of the observational account of the celestial novelties, they described their own astronomical experience. Thus, for example, Gall reported to his 1621 students of the Class on the Sphere, that

> we sighted and observed a comet in 1618, which our father Baptist Cysat, public professor of mathematics at the University of Ingolstadt, demonstrated, with great erudition, that stood above Venus.[18]

Before coming to Lisbon to teach mathematics at the College of Santo Antão and then embarking to India as a missionary in late 1629, Gall studied at the

12 Lembo, *Tratado da Esfera*, ANTT, MS Liv. 1770, f. 33*r*.

13 In Lisbon, Lembo also provided his students with very brief and practical instruction on how to build a telescope. Lembo, *Tratado da Esfera*, ANTT, MS Liv. 1770, ff. 135*r*-136*r*. See Leitão, "Galileo's Telescopic Observations", 910-11.

14 Lembo, *Tratado da Esfera*, ANTT, MS Liv. 1770, f. 33*v*.

15 Lembo, *Tratado da Esfera*, ANTT, MS Liv. 1770, f. 36*r*: "Veremos depois de algumas observacoins que com mais deligençia este anno querendo Deos faremos açerca do mesmo planeta".

16 Baldini, "Giovanni Paolo Lembo's Lessons in Lisbon", 145.

17 Nevertheless, the fact that Gall complained of not having an adequate telescope to observe Saturn's "satellites", in 1625, might suggest that he had at his disposal some other instrument of inferior quality. In his words: "I cannot solve this question through my observations because no ordinary telescope is adequate to reach the distance and [to observe] the constitution of the mentioned two companions [of Saturn]" ("Eu não acabo de resoluer por minhas obseruacoes porque não qualquer ocolo basta para alcancar a distancia ou constituição dos dittos dois compaheiros [de Saturno]"); Gall, *Tratado sobre a e*[*s*]*phera*, BNP, cod. 1869, f. 63*r*.

18 Gall, *In Sphaeram*, BGUC, MS 192, f. 17*v*: "Nos uimos, e obseruamos no anno de 1618 outro que o nosso padre Bautista Sizado publico profesor da mathematica na uniuersidade de Ingolstadio, com grande erudição demonstrou que ficaua sobre Venus".

University of Ingolstadt. There, he collaborated with Cysat, Scheiner and probably Johann Lanz (1564-1638) in the astronomical observations carried out at this university, the bastion of Catholic education in Southern Germany.[19] In Lisbon, the German Jesuit followed the astronomical activity of his confrères, not only in Europe but also in the East. As he stated:

> The fact that comets display movements that differ from those of the planets constrains us to attribute them distinct orbs from those of the planets. This last comet [of 1618] and the works of the above-mentioned mathematicians and those of Tycho, showed it to us. Letters addressed by our priests from Ethiopia, China and India also established it. Letters from Ethiopia reported that one of those two comets, which appeared less than a couple of years ago, moved southwards while the other northwards. But from China, news came that only one moved to the south. We observed the other comet moving to the north. This kind of movement has been observed neither in the planets nor in the fixed stars. A letter addressed from Cochin, which we received this year, corroborated this view as – apart from many other particular things – [it showed that] the movements either of trepidation or libration are not so fast, nor so great, nor are they made simultaneously to the south and the north.[20]

Gall did not identify the missionaries to whom he was referring. He might be alluding to Antonio Rubino (1578-1643), who observed the comet in Cochin while serving as rector of the city's college before departing for Japan,[21] or even to the Milanese Jesuit Cristoforo Borri, who would eventually replace him in the mathematical chair of the College of Santo Antão. Before coming to Portugal, Borri had carried out missionary work in Asia, having lived in Goa, Macao and Cochinchina (now Laos and Vietnam), where he observed the first of the 1618 comets. Additionally, he managed to establish a correspondence network across Asia that allowed him to conclude that the comets of 1618 moved in the celestial region. As he put it in his *Collecta astronomica*, a book destined to exert a profound influence on the Portuguese intellectual milieu:

> I carefully observed [the first comet of 1618] in the kingdom of Annam, generally called Cochinchina by the Portuguese. Father Jan Wremann, a Dalmatian, of the Society of Jesus, formerly professor of mathematics in

19 On Gall's biography, see Baldini, "L'insegnamento della matematica", 286-7.

20 Gall, *In Sphaeram*, BGUC, MS 192, ff. 18*r-v*: "Auermos de dar à estes cometas distintos orbes dos orbes dos planetas nos constrangem a isso seos mouimentos desimilhantes a todos os mouimentos dos planetas como uimos neste ultimo cometa [de 1618] e se pode uer assi nos mathematicos alegados, como tambem nas obras de Tycho o que confirmam cartas de nossos padres escriptas da Etiopia, China e India porque de Etiopa se escreue que hum daquelles dous cometas que a menos de dous annos aparecerão se mouia para o Sul, o outro para o Norte: porem da China só se fas menção do mouimento de hum delles, a saber daquelle que se mouia para o Sul, o outro nos o uimos mouerse para o norte. Os quais mouimentos nunqua forão obseruados, nem nos planetas, nem nas estrellas fixas, como bem se nota em huma carta, que este anno nos escreuerão de Cochim, porque os mouimentos ou de tripidação ou de libração, não sam tam aprecados, nem tam grandes, nem se fazem iuntamente para o sul e para o norte alem doutras muitas couzas em que differem".

21 Kirwitzer, *Observationes Cometarum*.

> Coimbra[22] and expert in that science, and companion on my journey from Portugal to China, also observed it in China. He collaborated with me not only in the observations concerning this comet, but also in other observations and always agreed with me. Father Manuel Dias, a Portuguese theologian and a very clever professor of philosophy from the Society of Jesus, observed the same comet in India, in the city of Cochin, and wrote a treatise against those who still considered, according to the outdated view, that comets are sub-lunar and elemental bodies.
>
> I, let me say, together with Father Jan Wremann, separated by a great distance, having compared together the data through letters, both unanimously concluded that that comet (whatever the Peripatetics' suppositions) was a celestial body and far above the Moon.[23]

Upon returning to Europe, Borri continued his astronomical observations. On the night of 6 July 1627, for example, he observed, in Coimbra, the Moon's surface using a telescope that probably belonged to André de Almada, a nobleman and Professor of Theology at the University of Coimbra.[24] His students in the Class on the Sphere were properly informed about these astronomical observations and their results.[25]

In short, the professors who taught mathematics at the College of Santo Antão were utterly familiar with the celestial novelties that deeply challenged the traditional worldview at the turn of the seventeenth century. As skilled astronomers, they knew what was at stake. From this point of view, they had the full credentials to follow Clavius's appeal to work out an astronomical solution, but what sort of solution did Clavius have in mind when he urged the astronomers "to see how the celestial orbs may be arranged in order to save the phenomena?"

22 Although Borri mentioned that Wremann had taught mathematics in Coimbra, according to Baldini, he was responsible for a private course on mathematics at the Lisbon College, in 1614-15, just before he went to China. See Baldini, "L'insegnamento della matematica", 285-6.

23 Borri, *Collecta astronomica*, 117[115]-6: "Ita egomet non negligenter observavi in Regno Annam vulgo a Lusitanis Cocincina dicto. Observavit etiam in regno sinarum Pater Ioannes Vremanus Dalmata e Societate Iesu, Conimbricae olim Mathematicarum professor, et in hac scientia versatissimus, et mearum peregrinationum a Lusitania ad Sinas usque comes, et socius. Is autem non solum in ijs, quae ad hunc cometam pertinent, sed et in plerisque alijs astronomicis observationibus mecum collaboravit, et consentaneum semper observationibus meis fuit. Item P. Emmanuel Diaz lusitanus theologus, et philosophiae professor acutissimus e Societate item Iesu observavit eundem cometam in India in civitate Cocin; qui quidem tractatum scripsit contra eos, qui etiam num iuxta antiquam opinionem cometas putarent esse sublunares, et elementares.

Ego, inquam, et P. Ioannes Vremanus longissimo terrarum tractu dissiti, cum per litteras simul contullissemus, unanimi consensu ambo conclusimus comentam hunc, quidquid Peripatetici sentiant, caelestem fuisse, et Luna multo superiorem".

24 Borri, *Collecta astronomica*, 137.

25 See, for example, Borri, *Nova Astronomia*, BGUC, MS 44, ff. 94*v*-5*r*.

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Lembo's telescopic observations of Venus and Mercury in Rome (1610-11) and Lisbon (1615). Giovanni Paolo Lembo, *Tratado da Esfera*, ANTT, MS Liv. 1770, ff. 33*r*-34*r*

Nestas ultimas pallauras em que o Padre Clauio se remette à obseruação dos Astronomos no modo com que se deuem saluar as Phenomenas que nestes nossos tempos se descobrirão e virão com o occulo nouamente inuentado pareçe que nos dá licença de por os orbes caelestes em hordem algum tanto diuersa do que elle com os demais Astronomos ordenou.

E ainda que eu me não tenha na conta daquelles a quem o Padre Clauio remeteo a obseruação disto contudo não deixarei de referir aquellas cousas que ha annos obseruei nos planetas por meo do mesmo occulo e as mostrei ao padre Clauio para que as visse das quoaes podera cada hum colher se por uentura os orbes caelestes se deuem ordenar de outro modo para saluar as Phaenomenas.

No anno pois de 610 tomando o occulo grande no mez de Outubro no principio da noute e vendo a Venus aduerti que na parte mais oriental e que mais ficca apartada do Sol, tinha algum deffeito da luz, o que eu no principio atribuia ao mesmo occulo porque não me podia persuadir que venus tiuesse a tal falta de luz, ou não fosse perfectamente redonda, mas fazendo a mesma experiençia muitas vezes hora com hum occulo hora com outro e vendo que sempre lhe ficcaua o mesmo deffeito na mesma parte detreminei de lhe buscar a causa com mais dilligencia dalli por diante repetindo as obseruaçoins o que fiz e achei que não somente o tal deffeito perseruaua na mesma parte mas que tambem se fazia maior cada vez mais e que iuntamente a mesma estrella appareçia maior no seu diametro visual de modo que indo os dias e a experiençias por diante à vespora de Santo Antonio Abbade 17 dias de Janeiro estando Venus junto da lua e estaua então a lua no quarto dia depois [f. 33*r*] de conjunção com o Sol pouco mais ou menos vista pello occulo pareçia de tanta grandesa em seu diametro visual, de quanta a lua sem occulo se mostraua; e com pontas do mesmo modo que a lua: de maneira que os mestres de Theologia, Philosophia e Mathematica do Colegio Romano que quasi todos alli se acharão ingenuamente confessauão que uião duas luas. A mesma obseruação fiz os meses passados estando iá aqui em Lixboa e a mostrei não somente a meus ouuintes; mas tambem a outras pessoas curiosas (muitas) que a virão com pontas do mesmo modo que a lua ao prinçipio menores depois maiores cada vez mais, falo com testemunhas de vista.

Depois da Coniunção com o Sol, estando Venus no seu perigeo do Epiçiculo conforme à comum oppenião que se explica nas Theoricas dos Planetas logo que se pode ver liure dos Rayos do Sol, vi o que dantes aduinhaua que áquelle deffeito da luz ficcaua para à parte occidental do mesmo modo que o deffeito da lua antes de se juntar com o Sol, no tempo da madrugada e depois correndo o tempo obseruei que o mesmo deffeito se fazia cada vez menor e que juntamente o semediametro visual de Venus se hia deminuindo atee que finalmente appareçia redonda mas em diametro visual muito pequeno, tanto que este diametro visual não tinha nem a baixa [?] parte daquelle com que Venus appareçia quando tinha maiores pontas. E depois da conjunção de Venus com o Sol no Appogeo, obseruei que aquelle deffeito successiuamente outra vez hia sobindo pouco e pouco, atee tornar as mes-

mas apparencias, que de primeiro e assim aduerti que fasia todos os annos mostrandosse hora chea hora meia chea, hora com pontas com as mesmas mudanças que a lua comforme e uariedade e tempo do seu periodo; Isto que em Venus se obseruou senão pode obseruar em Mercurio com a mesma dilligencia com que se obseruou em Venus [e] a lua porque o Sol nolo tira quasi sempre de vista, por se não apartar delle hum signo enteiro, e outra por ser muito pequeno, de modo que escassamente se podem aduertir os defeitos que padeçe, quoando se pode ver, mas quoando pude coniecturar assi em Roma aonde algumas vezes o obseruei vespertino e o mostrei a outros para o obseruarem como a Venus como tambem muito mais aqui em Lixboa o mez passado de Março quoando semelhantemente desçia para baxo, vespertino ao Perigeo do Epiciclo desde os 24, 26 dias atee o ffim do mez obseruei dilligentissimamente quasi todos os dias appareçia não de outro modo do que en Venus, nelle algum deffeito na parte contraria ao Sol, donde se pode conjecturar estar sogeito aos mesmos deffeitos que Venus. Sendo isto assim, e nem Venus nem mercurio se afastem tanto do Sol; que se possão oppor por diamentro, ou pella quarta parte do ceu, como a lua se oppoem ao Sol pera nelles se poderem ver as variedades que cada mez vemos e experimentamos na Lua; necessario he que pera saluar as apparençias que referimos tão semelhantes as da lua: confessemos que Venus e mercurio se mouem ao redor do Sol e que hora abaixo [ora] assima delle: hora antes, hora depois delle fasem seu curso como tambem se pode collegir das uarias oppenioens dos antigos dos quoaes huns poserão estes dois planetas assima outros abaixo do Sol, e na verdade huma e outra cousa podia constar das apparençias porque [f. 33*v*] pode mui bem aconteçer que no tempo das obseruaçoins se achassem humas vezes em çima outras abaixo do Sol e assim os que os poserão em çima do Sol disserão verdade conforme as obseruaçoins em que assim appareçeo e os que os poserão abaixo tambem fallarão verdade conforme as suas obseruaçoins em que os virão abaixo do Sol. [f. 34*r*]

Document II

English translation. Lembo's telescopic observations of Venus and Mercury in Rome (1610-11) and Lisbon (1615). Giovanni Paolo Lembo, *Tratado da Esfera*, ANTT, MS Liv. 1770, ff. 33*r*-34*r*

In these last words, in which father Clavius refers to the need for astronomical observations to save the phenomena that have been discovered and seen in our time through the newly invented telescope [*occulo*, i.e. 'eyeglass' or 'monocle'], he seems to permit us to organise the celestial orbs in a different order from that that he and other astronomers had conceived.

And even though I do not consider myself among those to whom father Clavius recommended this observation, I cannot ignore what I observed on the planets some years ago through the same telescope [*occulo*] and showed to father Clavius. From these [observations], each one can conclude whether we should rearrange the heavenly orbs differently to save the phenomena.

In October 1610, at the beginning of the night, while observing Venus with the large telescope, I noticed that there was some imperfection in the light at the easternmost part of its body, which was the farthest from the Sun. I first attributed it to the telescope because I could not persuade myself that Venus had such a lack of light or was not perfectly round. But, having repeated the same observation on several occasions, sometimes with one and sometimes with another telescope, and seeing that the same imperfection always remained in the same part of Venus, I decided to seek its cause more carefully by repeating the observations from then on.

I did so, and I realised that this imperfection not only persisted on the same part but also increased. The visual diameter of this imperfection and the star appeared to get bigger. Days and experiences [i.e. observations] progressed and on the eve of St. Anthony Abbot's day, 17 January, being Venus close to the Moon, which was then on the fourth day after [f. 33*r*] the conjunction with the Sun, while observing through the telescope, [I realised that] its visual diameter seemed to be as large as that of the Moon viewed through the naked eye, with its edges in the same way as the Moon, so that the masters of theology, philosophy and mathematics of the Collegio Romano, who were almost all there, did ingenuously confess to seeing two Moons. I repeated the same observation when I was already here in Lisbon, and I showed it not only to my students (*ouvintes*) but also to several other *virtuosi* (*pessoas curiosas*), who saw it with the same edges as the Moon, first smaller and then bigger – I declare this with support of sight witnesses.

After the conjunction with the Sun, being Venus at the perigee of the epicycle, upon getting rid of Sun's rays – according to the common opinion explained in the Theories of the Planets – I observed that that imperfection of light stood in the western part of its body, similar to what the Moon experiences before joining with the Sun at dawn, as I had previously foreseen. Later I observed that the same imperfection of light, together with the visual semidiameter of Venus, was diminishing up to the point where Venus finally appeared with a round shape but with a tiny visual diameter. This visual diameter was so small that it was not even comparable to that that Venus exhibits when it appears provided with larger edges. After the conjunction of Venus with the Sun at the apogee, I observed that this imperfection increased again little by little until it reached the same appearance it had in-

itially. And so, I concluded that this phenomenon happens every year, with Venus sometimes appearing full, sometimes half-full, sometimes with edges, with the same changes displayed by the Moon according to the passage of time and its cycle. This phenomenon, which was seen on Venus, cannot be observed with the same diligence on Mercury because the Sun almost always takes Mercury out of our sight as it does not move away from it one entire sign, and also because Mercury is tiny. So even when you can see Mercury, you hardly observe the phenomena it suffers. I came to this conclusion while in Rome, where I observed this planet sometimes in the evening and showed it to others so that they could see it like Venus. I repeated the observation of Mercury here in Lisbon, where I observed it more often during last March, when Mercury moved during the evening downwards in the epicycle's perigee. I observed it diligently almost every day from the 24th and 26th until the end of the month, and it appeared no different from Venus, with some imperfection on the opposite side of that of the Sun. One can conjecture from this observation that Mercury is subjected to the same phenomena as Venus. Despite the fact that we cannot see and observe [in Venus and Mercury] the same variations displayed by the Moon because neither Venus nor Mercury are so far from the Sun that, while in opposition, they are a diameter or a fourth part of the sky away from it, as the Moon does regarding the Sun, to save their appearances, which are so similar to those of the Moon, we must confess that Venus and Mercury move around the Sun and that sometimes they are below it and sometimes above, sometimes they move before it and sometimes after. The same conclusion follows from the various opinions of the Ancients, among whom some authors placed these two planets above the Sun and others below it. In fact, both views are consistent with the phenomena because [f. 33*v*] Venus and Mercury sometimes stand above the Sun and sometimes below it. Accordingly, those who put them above the Sun were right, according to their observations, because these revealed that the planets were in such positions. The other authors who claimed that Venus and Mercury are below the Sun were also right because they had observed the planets moving below the Sun. [f. 34*r*]