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## Studies in Renaissance and Early Modern Science

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# GALILÆANA
## Studies in Renaissance and Early Modern Science

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# – ESSAYS –

# Longomontanus' *De maculis in Luna* and the determination of terrestrial longitudes

Gonzalo Luis Recio
Universidad Nacional de Quilmes/Universidad Pedagógica Nacional
gonzalo.recio@unipe.edu.ar

**Abstract**
In *Astronomia Danica*, Longomontanus provides a method for calculating the terrestrial longitude for a given location on Earth. To do so, he relies on precise calculations of the lunar position so that he can know when he is observing it without any parallax in longitude. As I will show, this method has a fatal flaw that renders it unusable. However, Longomontanus also provides a simple observational method that indicates, via the disposition of the lunar spot and/or horns, the time when the Moon shows no parallax in longitude. This last method, though it does not need any use of tables, also has some problems. In this paper I will explain in detail these methods provided by Longomontanus, together with the problems they carry.

**Keywords**
Longomontanus, Galileo Galilei, longitude problem, Astronomia Danica, Renaissance astronomy

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## *Introduction*

In *Almagest* V, 3 Ptolemy gives a fairly detailed account of his study on the second lunar anomaly.[1] In order to do so, he uses some observations of the lunar elongation throughout the synodic month. For those observations to be useful though, they had to fulfill a set of conditions. Even if Ptolemy did not always follow his own advice, the criteria listed in that section are indeed necessary to carry out the investigation Ptolemy had in mind. It is of particular interest to us to look at the third condition given by Ptolemy: he says that at the times of observation, "[ ... ] the moon had no longitudinal parallax".[2] At this stage of the *Almagest* Ptolemy still had no theory of lunar parallax, so it makes sense for him to look for moments when he knew that the Moon was not affected by it, at least regarding its position in longitude. To show that the first of the observations he gives is indeed free of parallax problems, Ptolemy tells us that at the time "The apparent position of the moon was ♏ 9 °, and that was its true position too, since when it is near the beginning of Scorpius, about 1 ½ hours to the west of the meridian at Alexandria, it has no noticeable parallax in longitude".[3] But why is that?

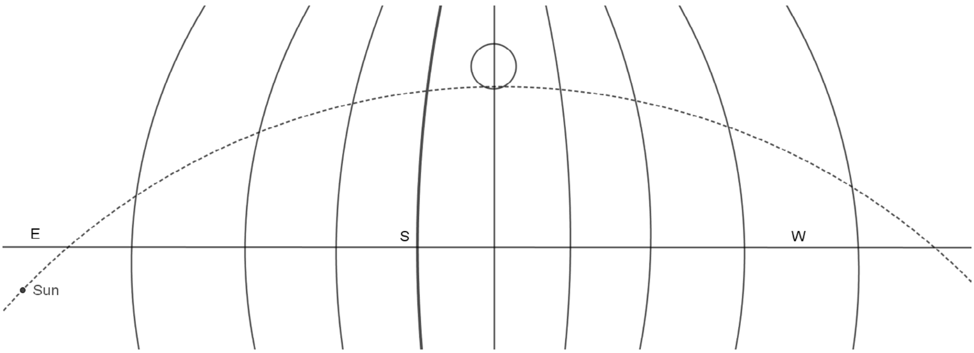


Figure 1. Stereographic projection of Alexandria's southern horizon during Ptolemy's observation (Feb 9, 139 in the morning). The horizontal line ESW is the horizon. All the lines perpendicular to the horizon are altitude circles, with the meridian represented by a thicker line. The west is to the right of the image, and the east is to the left. The dashed curve that intersects the horizon twice is the ecliptic. The Sun is on the east and has yet to rise. The Moon is some degrees to the west of the meridian, just as Ptolemy says. It can be seen that the altitude circle of the Moon intersects the ecliptic at a 90° angle.

1 Toomer, *Ptolemy's Almagest*, 222.
2 *Ibid.*, 223.
3 *Ibid.*

Refer to Figure 1. The Moon is to the west of the local meridian, which crosses the horizon to the south. As the figure shows, the altitude circle of the Moon is at that time intersecting the ecliptic at a right angle. It can be proven that, with respect to the longitudinal component of the lunar position, this configuration allows the observer to see the Moon as if he was at the center of the Earth, thus rendering the apparent longitude equal to the true longitude. The figure also shows that at that time – and only at that time – the point of the ecliptic determined by the altitude circle is 90° apart from the ecliptic's rising and setting points.[4]

In *Almagest* II, 13 Ptolemy provides[5] a table that gives the value of this angle for 0° in each sign and various latitudes. Ptolemy must have used it to determine the best available moments for his lunar observations, even if not always in the strictest of manners.[6]

Some fifteen centuries after Ptolemy worked on his tables of ecliptic angles and used them to test the Hipparchian lunar model by looking for moments where the Moon did not show parallax in longitude, Longomontanus explained in his *Astronomia Danica*[7] a method to take advantage of these configurations in order to determine the terrestrial longitude of any given location. In the section appropriately titled *De maculis in Luna, & ipsarum usu (On the spots on the Moon, and about their use)*, Longomontanus discusses the nature of the lunar features – and indeed of the Moon itself – , and how the lunar position and appearance can be used to solve one of the problems which was beginning to become extremely relevant in the wider European context: the problem of determining terrestrial longitudes.

The *De maculis* can be divided in two thematic parts: first, a discussion about the nature of the Moon and the causes of its spots and varying luminosity. Second, a method for determining the terrestrial longitude of the observer via carefully chosen lunar observations. In the first part Longomontanus deals with the typical discussions of the time: is the Moon opaque? What is the cause of its luminosity? What is the ultimate reason of its irregular appearance? In the course of his exposition Longomontanus shows his acquaintance with the recent works on these subjects, and in particular with Galileo's telescopic investigations.[8] Also, he seizes the opportunity to mention one of the hot theological topics of the day: the question of the merit of human deeds towards salvation. Just as there are people who say that the Moon produces its own light, so are people that profess that our meritorious works come from our own nature. This is labelled as the heresy of *synergism*, a somewhat diplomatic way of alluding to the Catholic position on the matter.[9] The true

4 See the Appendix for a geometrical demonstration of this relation.

5 Toomer, *Ptolemy's Almagest*, 123.

6 Neugebauer, "A History…", 92.

7 Longomontanus, *Astronomia Danica*, 191-197.

8 *Ibid.*, 192.

9 The metaphor is somewhat flawed, though, since synergists support a lesser claim, i.e., that salvation at least requires some kind of free cooperation on the part of man.

Christian doctrine, though, is given to us not only in the letter of the Sacred Scriptures, but also metaphorically in the skies: in the same way that the Moon shines inasmuch as it reflects the solar light which is freely given to it, so does man acts meritoriously inasmuch as he receives "Christ's spirit and the total good illumination".[10]

Whatever the theological and astronomical connotations of this first part of the section, this paper will be focused on the second one, where he develops his method for determining the terrestrial longitudes. While it contains some interesting, original aspects, Longomontanus' method is one of many examples that make use of the Moon to find the east-west position on the surface of the Earth. So, the first section of the paper is a brief historical introduction to the problem of finding terrestrial longitudes via the use of astronomical observations. The following section explains in detail the method Longomontanus proposes to make this calculation, and the problems involved in it. This method relies on the use of ephemerides and, as we will see, is plagued with various kinds of problems. Longomontanus provides, however, an additional idea which correctly indicates how an observer might use the orientation of the lunar face in order to determine the best moment for the lunar observations involved in the method. The explanation of this idea is the subject the next section. Finally, I will discuss some of the implication of Longomontanus' text in a Conclusion, which is followed by a technical appendix which discusses some geometrical properties of celestial configurations that are relevant to Longomontanus' argument.

## *Lunar observations and determination of terrestrial longitudes*

Ptolemy describes, in *Almagest* II, 1, the only method that we know of which was used in antiquity to determine distances in terrestrial longitude via astronomical observations. According to him, the inhabited part of the world was comprised within one half of the northern hemisphere. To support this claim, he points to the fact that: "[ … ] observations of the same eclipse (especially a lunar eclipse) by those at the extreme western and extreme eastern regions of our part of the inhabited world (which occur at the same time), never differ by more than twelve equinoctial hours; and the quarter [of the earth] contains a twelve-hour interval in longitude [ … ]".[11] So, given that a lunar eclipse is a phenomenon which takes place at the same absolute time for all observers, but not at the same local time, then it can be used to determine the distance in terrestrial longitude between two observers. Observer A would see the eclipse happening at 1 PM local time, and observer B will see it happening at 2 PM local time. This means that there is a time difference of one equinoctial hour between them, or 15° in terrestrial longitude. The text indicates that this can be used to determine that the extremes of "our part of the inhabited world" cannot

10 Longomontanus, *Astronomia Danica*, 192.
11 Toomer, *Ptolemy's Almagest*, 75.

be separated by more than 180°. In his *Geography* Ptolemy actually provides an example – maybe the only one he knew of – of this kind of calculation, when he refers to a lunar eclipse which took place on 20 Sept. -330, "[...] the one that was seen at Arbela at the fifth hour and at Carthage at the second hour [...]",[12] which would indicate that Carthage was about 45° to the west of Arbela (it is actually just about 34° to the west). This method continued to be used right to the end the middle-ages: Columbus tried to determine the positions of two American islands with lunar eclipse observations.[13]

While the lunar eclipse method took advantage of the fact that during those events observers could ignore the effects of parallax, because the phenomenon only depended on the relative positions of the Earth, the Sun and the Moon, during the middle-ages other methods that involved the Moon began to be used, ones that did not need for a lunar eclipse to take place. In the XIII$^{th}$ century *Theorica planetarum* attributed to Gerard of Sabbioneta we find the following procedure: "If the Moon is in the middle of the heavens and you equate it by means of a table for a certain region, you will know the longitude between the two regions by the difference between the places of the Moon without having to wait for an eclipse".[14] When the Moon is on the local meridian, it shows no parallax in RA. So, the procedure first asks for observer A to observe the right ascension of the Moon when it is on the local meridian via the determination of an angular distance to a star of known position. Then he has to compare that RA to the one predicted for the lunar meridian passage by tables computed for a specific location B, and thus to a specific, different, local time. The difference in RA will indicate, if the lunar speed for that day is known, the interval between the culmination at A and at B. If the intermediate lunar motion is accounted for, this allows for the determination of the difference in terrestrial longitude between the two locations. With infinite variations, and a continuous sophistication, this method continued to be used up until the first half of the 19$^{th}$ century.[15] In Longomontanus' times the problem was still being attacked by his fellow astronomers. As we will see later, the Danish astronomer had fruitfully read Galileo's *Sidereus Nuntius*, where the great Pisan first presented his discoveries of the Jovian moons to the wider public. Galileo had, in 1616, approached the Spanish government with a proposal to provide a method for finding longitudes which relied on the use of the Jovian moons (whose periods he was studying in detail) as a universal clock. After a second try in 1630, the negotiations fell through.

12 Berggren & Jones, *Ptolemy's Geography...*, 63.

13 West & Kling, *The Libro de las Profecías...*, 226-227. The eclipses he used were the one on 15 Sept 1494, and the one on 1 Mar. 1504.

14 Cremonensis, 1478 , pág. NP. In the printed edition I consulted, the folia are not numbered. The quoted text is in the next to last chapter. The translation is from Pedersen, *A Survey...*, 463.

15 Even today tables for "clearing" the lunar observed position of the effects of parallax and refraction in order to calculate the observer's terrestrial longitude are still published. Cf. Stark, *Stark Tables...*.

Several years later, in 1635, he approached the Dutch, who finally accepted it. However, the method was never practical at sea.[16]

As we will see in the following section, while it presents some interesting original aspects, Longomontanus' method is part of the "lunar tradition".

## *Longomontanus' method*

### a) Determination of the time for observation

The method presented by Longomontanus requires for the Moon to show no parallax in longitude, that is, the same requirement Ptolemy had asked for the lunar observations needed in his evaluation of Hipparchus' model. Unlike Ptolemy, Longomontanus does not use a table of ecliptic angles. Instead, he will look for the moment when the Moon is 90° away from the ecliptic's rising and setting points. As I indicated earlier, this is equivalent to the Ptolemaic requirement. To predict when this will happen for a given day is not a trivial calculation.

As an example, Longomontanus calculates this moment for 4 October 1617 (Julian).[17] This was the day of full Moon. First, he obtains the solar longitude at noon. For this he consults David Origanus' *Ephemerides Brandenburgicae*, which were calculated for Frankfurt an der Oder ("horizonti Francofurtano ad Viadrum").[18] He gives a solar longitude of 202;6°. In fact, this corresponds to 5 Oct. in Origanus' tables.[19] Then he also obtains the longitude

[16] Heilbron, *Galileo*, 235-236, 346-348.

[17] Longomontanus, *Astronomia Danica*, 194.

[18] Cf. Origanus, *Ephemerides Brandenburgicae*… . Origanus had already calculated a set of ephemerides for the years 1595-1630, also for Frankfurt an der Oder: the *Ephemerides Novae* (Origanus, 1599). These were derived from the Prutenic tables, although regarding the true nature of the cosmos he kept his geocentric preferences. During the intervening years, Origanus went through a sort of Tychonic conversion (Omodeo, "David Origanus'…", 440), and adopted not only the new cosmological framework, but also the parameters of the Tychonic model. For example, in the 1599 work he assumes the Prutenic solar eccentricity of 32,222 for a radius of 1,000,000, while in 1609 he adopts the Tychonic 35,840. These variations of course translated into different predictions for the same days. For 4 Oct. (Julian), for example, the 1599 ephemerides give a solar longitude of 200;48,45°, while the 1609 ephemerides give 201;5,30°. Although Longomontanus does not specify which ephemerides he is using, it is only natural that, being Tycho's disciple, he would use the Tychonic version from 1609. Also, the values he gives in *Astronomia Danica* fit much better with the 1609 work than with the 1599 one.

[19] Origanus gives 201;5,30° for 4 Oct. 1617 (Julian). No reduction for Longomontanus' location will account for the difference. The longitude given for 5 Oct. 1617 (Julian) is 202;5,13°. In the front page of the book he gives Frankfurt an der Oder's terrestrial longitude as 36°. Longomontanus gives 36;40° as Copenhagen's terrestrial longitude. (Longomontanus, *Astronomia Danica*, 195). This means a time difference of just 2.6 minutes. This is not nearly enough to account for

of the Moon for that moment: 20;20°[20] and adds 90° to it, obtaining 110;20°. This last step means that when the point of the ecliptic with longitude 110;20° is rising, then the point with longitude 20;20° will be 90° away from the rising and setting points of the ecliptic.

At this point he uses Origanus' *tabulae domorum*, which are part of the *Novae Motuum Coelestium*, a work that accompanied his 1609 ephemerides.[21] The tables rely on an astrological division of the local sky, the subject of which is beyond the scope of this paper.[22] Here it is enough to know that the *tenth house* or *10 domicilius* is the point of the ecliptic that is at the local meridian at a given time. The *horoscopus* (as Origanus labels it in the tables) or *prima domus, first house* (as Longomontanus references it) is the point of the ecliptic that is rising in the east at a given time. The tables are calculated for different latitudes, from an equatorial one (*sphaera recta*) up to 60°, with special section for the precise latitude of Frankfurt an der Oder, 52;20°. They have a first column labelled "Tempus a meridie" (from now on *time column*) which indicates the distance in time between the culmination of Aries 0° and the local noon for different solar longitudes,[23] or between the culmination of Aries 0° and the moment when a given point in the ecliptic is in a given position for the local observer.[24] So, first Longomontanus chooses the table with the cor-

the difference between both solar longitudes: it barely yields a solar motion of 7''. The correct difference in terrestrial longitude between those locations, though, is about 2°. This yields a time difference of about 8 minutes, and a solar motion of about 20''. This reduction would give a solar longitude at noon, for Copenhagen, of 202;5,33°, and Longomontanus could be giving a rounded value. This, of course, would mean that Longomontanus had a better value for the difference in terrestrial longitude between both cities than the one derived from Origanus' work.

20 In this case he correctly gives the value for Origanus' 4 Oct. (Julian). The tables give 20;13°, and a lunar motion for that day of 15;14°. A reduction for Copenhagen assuming modern terrestrial longitudes for both cities gives a lunar longitude of 20;18°, while a reduction using the difference derived from Origanus' terrestrial longitude for Frankfurt an der Oder gives a lunar longitude of less than 20;15°. This supports the idea that Longomontanus had a better estimation of the distance between both places.

21 Origanus, *Ephemerides Brandenburgicae…*, 299-370.

22 Cf. North, *Horoscopes and History*, 1-6) for a more detailed introduction to the astrological house system and its history.

23 The tables indicate at the top of each page that they are calculated "☉ existente in *x*", where *x* stands for any given sign. From 0° to 30°, that given sign is listed in the *10* column, the one that stands for the position at the local meridian. So, if the Sun is at a given longitude, then we enter the table through the *10* column and find that longitude, and that gives us, in the first column, the time between local noon and the culmination of Aries 0°.

24 The rest of the columns, labelled *11*, *12*, *Horosc.*, *2*, and *3*, reference other positions with respect to the horizon. For example, as we said, the *horoscopus* is the ecliptic point that is rising. So, the tables allow for one to know how much time there is between the moment when a given ecliptic point is rising, and the culmination of Aries 0°. *Mutatis mutandi*, the same can be said about the other *houses* in the tables.

responding latitude considering the 55;43° he indicates for Copenhagen.[25] Then he enters the table through the *10* column and looks for the longitude 202;6° he found for the Sun. This is because Origanus' ephemerides had given him the location of the Sun at noon, that is, when it is on the local meridian, or at the *tenth house*. The value in the time column is 13 h 18 m.[26] In modern terms, he found the RA of the Sun for 5 Oct. 1617 at noon (Julian) (although he thought he was doing it for 4 Oct.).

Next, he enters the table through the *horoscopus* column, and looks for 110;20°. As we said earlier, when that point of the ecliptic is rising, then the point with longitude 20;20° (where the Moon was at noon) will be at the appropriate position, and no parallax in longitude will be observed. The time column indicates 23 h 1 m.[27] In modern terms, he has found the RA of the local meridian when the ecliptic point 110;20° is rising. After that step, he calculates 23 h 1 m – 13 h 18 m = 9 h 43 m. This is the amount of time after noon when the point of the ecliptic with longitude 110;20° will rise that day, and therefore when the point with longitude 20;20° will be 90° away from the rising and setting points of the ecliptic.

However, by the time the ecliptic point 110;20° rises, almost 10 hours after noon, the Moon will no longer be at 20;20°. Instead, it will have increased its longitude, so that by then the ecliptic distance between it and 110;20° will be less than 90°. So, Longomontanus has to iterate the calculation to account for the difference. The procedure he carries out, though, is flawed. What Longomontanus needed to do was to calculate the advance in longitude during the intervening 9 h 43 m, and add that to the original 110;20°. Because that is the amount by which the position of the Moon will have moved, then it is also the amount by which the point 90° away from the Moon will have moved. Then, using the same *tabulae*, he could calculate as before the time when that resulting value is at the *horoscopus*.

25 Although Longomontanus explicitly indicates this step, there is no need for it when dealing with the *tenth house*, since for any latitude the time value for the meridian position will be the same. In fact, the *tabulae domorum* only give it once per page, whatever the latitude they provide first. However, because Longomontanus is also talking about obtaining the *horoscopus* related to the Moon, and because in that latter step the latitude is relevant, then his indication is not without utility.

26 In fact, Origanus gives 13 h 21 m 18 s for 202°, and an interpolation that accounts for the 6 minutes would only bring it higher. My opinion is that he simply took the value for 202° and that, similarly to the case in note 28, this is probably a slip of the pen, and he simply mixed the minutes with the seconds.

27 The preciseness of the value given by Longomontanus suggests some kind of interpolation. The tables provide values for latitudes 54° and 57°. Also, the longitudes in the *horoscopus* column are, in no case, exactly 20;20°. There is no obvious method of interpolation that provides exactly the value given by Longomontanus. The results I obtained by trying some combinations differ from 23 h 1 m by amounts that range from 2 min. to 9 min.

To do that, Longomontanus should have used the daily lunar motion, which according to Origanus' ephemerides was 15;14° on that day, and calculated the proportional for 9 h 43 m, which is 6;10°. That would give an ecliptic point in 110;20° + 6;10° = 116;30°, with a time value of about 23 h 40 m, and a rising time after noon of about 23 h 40 m – 13 h 18 m = 10 h 22 m.

Instead, Longomontanus explicitly points not to the daily lunar motion in longitude, but to the daily motion in elongation, which according to Origanus was 14;14°. This yields a proportional of 5;46°,[28] and an ecliptic point in 110;20° + 5;46° = 116;6°. Once he has the – incorrect – new longitude of the Moon, he repeats the previous step with the *tabulae domorum*, and finds that the time column for 116;6° at the *horoscopus* is 23 h 34 m,[29] with a rising time of 23 h 34 m – 13 h 18 m = 10 h 16 m. after noon.

Now, during the extra 33 minutes he has,[30] the Moon will have moved an extra distance: given the daily motion for that date, about 0;21°. The method thus requires an iterative procedure to be carried out, until a satisfactory value is reached. Longomontanus' explanation does not go further than this. So, in this way Longomontanus determines, for a given date, the time when the Moon is 90° away from the rising and setting points of the ecliptic, thus showing no parallax in longitude.

**b) Determination of the terrestrial longitude difference between two places**

The procedure Longomontanus proposes is part of the tradition I mentioned earlier. The path he proposes, though, is extremely flawed. The example he gives is for 6 Oct. 1617 (Julian).[31] On that date, he says, the Moon was 90° away from the rising and setting points at 11 h (noontime). According to Longomontanus, the tables indicate for that time a lunar longitude of 57;20°.[32] The known longitude of Aldebaran for that year was 64;26°.[33] So the calculated distance in longitude between the two was 7;6°. Having provided before

28 In the text, he gives 5;0;46° ("5 gr. 46 sec."), clearly a misspelling.

29 In this case the result is a close match to a double interpolation, one for the exact ecliptic longitude, and a second one for the exact geographical latitude, just as the one described in note 35.

30 That is, 10 h 16 m – 9 h 43 m = 33 m.

31 Longomontanus, *Astronomia Danica*, 195.

32 From from Origanus' ephemerides – with the proper reduction for Copenhagen and linear interpolation for 11 PM – we get 57;18°, so Longomontanus is here giving a rounded value. This might point to the fact that here Longomontanus *first* found the time, and *then* he found the lunar longitude. Such a procedure would go against the calculation method he explained, and suggests that he was simply working using the observational method described later in the paper.

33 In order to have a proper list of reference stars, Longomontanus gives the 1620 coordinates of 15 stars (Longomontanus, *Astronomia Danica*, 196): in Aldebaran's case, it is 64;29°. It is a rounded value, as it is the precession rate of 1' per year instead of Tycho's 51" per year (Brahe, *Opera Omnia vol. II*, 280).

an example of how to compute these values, here Longomontanus is just offering the final result of 11 h as the time, and 57;20° as the lunar longitude. We have no indication as to how he actually calculated the values.

Let us reconstruct this initial calculation by following the method provided in the previous section, using the same sources. For the given date, Origanus gives a solar longitude at noon of 203;4,58°, and a lunar longitude of 50;29°. If the times are reduced to Copenhagen using linear interpolation,[34] and we round them as Longomontanus does, we get 203;5° for the Sun (with the corresponding RA 13 h 25 m in Origanus' *tabulae domorum*), and 50;34° for the Moon. Now, 50;34° + 90° = 140;34°. The RA of the meridian when the point of the ecliptic with longitude 140;34° is rising is about 2 h 1 m.[35] This gives a time difference of 24 h – 13 h 25 m + 2 h 1 m = 12 h 36 m. The lunar motion for that day, according to Origanus, was 14;41°. The proportional motion is thus 7;43°, which puts the Moon at 50;34° + 7;43° = 58;17°. Again, 58;17° + 90° = 148;17°. According to the *tabulae* the RA of the meridian when this last ecliptic point is rising is 2 h 48 m.[36] So, we now get that 24 h – 13 h 25 m + 2 h 48 m = 13 h 23 m is the amount of time after noon when the Moon was 90° away from the rising point of the ecliptic. As before, more iterations are necessary to get better results: after all, during the extra 47 minutes of motion the Moon will have moved an extra 29' in longitude, resulting in 58;46°, with an RA of the meridian when the ecliptic point 58;46° + 90° = 148;46° is rising equal to 2h 51 m. This would mean that the correct time for observation on 6 Oct. is 24 h – 13 h 25 m + 2 h 51 m = 13 h 26. Longomontanus' error for the proper observation time is at least 13 h 26 m – 11 h = 2 h 26 m.

As I mentioned earlier, Longomontanus makes a crucial mistake when he uses the daily motion in elongation instead of the daily motion in longitude. So, if we retrace the path we just followed, but instead of using the 14;41° of the daily longitude for 6 Oct. we use the 13;41° Origanus gives for the daily elongation, we get a final time for proper observation, after three iterations, of 13 h 22 m after noon. Limiting the iterations to two, as in Longomotanus' previous example, only slightly changes the result. This shows that the 11 h given by Longomontanus is not a consequence of the conceptual error of using the daily motion in elongation instead of daily motion in longitude, but instead a product of a gross computational error. As I said in note 32, there are reasons to think that Longomontanus found this time not by going through the computational method he described, but instead

[34] All the following reductions are calculated assuming a difference in terrestrial longitude of 2° between Frankfurt an der Oder and Copenhagen. This is the modern value for that distance, and as I said before, it seems to fit much better with the reduced values that Longomontanus gives.

[35] For the interpolation, I first interpolated between two close longitudes in the *horoscopus* column for latitude 54°. Then I did the same for the *horoscopus* for latitude 57°. The I used those two values to interpolate for latitude 55;43°.

[36] Same method as in note 35.

via the observational method described in the next section of this paper. In fact, such an error is completely within the margin of that method, as I will explain later.

So, up to now we know the following data: a) the time $x$ for a given date when the Moon shows no parallax in longitude as seen from Copenhagen; b) the true distance in longitude between the Moon and Aldebaran for time $x$. Both a) and b) can be calculated from information readily available in tables. So, Longomontanus tells us, an observer at a place of unknown terrestrial longitude can calculate, using that information and with an additional lunar observation, the distance in terrestrial longitude from Copenhagen. All he has to do is observe the distance between the Moon and Aldebaran at his local time $x$. Because his local terrestrial longitude is different from Copenhagen's, then he will be looking at the Moon at a different absolute time than that calculated in a). So, the Moon will have moved from the position assumed in b). Because the tables provide the motion in longitude for the given date, then it is possible to calculate the elapsed interval between time $x$ at Copenhagen, and time $x$ at the place of unknown terrestrial longitude. As I said, this is a variation of the meridian method previously described by Gerard. In our case, Longomontanus assumes that at the second location, the observed distance in longitude between the Moon and Aldebaran is 10°, 2;54° more than the distance calculated for Copenhagen.[37] Given the lunar motion for that day of 14;41°, this means that between both times an interval of 4 h 45 m elapsed. Because 1 h is equal to 15° in terrestrial longitude, then we have that the second location is 71° 15' to the west of Copenhagen.

As it was usual with these methods that relied on the lunar distances to reference stars, one of the problems was that they needed very accurate lunar observations in order to give reasonable results. An error of just 5' in the observed distance amounts to a mean error[38] of 2° 17' in the resulting terrestrial longitude. Also, the method Longomontanus uses needs several iterations to determine the appropriate moment of observation in order to be below that value. But these are all practical problems which could, ideally, be managed. The fundamental problem with the method is the following: the ephemerides used for calculating the moment when the Moon showed no parallax in longitude – i.e., time $x$ – are ephemerides composed for Copenhagen or, as in our case, reduced to the terrestrial longitude of Copenhagen. This means that while time $x$ is the local time in Copenhagen when the Moon shows no longitudinal parallax, it is not the appropriate local time for other locations with other terrestrial longitudes. So, when the observer at the second location observes the Moon at his local time $x$, he will not see it free of the effect of parallax. Thus, the difference in the calculated and observed distances to the reference star will be a product of both the difference in terrestrial longitude between the two places and the effect of parallax in longitude in the second observation.

[37] Longomontanus, *Astronomia Danica*, 195.

[38] The true error depends on the corresponding daily lunar motion.

In order to avoid that problem, one possibility is to have a way of determining the appropriate moment of observation without having to consult any table. In the next section we will look at how Longomontanus explains how to do this in his *De maculis*.

## *Lunar spots and horns and the determination of terrestrial longitudes*

As it was indicated above, Longomontanus' method needs for the lunar observation to be void of parallax effect in longitude. While the method he proposes ignores that the lunar observation made from the place of unknown terrestrial longitude will be affected by parallax, in this section Longomontanus provides a supplementary method to determine the appropriate moment for observation that does not make use of tables.

As I pointed out above, the situation with no parallax in longitude can be described in several ways: a) the moment when the altitude circle of the Moon intersects the ecliptic at a right angle, b) the moment when the Moon is 90° away from the ecliptic's rising and setting points. The first one is the way Ptolemy describes it, and the second one the way Longomontanus does. But it can also be described in a third way c) when the plane determined by the observer, his zenith and the center of the Moon coincide with the plane determined by the center of the Earth, the ecliptic pole, and the center of the Moon. This last situation only takes place when a) or b) – which are equivalent – take place, and viceversa.[39] Longomontanus refers to this configuration as that when the Moon shows the observer its *erecta dispositio*,[40] its erect or upright position. By this he means that the observable features on the near side of the Moon are positioned with respect to the observer's horizon in the same manner as they would be to an observer on the ecliptic pole (Refer to Illustration 1). So, if the observer knows beforehand how the lunar spots look in the upright position, then he only has to wait until they look that way for him, and he will know that the Moon is in the correct configuration to determine its position with respect to the reference star. However, this is not always simple. An easier method is to observe the Moon when it is on a phase, showing its horns – the days before and after new Moon – , and to wait until the moment when the line determined by the tips of the horns is perpendicular to the observer's horizon. Because the Moon is roughly in the same plane as the ecliptic, then the Sun's rays will be cast on it from a direction parallel to the ecliptic. Therefore, the line determined by the tips of the horns will always be perpendicular to the ecliptic. This means that if that line is perpendicular to the observer's horizon, then he is looking at the Moon as if he was on the ecliptic pole, i.e., on the center of the Earth.

39 Again, see the Appendix for a proof of these relations.
40 Longomontanus, *Astronomia Danica*, 194.

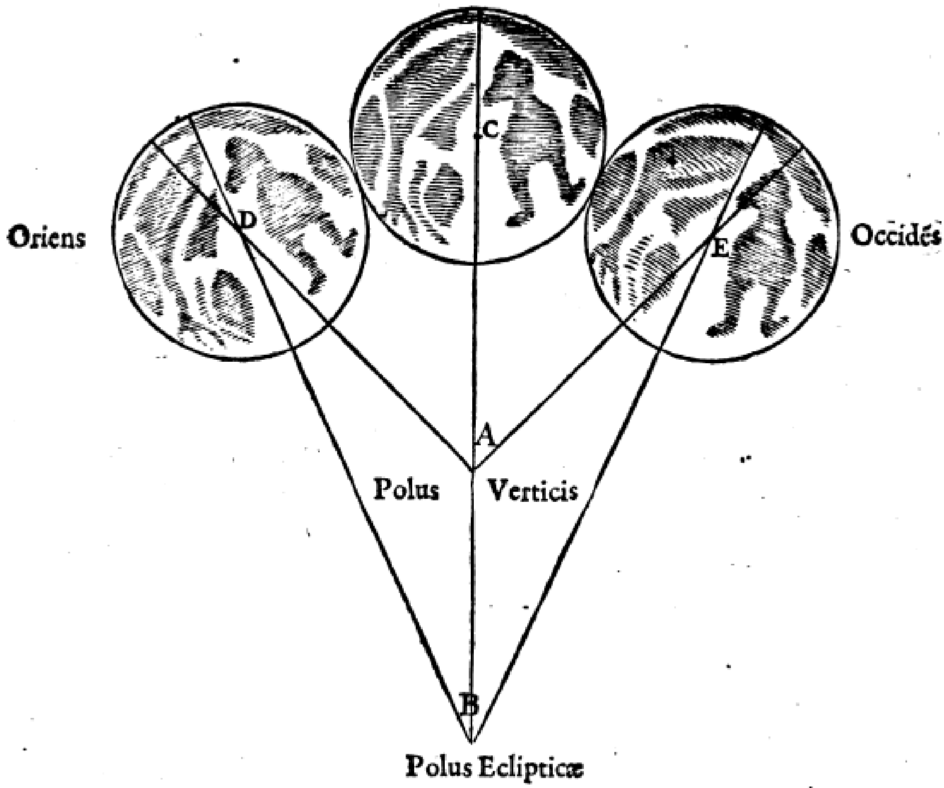


Illustration 1. Longomontanus' illustration for explaining description c) of the correct configuration. Point A is the observer's zenith, and B is the ecliptic pole. When the Moon is in the correct position C, then the plane determined by the center of the Earth, the center of the Moon, the observer's zenith, and the ecliptic pole, will coincide. In every other position (D and E, for example) the lunar disposition will be different as seen from A and B.

So, if an observer determines via tables the time when this configuration takes place for a place of known terrestrial longitude, and he then determines it via this observational method for the place of unknown terrestrial longitude he is at, then he has the two appropriate moments to determine the lunar distance to the reference star. By using the lunar daily motion, he can then calculate the amount of time between both positions, and therefore the difference in terrestrial longitude. As I said, while Longomontanus himself explains this alternative way of determining the appropriate moment of observation, he does not use it to avoid the problems his previous method has.

The method, however, has a fatal practical flaw, which is that it is extremely difficult even today – and certainly impossible in Longomontanus' times – to determine the precise moment when the line determined by the horns is intersecting the horizon at a right angle. The inclination of that line changes fairly slowly and an error of just 5' in the lunar position will result in errors of more than 2° in the final terrestrial longitude of the place. Assuming the mean lunar speed, this means an error of just 9 min. for the time of observation. The same problem holds, of course, for the version of the method that relies on the disposition of the lunar spots.

## *Conclusion*

In this paper I have analyzed the method proposed by Longomontanus to determine the terrestrial longitude of a given location. The method is one more attempt to solve the this problem via the use of lunar observations, particularly of determinations of angular distances to reference stars. While the method has some basic theoretical and flaws, Longomontanus provides alternative observational paths to determine the correct moments when the Moon should be observed in order to determine its relative position to the chosen star.

It is not clear to what extent was Longomontanus aware of the problems in his method. Although he surely knew that his "lunar horns" method could only give the time for the observation in an approximate manner, he does not indicate to what extent the imprecision inherent in the method would limit the astronomer's ability to obtain a useful time. Even more, in the examples he gives us he does not use the "lunar horns" method, simply assuming that the time which he calculated, for a place of known terrestrial longitude, would also be useful to observe a Moon with no parallax in longitude in a place of unknown terrestrial longitude. This is the most unexpected problem of all, because it is so obvious. Longomontanus, nevertheless, seems to have missed this crucial error, and thought his method to be sound.

Despite all its problems, this section from *Astronomia Danica* is nevertheless not void of importance. In it, Longomontanus pays attention to the features on the Moon as having a significant role to play. In this, he shows openness to the new fields that were rapidly developing, particularly the Galilean application of the telescope to astronomical observations. Although he does not list the telescope as an astronomical instrument in the section he devotes to them,[41] Longomontanus explicitly refers to the *Sidereus Nuntius* in his discussion of the nature of the lunar features,[42] in particular Galileo's hypothesis that the Moon is surrounded by a thick layer of dense vapors, and that this explains why we cannot see large spots reaching the edge of the visible side of the lunar face: the lunar vapors prevent the light from the spots located in those regions to reach

41 See Longomontanus, *Astronomia Danica*, 118-122.
42 *Ibid.*, 192.

us.[43] In this he is with Galileo and *cum praestantissimo Kepplero*. So, despite all the mathematical or practical problems this section has, it reveals an astronomer who is still well within the Ptolemaic tradition of circular, uniform motions, but that at the same time has studied, and accepted, the most striking results of modern telescopic astronomy. As another example we can point his description of the part of the lunar surface visible to us as being comprised of "rough [regions], and earth-like plains".[44] He is no doubt referring to Galileo's lengthy description in *Sidereus Nuntius* of the lunar terrain, and his comparisons to different geographical features extant on Earth. This suggests that he had embraced the anti-Aristotelian side in the debate about the nature of the Moon, and of the celestial bodies in general.

43 *Ibid.*, 192 and Galilei, *Sidereus Nuntius*, 52-53.
44 "[ … ] in scabros, terreisque similes campos [ … ]" (Longomontanus, *Astronomia Danica*, 192).

*Appendix. Demonstration that when the lunar altitude circle is orthogonal to the ecliptic the apparent and true lunar latitudes will be the same. It is also demonstrated that in that situation, and only in that situation, the Moon is 90° away from the rising and setting points of the ecliptic.*

Refer to Figure 2. The Earth is the sphere with center C. The solid circle is the celestial equator, with its pole P. The dashed circle is the ecliptic, with its pole E. The solid circle with center on C, and a radius CE and CL will necessarily be orthogonal to the ecliptic, because its plane is determined by the center of the Earth, the pole of the ecliptic, and a point on the ecliptic itself. As all the points in the celestial sphere, the ecliptic pole E will make one revolution around P – the small, dotted circle – every day. This means that the circle orthogonal to the ecliptic plane will sweep the entire celestial sphere once a day.

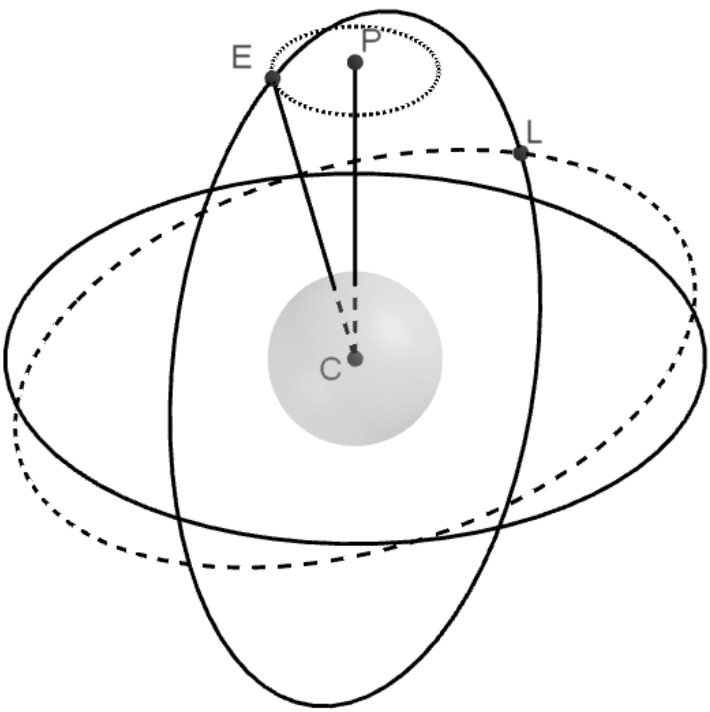


Figure 2. Diagram for the demonstration that a great circle concentric with the Earth, that passes through the ecliptic pole, sweeps the entire celestial sphere once a day.

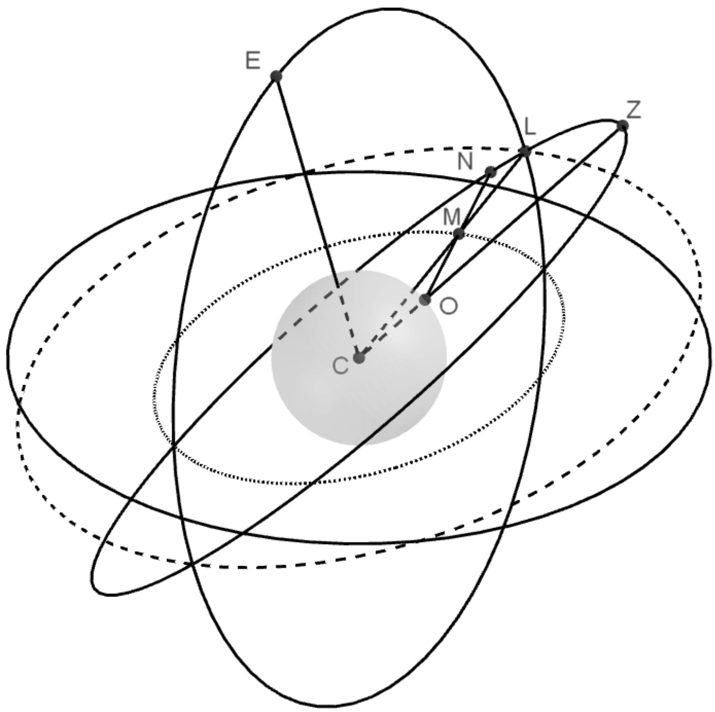


Figure 3. Diagram for the demonstration that an observer located anywhere on the Earth's surface will see the Moon without parallax in longitude once a day.

Refer to Figure 3. Let us add, to the previous figure, a (simplified) lunar model, the dotted circle with center C. For simplicity, we will assume that the Moon M is always on the ecliptic, i.e., the dotted circle has the same inclination to the celestial equator as the ecliptic. Now let us assume that point L is the true longitude of the Moon. This means that M is coplanar with the circle orthogonal to the ecliptic. The plane of this circle is thus determined by points ECM.

Then, we have the observer O at some position of the surface of the Earth, with a zenith at point Z. For him, the apparent position of the Moon will be N. As it can be seen, the Moon shows parallax both in longitude and in latitude. For our problem, we are only interested in the parallax in longitude. It is clear that to have no parallax in longitude we need for line OMN to be on the plane of the circle orthogonal to the ecliptic. When will this happen? Line OMN is on the plane determined by ZCM. But we know that, since Z is a point on the celestial sphere, at some time during the day it will be coplanar with the circle orthogonal to the ecliptic. When this happens, then the planes determined by points ECM and ZCM will be coplanar, and the true and apparent longitudes of the Moon will be the same. Finally, because the circle on plane ZCM will then be orthogonal to the ecliptic, it is the case that both longitudes will be equal when the lunar altitude circle is orthogonal to the ecliptic.

Refer to Figure 4. In the diagram we only have the dashed ecliptic, the circle orthogonal to the ecliptic, and the dotted horizon. Points A and B are the rising and setting points of the ecliptic. At this moment, the zenith Z is coplanar with the circle orthogonal to the ecliptic, so the lunar true and apparent longitudes are the same, as it can be seen in the diagram. Line ZOC is necessarily perpendicular to the plane of the horizon at point C, so it is also perpendicular to line ACB. But line ZOC is on the plane orthogonal to the ecliptic. So every line in that plane that passes through C must also be perpendicular to line ACB. But line LMC is on that plane. So line LMC is perpendicular to line ACB. But at this time L indicates the apparent (as well as the true) lunar longitude. So, when the lunar altitude circle is perpendicular to the ecliptic, it is the case that the point of the ecliptic that indicates the apparent lunar longitude is 90° away from the ecliptic rising and setting points.

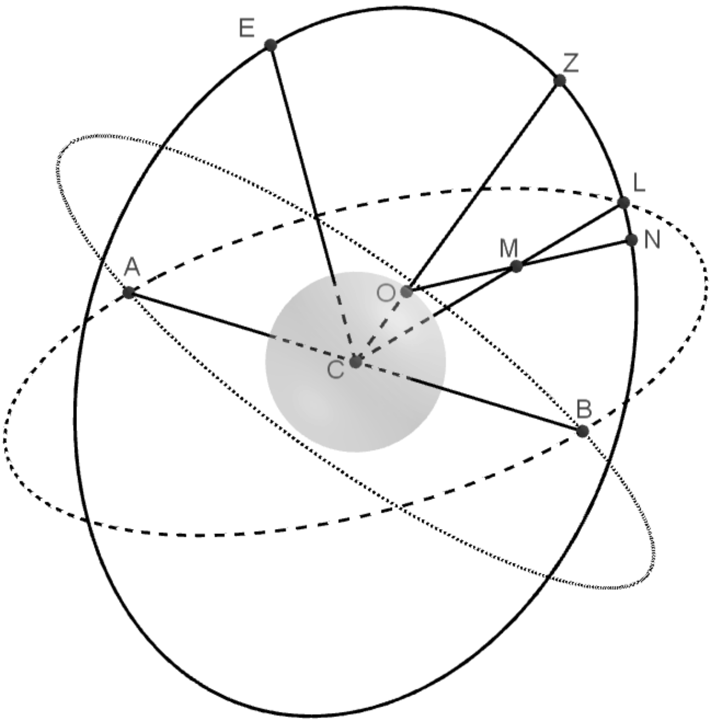


Figure 4. Diagram for the demonstration that when the Moon is seen without parallax in longitude, the point of the ecliptic corresponding to the lunar longitude is 90° away from the ecliptic rising and setting points.

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# The truth of the Moderns and the deception of the Ancients: Heavenly motions and the biblical hermeneutics of Paolo Antonio Foscarini

Franco Motta
University of Turin; franco.motta@unito.it

**Abstract**
Paolo Antonio Foscarini is among Galileo's most frequently named correspondents. His case revolves around the well-known treatise he wrote to defend the Copernican system, the *Letter concerning the opinion of the Pythagoreans and Copernicus about the mobility of the earth and the stability of the sun and the new Pythagorean system of the world*, published in January 1615 and listed in the Roman Index only a year later. It was this book that tipped the scales of Roman censorship towards a condemnation of heliocentrism; moreover, the remarks written to the author by Cardinal Bellarmine on receiving the book, insisting that heliocentrism may be considered and treated as a hypothesis but not a fact, anticipated the official attitude of the Catholic Church towards the new astronomy until the early 19th century. Analyzing two further writings by the same author, this paper shows that Foscarini's *Letter* must not be considered, as it has generally been, as an extemporaneous and ingenuous proposal, but rather as part of a wider, systematic project of renewing theology and natural philosophy, that has to be read within the dynamic context of the Italian scientific culture in the years that preceded the condemnation of Copernicus.

**Keywords**
heliocentrism, decree of 1616, biblical interpretation, correspondents of Galileo

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Among Galileo's correspondents, one of the most frequently named is the Carmelite Paolo Antonio Foscarini, whose case revolves around the letter he wrote to defend the Copernican system, published in January 1615 and listed in the Index only a year later. It was Foscarini's *Letter concerning the opinion of the Pythagoreans and Copernicus* and Galileo's *Letter to the Grand Duchess Christina* that tipped the scales of Roman censorship towards a condemnation of heliocentrism following a year of hesitation punctuated by contradictory rumors and signs. During that year, the uncertainties brought about by the new science plunged the theologians of the Roman Curia into deep crisis. Initially overcome in 1616 with a compromise (the expurgatory censure of Copernicus), in 1633 this crisis (with the condemnation of Galileo for his *Dialogue concerning the two chief world systems*) finally drove the Church into a long-lasting period of cultural entrenchment.

Foscarini suffered the most serious consequences of this move, early on. Copernicus' *De revolutionibus orbium coelestium* was corrected and recirculated together with Diego de Zuñiga's *Commentary on Jo*b, and Galileo resumed his scientific battle despite Bellarmine's admonition; the Carmelite father's *Letter* was instead banned without appeal. Unlike the other texts, it was officially listed in the 5 March 1616 Index decree and even had the unfortunate honor of providing the Holy Office's cardinals with the definition of heliocentrism as a "Pythagorean doctrine".[1]

The reason for this is commonly attributed to the fact that Cardinal Bellarmine, overseer of the case, perceived Foscarini's proposal as an open challenge to a centuries-old exegetical tradition according to which the Bible clearly established the Sun's motion around an unmoving Earth. This was part of a post-Tridentine theology that regarded the preservation of Tradition and the consensus of Church Fathers and Doctors as an indispensable line of defense against Protestantism. Not to mention that, unlike Galileo, Foscarini did not enjoy the protection of the Tuscan Grand-Ducal family with which Bellarmine had significant ties.[2] What is more, proponents of heliocentric astronomy

[1] The text of the decree in OG, XIX, 322-323. See Foscarini, *Lettera sopra l'opinione de' pittagorici e del Copernico*. Galileo's Copernican works and his letters on sunspots (OG, V), as well as his correspondence 1614-19 (OG, XII), approximately count fifteen passages from the Bible, the most critical being Joshua 10:12, Psalms 19:6, 93:1, 104:5 (modern numbering), Ecclesiastes 1:4-5.

[2] The condemnation of Foscarini cannot be separated from the "first trial" of Galileo and the censorship to Copernicanism, and is thus addressed by a very wide literature. Some key sources include Basile, "Galileo e il teologo Foscarini"; Caroti, "Un sostenitore napoletano della mobilità della Terra: il padre Paolo Antonio Foscarini"; Blackwell, *Galileo, Bellarmine, and the Bible*, 87 and following (with an English translation of the *Letter* in the *Appendix*, 217-251, with the title *A Letter [...] Concerning the Opinion of the Pythagoreans and Copernicus About the Mobility of the Earth and the Stability of the Sun and the New Pythagorean Systema of the World*. This translation is used in this article); Bucciantini, *Contro Galileo. Alle origini dell'*affaire, 53 and following;

themselves posthumously blamed the Carmelite friar for having unduly attracted the Inquisitors' suspicions by incautiously publishing the letter in Italian.[3]

Now, for the reappraisal of the *Letter concerning the opinion of the Pythagoreans and Copernicus* I would like to propose, we need to take a step backwards. As described above, following the 1616 decree Foscarini was perceived as responsible for a measure that, already at the time, was seen as incongruous and fraught with unpredictable consequences. The Carmelite had supposedly attracted the Inquisition's attention by "spreading this opinion among the people with a writing published in Italian".[4] This view doubtless made sense to observers of the time, as the *Letter* was the only text mentioned *ad titulum* in the censorship decree and to that date the only printed text expressly focused on reconciling heliocentrism and biblical accounts: in my view, however, it contained both plausibility and misunderstanding, a misunderstanding that went on to condition interpretations of Copernicus' condemnation for the time to come.

The element of plausibility refers back to the problem of language and, perhaps even more so, the form of the text. Foscarini's book was a vernacular work deliberately dealing with biblical hermeneutics: it thus circumvented, as it were, the firm disciplinary distinctions according to which Latin, the language of the theologians' guild, enjoyed a monopoly over topics of faith. Catechisms and devotional books were an exception, of course, but they represented a careful distillation of the content to be transmitted to the laity. Furthermore, being written in epistolary form, the *Letter* shrugged off the methodological requirements applied to treatises (largely still linked to the procedures of scholastic theology with its division into *quaestiones* and *articuli*) and giving the au-

Kelter, "A Catholic Theologian Responds to Copernicanism: The Theological *Judicium* of Paolo Foscarini's *Lettera*"; Beretta, "Une deuxième abjuration de Galilée oú l'inaltérable hiérachies des disciplines", 25-28; Pesce, "La ricezione dell'ermeneutica galileiana. Storia di una difficoltà nel distinguere ciò che è religioso da ciò che non lo è"; Damanti, Libertas philosophandi. *Teologia e filosofia nella* Lettera a Cristina di Lorena *di Galileo Galilei*, 77 and following; Ponzio, "Teologie e copernicanesimo: Bellarmino, Campanella, Foscarini"; Frajese, "Il decreto anticopernicano del 5 marzo 1616"; Omodeo, *Copernicus in the Cultural Debates of the Renaissance. Reception, Legacy, Transformation*, 297-303; Motta, "Nature, Faith, and the Judge of Faith. Some Considerations on the Historical-Political Context of Copernicus' Condemnation"; Bucciantini, *The strange case of Paolo Antonio Foscarini*, 255-266. As for biographical notices on Foscarini, see the valuable Boaga, "Annotazioni e documenti sulla vita e sulle opere di Paolo Antonio Foscarini".

3 Remo Quietano to Kepler, 13.VIII.1619, in OG, XII, 481. Regarding Kepler's hostility towards the dissemination of the new astronomy outside educated circles, see Bucciantini, *Contro Galileo*, 124-125. Michael Maestlin expresses the same opinion about Foscarini in his 1621 introduction to the second edition of Kepler's *Mysterium cosmographicum*: Fabbri and Favino, *Introduction*, XV.

4 Remo Quietano to Kepler, see note 3 (also cited in Bucciantini, *Contro Galileo*, 59).

thor greater freedom to arrange his arguments and choose his expository style.[5] As I will show below, Foscarini clearly availed himself of the rhetorical possibilities offered by the epistolary genre, and the peculiarities of his language and format undoubtedly took on a certain prominence in the critical eyes of Cardinal Bellarmine and the other theologians charged with examining it.

I believe there is also an underlying misunderstanding, however. The rationale for banning Copernicus and condemning heliocentrism as "false and altogether contrary to divine Scripture" (as the Index decree reads, a moderate solution in considering that the Holy Office advisors had judged it much more severely as "foolish, absurd in philosophy and formally heretical") stemmed not so much from the Roman Curia's hasty reaction to Foscarini's *Letter* and his ill-advised proposal of heliocentric exegesis. Rather, the rationale derived from a lengthy, careful examination of Galileo's writings, probably his *History and demonstrations concerning sunspots* and almost certainly his *Letter to Castelli* and *Letter to the Grand Duchess Christina*.[6]

The key point was Galileo's demand, imbued with implicit yet substantial theological-political significance, that experimental philosophy has its own space in knowledge production free from the judicial authority of the Roman magisterium. This claim paralleled the demands made in the same period by those theorizing the autonomy of the political realm from the religious one, and thus clashing fiercely with the papacy, such as James I of England in the 1606 debate on the Oath of allegiance to the Crown imposed to English Catholics, or Paolo Sarpi and the theologians of the Republic of Venice during the 1606-7 Interdict controversy.[7] On both occasions, it goes nearly without saying, Bellarmine stood out as an authoritative and tireless defender of ecclesiastical prerogatives.

In other words, I believe that most of the factors coming together to drive the Roman Church to ban heliocentrism "as a thesis" (*ut thesis*) lie beyond the *Letter concerning the opinion of the Pythagoreans and Copernicus* itself, and even beyond a pure matter of discordance between heliocentric astronomy and literal interpretation of the Bible, as has generally been argued.[8] In a different context, decades earlier, there were no legal repercussions

5 Extensive research shows the importance of the epistolary genre in the early modern evolution of knowledge; for a summary, see Torrini, "Epistolari e rivoluzione scientifica", emphasizing that "the letter becomes the elective form of new knowledge" (349).

6 The judgment of the advisors of the Holy Office and the decree of the Index are published in OG, XIX, 320-321 and 322-323 respectively. The *Istoria e dimostrazioni intorno alle macchie solari e loro accidenti*, as well as the *Lettera a Don Benedetto Castelli* and the *Lettera a Madama Cristina di Lorena Granduchessa di Toscana* in OG, V, 71-249, 280-288 and 309-348 respectively.

7 Regarding this point, see my article *Nature, Faith, and the Judge of Faith*.

8 In addition to the studies already mentioned in footnote 2, on this topic see Lerner, "L'hérésie heliocentrique: du soupçon à la condamnation"; Finocchiaro, *Defending Copernicus and Galileo. Critical Reasoning in the Two Affairs*, 138 and following. The broader issue of the Church's authority in controversial matters, even beyond the letter of the Bible, is instead addressed by

stemming from Diego de Zuñiga's "Copernican" exegesis of Job 9:6 or the dedication of Copernicus' *De revolutionibus* to Pope Paul III; on the opposite side, the same was true of Giovanni Maria Tolosani's *De coelo supremo immobili*, the first accusation of heterodoxy leveled at heliocentrism to come out of Rome (without further consequences). It was precisely this lack of precedents Sarpi had in mind when expressing his dismay after the 1616 condemnation: "The suspension of the book [by Copernicus] cannot but provoke surprise, because of the novelty of suspending an old book, seen by the whole world, and which in the past had not been censored either at the Council of Trent or in Rome".[9]

Reactions to Bellarmine's 12 April 1615 letter to Foscarini and Galileo seem to support my argument. The cardinal is known to have written his remarks on receiving Foscarini's book along with a handwritten note, later corrected and circulated under the title *Defensio epistolae super mobilitate terrae*, of which two copies survive. Bellarmine's text is so famous, suffice to reference its key points: heliocentrism may be considered and treated as a hypothesis but not as a fact; the Copernican interpretation of Scripture is opposed to the common consensus of both Church Fathers and recent commentators, and contrary to the Council of Trent rulings; there is still no physical evidence to prove a moving earth and fixed sun and unlikely to be any in the future, so we should rely on the common empirical datum showing that the sun moves in the third heaven.[10] His recommendation exactly prefigured the Index's decision slightly less than a year later: indeed, the Church's approach to Copernicanism in the 17$^{th}$ and 18$^{th}$ centuries was based precisely on this distinction between a purely mathematical conception, *ex hypothesi*, of heliocentrism, and a philosophical, realistic one.[11] Hence the widespread historiographical idea that Bellarmine had already concluded the matter as early as April 1615, and the banning of the *Letter* was simply the translation of these previous theoretical premises into legal regulations.[12]

Reinhardt, "Il concilio di Trento e le scienze naturali: la controversia fra Bellarmino e Galilei come paradigma".

9 Sarpi, *Sopra un decreto della congregazione in Roma in stampa presentato per l'illustrissimo signor conte del Zaffo a 5 maggio 1616. 7 maggio 1616*, 603.

10 OG, XII, 171-172. English translation in the *Appendix VIII* to Blackwell, *Galileo, Bellarmine, and the Bible*, 265-267; this translation is used in this article.

11 We know it was the accusation of having transcended this distinction by surreptitiously defending the Copernican system that led to Galileo's 1633 condemnation and his *Dialogue* to be listed on the Index. Agostino Oreggi's opinion, expressed as part of the special theological commission convened by Urban VIII to examine the *Dialogue*, also highlights this point. This text was recently discovered and published by Leonardo Anatrini, "The Theologian's Endgame: On the Recently Discovered Censorial Report on Galileo's *Dialogue* and Related Documents".

12 As is well known, the first to stress the importance of Bellarmine's letter to Foscarini was Pierre Duhem in 1908, in his *Sauver les apparences. Sózein tà fainòmena. Essai sur la notion de théorie physique de Platon à Galilée*, 144 and following.

Actually, if read at the time it was written, in April 1615, rather than after the promulgation of the decree condemning Copernicanism, Bellarmine's letter could be considered to leave some scope for negotiation. Indeed, I do not claim that the cardinal *really* credited Galileo and Foscarini with the possibility of a demonstration in physical terms of the earth's mobility – especially given that Aristotelian physics showed the exact opposite.[13] I argue only that, at that time, in the absence of a compelling doctrinal definition on Copernicanism and with the entire world of scholars (including the astronomers of the Roman College) pondering the nature of the "celestial novelties", the cardinal's words could be *understood* as a partial opening for discussion.[14]

Of course, there remains the problem of understanding what Bellarmine meant by the term "demonstrate". Generally speaking, in mediaeval and early modern science this concept fell within the semantic sphere of logical, mathematical or physical proof, as in the case of the *demonstratio potissima* elaborated by 16$^{th}$-century Paduan Aristotelian philosophers.[15] More specifically, according to Baldini, Bellarmine could have meant it either in the sense presupposed by the deductive method of Aristotle's *Analytica posteriora*, that is, on the basis of a concatenation of syllogisms that proceeded from a general proposition to a series of particular propositions – the method proper to the Aristotelian natural philosophy of the time – or in the sense proper to Renaissance mathematics (this will be mentioned in a moment), which aspired to achieve the status of demonstrative sciences.[16] It is true that Bellarmine himself, in 1572, in his Louvain lectures on Aquinas (the *Lectiones Lovanienses*), rejected the idea of the immutability and solidity of the heavens on the basis of the letter of the Bible, showing that he put Mosaic cosmology before adherence to

13 I have already addressed this issue in *Epistemologie cardinalizie. Ipotesi, verità, apologia*.

14 Ugo Baldini, who like few others has devoted documented studies to the scientific method in the Society of Jesus, notes how mathematicians at the Roman College were aware that Andreas Osiander's preface to the *De revolutionibus* was apocryphal, and that Copernicus should not be interpreted in hypotheticalist terms. For example, Father Christoph Grienberger, writing to his Brother Giuseppe Biancani about this latter's *Cosmographia*, writes that Copernicus "undoubtedly tries to prove that the system of the world is such as he imagined it to be", and mentions a conversation he had with Bellarmine on this subject: Baldini, *L'astronomia del cardinale*, 288. Besides, as Baldini argues (300, n. 18), when Bellarmine writes in his letter to Foscarini that "Your Reverence and Sig. Galileo should act prudently [see above, note 13] in being satisfied with speaking in terms of assumption and not absolutely, as I always believed Copernicus spoke", the latter phrase can also refer to "absolutely", and not necessarily to "in terms of assumption", as has generally been assumed. In his English translation Blackwell (265) adds an "also" ("as I always believed Copernicus also spoke") that is not present in the Italian original.

15 A brief overview of this topic can be found in Lohr, *Aristotelian Theories of Science in the Renaissance*.

16 Baldini, *L'astronomia del cardinale*, 291-293.

orthodox Aristotelianism.[17] But the very tenor of his letter to Foscarini makes it possible to categorically reject the possibility that he expected from the latter, and from Galileo, convincing proof of heliocentrism on the basis of scriptural exegesis.

In other words, Bellarmine's answer to Foscarini seems to me a weak and dilatory response. It offers an extrajudicial compromise ("it appears to me that Your Reverence and Mr. Galileo should act prudently in being satisfied with speaking in terms of assumptions [*ex suppositione*] and not absolutely"), leaves room for rebuttal ("I will not believe that there is such a demonstration [of the earth's motion] until it is shown to me")[18] and essentially reveals more hesitant uncertainty than implacable rejection by the Cardinal Dean of the Holy Office.

At least that is how Galileo's correspondents in Rome received it. On 18 April, Cardinal Barberini informed Monsignor Piero Dini that "I do not hear anything more being said about Galileo", and two days later an unnamed Jesuit father rejoiced with him that "the Galileo matters are settled".[19] Dini, writing again on 2 May, framed it as a success, "a point already gained, that is, that one can write as a mathematician and in order to hypothesize"; Benedetto Castelli expressed the same opinion a few days later. On May 16, Dini invited Galileo to do "the last revision of that writing [the *Letter to Christina*] that he says he has drafted", adding that "regarding the letter by the Carmelite friar, I am told by Prince [Cesi] that he will soon see other authorities, for more clarity in interpreting it".[20]

On 20 June, more than two months after Bellarmine's reply, Prince Cesi, diligent patron of the Copernican cause in Rome, continued to express full confidence that Foscarini would be able to resume his undertaking thanks to the "full and widespread treatise in Latin" he was drafting: "The work of the Father [Foscarini] will soon arrive, and will be so well equipped [...] that I believe it will suffice to quieten the negotiation forever and settle it".[21] Cesi then arranged to transmit what Galileo had sent him to the Carmelite "with all diligence".[22]

17 Excerpts are published in Baldini and Coyne, eds., *The Louvain Lectures (*Lectiones Lovanienses*) of Bellarmine and the Autograph Copy of his 1616 Declaration to Galileo*.

18 I depart here from Blackwell's translation of "I *do* not believe that there is such a demonstration, *for it has not been shown* to me". The original Italian uses the future tense, "io non crederò che ci sia tal dimostratione, fin che non mi sarà mostrata", hinting his opinion on the matter might possibly change in the future. Likewise, the original "*facciano prudentemente a contentarsi* di parlare *ex suppositione* e non assolutamente" must be translated with "*should act* prudently" instead of "*have acted* prudently", as in Blackwell's translation.

19 Dini to Galileo, 18 and 20.IV.1615, in OG, XII, 173-175.

20 Castelli to Galileo, 6.V.1615, *ibid.*, 177-178; Dini to Galileo, 2 and 16.V.1615, *ibid.*, 175-176, 181.

21 Cesi to Galileo, 20.VI.1615, *ibid.*, 189-190. See Damanti, Libertas philosophandi, 94 and following.

22 Cesi to Galileo, 25.VIII.1615, in OG, XII, 196.

This is not to say that Foscarini's *Letter* did not provoke strong perplexity and indeed very harsh reactions in Holy Office circles. The anonymous text *Iudicium de epistola F. Pauli Foscarini de mobilitate terrae* shows it was immediately given to the consultants of this congregation, or those of the Index, to examine and that they found a series of passages worth censoring.[23] Another consultant's comments in the margins of a copy of the book leave no room for doubt: "Nova philosophia non potest non esse falsa et periculosa" ("The new philosophy cannot be but false and dangerous") the censor notes next to the passage where Foscarini invokes "a new philosophy, and astrology based on the new principles".[24]

As mentioned above, however, the fact that the thesis of the sun's centrality was not defined as formally heretical in the 5 March 1616 censure decree indicates that the Holy Office and the Index chose to proceed on two different levels: a strictly theological one, scrutinizing the propositions with the usual severity, and what we might call a "political" level comprising more cautious considerations. Monsignor Giovanni Ciampoli feared that Foscarini's text would run a "great risk" at the Holy Office's late April 1615 meeting, but even this one ended so with such little apparent outcome that Benedetto Castelli was prone to hearty optimism: "As for the letter by the Carmelite Father, I was sure that the Church's most holy judgment would lead to no further deliberation".[25]

Let us now analyze Foscarini's case and text. First, the *Letter* should be read not as a spontaneous outpouring by its author but as part of a wider, systematic project of updating knowledge that he had developed in those years. His work can only be fully understood, therefore, as part of its broader framework, announced under the ambitious title *Institutionum omnis generis doctrinarum Syntaxis* alongside the second, twin text *Trattato della divinatione naturale cosmologica, over dei pronostici e presagi naturali*.

This premise should not be taken for granted. So far, historians have ordinarily dismissed Foscarini's *Letter* as an extemporaneous attempt to advance a biblical exegesis based on the idea that only revelation can confer an ultimate foundation of truth to Copernicanism, which according to the means offered by mere natural reason can instead only be considered a hypothesis. On the contrary, in this article I would like to show how Foscarini embraces a realist perspective in natural philosophy, that is, that he is convinced of the possibility of knowing phenomena in their reality through observation and reasoning, and, subsequently, of correctly interpreting the most obscure biblical passages regarding the constitution of the world.

23 The vote is reproduced by Berti, "Antecedenti al processo galileiano e alla condanna della dottrina copernicana", 72-73, and analyzed by Kelter, *A Catholic Theologian Responds to Copernicanism*.

24 The copy with notes is at the Biblioteca Casanatense in Rome, Vol. misc. 75.

25 Ciampoli to Galileo, 21.III.1615, in OG, XII, 160-161, and Castelli to Galileo, 6.V.1615, *ibid.*, 178, respectively.

Most scholars who have dealt with the case have devoted only a few lines to the *Letter*, without considering Foscarini's other writings, and thus without contextualizing his proposals on the interpretation of Scripture within his broader vision of natural philosophy. For example, Stillman Drake in his biography of Galileo mentions Foscarini only in very few lines, assigning the exposition of the contents of his booklet to the concise words of Federico Cesi.[26] So too do Annibale Fantoli, Richard Blackwell, William Shea and Mariano Artigas and John Heilbron, as well as Bruno Basile, Stefano Caroti, Michele Camerota and Paolo Ponzio.[27]

None of these authors mentions the works of the Carmelite that will be examined below, and all at the same time (with the exception of Blackwell) agree that he would have accorded absolute preeminence to Scripture as a source of truth, thus embracing a hypotheticalist position in conclusions deduced from natural reason alone.[28] We find a partial exception to this interpretation in Massimo Bucciantini, who places Foscarini's stances within the framework of Renaissance naturalistic encyclopedism, Maurice Finocchiaro and Pietro Daniel Omodeo, who analyze Foscarini's writings in more detail.[29]

Foscarini's *Syntaxis*, published in Cosenza in 1613, is actually the carefully-considered index of a complex, seven-volume treatise that the Carmelite was drafting. It is also the manifesto for a program of pedagogical modernization he envisaged taking the form of an encyclopedic handbook summarizing the sacred and profane sciences for a very broad, varied audience of teachers, learners and knowledge mediators, enabling them to "quickly

26 Drake, *Galileo at Work. His Scientific Biography*, 244-251, 244-245: "On 7 March Cesi sent Galileo the book of the stanzas by 'Salvi', mentioned previously, and with it 'a book that has just come out; this is a letter by a Carmelite father who defends the opinion of Copernicus while saving all the scriptural passages [...]'. The Carmelite was Father P.A. Foscarini of Naples [*sic*], whose little book was perhaps the crucial factor in Galileo's decision to support Copernicus openly, against the advice he had received from Cesi, Ciampoli, and Barberini to keep the battle on more general grounds".

27 Fantoli, *Galileo. Per il copernicanesimo e per la Chiesa*, 173-179; Blackwell, *Galileo, Bellarmine, and the Bible*, 87-110; Shea and Artigas, *Galileo in Rome. The Rise and Fall of a Troublesome Genius*, 67-69; Heilbron, *Galileo*, 210-212 (calling him incorrectly as the author of an encyclopedia); Basile, *Galileo e il teologo Foscarini*; Caroti, *Un sostenitore napoletano della mobilità della Terra*; Camerota, *Galileo Galilei e la cultura scientifica nell'età della Controriforma*, 282-291; Ponzio, *Teologie e copernicanesimo*, 96-102.

28 According to Blackwell, *Galileo, Bellarmine, and the Bible*, 92, "[The] notion of scriptural hegemony seems to express one side of Foscarini; namely, his role as an obedient theologian. On the other hand there are numerous passages in the *Lettera* where Foscarini indicates that it is possible for natural knowledge, and specifically an astronomical theory, to attain full certitude".

29 Bucciantini, *Contro Galileo*, 53-58; Finocchiaro, *On Trial for Reason. Science, Religion, and Culture in the Galileo Affair*, 96-99, 212-214; Omodeo, *Copernicus in the Cultural Debates of the Renaissance*, 297-303. According to Bucciantini, *The strange case of Paolo Antonio Foscarini*, 265-266, in Foscarini's view "human reason [...] can only achieve a level of possibility, not of truth".

find all those things that are necessary to them, in every kind of subject".[30] Both sacred and profane knowledge, it bears repeating: in fact, Foscarini viewed the unity of knowledge as the epistemological foundation of this work ("All doctrines are a single doctrine, divided and distributed into parts, such that whoever possesses it in its entirety possesses nothing but the knowledge, of every kind and unique, of all the things treated individually by each doctrine").[31]

Foscarini's program for rearranging and divulgating knowledge soon converged with Galileo's in proposing a new heliocentric cosmology conceived as the starting point for establishing a new order of knowledge, even while remained profoundly distinct from Galileo's epistemology. As Massimo Bucciantini points out, Foscarini's project was linked "to the construction of a typically Renaissance-style encyclopedia of knowledge, strongly influenced by the philosophy of Telesio and, perhaps, Bruno as well" and that even displayed "commonality and intellectual proximity" with the mathematical and Pythagorean program Niccolò Antonio Stelliola had presented in Naples.[32]

In other words, Foscarini's "modernity" had different features from Galileo's: it was philosophical, deductive and encyclopedic, rather than methodological and experimental. Nonetheless, it converged with other efforts to construct new systems of knowledge about nature and grow the tree of scientific fields proliferating between the 16th and 17th centuries. Think for instance of Bruno's work but also Patrizi's *Nova de universis philosophia*, or even earlier of Telesio's *De rerum natura*, and later Gassendi's writings, all aimed at dismantling the Aristotelian system of sciences in favor of a natural philosophy that would provide new underpinnings for knowledge of the world.

Leafing through Foscarini's preface, the profusion of Platonic quotations and evocations is so striking as to cast the work as a veritable anthem to Platonism and the mathematical method as the key to properly understanding reality in its multiform manifestations. And this vision is applied not only to physics and Aristotelian natural philosophy more generally, but also to moral philosophy, the military arts, medicine, visual arts, and theology. Even theological questions can be illuminated by physical demonstrations

30 *Institutionum omnis generis doctrinarum tomis VII comprehensarum syntaxis. Qua methodus et ordo, in tradendis omnibus disciplinis servandus explicatur, ut demum ad perfectam solidamque sapientiam perveniri possit*, *Praefatio*, 1*r-v* (not numbered).

31 "Omnes doctrinae sunt una quaedam doctrina, quasi per partes secta ac distributa, quam qui possederit universam, nil aliud possederit, quam rerum omnium, quae sigillatim a singulis pertractantur omnimodam atque unam cognitionem": *ibid.*, 2*r* (not numbered).

32 Bucciantini, *Contro Galileo*, 57. Regarding the parallels between Foscarini and Stelliola ("accomunati dall'idea eliocentrica copernicana, ma anche dall'aspirazione di superare i rigidi e obsoleti schemi di una scienza qualitativa per costruirne una nuova, che si esprimesse col linguaggio della matematica") see Gatto, *Tra scienza e immaginazione. Le matematiche presso il collegio gesuitico napoletano (1552-1670 ca.)*, 96-97.

based on the mathematical method, he suggests: "For it is clear to all [the interpreters and expositors of scholastic theology and Scripture] that many things in theology are proven on physical grounds, as with [the existence of] God, eternity and similar matters, or are supposed to be proven as a physicist would prove them".[33]

It is evidently impossible, without those texts that never saw the light, to determine whether such an emphasis on the universality of the mathematical method should be considered mostly a mere homage to the Platonic vogue of the time or whether instead Foscarini really felt involved in the *quaestio de certitudine mathematicarum*, the controversy over the epistemic status of mathematics that in the second half of the 16th century developed among Italian scholars, investing also the Roman College. Here, in particular, the confrontation was played out between Christoph Clavius and Benito Pereira, who held the chair of natural philosophy, respectively for and against the possibility for mathematics to achieve conclusive demonstrations of reality. Precisely in 1615, moreover, the same year in which the *Letter* was published, the issue was reopened within the Society of Jesus by a pupil of Clavius, Father Giuseppe Biancani, who defended the certainty of mathematical conclusions in the appendix to his *Aristotelis loca mathematica*.[34]

Foscarini managed to print only two sections of his promised *Syntaxis*, the *Trattato della divinatione naturale cosmologica, over dei pronostici e presagi naturali* and the *Letter* itself, both published in 1615 by the Naples-based Lazzaro Scoriggio printing house. The first volume's dedicatory letter, addressed to the Archbishop of Cosenza Giovanni Battista Costanzo, is dated 5 May 1614. This text must have been delivered and printed shortly before the *Letter*, seeing as, in his depositions for the trial against him brought by the Archbishop of Naples Decio Carafa, Scoriggio stated that he considered the Neapolitan archiepiscopal curia's *imprimatur* for the *Trattato* to be valid for the *Letter* as well.[35]

These works must indeed be considered coeval, the first completed in Foscarini's native Montalto Uffugo in Calabria *Citra* in May 1614 (date of the dedication to Costanzo), the second written in Naples, in his Carmelite convent residence in January of the following year. The two texts correspond, respectively, to the first chapter of the sixth treatise in the second book of the third volume ("De sympathia, et antipathia rerum, ex qua magia natu-

33 "Nam omnibus [theologiae scholasticae, et Sacrae Scripturae interpretibus ac concionatoribus] iam perspectum est, multa rationibus physicis in theologia, vel probari de Deo, de aeternitate, et similibus, vel ut a physico probata supponi": *Institutionum omnis generis doctrinarum tomis VII comprehensarum syntaxis*, 5*v* (not numbered).

34 On the *quaestio de certitudine mathematicarum* see Romano, *La Contre-Réforme mathématique. Constitution et diffusion d'une culture mathématique jésuite à la Reinaissance*, 153 and following; Gatto, *Matematica e ortodossia nel tardo '500. L'esempio dei gesuiti napoletani*. On the involvement of Pereira see De Pace, *Le matematiche e il mondo. Ricerche su un dibattito in Italia nella seconda metà del Cinquecento*, 75-120; Blum, *Studies on Early Modern Aristotelianism*, 119-122.

35 Boaga, *Annotazioni e documenti sulla vita e sulle opere di Paolo Antonio Foscarini*, 194-195.

ralis divinativa resultat") and evidently – albeit not explicitly – the second chapter of the first treatise in the fourth book of the second volume ("De ordine partium sphaerae mundi inter se, et singularum motu, vel immobilitate"). The complex architecture of these sections of the *Institutiones* suggests that Foscarini's overall project was very ambitious indeed. These two texts' status as parts of the same work is also indicated visually by using the same allegorical frontispiece, a frame juxtaposing the symbols of the *trivium* and *quadrivium* on the left with allegories from the Old and New Testament on the right so as to establish an immediate relationship, and harmony, between sacred and profane knowledge.[36]

To begin, it must be underscored the author's choice to publish vernacular versions of these works destined to be translated and included in the broad Latin synthesis of the *Institutiones*: "Seeing as, in this genre, many hold this treatise would be more useful if written in our common Italian language, I agreed to publish it in the vernacular first, in the hopes that it would be published later as part of that great work in Latin".[37] I noted above that the choice of Italian probably contributed, at least in part, to bringing this letter to the negative attention of the Holy Office. Why, however, did Foscarini decide to publish the *Trattato* and the *Letter* before they had been translated, and moreover out of synch with the *Institutiones'* planned progression of topics? This is a key point for reconstructing the origins of the *Letter concerning the Opinion of the Pythagoreans and Copernicus*.

We might imagine this choice reflected the author's desire to take active part in the debate triggered on one side by the astronomical wonders exposed in Galileo's *Sidereus nuncius* and the subsequent discussion on sunspots between Galileo and Apelles-Scheiner and, on the other, by the magmatic turn-of-the-century growth of a multiform array of naturalistic disciplines, from alchemy to botany, that sought to achieve synthesis and come together under the umbrella of an updated natural philosophy. Indeed, the *Letter* explicitly cites Galileo's work on sunspots and in particular the arguments of the *Second letter on sunspots*, August 1612, supporting the thesis of the fluidity of the sky and continuing with a description of the relativity of motion ("although it is true that one simple body has only one simple motion, this motion is always a circular motion. For only by a circular motion can any simple body remain in its natural place, be united with itself, and have a

36 *Trattato della divinatione naturale cosmologica, over dei pronostici e presagi naturali, delle mutationi dei tempi etc.*, 6. In the closing part of the *Letter*, 63-64, Foscarini declares that he is close to having the first two full tomes of the *Institutiones* printed; relying on P.T. Pugliese, *Antiquae Calabrensis Provinciae ordinis Carmelitarum exordia et progressus* (Naples, 1696), and Elia D'Amato, *Pantopologia Calabra* (Naples: Ex Typographia Felicis Mosca, 1725), Boaga states that "the manuscripts, preserved until the $18^{th}$ century, were later lost" (198).

37 "Perché in questo genere è paruto a molti dovere giovar più questo trattato se si scrivesse nella nostra commune italiana lingua, perciò ho voluto consentire che così volgarmente uscisse prima fuori, con speranza che appresso debba uscire nel suo luogo in quell'opra grande in latino": *Trattato della divinatione naturale*, 7.

motion properly 'in a place'. This happens because what is moved still remains united with itself, and although it is in motion, it still remains at rest in the same place").[38] At the same time, it should be recalled that, in the years between the *Sidereus nuncius* and the condemnation of Copernicanism, Prince Cesi strove to modernize natural science by bringing his Naples associates into the Lincei cenacle, trying to make this city the second main hub of erudition in Italy after Rome.[39]

In 1604, during his brief stay in Naples, Cesi had met the elderly Giovanni Battista Della Porta, supreme investigator and master of ceremonies for the *mirabilia* of the world – his *Magia naturalis* first published in 1558 was repeatedly translated throughout Europe – and Ferrante Imperato, the great collector of findings from the three kingdoms of nature; Imperato's *Historia naturale* (1599) was structured as a boundless catalogue of simple and compound elements, their qualities and actions. Della Porta joined the Lincei in 1610 (Galileo joined the year after, during his second trip to Rome), followed by the botanist and naturalist Fabio Colonna and the above-mentioned Niccolò Antonio Stelliola.[40]

The Lincei "Neapolitan colony" soon lapsed into inactivity after Della Porta's death in 1615, but it produced a final, important manifesto: Stelliola's *Encyclopedia Pythagorea*, published in Naples under the patronage of the Lincei in December 1616, nine months after Foscarini and the "false [...] pythagorean doctrine" were condemned. Stelliola's text was similar, at least in the form, to the Carmelite's *Institutiones*: a reasoned index of a work to be published in the future, guided by the principle of the unity of knowledge and displaying a strong anti-metaphysical bent.[41]

Divided into twelve books, the *Encyclopedia Pythagorea* appears – since all we have is a scanty summary of titles – to be largely distant from traditional didactic layouts and, therefore, both from the *Institutiones*' programmatically discursive and classificatory aims and their extension to profane and sacred knowledge. Apparently, the *Encyclopedia* was instead an illustration of the characteristics and effects of the numerical quantities of bodies, ranging from celestial motion to animal physiology, alchemy, optics and applied mathematics to disciplines such as commerce, architecture and military science. Yet what the *Encyclopedia* and Foscarini's known texts shared is a common inclination toward the

38 *A Letter [ ... ] concerning the opinion of the Pythagoreans and Copernicus*, 241. See *Seconda lettera delle macchie solari*, in OG, V, 116-141, 133 and following.

39 Olmi, "La colonia lincea di Napoli", 27; Paolella, "Giambattista Della Porta's *De aëris transmutationibus*: Natural philosophy and the Earth sciences", 83 and following. More generally, the importance of Naples intellectual circles in contributing to the development of experimental science in early 17th-century Italy is framed by the editors in their introduction to the volume, *The science of early modern Naples: A missing city*, *ibid.*, 1-25.

40 *Ibid.*, 33-34, 39 and following.

41 *Encyclopaedia Pythagorea*, *All'Almo Collegio salernitano*, 2. See on this work Gatto, *Tra scienza e immaginazione*, 97-98.

suggestions of Pythagoreanism, in which at the time was seen the possibility of rewriting natural sciences in the light of mathematical and quantitative method.[42] Giordano Bruno's *Cena de le ceneri* in particular was one of the first books to introduce the topic, detailing the entire line of ancient and modern followers of Pythagoreanism, from Heraclides Ponticus, Ecphantus, and Niceta Siracusano to Nicola Cusano and Copernicus. All of these authorities were also mentioned in the *Letter concerning the opinion of the Pythagoreans and Copernicus* as well as in Kepler's powerful synthesis, in particular the 1609 *Astronomia nova*.[43]

One of the founders of an academy "degli Inculti" in Montalto Uffugo, Foscarini served for less than a year, between 1601 and 1602, as regent of the Studio of the Carmine Maggiore in Naples, and in this period he likely encountered some of the above-cited figures, or at least their work. He again stayed at the Carmine Maggiore between 1614 and the beginning of 1615, while on his way to Rome; in the papal capital he then held the office of Lenten preacher at the Carmelite church of Santa Maria in Traspontina until returning to Calabria towards the end of April.[44]

It is not surprising, therefore, that Foscarini appeared on the stage of the learned world, accompanied by two printed treatises and an unspecified number of writings undergoing reorganization, during precisely those few years in which, from Paris to Prague, Florence, Rome and Naples, mathematics, naturalistic disciplines and knowledge of the divine seemed on the verge of uniting in a new synthesis that would transcend the Aristotelian consensus. It was in this period that the Lincei were devising "a strategy to respond to the great question of the moment: science and religion" and, in Prince Cesi's palace in Rome, discussions revolved around "various matters of mathematics, philosophy and theology" in an explosive encounter among "Peripatetics, Paracelsianists and Telesians".[45]

The time seemed ripe for discarding the body of knowledge contained in the framework of Aristotelianism and the affirmation of heliocentric astronomy played a key, even symbolic, role in this process. It proved that the findings of experimental astronomy and

42 Cirino, "La divinazione naturale in Paolo Antonio Foscarini", 164-165.

43 Casini, "The Pythagorean Myth: Copernicus to Newton", 183-199. See Bruno, *La cena de le ceneri*, third dialogue, 232. A short list of the "followers of Copernicus [who] saw him in the role of revivalist rather than revolutionary, and in company with Copernicus himself [...] acknowledged the debt to Pythagorean astronomers", including, alongside Foscarini, Zuñiga, Galileo and Kepler, also Anton Deusing, Ismaël Boulliau, Pierre Gassendi, and Joseph Moxon, can be found in Heninger, *Touches of Sweet Harmony. Pythagorean Cosmology and Renaissance Poetics*, 130-131 and 144-145, n. 131.

44 Boaga, *Annotazioni e documenti sulla vita e sulle opere di Paolo Antonio Foscarini*, 183; Damanti, Libertas philosophandi, 77 and following.

45 Ricci, "I Lincei: l'invenzione della mediazione accademica. Nuova scienza, religione, vita civile", 208; Francesco Ingoli to Bonifacio Caetani, 9.VIII.1613, in Bucciantini, *Teologia e nuova filosofia. Galileo, Federico Cesi, Giovambattista Agucchi e la discussione sulla fluidità e corruttibilità del cielo*, 411-412.

physical theories asserting homology between the sublunar and supra-lunar worlds were capable of subverting an image of the world based on a centuries-old tradition and sense-based impressions. In the last edition of his commentary on Sacrobosco's *De sphaera*, printed in 1611, a year before his death, Father Clavius – strict ruler of Jesuit mathematical studies – was himself obliged to pay homage to the *Sidereus nuncius* in his description of Venus *corniculata* ("horned") and its apparent orbit around the sun, leaving to his successors the task of redefining celestial orbits "to save these phenomena".[46] Foscarini is careful to mention this detail in his *Letter*, emphasizing that Clavius, who "rejects the Pythagorean opinion", nonetheless admits that astronomers "are forced to try to provide some other system, which he exhorts them to do with strong encouragement".[47]

Foscarini's desire to personally engage in the frantic evolution of this cultural transition, recognized by all his contemporaries, can be read in his texts. He sought to acquire legitimacy as an expert in theology, an up-to-date connoisseur of natural philosophy and, in some ways, a philosopher even more than a theologian. Some clues of this stance can be found in his *Trattato della divinatione naturale cosmologica*.

The aim of the treatise is "to address as fully, and distinctly as possible the natural omens of the mutations of the times, and consequently of many other natural predictions": a synthesis of a meteorological prognosis method that would help in deciphering the complex universe of signs forecasting "the rains, winds, storms, heat, cold, snow, frost, earthquakes, serenity, tranquility, drought, abundance, famine, or sterility, pestilence, and infertility".[48] The *Trattato* lists the various types of phenomena indicating imminent change in the weather as well as geological events and morbidity, from the appearance of celestial bodies to the behavior of animals and dreams, but always "naturally and without superstition".[49]

Regarding clues "gleaned from the sun, moon, or stars", for instance, Foscarini's treatise "does not include those pertaining to their influences, but [rather] to their appearances and colors, and other impressions of them caused by the interposition of terrestrial va-

46 *In Sphaera Ioannis de Sacrobosco commentarius, In cap. I Sphaerae*, 75. See on this late edition of Sacrobosco's *Sphaera* James M. Lattis, *Between Copernicus and Galileo. Christoph Clavius and the Collapse of Ptolemaic Cosmology*, 106-144. On Clavius and his astronomical school see also Baldini, ed., *Christoph Clavius e l'attività scientifica dei gesuiti nell'età di Galileo*.

47 *A letter [...] Concerning the Opinion of the Pythagoreans and Copernicus*, 222.

48 "L'intento nostro è di trattare più pienamente, e distintamente che sia possibile, de' presagii naturali delle mutationi de' tempi e per conseguenza di molte altre predittioni naturali, come de' segni che preannunciare possono e sogliono le pioggie, i venti, le tempeste e le procelle, il caldo, il freddo, le nevi, i geli, i terremoti, la serenità, la tranquillità, la siccità, l'abbondanza, la carestia, ovvero sterilità, le pestilenze, et infertilità [...] molto tempo prima ch'elle avvengano, con assegnare le cagioni filosofiche e i fondamenti da' quali derivano, e provengono simili presagii": *Trattato della divinatione naturale*, cit., 1-2.

49 *Ibid.*, 6.

pors, or other element[s], between our sight and their bodies, i.e. by their eclipses, or by comets".[50] It goes without saying that this is a liminal territory, a shadowy ground, in which insights from experimental physics and astronomy are rather superficially combined with a vision of the world as a repertoire of phenomena referring reciprocally to the action of common causes (cited sources include the *De rerum varietate* by Girolamo Cardano and the *De rerum praenotione* by Giovanfrancesco Pico della Mirandola).[51]

This methodological declaration may be read as the foundations of the ambitious endeavor of the *Institutiones* which, as mentioned above, were strategically anticipated by the *Trattato della divinatione naturale cosmologica* and the *Letter concerning the opinion of the Pythagoreans and Copernicus*. This point is supported by an anonymous letter delivered to Galileo in 1615 or 1616 that Antonio Favaro (undoubtedly correctly) attributed to Foscarini. The writer announces he is working on a cosmographic text that will "discuss the shape and figure of the world, its integral parts, number of elements and the sky, and whether we should consider the sphere of fire or multitude of orbs to be celestial bodies, the distinction between the matter of the sky and the elements, and similar matters".[52] In fact, the layout closely resembles the planned structure of the fourth book of the second volume of the *Institutiones*, the first astronomy treatise: "The first chapter will be devoted to the subject of cosmography, namely the mobile sphere of the world, its figure and parts, both according to the accident determined by its center, axis and pole, and according to the substance, which is determined by the spheres of the heavens and planets".[53] Foscarini even announces his forthcoming commitment to writing a treatise in the form of a dialogue, "a dispute or discussion [...] between Ptolemaics and Copernicans, or Peripatetics and Pythagoreans", thereby introducing an idea Galileo himself later realized.[54]

In his anonymous letter, Foscarini then lingers on the methodological approach devised for the *Institutiones*, closely resembling that of the *Trattato della divinatione naturale cosmologica*, with physics arguments sided by topics taken from a polychromatic doxographical *corpus* encompassing ancient mythology, oracles and hieroglyphics, the consensus of Pythagoreans and modern authors, as well as scriptural sources; finally, he concludes with an argument that both conveys the planned endeavor's high ambitions and accounts its following, real-life disastrous results: "At the end, [I will deal with] the danger that may come to the sacrosanct authority of the Vicar of Christ from deciding and deter-

50 *Ibid.*, 2.

51 *Ibid.*, 80. For more detailed considerations see Cirino, "La divinazione naturale in Paolo Antonio Foscarini", 161-175. In the same perspective, Basile, *Galileo e il teologo Foscarini*, 44, draws Foscarini and his "late Renaissance program" closer to the philosophies of Telesio, Campanella, and Robert Fludd.

52 OG, XII, 215-220, 215.

53 *Institutionum omnis generis doctrinarum tomis VII comprehensarum syntaxis*, 45.

54 OG, XII, 215.

mining whether or not some things in natural matter and depending on sense belong to faith or not, where occasionally, in the long run, time may prove the contrary".[55] Yet the heart of the letter's message is the claim that natural philosophy is chief among all forms of knowledge of the world. This assertion appears to be an attempt to gain the validation of the leading exponents of the new science: "All these things [the foundations of the Copernican system], in relation to that which most comes to contra[dict] Aristotle and common philosophy, will open the way for me to treat the method and real reason of philosophizing, [...] and the extent to which one must search for the naked truth in everything".[56] It is telling that Foscarini asked Galileo's opinion regarding the possibility that the uniform and constant East-ward winds sailors encounter at equatorial latitudes could be caused "by a slight resistance of the air, when it encounters the motion of the earth".[57]

Galileo, displaying his usual reserve – and probably because he had doubts about this hypothesis, so evidently in contrast with his core idea of the earth's inertial system – did not respond. Yet the very fact that Foscarini addressed a long letter to him outlining this program shows the credibility the Carmelite had already gained among the Roman Lincei. In fact, the *Letter concerning the opinion of the Pythagoreans and Copernicus* – which, although already published, was supposed to come immediately after the planned text as the second chapter of the same treatise – did succeed in ensuring its author was well received when he arrived in Rome around February 1615. Reading between the lines, we clearly see to whom the Epistle was really dedicated: "I believe that considerable appreciation will be expressed by those who are studying this issue, and especially by the most learned GALILEO GALILEI [ ... ], by the most learned JOHANNES KEPLER [ ... ] and by all the illustrious and most virtuous members of the Academy of the LYNX, who universally accept this opinion (if I am not mistaken). And indeed I have no doubt that these and other learned men could easily find similar reconciliations with the passages of Scripture".[58] Prince Cesi likely saw Foscarini as the appropriate interlocutor for initiating a dialogue with the Roman authorities to defend Copernicanism from the Dominicans' accusations: an interlocutor who was institutionally entitled to tread in the delicate sphere of the exegetical fallout of the heliocentric system theory, and, at the same time, declaredly in favor of a radical renewal of natural philosophy.

At the beginning of March, shortly after Foscarini arrived in Rome, Cesi sent Galileo a copy of the *Letter* which the Carmelite himself probably gave him *brevi manu*, judging it to be "a work that could not have come out at a better time".[59] On April 9, Castelli deliv-

55 *Ibid.*, 217.
56 *Ibid.*, 216.
57 *Ibid.*, 217.
58 *A letter [ ... ] concerning the opinion of the Pythagoreans and Copernicus*, 223. Capitalization is in the Italian original.
59 Cesi to Galileo, 7.III.1615, in OG, XII, 149-150.

ered a second copy to Galileo; he commented positively on the text even while noting it was not yet sufficient to settle the matter ("I believe there is still enormous space for the considerations of Y.E., much higher and truer"), and listed the passages he found most effective; Castelli also informed Galileo that the archbishop of Pisa, Monsignor Bonciani (previously highly suspicious of this theory), "having seen that finally the theologian friar printed, and with great solemnity of crucifixes and saints, in defense of this opinion, remained astonished [...]. Now he begins to say that Copernicus was truly a great man and great intellect".[60] At the same time, Foscarini and Galileo began a direct correspondence; as mentioned above, Cesi also kept Galileo informed about the progress of the Carmelite friar's work until at least the end of August. In this respect, Foscarini's enterprise appears to have been unquestionably successful for much of 1615. What helped him earn the trust of Cesi and Benedetto Castelli, the latter the most active defender of Copernicanism among Galileo's correspondents?

To answer this question, let us finally turn to analyzing the content and structure of the *Letter concerning the opinion of the Pythagoreans and Copernicus*. The text is known to be based on a concordist hermeneutics, i.e. a biblical vision according to which the sacred text contains recurring statements that are not only religiously true but valid also for history, geography and the natural world; as such, they must by definition accord with the findings of the secular sciences – and therefore, in the specific case of the world system, the conclusions of natural philosophy.

This does not mean, however, that the *Letter* is entirely devoted to a direct heliocentric interpretation of the biblical passages mentioned at the beginning and which constitute the main object of debate. There are some explicit statements of this kind, such as the miracle of the sun stopping in the sky to allow Israel to annihilate the Amorites (*Josh* 10:12-14) or the golden candlestick that God orders Moses to make (*Ex* 25:31 and following ) that he interprets as possibly containing the allegory of a sun-centered world system.[61] Moreover, Galileo had made a similar move in his *Letter to Castelli* (286 and fol.), repeating it in the *Letter to Christina* (346 and fol.) when he argues that Joshua's miracle is more in agreement with the Copernican system than the Ptolemaic one even though the conceptual core of Galileo's two texts, and their extraordinary modernity, lies in the assertion that the scientific method is fully independent of religion, and that the sacred sciences and natural philosophy thus belong to wholly distinct spheres.

If Foscarini's text touches only marginally on Copernican exegesis that is because it has a different aim, in relation to which all its arguments are mustered: to demonstrate that the natural reasons on which the Copernican system is founded are much more solid

60 Castelli to Galileo, 9.IV.1615, *ibid.*, 165-166. See Damanti, Libertas philosophandi, 86 and following.

61 *A letter [ ... ] concerning the opinion of the Pythagoreans and Copernicus*, 236, 247-249.

than those underpinning the Ptolemaic system, seeing as the latter demands consensus by virtue of a habit of thought. Such habit is deceptive, he argues: "This is caused completely by old habits, strengthened over many centuries. Once a habit is established and men are hardened into opinions which are trite and plausible, and which are part of everyone's common sense, then both the educated and the uneducated embrace them and are hardly able to be dislodged from them. The force of habit is so great that it is said to be another nature".[62]

Hence his idea that Scriptural authority should not be forced to embrace a geocentric reading; rather, judgment on the matter should be suspended until natural philosophy produces incontrovertible evidence as to the true constitution of the universe (evidence that, in Foscarini's opinion, could only demonstrate the earth's motion around the sun). This helps explain why the *Letter* was not immediately censored in April 1615 when the opinions of the Holy Office consultants were being evaluated even though, as noted above, these opinions were all extremely negative. The text does not openly defend a thesis using theological reasoning; rather, it shows that the new science's astronomical findings put biblically based insistence on geocentrism on shaky ground. Moreover, although geocentrism had historically enjoyed widespread support, at the time it was not actually supported by any doctrinal definition issued by a council, pope or the Holy Office itself. The Roman Curia did not take an official stand on the matter until nearly a year later although, as noted above, it was probably Galileo's Copernican letters that led to the final decision to condemn Foscarini.

The *Letter* is organized into three parts. The first provides a preliminary but detailed overview of how celestial innovations have advanced our vision of the cosmos, closing with a list of the most problematic biblical passages – the ones commonly invoked to support geocentrism – divided into six classes. The second and most substantial section proposes a set of exegetical norms to adopt in interpreting the cited passages and, more generally, any passage potentially speaking of natural truths: the "opposing passages which contain all the weapons and arguments which present the gravest opposition and test to the Pythagorean opinion" are thus countered by "six principles [ ... ], which are like the firmest bastions made of impregnable material".[63] This part is interesting because Foscarini's "six principles" (or, better, "foundations", *fondamenti*) are mainly a reasoned review of the philosophical arguments supporting heliocentrism; this section, the *Letter*'s longest and most structured one, can thus also be understood as a condensed explanation – quite likely, specifically *ad usum theologorum* – of the Copernican system. The third part, the shortest and most exegetical, presents an allegorical interpretation of two biblical images referring to the natural order: the above-mentioned candlestick in

[62] *Ibid.*, 218.
[63] *Ibid.*, 226.

*Ex* 25 and the fruit of the tree of knowledge in *Gen* 2:16-17, fruit Foscarini assumes to be Indian fig, or pomegranate. These fruits, with their "many seed particles", hard core and softer outer part seem to resemble the earth, "which in its center and neighboring parts is stony, metallic, and solid, while as one goes closer to the circumference, its parts are more rare and soft".[64]

The *Letter*'s first section reviews the biblical passages traditionally deployed against Copernican cosmology, divided into six classes. First come the verses affirming that the earth is stable (*Ps* 92 [93]:1 and 103 [104]:5; *Qoh* 1:4), second those describing the motion of the sun (*Ps* 18 [19]:6; *Qoh* 1:5-6; *Isa* 38:8; *Sir* 48:26; *Josh* 10:12), third those who locate the heavens above and earth below, that is, at the universe's center (essentially paraphrasing *Acts* 2:19 "dabo prodigia in caelo sursum, et signa in terra deorsum" of Joel's prophecy, *Joel* 3:3, "dabo prodigia in caelo et in terra"); fourth are the authorities placing hell at the center of the world and thus the earth's center (and here Foscarini cites not biblical passages but "the common opinion of theologians"), fifth those contrasting heaven with earth, the earth implicitly understood as the lowest place in the universe and therefore central and stable (*Gen* 1:1; *Ps* 115 [113]:15; *Matt* 6:10; 1*Cor* 15:47; *Col* 1:16 and 3:2) and, sixth, those holding that after Judgment the sun will stop in the east, a belief "taken from the Fathers and the theologians rather than from Sacred Scripture".[65]

In itself, this catalog of biblical geocentrism represents a reordered version of an anti-Copernican corpus that was circulating at the time in a more or less complete form; the most comprehensive example is the conclusion of Ludovico delle Colombe's pamphlet *Contro il moto della terra*, written between 1610 and 1611 and circulating in manuscript form among Florence's anti-Galilaean circles.[66] What is interesting about Foscarini's use of this list of *auctoritates*, however, is that he cites it not to establish an unquestionable *status quaestionis* – the world's geocentrism as described by Scripture – from which to set off in formulating a new exegesis of these biblical passages but rather to show that the accepted tradition involves a distorted reading of the Bible, founded on the ideas of the ancients and expressed by Aristotelian astronomy in its Ptolemaic synthesis. This is why the issue of accommodation – that is, the fact that authors inspired by the Bible used simplified language to 'accommodate' the common limits of less-learned people ("to accommodate the skills of the very rough and undisciplined", as Galileo states)[67] – that is so central in the *Letter to Castelli* and *Letter to Christina* appears more secondary in Foscarini's *Letter*, introduced only a third of the way through the treatise

64 *Ibid.*, 248.

65 *Ibid.*, 225.

66 Reproduced in OG, III/1, 251-290. Delle Colombe sent a copy of his work to Clavius in May 1611. See Damanti, Libertas philosophandi, 12-13.

67 *Lettera a Cristina*, OG, V, 315.

to present the first foundation of the exegetical method and even borrowed, implicitly but quite evidently, from the *Letter to Castelli*.[68]

It thus seems to me that Foscarini treats the question of the Bible's status as truth in relation to cosmology somewhat differently. In some cases, he suggests, the prophets did write about the sun's motion around the earth so as to adapt statements about the structure of the cosmos to popular common sense; in other cases, however, it was people's blind acceptance of the ancients' authority and idea of a geocentric universe that made them misguidedly interpret some biblical passages as references to the natural world when that was not the prophets' intention. Although this distinction may seem subtle, I nonetheless see it as significant and certainly useful for understanding the intentions and peculiar epistemic structure of the *Letter* as more than a naive attempt to take the Scriptural passages used to prove geocentrism and reread them in a Copernican sense.

In this perspective, the opening of the *Letter* sounds very interesting. Foscarini devises it under the light of the philosophical dispute between ancients and moderns, holding that the historical, incontrovertible fact of the discovery the American continent and the sub-equatorial lands is a proof of the latter's superior knowledge of the natural world ("the experiments of the moderns have on some particular issues closed the venerable mouth of the ancients"). "The mobility of the earth – he notes – is no more paradoxical and strange than the notion of the antipodes or the notion that the torrid zone is inhabitable, views discussed by many ancients of great and respected authority. The former notion was thought by many of them, and the latter by all of common sense to be impossible, and was flatly denied. Nevertheless by their considerable diligence and courage, rather than by authority, the moderns have shown [...] that both of these notions are quite true".[69] In the opening pages that set the tone for the rest of the text, a string of arguments unfold from this point to revolve around the opposition between truth derived from observation and experience vs. a scaffolding of abstractions ("the many dreams of Aristotle, and other ancient philosophers") people only believe out of respect for tradition. Foscarini thus distinguishes between a domain of factual truth, governed by observation, and a domain of metaphysical illusion plunged into crisis by the "celestial novelties": "If they [the ancients] could have seen and observed what the moderns have

68 "Elsewhere in a thousand places he is said to walk, to depart, to look at, to rush; also to have bodily organs, eyes, ears, lips, a face, a voice, a countenance, hands, feet, a stomach, clothes, arms; and also to have many passions, like anger, sorrow, regret, etc.": *A letter [...] concerning the opinion of the Pythagoreans and Copernicus*, 227. See Galileo's *Lettera a Castelli*, in OG, V, 282-288, 282: "So [in Scripture] not only do various contradictions appear, but also serious heresies and blasphemies; for it would be necessary to give God feet and hands and eyes, and no less bodily and human affections as anger, repentance, and hatred". Translated into English from the original Italian.

69 *A letter [...] concerning the opinion of the Pythagoreans and Copernicus*, 219.

seen and observed, and if they would have understood their arguments, then without doubt they would have changed their minds and would have believed these most evident truths. As a result there is no need to respect the ancients so much that everything which they have stated is believed to be established, and to hold it to be most certain, as though it were revealed and descended from heaven".[70]

It is in this epistemic perspective that we should read two specific passages of the *Letter*, passages that have in the past given rise to somewhat erroneous interpretations of Foscarini's thought. In the first, the Carmelite Father appeals to the primacy of the sacred pages as a source of truth, and this has been read as indicating that he was "fully convinced of the cognitive superiority of the scriptures, just as he is certain that human means are inadequate for knowing and fully understanding scriptural dicta".[71]

Foscarini does write that "what is central in this matter is that if something is found to be contrary to divine authority, and to the sacred words dictated by the Holy Spirit [...] then in that case one ought to abandon not only human reason but also sense itself".[72] Note, however, that these lines come immediately after the above-quoted statement about ancient astronomy's fallacious beliefs, thus making it clear that the "human reason" we must abandon is the one that formulated the Ptolemaic system with its fanciful correctives to account for the irregularities of planetary motion, the "innumerable difficulties and [the] patchwork of spheres [...], epicycles, equants, deferents, eccentrics, and a thousand other fantasies and chimeras".[73] On the contrary, Copernican theory stems from the evidence of the truth developed at the beginning of the age of the moderns ("When the opinion of Pythagoras and of Copernicus appeared on the world stage"). Exegetes should not cling to the cognitive superiority of divine word regarding nature, therefore, but rather harmonize such interpretation with the framework provided by new knowledge: "Hence, if the Pythagorean opinion is true, then without doubt God has dictated the words of Sacred Scripture in such a way that they can be given a meaning which agrees with, and is reconciled with, that opinion. This is the motive which has led me (given that that opinion already is clearly probable) to look and search for ways and means to accommodate many passages of the Sacred Scripture to it, and to interpret these passages, with the aid of theological and physical principles, in such a way that they

70 *Ibid.*, 219-220. The comparison between ancients and moderns was a typical *tópos* of late mediaeval and early modern philosophical debates: see on this Del Soldato, *Early Modern Aristotle. On the Making and Unmaking of Authority*, especially ch. 5, 109 and following.

71 Ponzio, *Teologie e copernicanesimo*, 97.

72 *A letter [...] concerning the opinion of the Pythagoreans and Copernicus*, 220.

73 *Ibid.* See also Blackwell, *Galileo, Bellarmine, and the Bible*, 91 and following, according to whom Foscarini's statements about the impossibility of achieving certainty in the knowledge of natural phenomena through reason play essentially a preventive and precautionary role in the *Letter*.

are not openly contradictory".[74] There is good reason to believe these statements are in line with Galileo's Copernican works.[75]

The second, closely related passage concerns Foscarini's supposedly hypothetical stance in attributing heliocentrism "only mathematical preeminence, which did not necessarily imply a realistic correlate, pertinent, that is, to the actual physical order of the phenomena".[76] As outlined above, however, Foscarini actually locates the roots of his own Biblical interpretation on the physical level (albeit in an empirical vision of phenomena and their causes that does not embrace the complexity of Galilaean experimentalism). The only part of the *Letter* to mention hypotheticism is the passage following Foscarini's critique of Aristotelians' "thousand other fantasies and chimeras": "The advocates of the common opinion [the Ptolemaic view] have confessed in their writings on the system of the world that they cannot guess or teach the true system, but can only study the one which is more probable and which, with good reason, can save the celestial appearances more conveniently".[77] In other words, Foscarini views this purely mathematical, hypothetical knowledge of the heavens not as the proper foundations for positioning the achievements of the new science, but rather as the outcome of Ar-

74 *A letter [...] concerning the opinion of the Pythagoreans and Copernicus*, 222-223.

75 See *Lettera a Castelli*, 283: "Since it is evident that two truths can never contradict each other, it is the duty of wise expositors to strive to find the true senses of the sacred passages, agreeing with those natural conclusions of which, previously, our manifest sense or the necessary demonstrations had made us certain and sure". It is of course possible that Foscarini references precisely these considerations in the quoted passage, as also affirmed by the principle according to which "one truth is not contrary to another" (*A letter [...] concerning the opinion of the Pythagoreans and Copernicus*, 222). Both Galileo and Foscarini, as noted by Beretta, "Une deuxième abjuration de Galilée", 15 and following, moreover here implicitly relate back to the principle sanctioned by the constitution *Apostolici regiminis*, issued by the Fifth Lateran Council in 1513, which mandated the rejection of the principle of the 'double truth'by affirming the need to concord philosophical truths with the truths of faith. This idea, in turn, relied on a vast theological background that found its first origin in Augustine's *De Genesi ad litteram*. The constitution was originally intended as a reaction to the principle of the double truth invoked by Alexandrinist Aristotelianism, particularly Pietro Pomponazzi, to support the mortality of the rational soul 'secundum saltem philosophiam', 'at least according to philosophy'; but if, as shown by Bianchi, *Pour une histoire de la 'double verité'*, 117-156, it did not get much hearing in this, nevertheless it was revived several times to deny the principle of double truth, particularly after its publication in the expanded edition of Nicolau Eymerich's *Directorium inquisitorum* edited by rota judge Francisco Peña in 1578. See also Constant, "A Reinterpretation of the Fifth Lateran Council Decree *Apostolici regiminis* (1513)", 353-379.

76 Camerota, *Galileo Galilei e la cultura scientifica*, 283. In relation to this point, the author references analogous considerations by Basile, *Galileo e il teologo Foscarini*, 21, and Caroti, *Un sostenitore napoletano della mobilità della Terra*, 96.

77 *A letter [...] concerning the opinion of the Pythagoreans and Copernicus*, 220-221.

istotelian astronomy's inability to adapt its observations of celestial movements to the theoretical assumptions of geocentrism. This is confirmed in the very next lines when he again depicts the advent of modern astronomy as a cognitive leap forward: "Then the invention of the perspective eyeglass occurred, and with firm sensation various beautiful things in the sky were discovered, all curious and unknown until these centuries".[78]

The text's second and most extensive part is also its most innovative. Here the Carmelite introduces what he defines as the "six foundations" ("six principles", in Blackwell's translation: but we find "fondamenti" in the Italian original) guiding exegetes to view Copernicanism without prejudice. Interestingly, in of all these rules for interpreting the sacred text in relation to astronomy, only the first one, the "first foundation", is actually methodological; the others are essentially questions of content, intended to lay out the Copernican system's philosophical rationales.

This "first foundation" is actually both the hermeneutic core of the *Letter* and the element most likely to have attracted Bellarmine's attention: indeed, this section contains the analogy (between the earth's motion and that of a boat setting sail) that the cardinal specifically referenced in his reply.[79] It also contains a reference – extemporaneous with respect to the overall text, yet explicit and clearly stated – to the issue of the Roman Magisterium's authority to pass judgement, in defense of which Bellarmine had spent his life studying.[80] This is also the part of the text that Castelli brought to Galileo's attention in his above-mentioned letter as the most relevant one, particularly in relation to the long passage ("worthy of great consideration", according to Castelli) in which Foscarini enunciates the idea of the Scriptures' exclusively salvific value ("their only purpose is to teach us the true path to eternal life"), thus reaffirming the separation

78 *Ibid.* In this sense I agree with Blackwell, *Galileo, Bellarmine, and the Bible*, 87 and following, specifically that Foscarini recognized that studying natural phenomena could lead to a comprehensive understanding of reality.

79 "You might tell me that Solomon spoke according to appearances, since it appears to us that the sun rotates when the earth turns, just as it appears to one on a ship who departs from the shore that the shore departs from the ship. To this I respond that, although to him who departs from the shore it does seem that the shore departs from him, nevertheless he knows that this is an error and he corrects it, seeing clearly that the ship moves and not the shore": Bellamine to Foscarini, in Blackwell, *Appendix VIII*, 267. See *A letter [...] concerning the opinion of the Pythagoreans and Copernicus*, 232: "The same thing happens when people are carried in a small boat on the sea near the shore; to them it seems that the shore moves and is carried backwards, rather than that they move forwards, which is the truth".

80 "[God] also established one, infallible ruler, i.e. the Holy Church which is washed in his blood. The Church together with its visible head, the Supreme Pontiff [...] cannot err, in matters of faith and our salvation only. But the Church can err in practical judgments, in philosophilca speculations, and in other doctrines which do not involve and pertain to salvation: *ibid.*, 234-235.

between faith and science that Galileo had introduced earlier in his *Letter to Castelli* and went on to argue more extensively in the *Letter to Christina*.[81]

In the "first and most important principle", Foscarini offers four possible interpretations to use "when Sacred Scripture attributes something to God or to any other creature [thus including the celestial bodies] which would otherwise be improper and incommensurate": an initial metaphorical interpretation, a second interpretation based on human reason ("*secundum nostrum modum considerandi*"), a third according to common opinion, in line with the 'accommodation' invoked by Galileo ("*secundum opinionem vulgi*"), and a fourth depending on the way the Creator or creatures are perceived by man ("*respectu nostri*"), such the phases of the moon that exist only in the observer's perception.[82]

The author does not explicitly reveal the sources of these methodological indications in the *Letter*; however, we can see that they derive – albeit quite approximately – from the authorities cited in the Latin apology sent to Bellarmine and focused entirely on defending the methodological propositions set out here. Specifically, these include the preamble to book one of the *Commentarii et disputationes in Genesim* by the above-mentioned Father Pereira (1590), Cajetan's *In Pentateuchum Mosis* (1531) and Ambrogio Catarino Politi's *Enarrationes in quinque priora capita libri Geneseos* (1552), as well as the renowned *Loci theologici* by Melchor Cano (1563) – a group of authors characterized by (almost) crystal-clear orthodoxy (Cajetan, we know, had raised various concerns specifically on the issue of biblical interpretation and the possibility of diverging from the *doctores'* consensus, a position Pereira himself had branded "audax et correctione digna").[83] Foscarini probably drew on these more recent authors to identify the patristic, medieval authorities: primarily Augustine, *De Genesi ad litteram*, and Jerome, *Super Hieremiam*, as well as Aquinas (I-II, q. 98 a. 3, ad 2um), usually cited via the chain of their commentators according to the canons of scholasticism.[84]

What follows is the idea of a complex interpretation of the Bible, fraught with difficulties and constantly striving to distinguish between the apparent surface of the story, modeled on infinite discursive registers ("divine wisdom [...] adjusts itself to each thing according to its nature and capacity; it works naturally and necessarily with nat-

[81] Castelli to Galileo, 9.IV.1615; see *A letter [...] concerning the opinion of the Pythagoreans and Copernicus*, 233.

[82] *Ibid.*, 226 and following.

[83] Pereira, *Commentarii et disputationes in Genesim*, I, 30. See the apology of Foscarini in Boaga, *Annotazioni e documenti sulla vita e sulle opere di Paolo Antonio Foscarini*, 204-214, 208 and following.

[84] As is well known, these quotations also appear in the *Letter to Christina*. Regarding this point and the use of *De Genesi ad litteram* in the Copernican debate more generally, see Camerota, "Galileo e la *accommodatio* copernicana", 129-151.

ural and necessary causes, and freely with the free; for mighty people, nobly; for common people, humbly [ … ]; and thus for all, it adapts itself to each one's style")[85] and an underlying layer that, ultimately, pertains only to the providential order, i.e. the divine plan for salvation ("his holy law, whose purpose is to enable us to come in the Word to a perfect knowledge and vision of the entire order [ … ]. Then we will see distinctly and clearly, and will understand without difficulty, direct or indirect, the truth of all these curiosities which in this life have been left to the industry of human inquiry and investigation").[86]

Although this position is formulated with all the complexity required by the subtleties of testamentary exegesis, it essentially asserts that same autonomy of science at the heart of Galilaean hermeneutics. This affinity, both conceptual and discursive, is evidenced by Foscarini's use of certain similes to help readers understand the idea that the Bible speaks *respectu nostri*, according to our point of view. For example, Foscarini writes, the sun is said to rise and set "by virtue of extrinsic denomination", that is, due to the motion of the bodies receiving its heat, like "a fire burning in a fireplace [ … ]. A man who is cold stands in front of the fire to warm himself. First he warms one part of his body; then he turns another part of his body toward the fire to warm it; turning thus in a circle, he warms his whole body";[87] likewise, Joshua's miracle can be explained in a heliocentric system as an interruption of the earth's rotation and thus an interruption of the "sun's splendor above the earth" in the same way that "if the hand is rotated around the light of a burning candle which is at rest, the light moves on the hand without the candle being moved".[88] These are sense-based similes that, in their simplicity, draw on the same rhetorical resources as Galileo's to feed readers' imagination and thereby lead them to recognize the credibility of the arguments. In this case as well, I believe, Foscarini proves himself much more of a "philosopher" than his reputation would suggest.

This aspect is even more evident in the following "foundations" which, as mentioned above, are not so much methodological principles as assertions of fact: the earth's fixedness must be understood in relation to the perpetuity of its governing laws, its immo-

85 *A letter [ … ] concerning the opinion of the Pythagoreans and Copernicus*, 233. I depart here from Blackwell's translation, which reads "divine wisdom [...] adjusts itself to each person according to his nature and capacity; for the natural and necessary scientists, naturally and necessarily; for the liberal arts, freely". Indeed, the original Italian text clearly refers not to "natural scientists" and "liberal arts", but rather to natural and liberal causes ("[La] sapienza divina [ … ] con tutte le cose s'accommoda secondo la capacità e natura loro, onde con le cause naturali e necessarie opra naturale e necessariamente, e con le libere liberamente": *Lettera sopra l'opinione de' pittagorici e del Copernico della mobilità della terra e stabilità del sole*, 31).

86 *A letter [ … ] concerning the opinion of the Pythagoreans and Copernicus*, 234.

87 *Ibid.*, 235.

88 *Ibid.*, 236.

bility must be understood at times as immutability, at times as a static state within the inertial system, and at other times as elements aggregating around its center; finally, the earth's central position in the universe stems from the sun's proximity to the higher planets and sky of fixed stars.

Indeed, he explains these principles by illustrating the Copernican system's physical premises, particularly the idea that celestial bodies' natural motion is circular. The argument seeks to undermine the Aristotelian-Ptolemaic cosmos by showing that the Copernican system does not simply consist of replacing the sun with the earth in the third heaven, but also entails a completely different philosophical framework: "Although circular motion relates *to the whole*, and straight line motion *to the parts*, this difference does not make them opposite motions, such that the one is called straight and the other circular [ … ]. For both can exist together and reside naturally in one body [ … ]. Hence it is seen that this philosophy is as far removed from Aristotle's as the new cosmographical system is removed from the one commonly held up to now".[89] This conclusion is quite significant for the purposes of Foscarini's overall argument in that it denies the Bible's heliocentric cosmology of any possible foundation in Aristotelian mechanics, thus – as he already made explicit at the beginning of the text – rendering it nothing more than a system of thought, inherited from antiquity and supported out of habit, projected onto a sacred text.

In light of these points, I would draw two basic conclusions about the *Letter concerning the opinion of the Pythagoreans and Copernicus*. First, far from being a makeshift, naive attempt to force traditional biblical exegesis in a Copernican sense, it should be placed within the framework of the efforts to renew natural philosophy and the hierarchy of knowledge that, in the early 17th century, found expression in the multiform, sometimes contradictory, bundle of conceptions we see in discussions among the Accademia dei Lincei as well as in the other manifestations of anti-Aristotelianism.

Second, as stated above, that Foscarini's epistemology cannot be considered an example of Renaissance mathematical hypotheticism, as maintained by Basile, Caroti, and Camerota:[90] on the contrary, the *Letter* operates at the level of defending the reality of Copernicanism. Indeed, the text's underlying structure uses specifically physical evidence to argue for abandoning geocentric interpretations of Scripture.

Several recurring textual elements attest to this and, in my opinion, leave little room for doubt. First, Foscarini's above-quoted considerations about matching scriptural exegesis with new scientific findings: "The Pythagorean opinion is either true or false. If it is false, it is not worthwhile to speak of it or to take it into consideration. If it is true, then it is of little importance if all philosophers and astronomers in the world deny it; rather

89 *Ibid.*, 249. Italics in the Italian original.
90 See above, n. 67.

there would be, as a result, a need to formulate a new philosophy and astronomy based on the new principles and hypotheses which that opinion requires".[91] The alternative 'either it is true or it is not' clearly links this text to Galileo's realist theory and renders it antithetical to Bellarmine's admonition that thinkers "be content to speak *ex suppositione* and not in absolute terms".

This is not the only significant passage, however: the entire *Letter* is dotted with expressions clearly indicating Foscarini's conviction that Copernican cosmology represented the true structure of the universe. The ancient authors "rendered *probable*" Pythagorean opinion and they confirmed it "at least indirectly" (222); the passage of Gen 1:16 "fecit Deus duo luminaria magna" "is to be understood in relation to us and according to the vulgar opinion, and not according *to the true and real being* which these bodies have" (230). Since celestial phenomena "occur otherwise *in reality and in fact*" with respect to common understanding, "when they are found to be written in the Sacred Scriptures [ … ] they ought always to be understood according to the vulgar sense" (232); "it is in no way my present intention to determine *the truth or falsity* of this position [on inertial motion], although I would maintain that it is most probable" (243); and, "the opinion of Pythagoras and Copernicus is so *probable* that it is perhaps more likely than the common opinion of Ptolemy. For from it one can derive the most precise system, and the hidden constitution, of the world in a way which is much more solidly *based on reason and experience* than is common opinion" (247).[92]

The recurrence of the adjective 'probable' may have led some readers to perceive in Foscarini's text a theory in which "every *mundi systema* is, after all, a hypothesis increasingly consistent with the truth, but never coinciding with that Truth which remains elusive to man and known only [...] through the *voluntas Dei*".[93] I believe what I have cited so far indicates the opposite, namely that Foscarini did not subscribe to such a transcendent meaning of ultimate truth and instead recognized the existence and accessibility of two forms of truth, scriptural and natural, and felt they could be brought into harmony thanks to the new science's invaluable insights.

It is the second form of truth, the one encompassing the fruit "of human quest, and investigation" and therefore the real constitution of the universe, that is translated as "probable" in theological terms. Indeed, in scholastic vocabulary "probable" indicates that which may be known by merely human means and thus does not enjoy the status of certainty (doctrinal and salvific certainty) characterizing revealed truths; this does not imply, however, rejecting a conclusion that reason paints as certain: "It does not mean a discouragement and skepticism of intelligence in facing the complexity of reality. [...]

91 *A letter [ … ] concerning the opinion of the Pythagoreans and Copernicus*, 222.
92 All italics mine.
93 Basile, *Galileo e il teologo Foscarini*, 21.

That which is probable is that which, thanks to the truth possibilities it holds, is worthy of garnering the adherence of the spirit".[94]

"Sacred doctrine – Aquinas explains in the *Prima* – can resort to the authority of philosophers where they have been able to know the truth through natural reason [...] Sacred doctrine resorts to these authorities as if they were extraneous and probable topics, while it resorts to the authorities of canonical scripture as if they were proper and necessary topics".[95] And this is the relevant gloss of one of the most influential commentators of Aquinas in the 16th century, Cajetan: "It should be known that the human reason spoken of here is nothing but the argumentation that draws strength from natural light alone. And this argumentation is twofold: some of its conclusions are necessary, and in this case we speak of demonstration, while others are probable, and in them there is greater uncertainty. Both types of argumentation are limited to the certainty of physical science, and consequently are foreign to the genus of theological knowledge, and in this case theology proceeds from human reason as from reasons extraneous to it".[96]

Later in that century, the "doctrine of probability" (*doctrina probabilitatis*), intended to guide the choice between several equally morally valid opinions, comes to life in theology (the matter Foscarini teaches at the Carmine maggiore). The theory belongs first and foremost to the sphere of moral theology, but more generally it also concerns how theology can draw on arguments derived from pure reason and human knowledge.[97] For Melchor Cano, another among the fathers of early modern scholasticism (*De locis theologicis*, 1563), history, based on human knowledge, is a probable *locus* from which arguments in defense of the faith can be deduced, though of course with a lower degree

[94] "Il ne signifie pas un découragement et comme un scepticisme de l'intelligence devant les complexités du réel. La probabilité du Moyen Age est au contraire toute pénétrée de l'idée de vérité. D'une *Est probable ce qui*, grâce aux chances de vérité qu'il porte en soi, *est digne d'obtenir l'adesion de l'esprit*": Deman, *Probabilisme*, 431 (italics in the text). This passage refers to the notion of probability in medieval scholasticism, but the author goes on to describe it continuing in the second scholastic phase, especially the School of Salamanca.

[95] «Auctoritatibus philosophorum sacra doctrina utitur, ubi per rationem naturalem veritatem cognoscere potuerunt [...] Sed tamen sacra doctrina huiusmodi auctoritatibus utitur quasi extraneis argumentis, et probabilibus. Auctoritatibus autem canonicae Scripturae utitur proprie, ex necessitate argumentando»: *Summa theologiae*, I, q. 1, a. 8 ad 2um (here in the *Leonina* edition, IV, 1888, 21-22; translation mine).

[96] "Sciendum est quod ratio humana de qua hic est sermo, nihil aliud est quam argumentatio aliqua ex solo naturali lumine robur habens. Et est duplex: quaedam necessario concludens, quae vocatur demonstratio; et quaedam probabiliter, quae magnam habet latitudinem. Utraque autem in aliqua certa scientia physica clauditur, et consequenter extranea est a genere scibili theologico; ac per hoc, theologia procedit ex ratione humana ut sic, ut ex extraneis": *Ibid.*, 23 (translation mine).

[97] Schuessler, *The Debate on Probable Opinions in the Scholastic Tradition*, 60 and following.

of certainty than the Word of God. Bartolomé de Medina, a prominent commentator of the *Summa theologiae* and considered the founder of probabilism, establishes a simple division between probable and improbable doctrines, where the former are "confirmed by strong arguments and the authority of the wise", and thus can be followed without doubt of error.[98]

In other words, in scholastic vocabulary 'probability' corresponds to ta very high degree of certainty human knowledge can achieve without divine revelation. And, as Foscarini explains, the divine Word has not chosen to gift man with explicit statements about astronomy. In his *Letter to Christina*, Galileo instead sets up "probable opinion" in opposition to "sure and demonstrated science". The fact that the Carmelite uses "probable" in the sense of 'the most we humans can know' rather than Galileo's sense expressed in the *Letter to Christina* – according to which the "probable opinion" is opposed instead to the "proven and assured science"[99] – likely has to do with his theological lexical instruments and certainly reflects that phase of knowledge transition, and consequently language, emerging from the great debate about new celestial findings.

98 *Ibid.*, 72-79.

99 "Delle proposizioni naturali alcune sono delle quali, con ogni umana specolazione e discorso, solo se ne può conseguire più presto qualche probabile opinione e verisimil coniettura, che una sicura e dimostrata scienza, come, per esempio, se le stelle sieno animate": OG, V, 330.

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### Abbreviations

OG = Galilei, Galileo. *Opere*. National Edition, edited by Antonio Favaro, 20 vols. Firenze: Barbèra, 1890-1909.

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# Navigating censorship: Galileo and Diodati's plan for the publication of the *Two New Sciences*

Lucia Bucciarelli
Università Cattolica del Sacro Cuore; lucia.bucciarelli@unicatt.it

**Abstract**
This article explores the background of the editorial operation that led to the publication of Galileo Galilei's *Two New Sciences* in 1638. As it was for the Latin editions of the *Dialogue* (1635) and the *Letter to the Grand Duchess Christina of Lorraine* (1636), Galileo actively participated in the printing operations of his final work, even though in the introductory texts he claimed to have no involvement whatsoever. The analysis of three manuscript sheets preserved at the Biblioteca Nazionale Centrale di Firenze highlights not only Galileo's active role in the editorial process but also his contribution to devising a plan to appear completely uninvolved in that publication. In the National Edition of Galileo's works edited by Antonio Favaro, it is noted that these three sheets are written in the same handwriting, without identifying the author. This article intends to show that the author of these manuscripts is Elia Diodati. The comparison of the handwriting on these sheets with other autograph letters by Diodati, alongside the reconstruction of the role played by the Parisian jurist in the editorial operation, supports this hypothesis.

**Keywords**
Galileo Galilei, Elia Diodati, Two New Sciences

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## *Introduction*

> The discovery of many fallacies in doctrines that have been followed in the schools for many centuries, and the partial communication and partial publication of these discoveries, has stirred such an indignation in the minds of those who wish to be regarded as the sole possessors of wisdom that, being exceedingly sagacious and powerful, they have been able to find a way to suppress what has been discovered and published, and to prevent the release of what I have yet to bring to light; they have found a way to obtain from the Supreme Tribunal a very strict order for the Inquisitors not to licence any of my works: an order, I say, of the broadest nature, covering *omnia edita et edenda*.[1]

In the aftermath of his 1633 condemnation, Galileo Galilei often expressed a profound sense of distrust and bitterness in his communications with friends and correspondents. The harsh prohibition against publishing any of his works, along with the ban on discussing *sub poena relapso* the Copernican system, significantly constrained his scientific endeavours.[2] In addition to the stringent restrictions imposed by the Holy Office, in those years Galileo also faced personal tragedies, including the death of his beloved daughter Virginia in 1634 and the progressing deterioration of his eyesight, which ultimately led to blindness. During this challenging period, to avoid further persecution, Galileo had no choice but to adhere strictly to the silence imposed by the Holy Office.

Actually, the Pisan mathematician never truly considered abandoning the cause that had led to his harsh condemnation. In the months immediately following the decree, indeed, he resumed supporting various projects that kept him in close contact with the European scientific and intellectual community.[3] Beyond his significant contribution to the publication of the Latin editions of the *Dialogue* and the *Letter to the Grand Duchess Christina of Lorraine*,[4] Galileo was particularly active in responding to comments and criticisms from his opponents, which he countered through letters and annotations on texts.[5] With the help of Vincenzo Renieri, he proposed to the Dutch government a method for calculating longitude based on the tables he derived from the movement of Jupiter's four moons.[6] Through extensive correspondence with Pierre Carcavy, Elia Diodati, and

1 OG, XVI, 361.

2 Fulgenzio Micanzio informed Galileo about the ban on publishing any of his works in two letters dated 10th February and 10th March, 1635 (OG, XVI, 209, 230).

3 Raphael, "Printing Galileo's *Discorsi*: A Collaborative Affair", 483-485.

4 Bucciarelli, "Back to Battle: The Latin Edition of the Dialogue and of the Letter to Christina (1635-1636)", 93-101.

5 Particularly notable is Galileo's sharp response to Antonio Rocco's *Philosophical Exercises* (1633). OG, VII, 529-701, 712-50. See Hall, *Galileo's reading*, 71-101.

6 OG, XVIII, 304. See Drake, *Galileo at Work*, 374; Van Helden, "Longitude and the Satellites of

Lodewijk Elsevier in Toulouse, Paris, and Leiden respectively, he advocated for the possibility of printing a complete collection of his published and unpublished works.[7] Finally, he tirelessly worked on composing a "treatise on a new subject in mechanics, full of many curious and useful speculations".[8]

This last reference alludes to the *Discourses and Mathematical Demonstrations Relating to Two New Sciences*, Galileo's last work. Painstakingly developed during his years in Padua, this treatise introduced a new theory of motion which sought to legitimize the scientific and astronomical positions already expressed in the *Dialogue*. In this theoretical framework, the Copernican model was intrinsically connected to the geometrization of motion and an atomistic conception of matter. The former, inspired by Archimedes, had already been employed in the *Dialogue* to counter Aristotelian arguments against the movement of the Earth;[9] the latter was elaborated through the geometry of indivisibles and prominently featured in the first two days of the *Two New Sciences* dedicated to the strength of materials.[10]

Besides providing indirect but essential support to the Copernican system, Galileo's two most important works also presented an undeniable continuity:

> Sagr. And let this be the final conclusion of our four days' arguments, after which if Salviati should desire to take some interval of rest, our continuing curiosity must grant that much to him. But this is on condition that, when it is more convenient for him, he will return and satisfy our desires – mine in particular – regarding the problems set aside and noted down by me to submit to him at one or two further sessions, in accordance to our agreement. Above all, I shall be waiting impatiently to hear the elements of our Academician's new science of natural and constrained local motions. Meanwhile, according to our custom, let us go and enjoy an hour of refreshment in the gondola that awaits us.[11]

It is not difficult to read between the lines of the *Dialogue*'s epilogue the announcement of a new work: Salviati, Sagredo, and Simplicio would return with the same personas they had assumed years earlier, discussing new, interesting, and stimulating topics. In addition to the characters, in the *Two New Sciences* Galileo also revived the dialogic form, once again employing a rhetoric that was highly functional to the scientific structure.

Jupiter", 85-100; Stefani, "Un telescopio a due occhi? Favaro, Venturi e il celatone di Galileo", 169-185.

7 Camerota, *Galileo Galilei e la cultura scientifica nell'età della controriforma*, 545-547.

8 OG, XVI, 59.

9 Galluzzi, *Tra atomi e indivisibili. La materia ambigua di Galileo*, 29-54.

10 Biener, "Galileo's First New Science: The Science of Matter, 262-287; Galluzzi, *Tra atomi e indivisibili. La materia ambigua di Galileo*, 91-114.

11 OG, XII, 489.

These stylistic and thematic choices caused apprehension among those who, still troubled by the risks faced by Galileo before the tribunal of the Holy Office, did not consider it prudent to revisit the elements and features that had characterized the ill-fated *Dialogue*. However, the fear of a recurrence did not discourage Galileo. Aware of the impossibility of freely publishing his work in the stifling cultural climate of Italy – a climate exacerbated by his own case – he had already devised a clever backup plan: the only solution to circumvent the enforced silence was to take the route leading to Europe. There, the cultural environment, already active through the Republic of Letters in publishing his other works, was eager to support Galileo's desire.

The printed edition of Galileo's final work, the one he cherished the most,[12] was about to become the last act of his ambitious scientific enterprise, with Galileo serving both as the author in writing and the covert director in the publication. The European context once again proved to be an exceptional cultural stage to enact Galileo's much-discussed script.

Building on this premise, this article intends to shed new light on the intricate editorial strategies that led to the publication of Galileo's *Two New Sciences*. The analysis of three manuscript sheets preserved at the Biblioteca Nazionale Centrale di Firenze, reveals Galileo's calculated efforts to appear uninvolved in the printing process of his last work, while also suggesting Elia Diodati's significant contribution. By comparing Diodati's handwriting with these manuscripts and by examining his key role in Paris, this study argues that Diodati was a crucial – if understated – figure in shaping the final publication of Galileo's *Two New Sciences.*

The historiography has long investigated key aspects of the *Two New Sciences*, viewing its edition as essential to understanding Galileo's later years and scientific legacy. Notable contributions in this field include Renée J. Raphael's article, "Printing Galileo's Discorsi: A Collaborative Affair," and Stèphane Garcia's monograph, *Élie Diodati et Galilée. Naissance d'un réseau scientifique dans l'Europe du XVIIe siècle.*[13] The former provides essential context for understanding the network of contributors who participated in the production of Galileo's *Two New Sciences*. The latter has explored much of the Galileo-Diodati relationship, particularly in relation to the Latin edition of the *Dialogue* and the *Letter to the Grand Duchess Christina of Lorraine.* This article seeks to engage with these works to enrich the nuanced narrative behind the edition of Galileo's *Two New Sciences* and to add new perspectives to the interpretive layers that continue to shape our understanding of Galileo's last years.

12 OG, XVI, 273.

13 Garcia, Élie *Diodati et Galilée. Naissance d'un réseau scientifique dans l'Europe du XVII*[e] *siècle*.

## *The troubled edition of Galileo's* Two New Sciences

Galileo began working on his new treatise during his stay in Siena with Archbishop Ascanio Piccolomini just a few weeks after his condemnation – a sign that his enthusiasm had not diminished but had, in fact, gained renewed vigour. Two years later, the first two days of the *Two New Sciences* were already completed, and by the end of 1635, he was finalizing the third day, which focused on local motion. In addition to drafting the text, Galileo promptly began organizing the printing operations. Managing this process, however, proved to be highly problematic and caused delays in the publication.

The Galilean historiography – in particular Rapahel's account – has reconstructed in detail the manoeuvres that prepared the way for the edition of the *Two New Sciences*. The copious correspondence that Galileo exchanged with his extensive network of contacts in those years, indeed, helps to understand that, despite the restrictions imposed by his condemnation and house arrest, in 1635 Galileo explored multiple avenues to secure a printer to his work.

The first attempt to circumvent censorship was made in Venice, where the political and intellectual environment was more permissive compared to the strict controls exercised by the Holy Office in other Italian cultural centres. Despite the diligent efforts of Fulgenzio Micanzio, who managed this operation, the ban on publishing any work by the author of the *Dialogue* remained unshaken. In a letter dated 10th February 1635, Micanzio informed Galileo of a conversation he had with the Inquisitor of the lagoon city, who had already prohibited the reprinting of Galileo's *Discourse on Floating Bodies* in observance of the general ban *de editis omnibus et edendis.*[14]

Micanzio's attempt in Venice demonstrated that publishing Galileo's work in Italy was impossible. Therefore, to avoid exacerbating an already tense situation, Galileo had no option but to seek publication in Europe. Even across the Alps, however, it was necessary to carefully consider the best route for sending Galileo's precious manuscript, as the presence of Jesuits in many cultural centres posed additional challenges.

In 1635, at the suggestion of Grand Duke Ferdinando, Galileo sent a manuscript containing the first two days of his work to the engineer Giovanni Pieroni, who was at the service of the Holy Roman Emperor in Vienna.[15] Pieroni intended to have Galileo's work printed in Prague.[16] However, the influence of the Jesuits in both Prague and Vienna was so strong that it impeded the publication. Pieroni had to seek the assistance of Cardinal Dietrichstein, Bishop of Olmütz, to establish contact with a local printing house.[17] Although the engravings for the illustrations were prepared, Pieroni was eventually forced to

[14] OG, XVI, 209.
[15] *Ibid.*, 303-304.
[16] *Ibid.*, 359.
[17] *Ibid.*, 393.

abandon the project due to the sudden death of Cardinal Dietrichstein. He had no choice but to return the manuscript to Galileo.[18]

In the spring of 1636, while finalizing his studies on the projectile motion for what would become the fourth day of the *Two New Sciences*, Galileo welcomed the printer Lodewijk Elzevier at his residence in Arcetri, where he had returned to live two years earlier following a permit from Pope Urban VIII.[19] That visit, facilitated by Elia Diodati, was not merely a courtesy but was pivotal in arranging the edition of the work. Although we lack specific details of the meeting, we know that the outcome was successful: in the following months, Galileo prepared a copy of the first three days of his work to be sent to Venice. There, Micanzio would deliver the manuscript to Elzevier, who was in the lagoon city on business.[20]

At this point, historians have generally maintained that the final printing of the *Two New Sciences* by the Elzeviers was primarily the result of the efforts of Galileo's closest collaborators. However, as I intend to demonstrate in this article, Galileo did not relinquish his central role and continued to actively supervise the printing operations that led to the edition of his last work. In addition to supervising the operations, he also devised a plan to conceal his involvement, ensuring that no one could challenge his hidden role as the mastermind behind this delicate editorial undertaking. His contribution, although subtly concealed, emerges through unexpected channels and behind-the-scenes maneuvers that challenge the traditional narrative and reveal Galileo's active participation in shaping the final form of his *Two New Sciences*.

A crucial event for understanding Galileo's plan to print the *Two New Sciences* and to conceal his involvement in the editorial project was the visit he received in October 1636 at Arcetri from the Count of Noailles, the French ambassador in Rome to whom Galileo would later dedicate his work.[21] As Galileo would later recount in the dedication, indeed, during that visit, the Count of Noailles received a valuable copy of the manuscript of the *Two New Sciences*. This detail is not merely a marginal note: as it will emerge in the second part of this article, the visit of the Count de Noailles and the alleged gift of the manuscript were crucial in portraying Galileo as completely uninvolved in the publication of his own work.

18 Raphael, "Printing Galileo's *Discorsi*: A Collaborative Affair", 488-495.

19 OG, XVI, 452.

20 *Ibid.*, 475.

21 François de Noailles (1584-1645) served as the French ambassador to Rome from April 1634 to October 1636. He had met Galileo in Padua in 1603, where he had been one of his students. Following Galileo's condemnation in 1633, he attempted to lessen the severity of his punishment, though unsuccessfully. In 1636, he obtained a permission to meet with the Tuscan mathematician in Poggibonsi during his return journey to France. See Favaro, *Amici e corrispondenti di Galileo,* 1317-1346.

By the end of 1636, as revealed in a letter to Diodati dated 6th December, Galileo was still grappling with the parabolic motion of projectiles. He was working through notes from his Paduan studies and found "considerable difficulty in understanding many of the things discovered in his younger years".[22] The text for the fourth day was not completed until March 1637. Once again, Micanzio sent this portion of Galileo's work to Elzevier, who on 16th March requested from the Venetian Servite "the remainder with the frontispiece".[23] In Galileo's plans, the "remainder" was intended to include a fifth day on the force of impact. However, Galileo's deteriorating health forced him to abandon this part of the project.

The printing process continued until January 1638, when Elzevier sent Galileo the drafts of the final pages of the work, requesting the dedication and the title.[24] The former was sent to Leiden by Diodati after receiving formal approval from the Count de Noailles; the latter, chosen by Elzevier, was not well received by Galileo, who later described it as "too vulgar, if not plebeian".[25] After a tortuous and laborious collective effort involving many members of the Republic of Letters who had rallied around Galileo,[26] the *Two New Sciences* were finally published in the spring of 1638.

From the correspondence with his closest friends and collaborators, it is evident that Galileo was an active promoter of this editorial endeavour. However, he had to publicly present his work as if it had been edited without his knowledge. Although the *Two New Sciences* did not explicitly advocate Copernicanism, they nonetheless constituted a significant defence of the new natural philosophy underpinning the heliocentric system. The book, indeed, was presented to the readers as a publication made possible largely through the goodwill of the Count de Noailles, to whom the work was dedicated. Galileo's involvement was carefully concealed between the lines of his work.

## *Behind the scenes*

The dedication to the French ambassador that precedes the text of the *Two New Sciences* is the principal document through which Galileo obscured any evidence of his involvement in the publication of his work:

> I recognize as resulting from your excellency's magnanimity the disposition you have been pleased to make of this work of mine, notwithstanding the fact that I myself, as you know,

22 OG, XVI, 524.
23 OG, XVII, 45.
24 *Ibid.*, 265.
25 *Ibid.*, 370. We do not have information on the title Galileo intended to give to his work, apart from the initial word: *Dialogues*.
26 Torrini, "Galileo e la Repubblica degli scienziati", 788-789; Raphael, "Printing Galileo's Discorsi: A Collaborative Affair".

> being confused and dismayed by the ill fortune of my other works, had resolved not to put before the public any more of my labors. Yet in order that they might not remain completely buried, I was persuaded to leave a manuscript copy in some place, that it might be known at least to those who understand the subjects of which I treat. And thus having chosen, as the best and loftiest such place, to put this into your excellency's hands, I felt certain that you, out of your special affection for me, would take to heart the preservation of my studies and labors. Hence, during your passage through this place on your return from your Roman embassy, when I was privileged to greet you in person (as I had so often greeted you before by letters), I had occasion to present to you the copy that I then had ready of these two works. You benignly showed yourself very much pleased to have them, to be willing to keep them securely, and by sharing them in France with any friend of yours who is apt in these sciences, to show that although I remain silent, I do not therefore pass my life in entire idleness.[27]

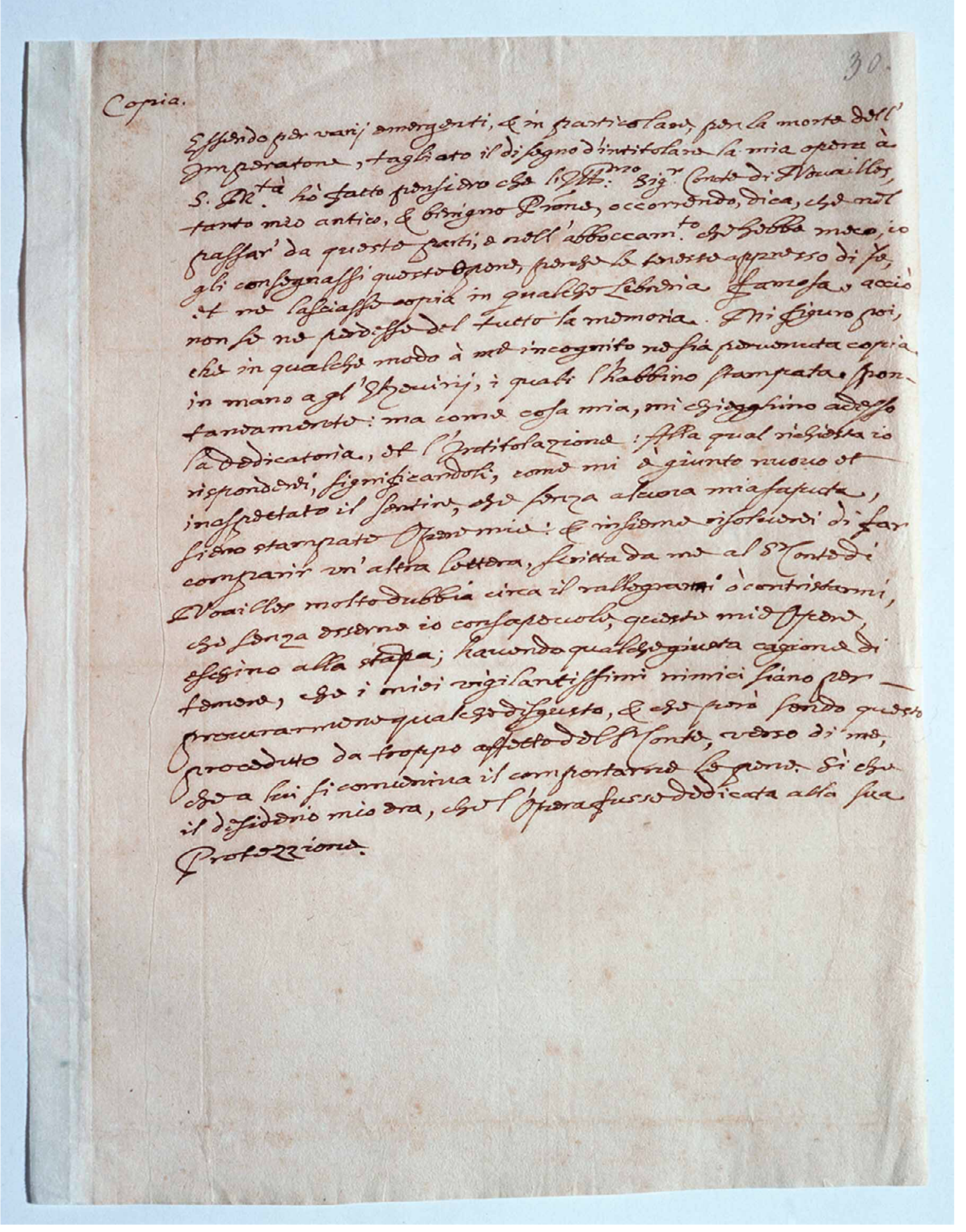
How should we read this incipit? Evidently, this is a masterful act of dissimulation. Galileo, indeed, claims that after his condemnation, he had decided not to expose any of his "labours" to the public. Actually, he had not only been actively involved in the Latin editions of the *Dialogue* (1635) and the *Letter to the Grand Duchess Christina of Lorraine* (1636), but he had also pursued every possible avenue to publish his latest work. He now sought to convince his readers – and his opponents – that the publication of the *Two New Sciences* was entirely due to the Count of Noailles' magnanimity.

Besides, it is indicative that Galileo chose to dedicate his last work to the French ambassador. He could have honoured the Grand Duke of Tuscany or another eminent patron of the sciences. Why, then, did he choose the Count? Most likely, Galileo knew that the French ambassador was the only prominent figure upon whom he could plausibly place the burden and responsibility for the publication of the *Two New Sciences*. After all, the Count had been authorized by Urban VIII to visit Galileo in October 1636. Thus, in the eyes of the world and of the Holy Office, as Galileo emphasises in the dedication letter, it was credible that during his visit to Arcetri, the Count received a copy of the work that Galileo happened to have ready. However, as revealed by his correspondence with Micanzio, Galileo had sent the manuscript of the *Two New Sciences* to the printers months before his meeting with the Count de Noailles.

The details of this operation are documented in a manuscript letter (Fig. 1) preserved at the Biblioteca Nazionale Centrale di Firenze (MS Gal. 72, f. 30r):

> Due to various unforeseen circumstances, particularly the death of the Emperor, the plan to dedicate my work to His Majesty has been abandoned. I have therefore thought that the Illustrious Count de Noailles, a dear friend and kind patron, if needed should say that

27 Galilei, *Two new sciences: including centers of gravity & force of percussion*.



30.

Copia.

Essendo per varij emergenti, et in particolare per la morte dell'
Imperatore, tagliato il disegno d'intitolare la mia opera à
S. M.tà hò fatto pensiero che l'Ill.mo Sig.r Conte di Noailles,
tanto mio antico, et benigno Padrone, occorrendo, dica, che nel
passar da queste parti, e nell'abboccam.to che hebbe meco, io
gli consegnassi queste Opere, perche le tenesse appresso di se,
et ne lasciasse copia in qualche Libreria famosa, acciò
non se ne perdesse del tutto la memoria. Mi figuro poi,
che in qualche modo à me incognito ne sia pervenuta copia
in mano agl'Elzevirij, i quali l'habbino stampata, e spon-
taneamente: ma come cosa mia, mi chieggono adesso
la dedicatoria, et l'intitolazione: alla qual richiesta io
risponderei, significandoli, come mi è giunto nuovo et
inaspettato il sentire, che senza alcuna mia saputa,
siano stampate Opere mie: et insieme risolvendomi di far
comparir un'altra lettera, scritta da me al S.r Conte di
Noailles molto dubbia circa il rallegrarmi ò contristarmi,
che senza esserne io consapevole, queste mie Opere
eschino alla stampa; havendo qualche giusta cagione di
temere, che i miei vigilantissimi nimici siano per
procurarmene qualche disgusto, & che però sendo questo
proceduto da troppo affetto del S.r Conte, verso di me,
che a lui si conveniva il comportarne le pene. Si che
il desiderio mio era, che l'Opera fusse dedicata alla sua
Protezzione.

Fig. 1 – MS Gal. 72 f. 30*r*, Biblioteca Nazionale Centrale di Firenze.

> during his visit here and during our meeting, I entrusted him with these works so that he could keep them and leave a copy in some renowned library to ensure they are not completely forgotten. I then imagine that, in some way unknown to me, a copy has reached the Elzeviers, who have printed it spontaneously: however, as it is my work, they now ask me for the dedication and title. To this request, I would respond that I have just learned that, unexpectedly and without my knowledge, my works have been printed. I would also decide to issue another letter, written by me to Count de Noailles, expressing my uncertainty about whether to rejoice or lament that these works of mine have been printed without my awareness. I have some legitimate reason to fear that my vigilant enemies might cause me trouble, and thus considering that this situation stems from the Count's excessive affection towards me, it would be fitting for him to bear the consequences, thus making it my desire that the work be dedicated to his protection.[28]

The author of this letter is Galileo, who communicates to his correspondent the script to feign his ignorance of the Leiden edition. The key figure in this charade is the Count of Noailles. Through his correspondent, indeed, Galileo requests the Count to state, if necessary, that "when passing through these parts, and during our meeting, I handed him these works". The scheme continues with the staged publication of the *Two New Sciences* in Leiden: a manuscript copy of Galileo's work somehow made its way to the Elzeviers, who then requested a dedication and a title from the author. To this request, Galileo would respond that he had been "newly and unexpectedly informed that my works had been published without my knowledge". Once again, the intention was to convince the readers that the work had been published without the author's consent.

The plan to draft the dedication was ready. But who was the recipient of Galileo's letter containing these instructions? Folio 30r bears the heading "Copy"; indeed, the handwriting on the letter is not Galileo's. Who made this copy? The author of this copy – and most likely the recipient of Galileo's missive – was Elia Diodati. A comparison of this folio with other autograph letters by the Parisian jurist supports this hypothesis (Fig. 2).[29] In the *National Edition of Galileo's works*, Antonio Favaro notes that folio 30r is written "in the same handwriting as the manuscripts of the dedication and the preface to the *Discourses and Mathematical Demonstrations Concerning Two New Sciences*".[30] Indeed, folios 28r-v (Fig. 3, Fig. 4), which contain the dedication to the Count of Noailles, and folios 31r-v and 32r (Fig. 5, Fig. 6, Fig. 7), which include an almost final version of the printer's letter to the readers (i.e., the preface), also appear to be written in Diodati's hand.

28 OG, VIII, 365.

29 Confront, for example, Diodati's handwriting in the manuscript letter he sent to Roberto Galileo on 2nd June 1637, currently preserved at the Archivio di Stato di Firenze, 5351, c. 4r-v (digital version: https://opac.museogalileo.it/imss/resource?l=en&uri=00005773).

30 OG, VIII, 365, note 1.

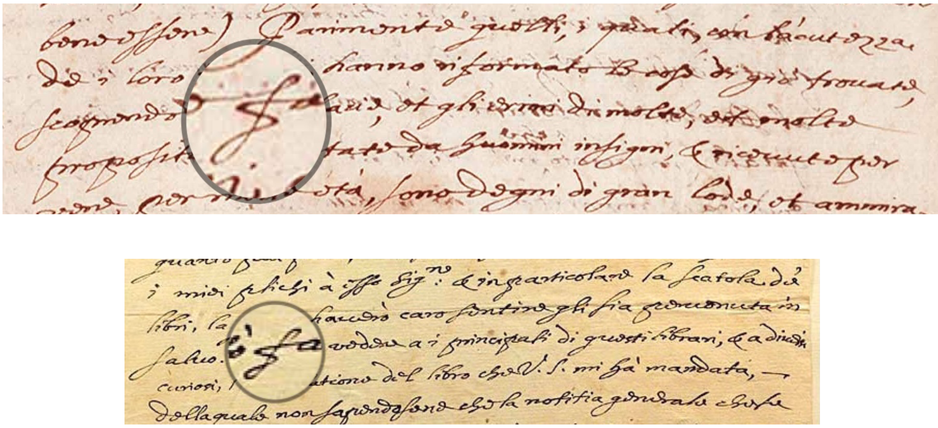


Fig. 2 – Comparison of the letter *f* in manuscript 31*r* and in an autograph letter by Diodati.

Beyond the calligraphic evidence, we can identify the Parisian jurist as the author of these folios for his pivotal role in the publication of the *Two New Sciences*. The instructions for finalizing the printing of the dedication and the preface were sent to Elzevier through Diodati in January 1638. As it was for the Latin editions of the *Dialogue* and the *Letter to the Grand Duchess Christina of Lorraine*, Diodati oversaw the editorial operations of the *Two New Sciences* from Paris, presumably after receiving instructions or approval from Galileo himself.

In the specific case of folio 30r, it is unclear whether Galileo was directing the jurist on how to write the dedication or merely informing him of the strategy he had employed to compose it. In the first scenario, it is possible that Diodati wrote the dedication according to Galileo's instructions. In the second scenario, Galileo may have sought the Count of Noailles's approval for the orchestrated narrative surrounding the printed edition of his work through Diodati before drafting the dedication.

Regardless, the text of the dedication on folios 28r-v is essentially identical to the one later published in March 1638.[31] Folio 30r, however, precedes the drafting of the dedication itself, as it seeks a form of authorisation from the Count of Noailles to approve the strategy. For his part, on 10th January 1638, the French ambassador effectively granted his consent for the dedication. However, his letter to the Pisan mathematician suggests that he had neither read Galileo's *Two New Sciences* nor, quite possibly, even received the manuscript. He only noted that Diodati had informed him about the book:

[31] The five variations between the manuscript and the printed text are insignificant and are noted by Antonio Favaro (*Ibid.*, 43-44).

> Ce sera donc, Monsieur, avec beaucoub de joye et d'honeur, que ie verray mon nom a la teste du livre duquel M.$^{r}$ Deodati m'a parlé; en recognoissance de quoy il n'y a chose au monde que vous puissies desirer de moy, que ie ne sois prest de vous rendre.[32]

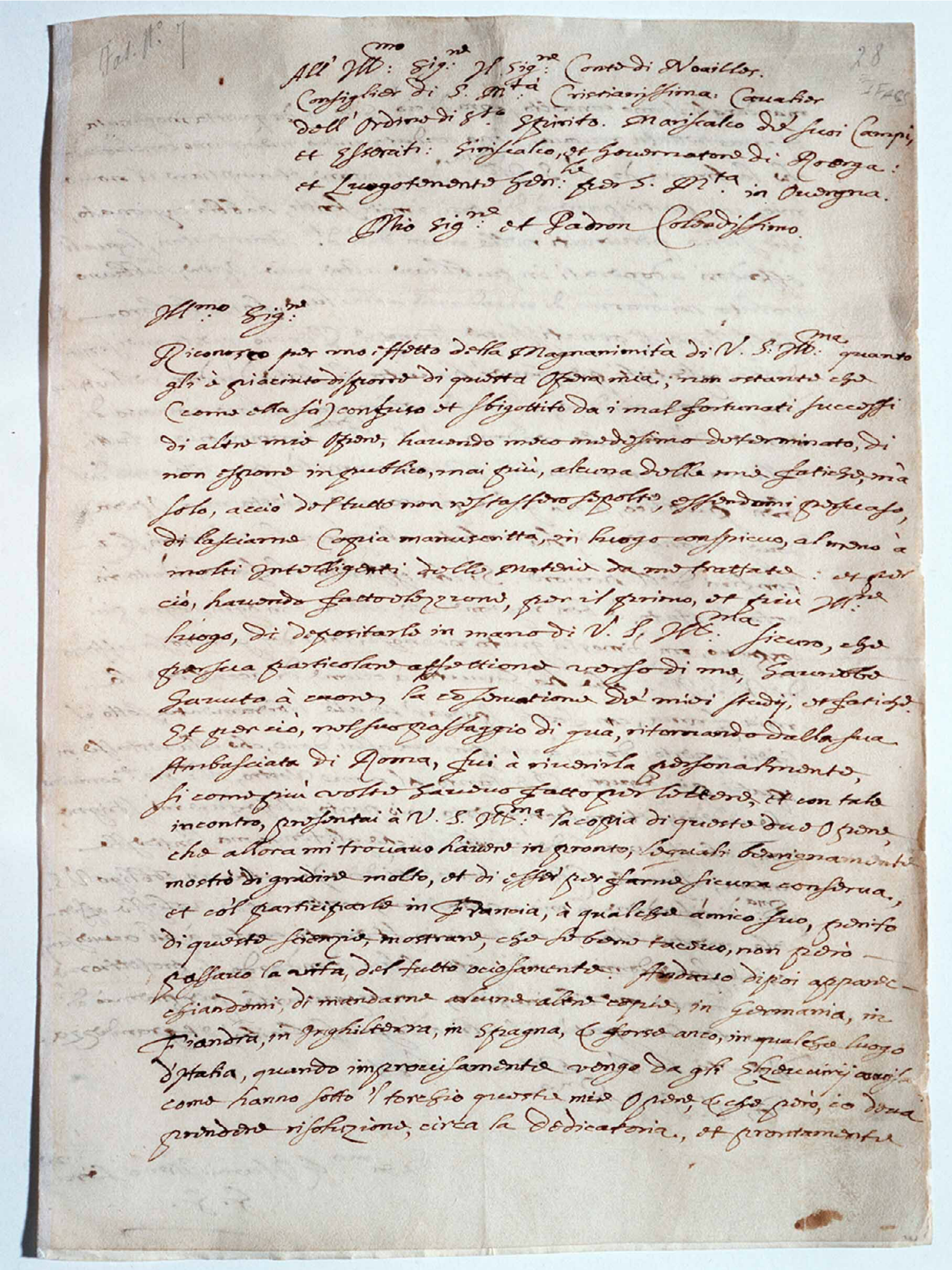
What follows in the dedication letter to the Count of Noailles meticulously adheres to the plan outlined by Galileo in his script. The Tuscan mathematician asserts that he decided to dedicate his work to the Count only after acknowledging that the Elzeviers were printing it without his prior knowledge. According to Galileo, it was the French ambassador who, "out of zeal for the public good," had sent the manuscript to the printers. Had the decision been his alone, Galileo "would have been content for the work to remain in more confined spaces". However, since the Count of Noailles had chosen to publish it to "enhance my fame by allowing it to spread its wings freely under the open sky", dedicating the work to the French ambassador seemed imperative. The dedication concludes with a heartfelt plea for protection, with Galileo asking the Count to "defend my reputation against those who would seek to harm it, as you have placed me in the arena against my adversaries".[33]

The readers of this dedication could not have suspected that Galileo's words were a cunning strategy to evade censorship. Nor could they have imagined the extensive behind-the-scenes efforts that Galileo and his correspondents had undertaken over three years, out of the Holy Office's sight, to realise the 1638 edition. Without Diodati's adept diplomatic manoeuvring and Elzevier's foresight, Galileo's final work might not have achieved the widespread circulation it did across Europe.

Diodati was not only the facilitator of the agreement between the author and the publisher for the publication of the *Two New Sciences*; presumably, he was also the author of the printer's letter to the readers that opened the work. In the printed edition, this letter is unsigned by Elzevier, and several clues suggest that the Parisian jurist was its likely author. The fact that the Dutch publisher did not compose the letter to the readers is corroborated by Galileo's own words to Fulgenzio Micanzio in the postscript to a letter dated 16$^{th}$ August 1636: "The title, dedication, and proem *Ad lectorem* will be sent in due time. This is a notice for Mr. Elzevier".[34]

In the manuscript Gal. 72, housed in the Biblioteca Nazionale Centrale di Firenze, folios 31r-32r contain the autograph version of the printer's letter to the readers written in Diodati's hand. This letter was presumably sent by the Parisian jurist to Galileo for review before its publication in the 1638 edition of the *Two New Sciences*. The fact that this manuscript has passed through several hands is corroborated by the outer part of the letter – folio 32v (Fig.

32 OG, XVII, 246.
33 OG, VIII, 44.
34 OG, XVI, 476.

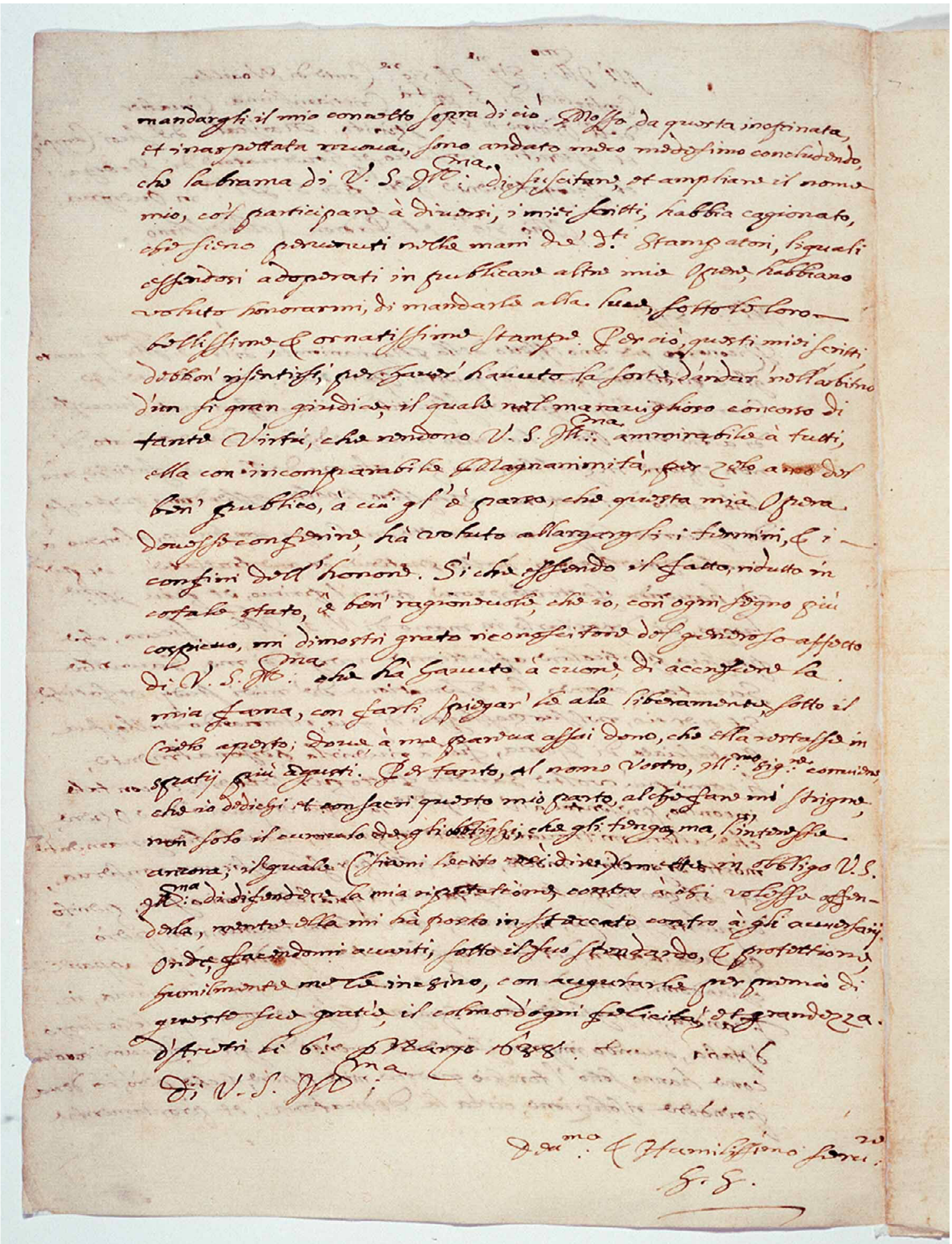


All'Ill.mo Sig.re Il Sig.re Conte di Noailles.
Consiglier di S. M.tà Cristianissima. Cavalier
dell'Ordine di S.to Spirito. Mariscalco de' suoi Campi,
et Esserciti: Siniscalco, et Governatore di Roerga:
et Luogotenente Gen.le per S. M.tà in Overgna.
Mio Sig.re et Padron Colendissimo.

Ill.mo Sig.re

Riconosco per uno effetto della Magnanimità di V. S. Ill.ma quanto
gli è piaciuto disporre di questa Opera mia, non ostante che
(come ella sa) confuso et sbigottito da i mal fortunati successi
di altre mie Opere, havendo meco medesimo determinato, di
non esporre in publico, mai più, alcuna delle mie fatiche, ma
solo, acciò del tutto non restassero sepolte, essendomi persuaso,
di lasciarne Copia manuscritta, in luogo conspicuo, almeno à
molti Intelligenti delle materie da me trattate: et per
ciò, havendo fatto elezzione, per il primo, et più Ill.re
luogo, di depositarle in mano di V. S. Ill.ma sicuro, che
per sua particolare affettione verso di me, havrebbe
havuto à cuore, la conservatione de' miei studij, et fatiche.
Et per ciò, nel suo passaggio di quà, ritornando dalla sua
Ambasciata di Roma, fui à riverirla personalmente,
sì come più volte havevo fatto per lettere, et con tale
incontro, presentai à V. S. Ill.ma la copia di queste due Opere
che allora mi trovavo havere in pronto, le quali benignamente
mostrò di gradire molto, et di esser per farne sicura conserva,
et col parteciparle in Francia, à qualche amico suo, perito
di queste scienzie, mostrare, che se bene tacevo, non però
passavo la vita, del tutto ociosamente. Andavo dipoi apparec-
chiandomi, di mandarne alcune altre copie, in Germania, in
Fiandra, in Inghilterra, in Spagna, e forse anco, in qualche luogo
d'Italia, quando improvvisamente vengo da gli Elzevirij avvisato
come hanno sotto 'l torchio queste mie Opere, e che però, io deva
prendere risoluzione, circa la Dedicatoria, et prontamente

Fig. 3 – MS Gal. 72, f. 28*r*, Biblioteca Nazionale Centrale di Firenze.



mandargli il mio consiglio sopra di ciò. Mosso da questa inopinata,
et inaspettata nuova, sono andato meco medesimo concludendo,
che la brama di V. S. Ill.ma di suscitare et ampliare il nome
mio, col participare à diversi, i miei scritti, habbia cagionato,
che siano pervenuti nelle mani de' d.ti Stampatori, liquali
essendosi adoperati in publicare altre mie Opere, habbiano
voluto honorarmi, di mandarle alla luce sotto le loro
bellissime, & ornatissime stampe. Per ciò, questi miei scritti
debbon' risentirsi, per haver' havuto la sorte d'andar nell'arbitrio
d'un sì gran giudicio, il quale nel maraviglioso concorso di
tante Virtù, che rendono V. S. Ill.ma ammirabile à tutti,
ella con incomparabile Magnanimità, per zelo anco del
ben' publico, à cui gl'è parso, che questa mia Opera
dovesse conferire, hà voluto allargargli i termini, & i
confini dell'honore. Sì che essendo il fatto, ridotto in
cotale stato, è ben' ragionevole, che io, con ogni segno più
cospicuo, mi dimostri grato riconoscitore del generoso affetto
di V. S. Ill.ma che hà havuto à cuore, di accrescere la
mia fama, con farli spiegar' le ale liberamente sotto il
Cielo aperto; dove à me pareva assai dono, che ella restasse in
spatij più angusti. Per tanto, al nome vostro, Ill.mo Sig.re conviene
che io dedichi et consacri questo mio parto, al che fare mi strigne,
non solo il cumulo degli obblighi, che gli tengo, ma l'interesse
ancora, il quale (siami lecito il dire) mette in obbligo V. S.
Ill.ma à difendere la mia riputatione contro à chi volesse offen-
derla, mentre ella mi hà posto in steccato contro à gli avversarij.
Onde facendomi avanti, sotto il suo stendardo, & protettione,
humilmente me le inchino, con augurarle per premio di
queste sue gratie, il colmo d'ogni felicità et grandezza.
D'Arcetri li 6 di Marzo 1638.

Di V. S. Ill.ma

Dev.mo & Humilissimo Servitore
G. G.

Fig. 4 – MS. Gal. 72, f. 28*v*, Biblioteca Nazionale Centrale di Firenze.

8), which shows two classificatory inscriptions "Prefazione" written by two different hands.[35] Furthermore, a collation between the manuscript and the 1638 printed edition reveals several variants, suggesting that this manuscript was not merely a copy made after the Leiden publication but was likely sent by Diodati to Galileo specifically for supervision and approval. The variants in the manuscript compared to the printed edition mostly involve syntactic choices, reordering of some adjectives, or different adjective selections. Additionally, some of Galileo's titles are omitted in the printed edition, in which Galileo is referred to only as "Accademico Linceo", while the manuscript includes his full title "Linceo e meritamente Primario Matematico del Ser.mo Gran Duca di Toscana, con grandissima preminenza".[36]

In addition to the handwriting and the prominent role played by Diodati in the edition of the *Two New Sciences*, it is the content of the text that further connects the printer's letter to the Parisian jurist. The letter opens with a comparison to ancient ages when inventors were honoured and even deified. Similarly, those "who, with the sharpness of their intellects, have reformed already discovered things, uncovering the fallacies and errors in many propositions put forth by distinguished men and accepted as true for many ages, are worthy of great praise and admiration". The author goes on to assert that such "praise" should be particularly directed towards the "most perceptive intellects" who, "in recent centuries", have renewed arts and sciences. Among these intellects, Galileo stands out prominently. His distinction is attributed to two primary reasons:

> for having demonstrated the inconclusiveness of many arguments regarding various conclusions, confirmed with solid demonstrations (as his already published works are full of them), and also for being the first to discover and report, using the telescope (which had originally emerged in these our regions but was then perfected significantly by him), the news of Jupiter's four moons, of the true and certain demonstration of the Milky Way, of the sunspots, of the roughness and nebulous regions of the Moon, of Saturn's tripartite nature, of the crescent phase of Venus, and the nature and arrangement of the comets; discoveries unknown to ancient astronomers and philosophers, so that it can be said that through these revelations, he brought a new light into the world and revitalized astronomy.

The first reason is a cryptic allusion to the *Dialogue*, in which the "inconclusiveness of many arguments" concerning the Ptolemaic system and, by extension, the doctrine of the Earth's immobility, is demonstrated. The second reason pertains to Galileo's telescopic discoveries, through which a new light appeared to the world and revitalized astronomy. In celebrating these discoveries, Diodati employs nearly the same words he used in 1636,

35 Two classificatory inscriptions by two different hands also appear on the outer part of the manuscript containing the dedication (MS Gal. 72, f. 29v).

36 OG, VIII, 45-46.

when in the preface to the Latin edition of the *Letter to the Grand Duchess Christina of Lorraine* he remarked that:

> Indeed, having brought the Dutch telescope to a higher level of perfection, like another Prometheus, with this optical instrument that illuminates the hidden recesses of the heavens, he was the first to reveal to us celestial bodies, that is, new stars unseen and unknown to the ancient astronomers; [he discovered] the much-sought cause of the Milky Way, which was doubtful and obscure to ancient philosophers and astronomers, the sunspots, the roughness of the Moon and scattered shadows here and there, Saturn's tripartite nature, the crescent phase of Venus, and the distinctive characteristics of the other planets, as well as the fact that they all receive light from the Sun (from which [discoveries] the ineffable light of astronomical science has shone).[37]

Just five years after Galileo's condemnation, Copernicanism reappeared in disguise, concealed behind Diodati's veiled prose. Indeed, the Parisian jurist subtly referenced the opening of the *Dialogue* when, in discussing astronomy, he wrote:

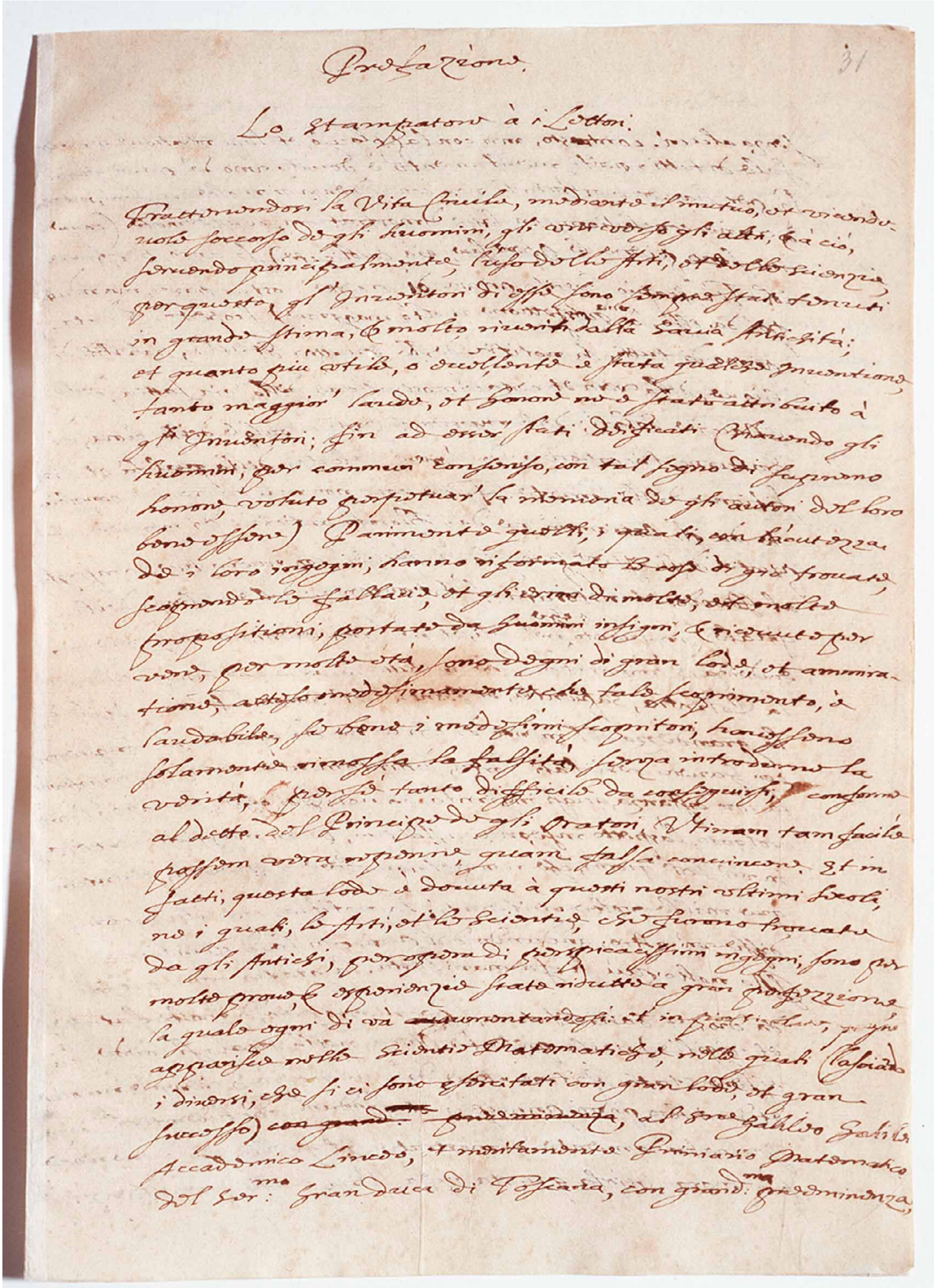
> from the excellence of which (as in the heavens and in celestial bodies the power, wisdom, and goodness of the Supreme Creator shine with greater evidence and admiration than in all the other creatures) results the great merit of those who have revealed this knowledge to us, by making such bodies distinctly visible to us, despite their almost infinite distance.[38]

The celebration of Galileo's enterprise continued with the presentation of his latest work. Diodati introduced the author of the treatise as a pioneering figure in the two new sciences addressed. Galileo was praised for having geometrically demonstrated those two disciplines from their fundamental principles and for having revealed a wide array of phenomena and propositions related to them that had not been previously observed.

The theme of scientific progress through the new experimental method was evidently dear to Diodati. Consistent with the Latin editions of 1635 and 1636, the conclusion of his preface reflected one of the primary goals of his cultural project – the promotion of scientific investigation for the betterment of humanity:[39]

> Of these two new sciences, full of propositions that will be endlessly expanded over time by

37 OG, XVI, 194.
38 OG, VIII, 27.
39 Garcia, Élie *Diodati et Galilée. Naissance d'un réseau scientifique dans l'Europe du XVII^e^ siècle*, 348-363.



Prefazione.

Lo Stampatore à i Lettori.

Trattenendosi la Vita Civile, mediante il mutuo, et vicendevole soccorso degli huomini, gli uni verso gli altri, et a ciò, servendo principalmente l'uso delle Arti, et delle Scienze per questo gl'Inventori di esse sono sempre stati tenuti in grande stima, et molto riveriti dalla savia Antichità; et quanto più utile, o eccellente è stata qualche inventione tanto maggior laude, et honore ne è stato attribuito à gli Inventori; fin ad esser stati deificati (havendo gli huomini, per commun consenso, con tal segno di supremo honore, voluto perpetuar la memoria de gli autori del loro bene essere) Parimente quelli, i quali, con l'acutezza de i loro ingegni, hanno riformato le cose di già trovate, scoprendo le fallacie, et gli errori di molte, et molte propositioni, portate da huomini insigni, et ricevute per vere, per molte età, sono degni di gran lode, et ammiratione, atteso massimamente, che tale scoprimento, è laudabile, se bene i medesimi scopritori, havessero solamente rimossa la falsità, senza introdurne la verità, per se tanto difficile da conseguirsi, conforme al detto del Principe de gli Oratori, Utinam tam facile possem vera reperire, quam falsa convincere. Et in fatti, questa lode è dovuta à questi nostri ultimi secoli, ne i quali, le Arti, et le Scientie, che furono trovate da gli Antichi, per opera di perspicacissimi ingegni, sono per molte prove, et esperienze state ridotte a gran perfettione, la quale ogni dì và augumentandosi: et in particolare, poi apparisce nelle Scientie Matematiche, nelle quali (lasciando i diversi, che si ci sono esercitati con gran lode, et gran successo) ~~con grande preeminenza~~, del Sig.re Galileo Galilei Accademico Linceo, et meritamente Primario Matematico del Ser.mo Gran Duca di Toscana, con grande preeminenza,

Fig. 5 – MS Gal. 72, f. 31r, Biblioteca Nazionale Centrale di Firenze.

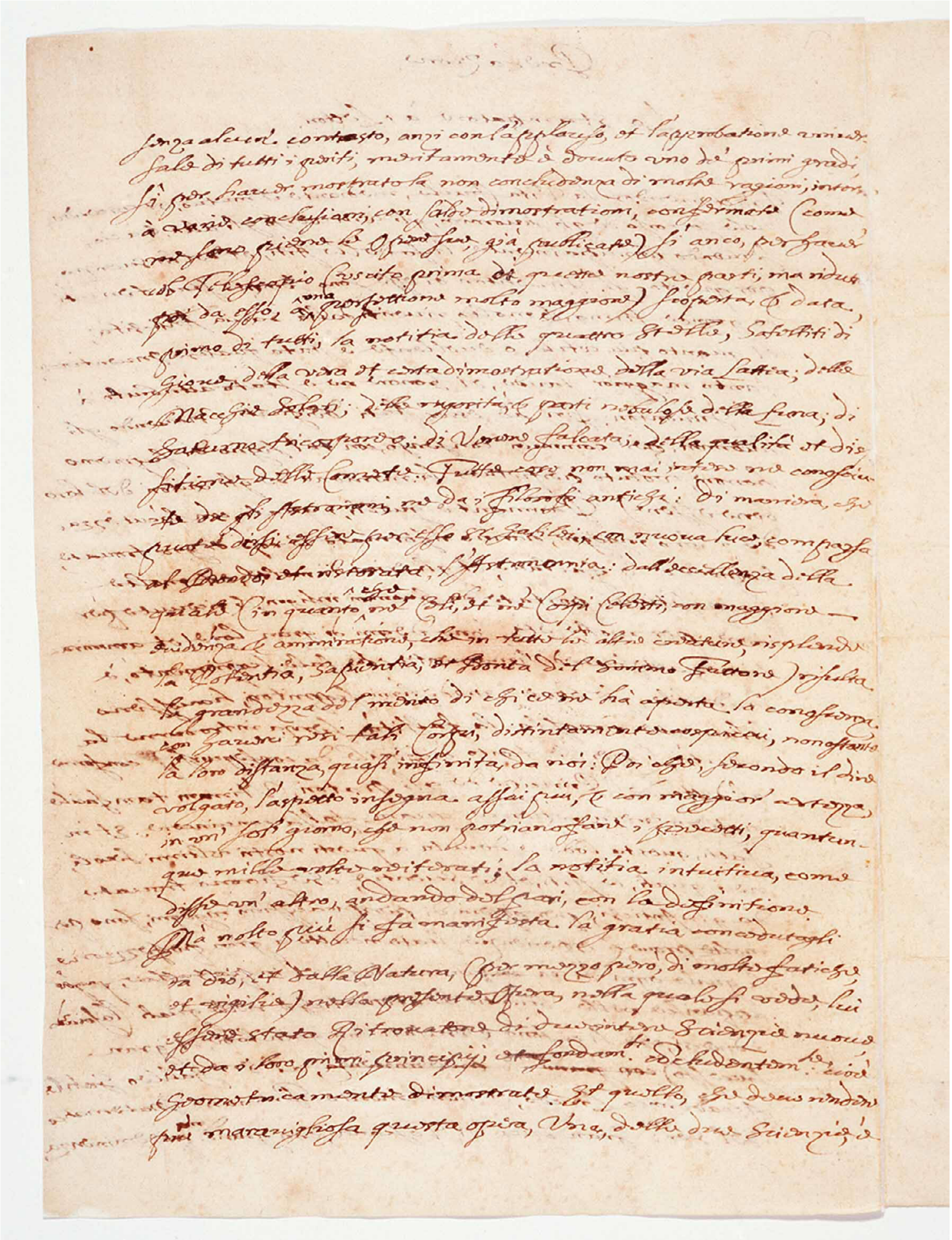


Fig. 6 – MS Gal. 72, f. 31v, Biblioteca Nazionale Centrale di Firenze.

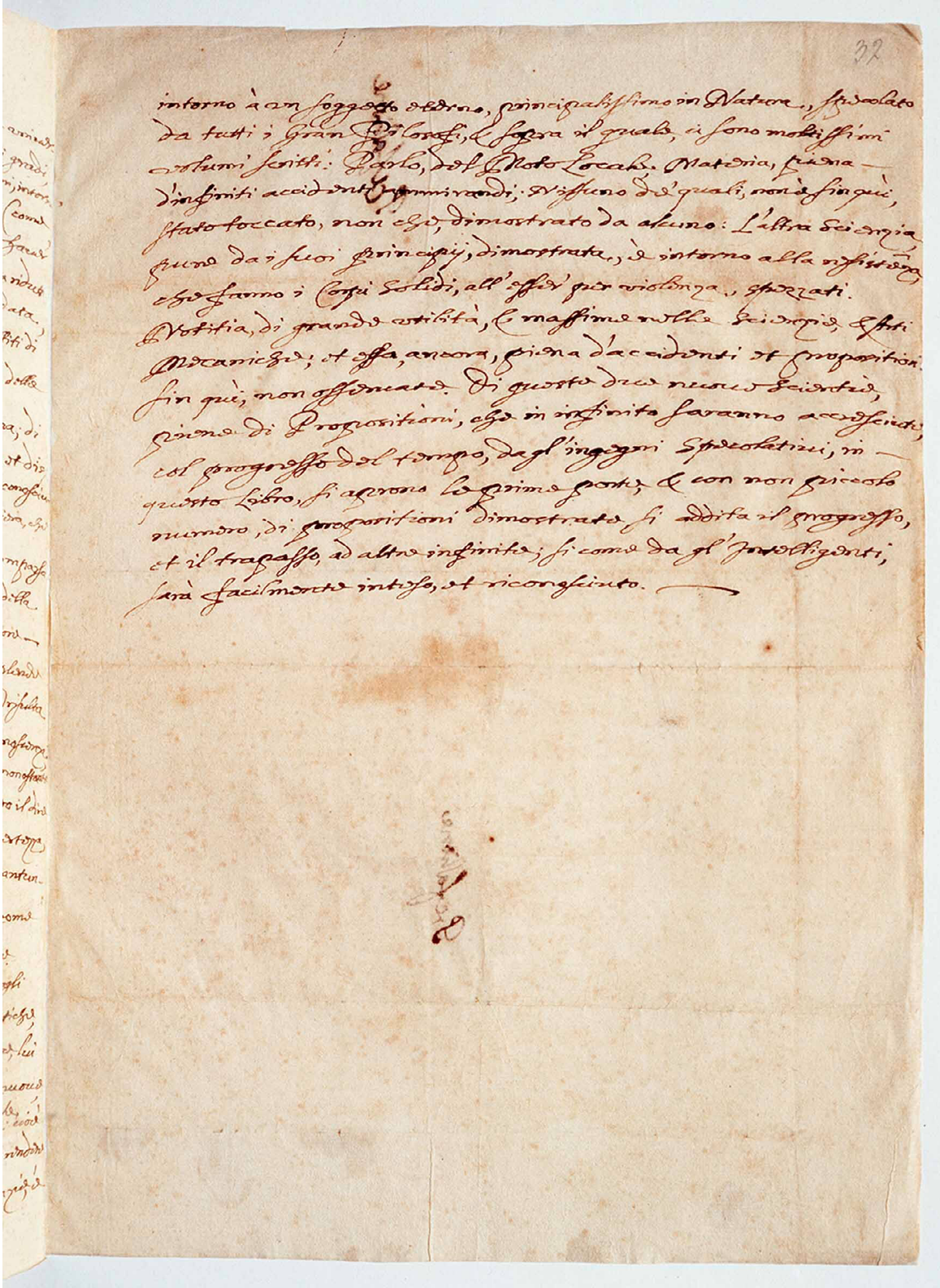


Fig. 7 – MS Gal. 72, f. 32r, Biblioteca Nazionale Centrale di Firenze.

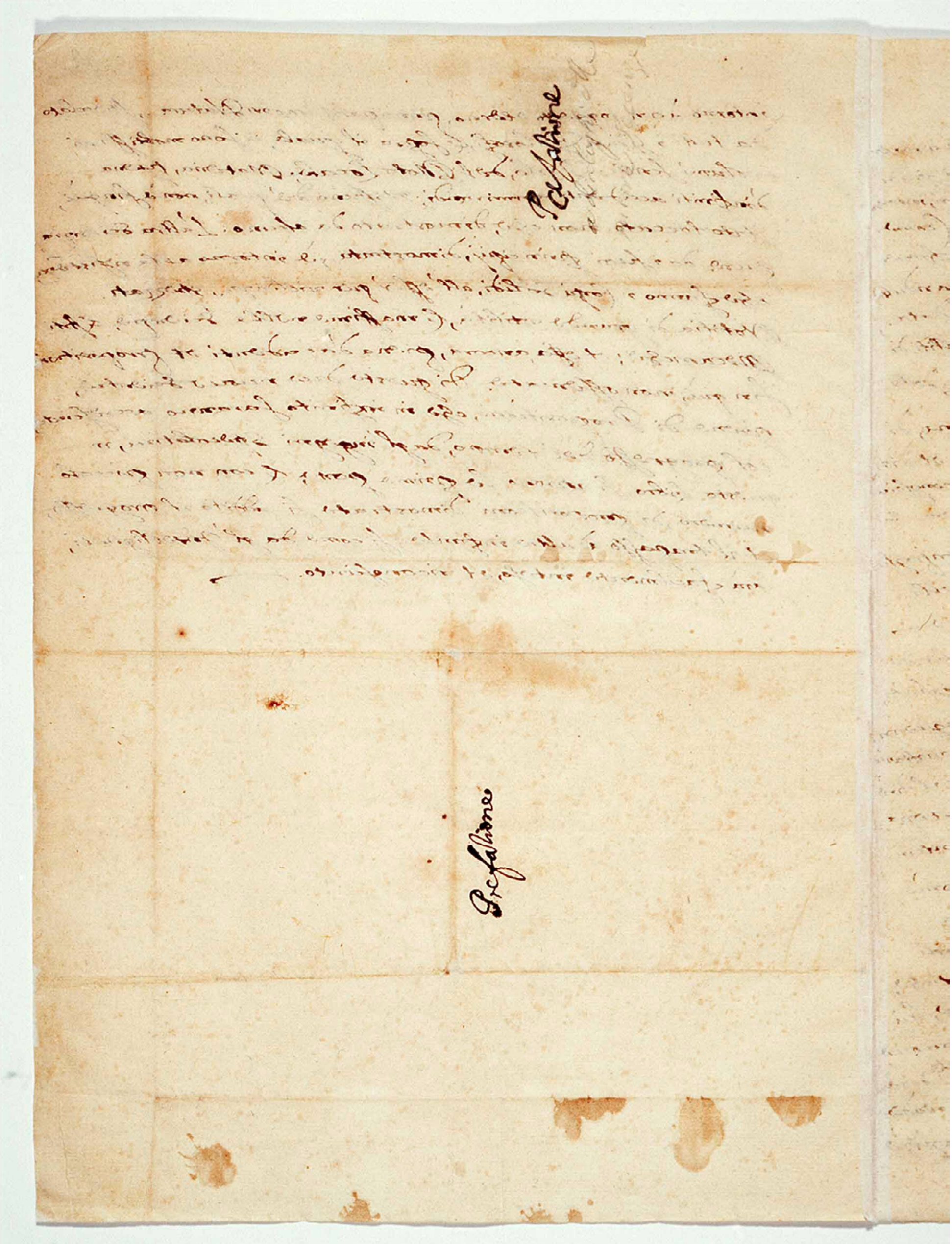


Fig. 8 – MS Gal. 72, f. 32v, Biblioteca Nazionale Centrale di Firenze.

> speculative minds, in this book the first doors are opened, and with a considerable number of demonstrated propositions, it points to the progress and transition to countless others, as will be easily understood and recognized by the learned.

Galileo epitomised the new savant – both discoverer of a new science and promoter of the dissemination of a new knowledge, which fostered hopes for the long-awaited cultural renewal. The powerful instruments wielded by the Church to hinder the free exchange of ideas appeared ineffective against the inexorable momentum of science, which, with both determination and caution, dismantled every barrier erected by dogmatism. Galileo's latest work was the most striking testament to this phenomenon: ostensibly, it addressed only geometric problems, such as the theory of motion and the behaviour of spherical objects. However, a more perceptive reader would discern, woven into Galileo's sharp rhetoric, the profound connection between the new Earth and the new heaven, and would recognize that the motion and the spheres studied with geometric precision were, in fact, reflections of the movement and nature of the planets. In this regard, the *Dialogue* and the *Two New Sciences* are distinctly complementary for a comprehensive understanding of the Universe's order – mathematics and philosophy, inseparable.

## *Conclusion*

The strict controls following Galileo's 1633 condemnation left no room for the free circulation of scientific texts, severely limiting the publication of new works. These measures rendered the dissemination of ideas and manuscripts extremely difficult, compelling many intellectuals to operate in secrecy and to resort to clandestine channels to circulate their writings.[40] The editorial operation that led to the publication of the *Two New Sciences* represents a prime example: bundles of letters, cleverly concealing the pages of Galileo's work, travelled through the hands of his most trusted friends and collaborators, following a route that from Venice and Paris led to the Elzeviers' presses in Leiden.

The Galilean historiography, particularly Raphael's work, has made considerable strides in highlighting the significant contribution of Galileo's closest collaborators to the publication of the *Two New Sciences*. Focusing on the figure of Elie Diodati, my analysis seeks to strengthen this thesis while also emphasizing the central role that Galileo himself continued to play in directing the editorial operation of his work. His involvement remained decisive: despite the pervasive censorship of the time, he orchestrated complex strategies to ensure that his ideas could reach a wider audience.

In addition to the strategies arranged to circulate the manuscript of the *Two New Sci-*

[40] Marcus, Findlen, "Deciphering Galileo: Communication and Secrecy before and after the Trial", 953-995.

*ences*, Galileo and Diodati devised a subtle plan to obscure the author's inevitable involvement in this delicate editorial operation. Garcia's monograph skilfully reconstructs the figure of Elie Diodati and his relationship with Galileo. His work remains essential for understanding the collaboration between the two during Galileo's final years, particularly in relation to the Latin edition of the *Dialogue* and the *Letter to Christina of Lorraine*. My analysis of Diodati's role in the edition of the *Two New Sciences,* supports Garcia's thesis, providing new evidence that documents the Parisian jurist's involvement in the material production of Galileo's final works.

Beyond logistical and editorial support, my analysis aims to highlight another dimension of the relationship between Galileo and Diodati: following Galileo's directions, Diodati meticulously prepared every page of the writings preceding the *Two New Sciences*, forging so a profound intellectual partnership with the Tuscan mathematician. The depth of this collaboration is immortalized in the manuscripts preserved at the Biblioteca Nazionale Centrale di Firenze, serving as an enduring testimony to the carefully orchestrated efforts and to the unwavering commitment that enabled the *Two New Sciences* to defy censorship and reach a wider audience. This legacy underscores the significance of Galileo and Diodati's shared mission to advance knowledge and preserve the integrity of scientific inquiry, even in the face of a formidable opposition.

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# An early theological application of Galileo's "doctrine" of motion: Insights from Benedetto Castelli's first letter to Galileo (April 1, 1607)

Ivan Malara
University of Milan; ivan.malara@unimi.it

**Abstract**
In 1607, Benedetto Castelli sent a letter to Galileo Galilei from Cava de' Tirreni. This correspondence provides valuable insights into Castelli's mathematical training and is significant for two main reasons. First, it demonstrates that by 1607, Galileo had already articulated key principles of his scientific work, such as the relativity of motion and a concept resembling inertia. Thus, the letter serves as an important source on Galileo's advanced thinking prior to the publication of *Sidereus Nuncius* (1610). Second, it explores the relationship between Galileo's ideas on motion, the eternity of the world, and the existence of God. Castelli refutes Aristotelian errors and underscores the limitations of Galilean science regarding theological matters, aiming to prevent conflicts between scientific inquiry and religious truths. This letter thus highlights the early debates sparked by Galileo's new "doctrine" of motion, occurring before any of his major findings were published.

**Keywords**
Galileo Galilei, Benedetto Castelli, Jacopo Zabarella, motion, eternity, creation, existence of God

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## *1. Introduction*

When asked "Does the eternity of motion make God unnecessary?", a historian of philosophy would likely respond with a spontaneous and firm "No, it doesn't". To arrive at this answer, it suffices to consider Aristotle's argument for the necessity of an unmoved mover that has always and will always set the entire universe in motion. This argument also reappears in Thomas Aquinas's first way *ex motu*, which indirectly suggests that the eternity of motion, and thus of the universe, does not necessarily contradict the existence of a God who creates all things *ex nihilo*. Throughout history, many examples like these can be found. They are generally referred to as 'cosmological proofs'; that is, arguments developed to demonstrate that certain features of the universe (such as motion) are logically tied to the existence of God.[1]

Being aware of all this, it becomes quite challenging to interpret the words that Benedetto Castelli wrote to Galileo in a letter from 1607:

> if it were true that motion is eternal, I could become atheistic and say that we don't need God. What a wicked blasphemy![2]

Castelli seems to answer the initial question in the affirmative, as it appears that, for him, the eternity of motion does indeed make God unnecessary. But why does he place the eternity of motion in contradiction with the existence of God? Is it possible that a Benedictine like him was unaware of the well-known arguments developed by Aristotle and Aquinas? Moreover, why would he express all of this specifically to his mathematical mentor, Galileo?

As I will attempt to show, Castelli's words do not suggest that the eternity of motion is incompatible with the existence of God. His polemical target was not the concept of eternal motion as being contrary to revealed truth. Instead, he was criticizing the efforts of those who sought to use Galileo's science to prove the existence of God.

Castelli's 1607 letter, then, conveys a cautionary message aimed at preventing a theological shift in Galileo's science. At the same time, it offers important evidence that, some years before the exegetical dispute leading to the so-called *Copernican Letters* (1613-1615), there had been an attempt to apply Galileo's new natural philosophy to theological issues, such as the creation of the world and the existence of God. Particularly notable is Castelli's cautious stance, where he clearly delineates the limits of Galilean science.

1 For insights on cosmological proofs, see the classic study by Craig, *The Cosmological Argument from Plato to Leibniz*. In particular, pages 20-47 for his discussion on Aristotle and 158-175 for an examination of Thomas's first way.

2 "[...] se fusse vero che il moto fosse eterno, io potrei doventar ateista e dire che di Dio non havemo bisogno, bestemia scelerata" (OG, X, 170). The English translation of certain sections of this letter is drawn from the version found in Redondi, "From Galileo to Augustine", 180-182.

While other scholars have examined this letter, I believe it has not been fully understood.[3] It is a brief yet dense text, rich with content and implicit references to vexed questions on the eternity of motion, often discussed in relation to Book VIII of Aristotle's *Physics*. To fully grasp its significance, it will be necessary to contextualize it using commentaries and textbooks that were circulating during Castelli's time. The goal here is not to trace Castelli's direct sources but to examine the background sources that illuminate some standard arguments shaping the cultural framework within which both Castelli and Galileo operated. Due to textual similarities with Castelli's exposition, I have prioritized quotations from Jacopo Zabarella's commentary on the *Physics*.

First, however, it seems fitting to begin by sketching a profile of the letter's recipient, Galileo in 1607. Following that, I will consider and analyze the letter in nearly its entirety, excluding the final lines where Castelli invites Galileo to address his reply to Ermagora Basadelli, as these require a separate study to explore Basadelli's role in the early correspondence between Castelli and Galileo.[4]

## *2. Galileo in 1607*

In 1607, Galileo was a professor of mathematics at the University of Padua. Fifteen years earlier, he had moved from the Grand Duchy of Tuscany to the Republic of Venice, after spending three years – between the winter of 1589 and the fall of 1592 – teaching mathematics at the University of Pisa. At this point, Galileo was 43 years old and had spent nearly half his life teaching mathematics.[5]

At the time, he had published only two books under his own name, both concerning a measuring instrument known as the geometric compass. The first book, *The Operations of the Geometric and Military Compass* (*Operazioni del compasso geometrico militare*, 1606), was a manual on how to use a multifunctional compass Galileo had invented to simplify a wide range of measurements and calculations, particularly for military applications. With the help of Marcantonio Mazzoleni, Galileo began manufacturing and selling these com-

3 The theses of Bucciantini and Redondi will be addressed *infra*, in Section 3.2.

4 OG, X, 171: "Horsù: mi manca la carta; se V.S. si degnerà di scrivermi, potrà indirizzare la lettera in Roma a D. Hermagora da Padoa in Monte Cavallo, che l'haverò sicure". Another letter from Castelli, written in Cava in October 1607, was sent to Basadelli and also partially addressed to Galileo. For details, see OG, X, 183-184, and the complete version in Castelli, *Carteggio*, 35-37.

5 For details on Galileo's move from Pisa to Padua, see Favaro, *Galileo Galilei e lo Studio di Padova*, I, 25-50, and Camerota, *Galileo Galilei e la cultura scientifica nell'età della Controriforma*, 78-82. Galileo began teaching mathematics at a very young age. Documents show that in 1588 he taught mathematics to the Benedictine Epifanio Parini (born Sebastiano) at the Abbey of Passignano, near Florence. See OGA, IV, 23.

passes.[6] He likely hoped that the sales would help cover his increasing living expenses, which his modest professor's salary struggled to meet.[7] Moreover, he probably believed the compass could strengthen his connections with the Grand Duchy of Tuscany. In fact, he dedicated the book to Prince Cosimo de' Medici, hoping to win the favor of Cosimo's father, Grand Duke Ferdinand I de' Medici, and hasten his return to Tuscany.[8] Unfortunately, the compass did not generate the profits he had hoped for, and the book, instead of facilitating his return, brought him trouble. Galileo's work was plagiarized, which forced him to write – probably around June 1607 – a second book defending himself against the false accusations of Baldassarre Capra (*Difesa contro alle calunnie ed imposture di Baldessar Capra*, 1607).[9]

Though Galileo had only published two books on a measuring instrument by 1607, he was far more than just an ingenious inventor or unlucky "entrepreneur", as one might put it. His work on the geometric compass was merely the tip of a vast iceberg. Since his time as a professor in Pisa, Galileo had developed a deep interest in several philosophical topics, particularly problems related to motion, which he discussed with colleagues, students, and friends. By 1607, he had written many works that he either preferred to publish under pseudonyms or chose to keep private in his drawer.

If one could peer into that drawer, they would find, alongside his youthful work on the hydrostatic balance (*La bilancetta*)[10] and notes on Aristotelian natural philosophy and

6 See OG, II, 363-424. For Stillman Drake's English translation, see Galilei, *Operations of the Geometric and Military Compass*. For further information on Galileo's compass, see Favaro, *Galileo Galilei e lo Studio di Padova*, I, 165-192; Drake, "*Tartaglia's Squadra and Galileo's Compasso*"; Valleriani, *Galileo Engineer*, 27-41.

7 For an in-depth look at Galileo's financial situation in Padua, consult Camerota, *Galileo Galilei e la cultura scientifica nell'età della Controriforma*, 110-113.

8 As is well known, Mario Biagioli regarded the compass and the telescope as crucial instruments of credit; see Biagioli, *Galileo's Instruments of Credit*, 1-19. Although Galileo officially returned to Tuscany in 1610, he often spent his summers in Florence prior to that. In 1605, he was invited by Grand Duchess Christina of Lorraine to spend his summers at the Villa Pratolino (cf. OG, X, 156), where he introduced Prince Cosimo to mathematics and taught him how to use the geometric and military compass. See Camerota, *Galileo Galilei e la cultura scientifica nell'età della Controriforma*, 115.

9 See OG, II, 513-599. Camerota notes that Galileo's defence against Baldassarre Capra was published in August, just before he sent a copy to Prince Cosimo (cf. Camerota, *Galileo Galilei e la cultura scientifica nell'età della Controriforma*, 129; OG, X, 177-178). One may add that internal evidence suggests Galileo wrote the defence in June. In the preface (*A i lettori*), he states that Capra translated the *Operations of the Geometric and Military Compass* into Latin "ed alcune cose frivolissime aggiungendovi, lo ristampa *tre mesi sono*" (OG, II, 533, emphasis added). A few pages later, Galileo notes that Capra's plagiarism was published "li 7 marzo del 1607" (*ibid.*, 539).

10 See OG, I, 215-228. For a recent study on this early work by Galileo, see Mottana, *Galileo e la bilancetta*.

logic (MSS Gal 46 and 27),[11] a variety of writings: two lectures on the size and depth of Dante's *Inferno*, delivered at the Academy of Florence between 1587 and 1588 (*Due lezioni all'Accademia Fiorentina circa la figura, sito e grandezza dell'Inferno di Dante*);[12] possibly a commentary on Ptolemy's *Almagest* (never found, if it existed);[13] some early writings on motion (*De motu antiquiora*);[14] a compendium of Sacrobosco's *Sphere* (*Trattato della sfera ovvero cosmografia*);[15] two versions – one longer than the other – of a treatise on the workings of machines (*Le mecaniche*);[16] a treatise on the rudder (now lost);[17] two writings on military architecture (*Breve istruzione dell'architettura* and *Trattato di fortificazione*);[18] numerous drawings and theorems related to motion (MS Gal. 72);[19] and intriguing works and notes on solid geometry (*Theoremata circa centrum gravitatis solidorum* and *Postille ai libri De Sphaera et Cylindro di Archimede*).[20]

In the same drawer, one would also find fascinating material that Galileo likely felt too fearful to publish. Thanks to his correspondence with Jacopo Mazzoni and Johannes Kepler, we know that by 1597, Galileo had already "come to the opinion of Copernicus

11 Favaro transcribed large portions of MS Gal. 46 in the National Edition (OG, I, 15-177) and partially transcribed MS Gal. 27 (OG, IX, 280-281, 291-292). William F. Edwards published the complete transcription of MS Gal. 27 in 1988 (see Galilei, *Tractatio De Praecognitionibus et Praecognitis and Tractatio De Demonstratione*). Mario O. Helbing recently edited another transcription in the Appendix to the National Edition (see OGA, III, 15-100). The composition dates of both manuscripts are debated but are generally believed to predate Galileo's move to Padua in 1592.

12 See OG, IX, 29-57, and Galilei, *Due lezioni dell'Accademia Fiorentina circa la figura, sito e grandezza dell'Inferno di Dante*.

13 Galileo himself refers to this commentary in his early treatise on local motion; see OG, I, 314.

14 See OG, I, 251-419.

15 See OG, II, 211-215. On this treatise, see Cardoso-de Andrade Martins, "*O* Trattato della Sfera …"; de Andrade Martins, "*Galileo Galilei, y la tradición del* Tractatus de sphaera"; Cardoso-de Andrade Martins, "*Galileo's* Trattato della sfera".

16 See OG, II, 155-191. An English translation by Stillman Drake is included in Galilei, *On Motion and On Mechanics*, 147-186. For a critical edition, see Galilei, *Le mecaniche*.

17 According to Camerota, letters written by Giovanni Ciampoli between 1624 and 1625 suggest that Galileo composed a "trattato sul timone" during his time in Padua. See Camerota, *Galileo Galilei e la cultura scientifica nell'età della Controriforma*, 86; Ciampoli's letters in OG, XIII, 295, 246-247, 254. Additionally, Camerota highlights an interesting fragment in OG, VIII, 609. See also OG, X, (Galileo to Contarini, March 22, 1593), 55-57, and *ibid.*, (Contarini to Galileo, March 28, 1593), 57-60.

18 See OG, II, 15-146. For information on Galileo's courses on fortifications, see Valleriani, *Galileo Engineer*, 71-89.

19 This important manuscript can be viewed online, <https://teca.bncf.firenze.sbn.it/ImageViewer/servlet/ImageViewer?idr=BNCF0003760961#page/1/mode/2up> (last accessed October 15, 2024). For a recent study of the manuscript, see Büttner, *Swinging and Rolling*.

20 See OG, I, 187-208 (*Theoremata*), 233-242 (*Postille*).

many years prior" (*in Copernici sententiam multis ab hinc annis venerim*).[21] In a letter to Kepler, Galileo mentions that by 1597, he had written numerous refutations of arguments against the Copernican system ("*multas conscripsi et rationes et argumentorum in contrarium eversiones*"), but he preferred to keep them hidden, fearing ridicule. In the same letter, he also asserts that heliocentrism allowed him to explain certain terrestrial phenomena that were otherwise inexplicable ("*ac tali positione multorum etiam naturalium effectuum caussae sint a me adinventae, quae dubio procul per communem hypothesim inexplicabiles sunt*").[22] Thus, it is possible that by 1607, Galileo had already formulated his first theory of tides, based on the Earth's double circular motion on its axes and around the Sun.[23]

Despite not yet being recognized as a philosopher, in 1607 Galileo was already more than just an esteemed professor of mathematics.[24] His interests were wide-ranging, and his research in natural philosophy had led to significant discoveries. A letter written in 1602 to Guidobaldo del Monte reveals that by the early 1600s, Galileo had already developed the concepts of isochronism and the law of chords.[25] At the same time, he shared with Paolo Sarpi a keen interest in the properties of magnets,[26] worked on the construction of a thermoscope,[27] and served as the 'print supervisor' (*censore sopra le stampe*) for the Accademia dei Ricovrati.[28] By 1604, he had also arrived at the correct law of free fall, although he still adhered to the mistaken belief that the velocity of a falling object was proportional

21 OG, X (Galileo to Kepler, August 4, 1597), 67-68. On this letter, see Bucciantini, *Galileo e Keplero*, 49-68. The letter to Mazzoni (May 30, 1597) is transcribed in OG, II, 197-202.

22 OG, X (Galileo to Kepler, August 4, 1597), 68.

23 See Drake, *Galileo Studies: Personality, Tradition, and Revolution*, 200-213; Drake, *Galileo at Work*, 36-38. While Drake linked this theory to Sarpi's 1595 observations, Camerota noted that Galileo may have been aware of a similar theory in Andrea Cesalpino's *Quaestiones peripateticae*, published in 1571 (see Camerota, *Galileo Galilei e la cultura scientifica nell'età della Controriforma*, 98-99). Cesalpino was one of Galileo's teachers in Pisa.

24 In 1604, Vincenzo Gonzaga, Duke of Mantua, invited Galileo to become his court mathematician. Although Galileo was interested, he would have accepted the position if the pay had been higher. See Camerota, *Galileo Galilei e la cultura scientifica nell'età della Controriforma*, 116; OG, X (Galileo to Vincenzo Gonzaga, May 22, 1604), 106-107.

25 See OG, X (Galileo to Guidobaldo del Monte, November 29, 1602), 97-100. On this letter, see Büttner, *Swinging and Rolling*, 61-73.

26 See OG, X (Sarpi to Galileo, September 2, 1602), 91-93; Favaro, *Galileo Galilei e lo Studio di Padova*, I, 237-243.

27 See *ibid.*, 193-212; Camerota, *Galileo Galilei e la cultura scientifica nell'età della Controriforma*, 130-132; Valleriani, *Galileo Engineer*, 158-172. Valleriani argues that a 1626 letter from Galileo to Marsili has never been cited as evidence that Galileo had already built and used the thermoscope by 1606 (see *ibid.*, 160, n. 8). However, Camerota had already pointed this out (see Camerota, *Galileo Galilei e la cultura scientifica nell'età della Controriforma*, 593, n. 231).

28 See OG, XIX, 207-208; Lazzarini, *Galileo, Padova e l'Accademia dei Ricovrati*.

to the distance it fell.[29] By 1607, however, he likely began to reject this principle, ultimately replacing it with the understanding that velocity is proportional to time.[30]

Additionally, from the fall of 1604 onwards, Galileo corresponded with figures like Ilario Altobelli and Leonardo Tedeschi, who kept him informed about a remarkable discovery: the observation of a new star in the supposedly incorruptible sky.[31] Shortly afterward, Galileo perhaps co-authored, or simply inspired, three works: The *Dialogue of Cecco di Ronchitti of Brugine concerning the New Star* (*Dialogo de Cecco di Ronchitti da Bruzene in perpuosito de la stella Nuova*, 1604);[32] Astolfo Arnerio Marchiano's *Discourse on the New Star* (*Discorso sopra la Stella Nuova comparsa l'Ottobre prossimo passato*, 1605);[33] and the *Considerations of Alimberto Mauri on Some Passages in the Discourse of Lodovico delle Colombe about the Star Which Appeared in 1604* (*Considerazioni d'Alimberto Mauri sopra alcuni luoghi del discorso di Lodovico delle Colombe intorno alla stella apparita* [nel] *1604*, 1606).[34] When it came to controversies in natural philosophy, Galileo seemed to prefer working under aliases.

Thus, Galileo was being quite truthful when, in 1597, he told Kepler about his fears of publicly opposing the Aristotelians.[35] This provides yet another clue that by 1607, Galileo's unpublished writings may have been even more substantial than we might imagine.

[29] See OG, X (Galileo to Sarpi, October 16, 1604), 115. For insights on the "spontaneity" of thinking in terms of space rather than time, see Koyré, *Etudes Galiléennes*.

[30] See Camerota, *Galileo Galilei e la cultura scientifica nell'età della Controriforma*, 144-148. Camerota presents compelling evidence that Galileo recognized and rectified his initial mistake between 1607 and 1609.

[31] See OG, X, 116-120, 122-133.

[32] See OG, II, 307-334. For an English translation by Drake, see Galilei, *Galileo against the Philosophers*. Favaro suggests that this work was written by Girolamo Spinelli with Galileo's assistance, although the extent of Galileo's contribution remains uncertain (see OG, II, 272; Favaro, "Galileo Galilei ed il «Dialogo de Cecco di Ronchitti da Bruzene in perpuosito de la stella nova»", 195-237). Recently, Matteo Cosci argued that Galileo is the only author of this dialogue (see Cosci, "Astronomia pavana nel *Dialogo de Cecco*").

[33] This work is not included in the National Edition of Galileo's works. Maria Laura Soppelsa hypothesized that Arnerio served as "portavoce o eventuale schermo mimetico dello stesso Galilei" (Soppelsa, *Genesi del metodo galileiano*, 27). She also noted interesting parallels between Arnerio's *Discorso* and Galileo's lessons on the *nova* (see *ibid*., 32, n. 19). Recently, Matteo Cosci proposed that Astolfo Arnerio Marchiano is merely a pseudonym for Galileo (see Cosci, "Galileo *alias* Astolfo Arnerio Marchiano").

[34] This work was also excluded from the National Edition by Favaro, likely because Galileo assured Ludovico delle Colombe that he was not the author of the *Considerations*. See OG, X (Lodovico delle Colombe to Galileo), 176-177. For the English translation by Drake, see Galilei, *Galileo against the Philosophers*, 73-130. Recently, Matteo Cosci has sought to prove that Galileo is the true and sole author (see Cosci, "Galileo *alias* Alimberto Mauri").

[35] In this sense, as Maurice Clavelin emphasized, Galileo's time in Padua was marked by a "silent Copernicanism" (see Clavelin, "Le copernicanisme Padouan de Galilée").

## *3. Castelli's first letter to Galileo*

Benedetto Castelli's letter adds an intriguing dimension to this already multifaceted picture. Dated April 1, 1607, the letter states that, according to Galileo, "motion is nothing other than a change of one thing in relation to another" (*il moto non sia altro che una mutazione di una cosa in relazione a un'altra*) and that "a mover is necessary to start the motion, but the lack of obstacles is sufficient to continue it" (*a principiar il moto è ben necessario il movente, ma a continuarlo basta non aver contrasto*). This correspondence provides significant evidence that by 1607, Galileo had embraced the concept of the relativity of motion, along with an idea that closely parallels our modern understanding of inertia.[36]

Moreover, this letter also sheds light on an otherwise obscure period of Castelli's life.[37] In 1607, Castelli was in the Kingdom of Naples, residing at the Benedictine Abbey of La Trinità della Cava, near Salerno. He had moved there from the Abbey of Santa Giustina in Padua, where, between 1603 and 1604, he had met Galileo, who provided him and another Benedictine, Girolamo Spinelli, with private mathematics lectures.[38] It is likely that even before his encounter with Galileo, Castelli had received some foundational education in geometry, arithmetic, and perhaps astronomy. At the monastery of San Faustino in Brescia, Benedetto Castelli was probably introduced to these subjects, although his primary focus was theology.[39]

[36] See OG, X, 170. Galileo first introduces and publishes his inertial conception of motion in the *Letters on Sunspots* (1613) (see OG, V, 134, and the English translation in Galilei-Scheiner, *On Sunspots*, 125). Franco Giudice effectively highlights the continuity between Galileo's cosmological and mechanical reflections (see Giudice, "Galileo's Cosmological View", 60-63).

[37] On Castelli's life, see OG, XX, 412-413; Masetti Zannini, *La vita di Benedetto Castelli*; Drake, "Castelli, Benedetto"; Shore, "Castelli, Benedetto (Antonio)"; Ricciardo, "Introduzione". On Castelli's family, see Piccinali, "La famiglia di Benedetto Castelli".

[38] See Favaro, *Galileo Galilei e lo Studio di Padova*, I, 150. As for the histories of S. Giustina Abbey and Cava Abbey, they have been intertwined since 1492. In 1392, Pope Boniface IX elevated Cava to city status, making it a cathedral headed by a bishop. Subsequently, the Benedictine rules and customs began to decline. In 1482, Cardinal Oliviero Carafa was appointed to restore these traditions. The Abbey was given *in commendam* to him, who then entrusted it to diligent monks from S. Giustina in 1492. In 1497, Pope Alexander VI abolished the commandery, suppressed the bishopric, and sanctioned the perpetual union between Cava and S. Giustina (see Mattei Cerasoli, "La badia della SS. Trinità di Cava", 191-194). From 1504, when the Abbey of Monte Cassino joined the community of S. Giustina, the latter became known as the 'Community of Monte Cassino'. At the time Benedetto Castelli was assigned to the Trinity Abbey at Cava, it was still administered by the monks of S. Giustina.

[39] Luca Piccinali has conducted a significant study on Castelli's work in Brescia and Padua (see Piccinali, "La formazione scientifica di Benedetto Castelli", 49-121). He highlights that the Benedictines had access to various important texts in mathematics and astronomy but also notes that "la maggior parte dei testi fosse di carattere religioso, dai testi sacri ai Padri della Chiesa per arrivare sino a san Tommaso e ai testi di autori ecclesiastici cinquecenteschi. Questo per sotto-

The April 1607 letter is the earliest surviving evidence of the connection that Galileo and Castelli established in Padua. It appears that the two quickly developed a close friendship, as Castelli promised Galileo to keep him informed about his circumstances ("*stato mio*") before leaving Padua. Indeed, the letter begins with Castelli apologizing for his inability to fulfill this promise immediately ("*debito mio*"), explaining that he had been delayed by certain "current troubles" (*correnti turbolentie*).[40] He then mentions that, at Cava, he is lecturing on Euclid, providing him with an opportunity to outline the progress he has made in his mathematical studies.

After leaving Padua, Castelli focused on Euclid's *Elements*, progressing from Book VII to the 40th proposition of Book X.[41] After encountering significant challenges with that proposition, he moved on to Book XI and continued seamlessly through Book XII, eventually tackling Book XIII to the very end of the *Elements*. Shortly after, he began studying Ptolemy's *Almagest*, though he struggled with the "first corollary" (*primo corollario*) of Chapter XII and sought "some enlightenment" (*qualche lume*) from Galileo on the matter.[42] Castelli also delved into the *Sphaerics* by Theodosius of Bithynia, as well as the first

lineare che almeno da quando Castelli aveva dieci anni (1588) la sua educazione gli fu sempre e solo impartita da ecclesiastici su libri per la maggior parte di argomento religioso" (*ibid.*, 115). Furthermore, according to Massimo Bucciantini, the Abbey of S. Giustina "era considerato il centro culturale dell'ordine benedettino cassinese, in cui, tra l'altro, erano forti gli influssi della tradizione ne[o]platonica, e dove le discussioni sul ruolo e il grado di certezza delle matematiche si intrecciavano a quelle sui rapporti tra matematica e teologia, tra simbologia cristiana e figure e simboli geometrici" (Bucciantini, "Atomi geometria e teologia nella filosofia galileiana di Benedetto Castelli", 173).

40 "Per le correnti turbolentie son stato necessitato a mancar del debito mio, con non dar conto a V.S. del stato mio: hora, con l'occasione del nostro Capitolo Generale, prima li faccio profonda riverenza, dandoli aviso che il stato mio è assai megliore di quello a che io sto di continuo preparato; poi vivo al servitio di questo mio prelato [viz. Lorenzo Pacifico of Antwerp: see Mattei Cerasoli, "La badia della SS. Trinità di Cava", 214], che non manca di honorarmi [...]" (OG, X, 169).

41 "[...] leggo poi una lettione d'Euclide, del quale io già ho visto il 7o, 8o, 9o et sin alla quarantesima del Xo, et di lì, suffocato dalla moltitudine (per confessar il peccato mio) de' vocaboli, profondità delle cose e difficultà di demonstrationi, mi son trasferito al'XI, XII, e XIII, de' quali ho visto tutto quello che dalle viste propositioni dependeva. Dopoi ho datto l'assalto a Tolomeo, ma son restato intricato al primo corollario del capitolo duodecimo: se V.S. mi vole favorire con darmi qualche lume, infilzarò quest'obligo con gli altri. Ho datto di piglio alli Elementi Sferici di Theo[dosio], et insieme ho cavati gli piedi dalle sette prime propositioni di Archimede De iis que vehuntur in aqua: all'ottava, starò aspettando in luce il trattamento suo De centro gravitatis solidorum, il quale alla detta materia mi pare necessario" (*ibid.*, 169-170).

42 It should be noted that in that part of the *Almagest*, Ptolemy does not mention any corollary. However, the term "correlarium primum" appears in one of Luca Gaurico's marginal notes in the ninth chapter of the first book of the 1528 Latin edition: "Correlarium primum: Data alicuius arcus chorda, nota fiet chorda arcus residui de semicirculo" (Ptolemy, *Almagestum seu Magnae Contructionis Mathematicae Opus*, 5r).

seven propositions of Archimedes' *On Floating Bodies*.[43] Concerning Proposition VIII, Castelli expressed a desire to wait until Galileo's treatise *On the Center of Gravity of Solid Bodies* was published, convinced of its importance to the subject.[44]

The first paragraph of the letter concludes with a curious remark about Castelli's efforts to introduce his pupils to Galileo's "rare virtues" (*rare virtù*).[45] By 1607, at Cava de' Tirreni, Castelli was already acting as a proponent of Galileo's ideas.

The letter also includes two other brief yet substantial paragraphs. In the first of these, Castelli states that Galileo's "definition of motion" (*definitione del moto*) led him to conclude that Aristotle's argument for the eternity of motion is unconvincing:

> In recent days, I had the occasion to express my thought regarding Aristotle's reasoning put forward to confirm the eternity of motion, which concludes that motion existed before the first motion of his opponent [*il primo moto del'avversario*]. This reflection was prompted by the definition of motion provided to me by Your Lordship – that is, motion is nothing but a change of one thing in relation to another. Therefore, I have decided to send a copy to Your Lordship so that, if any withdrawal or correction is needed, you may kindly inform me.[46]

In the paragraph that follows, which concludes the letter, Castelli elaborates on this point. To better understand the topics he addresses, the final paragraph of the letter will be divided into two parts, each analyzed separately: the first (3.1) concerning Aristotle's proof of the eternity of motion, and the second (3.2) addressing a new proof for the existence of God.

43 In *On Floating Bodies*, the concepts of circumference and sphere are pivotal in Archimedes' demonstrations (see Archimedes, *De iis quae vehuntur in in aqua libri duo*, 1r-1v).

44 Proposition VIII is presented without proof, which Commandino provides in his Latin edition (see *ibid*., 6r-6v). Castelli argues that the proposition can be better understood in the context of Galileo's *Theoremata circa centrum gravitatis solidorum*, which he began at a young age and continued while in Padua (see OG, I, 181-185). Galileo ultimately chose not to publish this treatise after discovering that Luca Valerio had already provided a satisfactory solution for determining the center of solid bodies (see OG, VIII, 313). Given Castelli's belief that Galileo would eventually publish it, it seems likely that in 1607, he had not yet encountered Valerio's work, first published in 1604 and again in 1661, nineteen years after Galileo's death.

45 "Gli miei discepoli adorano le rare virtù, et a' nostri secoli uniche, di V.S., delle quali spesso ne faccio quella che io posso mentione" (OG, X, 170).

46 "Mi è poi occorso, a' giorni passati, sfogar un pensier mio circa la ragione d'Aristotele addotta per confirmar l'eternità del moto, la quale conclude esser stato il moto avanti il primo moto del'avversario; e perché a questo m'indusse la definitione del moto dattami da V.S., cioè che il moto non sia altro che una mutatione di una cosa in relatione a un'altra, ho fatto disegno, come si sia, mandarne copia a V.S., acciò, se ci è bisogno di annullatione o di correttione, si degni compiacermene" (*ibid*.).

### 3.1. On Aristotle's proof of the eternity of motion

Castelli refers to a specific passage from Aristotle's *Physics*, which, in the modern citation system based on August Immanuel Bekker's edition, corresponds to *Phys*. 251a16-20. In Castelli's time, references followed the division used by Averroes in his commentary on Aristotle's works.[47] The passage in question aligned with texts 5-6 of Book VIII of the *Physics*, which, in William of Moerbeke's *translatio nova*, reads as follows:

> TEXT 5. Therefore, it is necessary that [the moving things] either were made at some point, when they did not exist, or that they are eternal.[48]
> TEXT 6. If, then, each of the mobile or mover [things] was made, it is necessary that another change and motion occurred beforehand, by which that which is capable of being moved or of moving was made.[49]

The Jesuits of Coimbra, in their renowned commentary on the *Physics* (1592), offered the following paraphrase:

> [Aristotle] proves that there was no first motion, but that before any other motion, one already existed, and he argues as follows: If motion had a beginning in time, either the mover and the mobile [*movens et mobile*], to which this first motion would belong, would have started at some point, or they would have existed from eternity. If they started at some point, then it must have been through some motion; for this reason, the motion that was previously called the first would no longer be the first.[50]

In text 4 (*Phys*. 251a8-16), Aristotle had argued that motion is always associated with "things" (the term "*res*" is used in both the *nova* and the *vetus* to translate the Greek "πράγματα"). So, there can be no motion without things. At least two things are essential: the

47 For the *Physics*, see the fourth volume of the Giunta edition: Aristotle, *De physico audito libri octo*. This work includes both the *translatio vetus* and the *nova*, which I will refer to later for convenience, but also because it was preferred by some commentators, including Zabarella.

48 "Ergo et haec necessarium est aut facta aliquando esse, cum non essent; aut perpetua esse" (Aristotle, *De physico audito libri octo*, 341v, L-M).

49 "Si igitur factum est mobilium, ac motivorum unumquodque, necessarium est prius, quam accepta, aliam esse factam mutationem, et motum, secundum quem factum est id, quod potest esse motum, aut movisse" (*ibid*., 342r, B-C).

50 "Probat [Aristoteles] nullum fuisse primum motum, sed ante quencunque alium extitisse, ratiocinaturque in hunc modum. Si exordium temporis motus habuisset, vel movens et mobile, cuius esset ille primus motus, coepissent aliquando, vel fuissent ab aeterno; si aliquando coepissent; igitur per aliquem motum: quare iam motus ille, qui antea primus dicebatur, primus non esset" (Conimbricenses, *In octo libros Physicorum*, 701).

mobile (*mobile*), which is capable of being moved, and the mover (*movens*), whose capacity (or potentiality) for motion is already realized (or actualized) and thus can set the mobile in motion. This is how motion can occur, which Aristotle defines as "the act of the mobile inasmuch as it is mobile".[51]

As the Jesuits of Coimbra explain in the aforementioned passage, Aristotle asserts that if motion had a beginning, then both the mover and the mobile would have had to come into existence, meaning they were generated. However, for Aristotle, the process of generation can only happen through change (*mutatio*) and motion (*motus*). So, the idea that motion had a beginning leads to the conclusion that there was motion prior to the supposed first motion; therefore, motion is eternal. Consequently, since motion cannot be separated from things – such as the celestial spheres in Aristotelian cosmology – it follows that the universe is also eternal. The eternity of motion thus demonstrates the eternity of the world.

Here is how Castelli succinctly summarizes Aristotle's reasoning:

> So, having supposed that the existence of the mover and the mobile [*movente e mobile*] must precede motion, Aristotle continues and says: Either they were made or they are eternal. If they are eternal, why was motion not made? If they were made, then [they were made] through motion; thus, there was motion before motion.[52]

In this passage, Castelli also summarizes part of text 7 (*Phys.* 251a20-28) from Book VIII of Aristotle's *Physics*, which considers the possibility that mover and mobile have existed forever. In this case, too, Aristotle concludes that motion is eternal.[53]

In Castelli's summary, however, Aristotle asks a sort of rhetorical question: "If they are eternal, why was motion not made?" (*se eterni, perché non si faceva il moto?*). Although Aristotle does not actually pose this question, a very similar paraphrase can be found in Jacopo Zabarella's commentary (published posthumously in 1601): "… why, indeed, did

[51] "Incipiemus autem primum ex definitis a nobis prius in physicis. Dicimus itaque *motum esse actum mobilis, secundum quod est mobile. Necesse est ergo existere res, quae possunt moveri secundum unumquemque motum*. Et sine etiam motus definitione omnis utique confitebitur necessarium esse moveri id, quod potest moveri secundum unumquemque motum: ut alterari quidem alterabile, ferri atuem secundum locum mutabile. Quare prius oportet combustibile esse antequam comburant, et combustivum, prius quam comburat" (Aristotle, *De physico audito libri octo*, 340r-v, F-G, emphasis added). The definition of motion is taken from Book III, text 4, of the *Physics* (see *Phys.* 200b32-33), where Aristotle also claims, in text 6, that there can be no motion without things (see *Phys.* 201a10-11).

[52] "Supposto donque da Aristotele che a principiar il moto è necessario che preceda la essistentia del movente e mobile, segue dicendo: O che questi sono fatti, o eterni: se eterni, perché non si faceva il moto? Se fatti, adonque per moto: talché era il moto avanti il moto" (OG, X, 170).

[53] See Aristotle, *De physico audito libri octo*, 342v, I.

[mover and mobile] not make motion?" (... *cur enim non faciebant motum?*).[54]

Moreover, Castelli summarizes text 6 with the phrase, "if they were made, then through motion" (*Se fatti, adonque per moto*). This is later repeated in Latin: "*si facta* [...] *ergo per motum*".[55] This identical phrasing also appears in Jacopo Zabarella's commentary on text 6.[56] Later, in his commentary on text 9, Zabarella summarizes Aristotle's reasoning with the expression, "*si factum: ergo per motum*". Here, "*factum*" refers to "the mobile, namely, the universe" (*mobile, nempe, universum mundum*). The mover is identified by Zabarella as God.[57] However, the mover in texts 5 and 6 of Book VIII of the *Physics* is clearly a thing, a *res* that, while moving, sets the mobile in motion. Therefore, by equating it with God – who, in the Aristotelian tradition, is the unmoved mover that is always in act and devoid of matter – Zabarella appears to stretch the interpretation of the passage.

At any rate, mobile and mover were already mentioned by Zabarella in his comment on text 5, which, in its structure, accords with the one of the previously quoted passage from Castelli's letter:

> Having established that motion requires a mover and a mobile, Aristotle begins to argue here by assuming an opponent who claims that motion has begun. He asks his opponent whether mover and mobile were made or are eternal. By so doing, from either assumption he can demonstrate that there was a prior motion before the first motion, which implies a contradiction.[58]

Here, there is a reference to a supposed "opponent" ("*Aristoteles... supponens adversarium dicentem incoepisse omnino motum*"), which also appears in Castelli's letter ("...il primo moto del'avversario"), but for which there is no trace in Aristotle's text.[59]

54 "[...] Aristoteles [...] dicit primum positionem hanc cuilibet consideranti videri irrationabilem quod motor, qui est aptus movere, et mobile aptum moveri, praefuerint aeterno tempore absque ullo moto, cur enim non faciebant motum? cur tunc potius quam antea?" (Zabarella, *In libros Aristotelis physicorum commentarii*, 104r).

55 See *infra*, n. 71.

56 "Dubitari hic posset adversus illam consequentiam Aristotelis, *si facta, ergo per motum* [...]" (Zabarella, *In libros Aristotelis physicorum commentarii*, 103v, emphasis added).

57 "[...] quando enim quaerit Aristoteles si fuit primum initium motus motor et mobile suntne facta an sunt aeterna? nos respondemus motorem quidem semper fuisse, et semper eodem modo se habuisse; sed mobile, nempe, universum mundum, esse factum a Deo" (*ibid.*, 108r).

58 "Iacto illo fundamento quod motus requirit motorem, et mobile, Aristoteles hic incipit argumentari, et supponens adversarium dicentem incoepisse omnino motum, quaerit ab eo an motor, et mobile sint facta, an sint aeterna, ut ex utrolibet dato ostendat fuisse motum priorem primo motu, quae est implicatio contraditionis" (*ibid.*, 103r).

59 See *supra*, n. 46.

It is likely that this was a common way to present these passages from the *Physics*.[60] Therefore, it is uncertain whether Castelli drew directly from Zabarella's commentary. Nonetheless, it can be concluded that Castelli's reading of texts 5 and 6 from Book VIII of the *Physics* was certainly mediated by some form of commentary, which is not surprising.

What is surprising, however, is how Castelli refutes Aristotle's argument for the eternity of motion. Typically, it was customary to distinguish the concept of generation from that of creation. It was believed that while generation occurs through physical motion and requires pre-existing matter, creation is instantaneous and *ex nihilo*, meaning it comes from nothing.[61] Thus, Aristotle's argument had limited validity, as it applied only to what was generated from something else and could not be applied to what was created by God from nothing.[62]

According to Thomas Aquinas and other commentators, when arguing for the eternity of motion, Aristotle implicitly assumed the principle *ex nihilo nihil* (nothing comes from nothing) as the foundation of his reasoning. Therefore, his argument can be solved by appealing to creation from nothing. However, Zabarella did not entirely agree with Aquinas. While he acknowledged that the unexpressed principle *ex nihilo nihil* effectively served as a cornerstone of Aristotle's argument, he also believed that the notion of creation *ex nihilo* could not be used to refute it.[63]

60 I found no mention of the "opponent" in the other commentaries I reviewed while writing this paper.

61 I am simplifying for the sake of clarity. For the different ways in which the term *creatio* was used, see Conimbricenses, *In octo libros Physicorum*, 706-707.

62 This is well exemplified by Benet Perera in his well-known textbook, where he responds to Aristotle, Proclus, and Averroes: "[…] rationes Aristotelis, quae tali fundamento nituntur atque fulciuntur [i.e., ex nihilo nihil], infirmas esse necesse est. Nam et primam materiam, et primum mobile, et omnes coelos de novo productos esse dicimus, non per motum physicum et ex aliquo subiecto, ut Aristoteles argumentatur, sed per creationem ex nihilo"; "[…] aliud est loqui de generatione uniuscuiusque rei particularis, aliud vero de procreatione Universi et omnium entium, quae ex aliquo subiecto antecedente non potuerunt existere. […] Ad haec, quod vere generatur, id est per motum efficitur, id et in tempore, et ex aliquo subiecto fieri necesse est; at procreatio Mundi non est motus, nec in tempore fit, immediate enim fit a Deo, qui in tempore non operatur"; "[…] creare mundum ex nihilo, non potest nisi is qui habeat infinitam vim et potestatem, quique sit summe bonus et sapiens, hunc autem Deum esse, manifestum est apud omnes" (Perera, *De communibus omnium rerum naturalium principijs et affectionibus libri quindecim*, 466d, 479d-480b, 499c).

63 "Admonere autem hic volo me hac in re non omnino Divo Thomae assentire, quod enim dicat rationem Aristotelis ita solvi, id quidem verissime dicitur, sed quod haec fuerit Aristotelis mens, nempe, quod de creatione cognoverit, quod fieri possit ex nihilo, et de sola generatione dixerit quod nihil potest ex nihilo fieri; hoc quidem ego nullo modo sentio, sed credo Aristotelem negasse omnem productionem ex nihilo, neque cognovisse creationem, siquidem non fuit Christianus, quando igitur utitur hoc principio ex nihilo nihil fit, puto ipsum semper intelligere

In his commentary on the *Physics*, Zabarella argues that Aristotle's proof for the eternity of motion is compelling as long as one accepts the principle *ex nihilo nihil*. However, Christian thinkers, who believe the truth has been revealed through faith, start from a different principle – namely, the principle that God created the universe *ex nihilo*. While this latter position is indeed true and must be affirmed by Christians, Aristotle's argument remains logically valid and irrefutable when based on the principle *ex nihilo nihil*. In summary, Zabarella concludes that these are two antithetical positions because they rest on opposing principles. And it makes no sense to engage in a discussion with those who do not share the same argumentative principles ("*certum est nullam esse posse disputationem inter eos, qui non conveniunt in pincipijs*").[64]

Those like Philoponus, who wish to "fight for Christian truth against Aristotle" (*pro Christiana veritate contra Aristotelem pugnare*), risk misinterpreting Aristotle simply to refute him. In fact, Philoponus mistakenly believed that Aristotle did not use the principle *ex nihilo nihil* in Book VIII of the *Physics*. According to Zabarella, Simplicius and others also erred when, responding to Philoponus, they conceded that Aristotle did not employ that common principle, but rather his own, specifically his definition of motion as "the act of the mobile inasmuch as it is mobile".[65]

Castelli was most likely aware of these discussions and interpretations. However, his refutation of Aristotle's argument for the eternity of motion begins – this is noteworthy – with the new definition of motion proposed by Galileo. He does not rely on the Christian concept

id universaliter verum esse, ita ut nulla detur productio nisi ex praesupposita materia, hoc enim ita constituto valida est consequentia haec, factum, ergo per motum, sed eo negato, ut nos negare debemus, ratio Aristotelis corruit, et nihil habet efficacitatis" (Zabarella, *In libros Aristotelis physicorum commentarii*, 108r). A few lines earlier, Zabarella refers to "S. Thomas in prima parte summae quaestione quadragesima sexta articulo primo".

64 "Contra vero in Philosophia Aristotelis est principium indemonstrabile, quod nullo modo potest aliquid fieri ex nihilo, at certum est nullam esse posse disputationem inter eos, qui non conveniunt in pincipijs, vana est igitur omnino haec disputatio [de creatione contra Aristotelem], nec nos in praesentia aliud dicere debemus, nisi quod in principijs Aristotelis haec ratio est validissima, et insolubilis, a nobis tamen Christianis facile solvitur negato illo principio ex nihilo nihil fit, dicimus mundum a Deo creatum statim incoepisse moveri, nec ostendi posse quod fuerit motus alius prior illo primo, propterea quod creatio fit sine ullo motu, et nulla praesupposita materia" (*ibid.*, 108r-v).

65 "Ioannes igitur volens pro Christiana veritate contra Aristotelem pugnare, conatus est hanc primam rationem demoliri, totaque disputatio ipsius tribus capitibus continetur, ut apud Simplicium legere possumus [...]. Objicit Ioannes Aristoteli quod non usus sit hoc principio, ex nihilo nihil fit, ex quo haec demonstratio fuisset validissima. Ad hoc Simplicius, et alij respondent concedendo non usum esse Aristotelem hoc fundamento, quoniam (dicunt) maluit uti principijs proprijs, quam principio illo nimis communi, ideo uti voluit definitione motus, ut principio proprio, et ex natura motus demonstrare motus aeternitatem. Sed horum sententia mihi non probatur [...]" (*ibid.*, 107v-108r).

of creation *ex nihilo*, nor on the notion of an omnipotent God who creates the world from nothing instantaneously and without physical motion. Instead, he relies on Galileo's new definition that "motion is nothing but a change of one thing in relation to another". Thus, even if Aristotle based his argument solely on his own definition of motion (as interpreted by Philoponus, Simplicius, and others), his argument for the eternity of motion would still be flawed because it stems from a fundamental misunderstanding of what motion truly is.

In response to Aristotle's conclusion, "if made, then through motion", Castelli asserts that this is a "distorted consequence" (*consequenza stroppiata*). He attempts to demonstrate this by proposing and confirming "two lemmas, which are true not only in themselves but also within Aristotle's own doctrine".[66]

The first lemma states that "if the totality of things were to be made, it would be impossible to do so through motion". Although Castelli argues that this lemma can be derived from Aristotle's doctrine, he actually derives it from Galileo's understanding of motion:

> And the reason is that, given the definition of motion, one must first look for something in relation to which the change occurs, and since we are proposing the production of the totality of things, nothing can be found: therefore, [the totality of things] is not produced through motion, which was our point.[67]

Castelli argues that, because motion requires a change relative to something else, it would be impossible to find anything against which the totality of things could begin to move. If nothing exists outside this totality, motion cannot occur. Therefore, if the universe was created, it could not have been through motion.

From this, it seems that, for Castelli, the complete absence of any relata removes the necessary condition for the *existence* of motion, suggesting that motion is *ontologically* understood as a relative state. It is hard to know whether this truly reflects the full scope of Galileo's definition of motion in 1607. Unfortunately, his response to Castelli's letter (if there was any) has not survived.

However, it is important to emphasize, once again, that Castelli challenges Aristotle's conclusion by resorting to Galileo's new definition of motion, which does away with the concepts of act, potency, mover, and movable. This shift is far from insignificant. Also,

66 "Che questa sia una consequenza stroppiata, io lo provo, proposti prima e confirmati doi lemmi, verissimi non solo da sé, ma nella dottrina istessa d'Aristotele" (OG, X, 170). The expression "consequenza stroppiata" reminded me of Galileo's use of "conseguenza stravolta" a few years later in his argument against Ludovico Delle Colombe (see OG, XI, 149).

67 "Il primo è, che se il tutto si facesse, saria impossibi[le] farsi con moto. La ragione è, perché ricercandosi, per la definitione del moto, qualche cosa a rispetto della quale si faccia la mutatione, et essendo da noi proposta la mutation del tutto, niente si ritrova: adonque non si fa con moto, che era il proposito nostro" (OG, X, 170).

although Castelli concedes that his objection aligns with what even the Aristotelians are willing to concede (that is, the universe was not created through motion), his argument differs from theirs. While they invoke God's omnipotence and creation *ex nihilo*, he draws on Galileo's definition of motion. In summary, Castelli seeks to challenge Aristotle on his own ground, but with a new weapon – Galileo's natural philosophy.

To illustrate Aristotle's paralogism, Castelli also invokes the principle *ex nihilo nihil*, which he calls an "axiom".[68] The second "lemma" states that

> it would not be absurd, contrary to what the Peripatetics claim, that if the totality of things were made, it would be made from nothing. Indeed, it is not only unproblematic but also necessary that, if the totality of things were to be made, it would come from nothing. Thus, we can say that the axiom *Ex nihilo nihil* should, by necessity, be understood and limited (if it has any semblance of truth) to particular productions, not to that of the totality of things (if it were to be made).[69]

As noted, for some commentators, Aristotle's argument is grounded in the principle *ex nihilo nihil*. When based on this principle, Zabarella argued that the argument is compelling and irrefutable. However, by denying this foundational principle, one can rightly assert that the world was created by God *ex nihilo*. In Zabarella's view, these conclusions arise from opposing axioms, resulting in different and non-communicating conceptual frameworks.

Castelli seems to critique positions like this, arguing that it is incorrect for the "Peripatetics" to claim that it is absurd to accept creation *ex nihilo* once the axiom *ex nihilo nihil* is acknowledged. According to Castelli, this axiom is limited by definition: it can only be applied to the production of particular things, not to the totality of things.

Whether successful or not, Castelli's attempt reflects a desire to dismantle Aristotle's argument without relying on the terminological and conceptual distinctions between generation and creation. Even if, as some commentators believed, Aristotle used the principle *ex nihilo nihil*, he applied it incorrectly, as he used it in the one context where it is inapplicable: the generation of the universe. Thus, Aristotle failed to recognize that the generation of the universe represents a singularity that cannot be explained through that common principle.

68 See also Perera, *De communibus omnium rerum naturalium principijs et affectionibus libri quindecim*, 479d: "[ … ] Proclus *ex illo communi axiomate* Ex nihilo nihil fit, conatur ostendere Mundum non potuisse generari [ … ]" (emphasis added).

69 "Il secondo è, che non sarebbe un assurdo quello che per tale si va predicando da' Peripatetici, che se il tutto si facesse, si farebbe di niente, poiché non solo non è inconveniente, ma saria necessario che, facendosi il tutto, di niente si facesse: talché potiamo dire che l'axioma Ex nihilo nihil va inteso e limitato a forza (se però have spetie di verità) alle prodottioni particolari, non a quella del tutto (se si facesse)" (OG, X, 170).

In this respect, the 1607 letter displays argumentative features similar to those used by Galileo himself in his many debates against the Aristotelians. Castelli seeks to illustrate that, in a sense, Aristotle has undermined his own position. By acknowledging the possibility that the universe might have had a beginning, he simultaneously ruled out the possibility that it could have been generated through motion and from something else. Yet he failed to recognize this point. Using a metaphor that Galileo would later employ in the *Dialogue*, one could say that, for Castelli, Aristotle created the organ of philosophy – namely, logic – but failed to master how to play it.[70]

In general, Castelli's intention is not to prove that the world had a beginning or that Galileo's science can demonstrate this. Instead, he aims to refute the argument that Aristotle believed he had used to establish the eternity of motion and the universe. He does this within the limits of human understanding, as a natural philosopher would.

This point becomes evident when Castelli summarizes his refutation:

> Now, how can this good man infer: if they were made, then [they were made] through motion, when neither he nor anyone else, who has even a little understanding of words, can say that universal production occurs (if it occurs) through motion? Does he not see that, while he admits [that they were made], he is cutting off the path for himself, since this passage "*si facta*", as in the first lemma, does not allow one to say "*ergo per motum*"?[71]

And right afterward:

> I am not saying that it [i.e., motion/the world] was made or not made, but that its progress doesn't teach me anything [about whether it was made].[72]

As a believer and a member of the Benedictine order, Castelli could certainly assert that the world was made, meaning it was created *de novo* by God. However, he believes such a statement would be unprovable using only human reason. He prefers to limit him-

70 See OG, VII, 59-60. See also Galilei, *Dialogo*, II, 204-206, wich quotes a passage by Niccolò Aggiunti (Castelli's pupil), transcribed and translated by Michele Camerota.

71 "Hora, come può inferire quest'huomo da bene: Se son fatti, adonque per moto? se né lui né altri, che habbiano solo un puoco di lume di intelligenza di parole, ponno dire che la prodottione universale si faccia (se si fa) con moto? Non vede egli che, mentre mi dona, non concede, questo passo *si facta*, che immediate da sé stesso si tronca la strada, come nel primo lemma, di poter dire: *ergo per motum*?" (OG, X, 170).

72 "Io non dico né che sia fatto né che non sia fatto, ma che il progresso suo non mi fa guadagnar niente" (*ibid.*). This sentence is somewhat ambiguous. While the term "progresso" could be interpreted as referring to Aristotle's logical argument for the eternity of the world, I am more inclined toward another interpretation, which I will explain below.

self to presenting his perspective as a natural philosopher. In this role, he cannot determine, based on observations of natural phenomena, whether the world had a beginning or has always existed ("… il progresso suo non mi fa guadagnar niente").

At that time, not everyone shared this view, but Castelli certainly finds himself in good company, as Thomas Aquinas also asserted that "the novelty of the world cannot be demonstrated from the world itself" (*novitas mundi non potest demonstrationem recipere ex parte ipsius mundi*).[73]

Castelli's primary objective is to demonstrate that Aristotle was an inconsistent natural philosopher, as he failed to recognize the inherent limits of the discipline he practiced in the *Physics*. Aristotle deluded himself into believing he had proven the eternity of motion and, by extension, the eternity of the universe. This was actually evidence of his inability to fully understand motion and argue correctly.

### 3.2. On a new proof for the existence of God

Seamlessly, Castelli introduces a new argument that some believed could prove the existence of God:

> Then, from the doctrine of Your Lordship [Galileo] that a mover [*movente*] is necessary to start the motion, but the lack of obstacles is sufficient to continue it, makes me want to laugh [*mi vien da ridere*] when they magnify such a doctrine as though it made the existence of God known to me. For, if it were true that motion is eternal, I could become atheistic and say that we don't need God. What a wicked blasphemy![74]

Two distinct interpretations of this passage have been proposed. Both, in my opinion,

[73] See Thomas Aquinas, *Summa theologiae*, 352, cols. 1-2 (i.e., I, q. 46, a. 2). Not everyone agreed with this conclusion. Some argued that it could indeed be demonstrated that the world had a beginning. The issue is also addressed in Galileo's *Juvenilia*, where it is argued that, although it is impossible to prove that God created the world *de novo* ("quandoquidem demonstrare non potest […]"), it can still be shown in various ways, such as by appealing to the Holy Scriptures and the Fourth Lateran Council (see OG, I, 26). This stands in stark contrast to the conclusion reached by the Jesuit Muzio Vitelleschi of the Collegio Romano in his *reportationes*, where he writes that "lumine naturali non solum quomodocumque cognosci potest mundum non fuisse aeternum, sed ita probari ut non melius in philosophia probentur multa quae censentur physico demonstrare" (APUG, Muzio Vitelleschi's *reportationes*, FC 392, f. 8v). Vitelleschi deliberately positions himself in opposition to the thesis of Thomas Aquinas.

[74] "Dalla dottrina poi di V.S., che a principiar il moto è ben necessario il movente, ma a continuarlo basta il non haver contrasto, mi vien da ridere quando esaltano questa dottrina come quella che mi faccia venir nella cognitione dell'esistentia di Dio; consciosiacosaché se fusse vero che il moto fosse eterno, io potrei doventar ateista e dire che di Dio non havemo bisogno, bestemia scelerata" (OG, X, 170).

are influenced by an underlying bias: Castelli was a man of God, and as such, he criticized anything that contradicted the truth of faith.

On the one hand, Massimo Bucciantini, who has highlighted the significance of the 1607 letter since 1992, argued that it is crucial to differentiate between the referents of two expressions used by Castelli in the quoted passage. The "doctrine of Your Lordship" that Castelli mentions is not the same as the one he later critiques, which he explicitly refers to as "such a doctrine". This latter doctrine, Bucciantini claimed, specifically relates to the Aristotelian concept of the eternity of motion that Castelli had previously challenged. While he initially critiques this doctrine from a logical-scientific perspective, in the quoted passage, he shifts his focus to a metaphysical and theological viewpoint.[75]

Thus, Bucciantini contended that for Castelli

> the impossibility of reconciling the Aristotelian conception of the eternity of the world with the Christian thesis of creation – and, therefore, the accusation that the conception of the eternity of motion makes God unnecessary – establishes the full superiority of Galileo's science of motion over that of Aristotle.[76]

This interpretation encounters at least one significant difficulty. If it were correct, indeed, Castelli would blatantly contradict himself: how can the Aristotelians, who apparently seek to prove the existence of God based on "such a doctrine", which for Bucciantini means the eternity of motion, be refuted "if it were true that motion is eternal"? Evidently, Castelli's main target is neither the Aristotelians nor the eternity of motion.

On the other hand, Pietro Redondi, argued that "such a doctrine" specifically refers to Galileo's assertion that "a mover is necessary to start the motion, but the lack of obstacles is sufficient to continue it". Thus, Redondi identified the polemical target of Castelli as those who aimed to prove the existence of God by employing 'Galilean inertia'.[77] He claimed that, as a Christian, Castelli could not accept that the universe was created by God through motion. In other words, Castelli struggled to justify Galileo's "inertia" based on the existence of God. In 1607, Castelli was not

[75] See Bucciantini, "Atomi geometria e teologia nella filosofia galileiana di Benedetto Castelli", 174-175, and n. 9 against Libero Sosio's interpretation.

[76] "[ … ] l'impossibilità di conciliare la concezione aristotelica dell'eternità del mondo con la tesi cristiana della creazione – e, quindi, l'accusa rivolta alla concezione dell'eternità del movimento di fare a meno dell'operato di Dio – sanciscono la piena superiorità della scienza galileiana *de motu* rispetto a quella aristotelica" (*ibid.*, 174).

[77] While I am not entirely opposed to the anachronistic use of the term 'inertia' for the sake of convenience, I disagree with Redondi's claim that Castelli was specifically referring to "inertial rectilinear motion" (see Redondi, "From Galileo to Augustine", 181).

> as ingenious a theologian as Descartes to postulate inertia on the immovability of God. Castelli had only his faith to rely on when he reminded Galileo at the end of his letter that, "if it is true that motion is eternal, I could begin atheistic (*ateista*) and say we don't need God. What a wicked blasphemy!"[78]

Redondi's interpretation, while containing some interesting insights, is, in my view, misleading. It is incorrect to assert that Castelli highlights the "impious" nature of attempts – whether Aristotelian or otherwise – to prove that the world was created through motion in his 1607 letter.[79] Castelli's objective is quite different.

First, as noted, he argues against Aristotle that it is impossible to prove the eternity of motion without exceeding the limits of natural reason. In this sense, Castelli believes that there can never be a 'cosmological' proof of the eternity of motion and the world; that is, a proof relying on the sensible data that natural philosophers study. This skepticism applies also to the beginning of motion, which cannot be demonstrated in natural philosophy according to Castelli. Secondly, he expresses his discontent with those who use Galileo's doctrine to argue that motion requires at least an initial mover, i.e. God, in order to continue indefinitely from that point onward. Indeed, consistent with his earlier claim about the impossibility of proving the beginning or eternity of motion, Castelli finds this argument for God's existence to be ridiculous. He contends that if, by some other means, it were discovered one day that the world is eternal, those who accepted this 'Galilean' proof for God's existence would ultimately have to become atheists. "What a wicked blasphemy!"

Castelli remarks that all of this "makes [him] laugh" (*mi vien da ridere*). This expression, to an attentive reader, evokes the attitude of the unbelievers mentioned by Thomas Aquinas in the *Summa theologiae*, where he states that creation *de novo* is a matter of faith ("*credibile*") and is not subject to scientific demonstration ("*non autem demonstrabile vel scibile*"):

> that the world had a beginning is an object of faith, but not of demonstration or science. And it is useful to consider this, lest anyone, presuming to demonstrate what is of faith, should bring forward reasons that are not cogent, so as to give occasion to unbelievers to laugh, thinking that on such grounds we believe things that are of faith.[80]

78 *Ibid.*, 182.

79 "In this letter, Castelli went on to argue about the danger of holding that the world had been created "by motion"; this was tantamount to claiming that motion was as eternal as God. Those Aristotelians who deduced the eternity of the world from the perpetual revolutions of the heavens ('if they are created, then it is by motion') were *impious*. However, enthusiasts who took God to be the initial source of an inertial rectilinear motion were also wrong" (*ibid.*, 181, emphasis added).

80 "Unde mundum incoepisse est credibile, non autem demonstrabile vel scibile. Et hoc utile est ut consideretur, ne forte aliquis, quod fidei est demonstrare praesumens, rationes non necessa-

To prevent unbelievers from having material for mockery (*materia irridendi*) – essentially, an opportunity to ridicule Christians – Thomas cautiously advised avoiding certain types of demonstration altogether. Castelli echoes this sentiment but directs his warning specifically at some of the early 'users' of Galileo's doctrine.

His admonition is addressed to Galileo, not, as David Wootton has claimed, because Galileo himself suggested using his own doctrine of motion to prove God's existence.[81] There is no basis to entertain this hypothesis. It is entirely possible that Castelli felt comfortable confiding in his mentor about individuals known to both of them. Perhaps he believed that Galileo essentially shared his views.

At any rate, it is noteworthy that in the 1607 letter Castelli seems to already align himself with the distinction of domains and disciplines that Galileo would later defend in the *Copernican Letters*. Castelli consciously contrasts the "theological drift" that some attempted to impose on Galileo's science. This is not the same as Redondi's claim that Galileo's "mechanics involved a theological drift", and that this "problematic link between motion and creation was indeed very close to the problem of time as discussed by Augustine against the Manichees".[82] I highlight this point because Redondi's view has been taken up by Kenneth J. Howell, who suggested that

> Galileo's reason for appealing to Augustine [in the *Letter to Christina*] results in part from his view of the relativity of motion, an argument that reflects a closer continuity between his science and his interpretation of Scripture that has generally been recognized.[83]

The idea of a "link" or "continuity" between Galileo's science and his reflections on theological matters stems partly from a misinterpretation of Castelli's 1607 letter. In fact, Castelli's real aim was to prevent Galileo's new "doctrine" of motion from being misused and improperly applied by others in theological discussions about creation and the existence of God.

## 4. Conclusion

When asked "Does the eternity of motion make God unnecessary?", Castelli would undoubtedly have replied with a spontaneous and firm "No, it doesn't". This is made clear through a close reading of Castelli's first letter to Galileo. If my interpretation is valid, this

rias inducat, quae praebeant materiam irridendi infidelibus, existimantibus nos propter huiusmodi rationes credere quae fidei sunt" (Thomas Aquinas, *Summa theologiae*, 352, col. 2; i.e., I, q. 46, a. 2).

81 See Wootton, *Galileo: Watcher of the Skies*, 240-250.

82 Redondi, "From Galileo to Augustine", 181. See also Id., "Natura e Scrittura".

83 Howell, *God's Two Books*, 187.

letter is an invaluable testimony to the state of the debate surrounding Galilean science before any formal publication on the subject.

It is likely that someone well-known to both Castelli and Galileo attempted to prove the existence of God through Galileo's doctrine of motion. This certainly occurred in Padua, although it is nearly impossible, at this time, to determine who applied Galilean science to theological matters.[84] However, this effort was not well-received by Castelli, who promptly alerted his master to ensure that the new science would not be ridiculed. He wanted to prevent any association of the new science with clumsy arguments about creation and the existence of God. There is no doubt, in my opinion, that Castelli's caution stemmed from a deep grounding in theology, particularly from reading Aquinas.[85]

In this regard, my interpretation of the letter diverges sharply from Pietro Redondi's view that Galileo's science of motion had theological roots in Augustine's reflections on time. Redondi argues that Castelli failed to see this link or reconcile Galilean inertia with a God as creator. However, his claim that Galileo "applied [Augustine's metaphysics of time] to dynamics" remains unproven and cannot be inferred from Castelli's 1607 letter.[86] Instead, as I have shown, there is a clear connection between Castelli's cautious approach to Galileo's science in theological matters and Thomas Aquinas's arguments.

At the same time, Castelli illustrated how fruitful the new science could be in countering Aristotle's paralogisms. In his 1607 letter, he says that he has come to understand the flaws in Aristotle's proof of the eternity of motion after reflecting on Galileo's new definition of motion. Thus, by setting aside arguments based on distinctions between act and potency, mover and mobile, generation and creation, Castelli was able to critique Aristotle from the standpoint of a natural philosopher.

In 1607, Castelli praised Galileo's new philosophy of nature over the Aristotelian one while also urging caution in this praise. The risk was that one could exaggerate to the point of venturing into areas where Galileo's science would never gain traction. It is quite possible that by 1607, when Castelli wrote his letter, he was already aware of which arguments resonated with Galileo.

84 As shown above in Section 2, Galileo was accustomed to discussing his scientific findings with his pupils and friends.

85 See *supra*, n. 39.

86 Redondi, "From Galileo to Augustine", 182. Redondi has further argued that "Galileo ha bisogno di Dio come garante della razionalità naturale e delle leggi matematiche dei fenomeni. Ma non Galileo come persona, è la sua scienza meccanica, il suo copernicanesimo, la sua fisica matematica a fondarsi su un'idea del mondo come risultato di un disegno razionale miracoloso." (Redondi, "Natura e Scrittura", 156). However, in my view, this assertion still lacks sufficient textual evidence.

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### Abbreviations

OG = Galilei, Galileo. *Opere*. National Edition, edited by Antonio Favaro, 20 vols. Firenze: Barbèra, 1890-1909.

OGA = Galilei, Galileo. *Opere*. Appendix to the National Edition, edited by M. Camerota *et al.*, 4 vols. Firenze: Giunti Editore, 2013-2019.

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APUG = Archivio Storico della Pontificia Università Gregoriana

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# Luce, umore e atomi: la fisica del vino dopo Galilei

Lorella Mangani
independent scholar; l_mangani@virgilio.it

**English title**
Light, humor and atoms: The physics of wine after Galilei

**Abstract**
Galileo's interest in the nature and composition of wine, summarised in the saying "wine is a compound of humour and light" that is often ascribed to him, provided the basis for the research of the subsequent generation of scientists. These scientists had learned from their master how to approach the physics of wine in mechanistic and corpuscularian terms. Lorenzo Magalotti, Francesco Redi and Giuseppe Del Papa further developed this theme through a reflection and detailed analysis of the particulate structure of matter, the corporeal nature of light and the innumerable unsolved questions concerning the study of the apparati and organic functions of bodies, as well as good dietetic and therapeutic practices.

**Keywords**
Galileo Galilei, wine, atomism, light, Lorenzo Magalotti, Francesco Redi, Giuseppe Del Papa

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Nella sarcastica similitudine dei fiaschi che, così come gli uomini, non possono rivelare la squisitezza del loro contenuto soltanto dagli orpelli esteriori e dalla mera foggia, a conclusione del *Capitolo contro il portar la toga,* Galilei dava brillante e pungente sfoggio poetico della sua palese avversione per tutto ciò che si ammanta di vuota esteriorità e di banale apparenza, ricorrendo, come per lui doveva essere facile, a immagini e correlativi mutuati dalla passione per il vino che da sempre coltivava.

> Anzi vo' dirti una mia fantasia, / che gli uomini son fatti com'i fiaschi./ Quando tu vai la state all'osteria, / alle Bertuccie, al Porco, a Sant'Andrea, / al Chiassolino o alla Malvagia, / guarda que' fiaschi, innanzi che tu bea / quel che v'è drento; io dico quel vin rosso, / che fa vergogna al greco e alla verdea: / tu gli vedrai che non han tanto in dosso, / che 'l ferravecchio ne dessi un quattrino; / mostran la carne nuda in sino all'osso: / e poi son pieni di sì eccellente vino, / che miracol non è se le brigate / gli dan del glorioso e del divino. / Gli altri, ch'han quelle veste delicate, / se tu gli tasti, o son pien di vento, / o di belletti o d'acque profumate, / o son fiascacci da pisciarvi drento.[1]

Le osterie erano luoghi di amena frequentazione per le brigate studentesche e di certo lo erano altrettanto per il professore di matematiche, così restio alla toga accademica quanto invece amante dei piaceri bacchici, ma anche esperto viticoltore fin dal suo trasferimento a Padova, dove è noto coltivasse un orto vitato attiguo a una delle case che abitò.[2] Dopo il ritorno a Firenze, l'argomento del vino compare spesso nella corrispondenza dello scienziato, e specialmente negli anni del confino ad Arcetri Galilei si dilettò con abile dedizione alla coltura della vite e alla produzione vinicola domestica.[3]

Contribuirono forse la squisita attitudine pratica e il "passatempo" dell'agricoltura a orientare gli interessi della fisica di Galilei anche nella dimensione del mondo vegetale, così come testimonia Vincenzo Viviani,[4] e in particolare non dovette mancare l'attenzione per i fenomeni vegetativi della vite, della maturazione e della fermentazione delle uve. E se tali studi originali non sono direttamente reperibili tra gli scritti galileiani, di sicuro tuttavia costituirono la base solida delle indagini approfondite dalla generazione successiva degli allievi, che dal maestro della scienza sperimentale appresero come affrontare lo studio della fisica del vino in termini meccanicistici e corpuscolaristici.[5]

1 OG, IX, 222-223.

2 Scandaletti, *Galileo privato,* 99-104.

3 Vd. le ricerche promosse dall'Accademia dei Georgofili: Fiorino, Vergari, Viviani, *L'ipotesi ricostruttiva della cantina di Galileo Galilei a Villa il Gioiello*, 5-27.

4 OG, XIX, 625.

5 Favaro, *Un motto di Galileo intorno al vino*, 10-11. Di notevole interesse Camporesi, *Il tramonto della luna. Il vino, la vite e la nuova scienza*, 117-158. Sul tema Cecchetti, *"Composto di umore e di luce": Galileo, il vino e Camporesi*, in *Galileo, le scienze e le arti*, 7-14.

La testimonianza di Lorenzo Magalotti[6] in una celebre lettera a Carlo Dati rappresenta un riferimento fondamentale, poiché il contenuto cita un detto galileiano che Magalotti riferisce di aver appreso dalle parole di Raffaello Magiotti. Secondo Magiotti, il grande Galileo "era solito dire, che il vino è un composto di umore e di luce", dove la luce, nell'interpretazione che Magalotti ascrive allo scienziato pisano,[7] altro non è che "un finissimo, impalpabile, ed ultimo polverizzamento de' corpi, qualora ne' suoi primi altissimi componenti, infiniti, indivisibili si risolvono".[8]

La corporeità della luce era un punto fermo nelle teorie corpuscolari diffuse tra gli allievi di Galilei, nella cerchia fiorentina degli accademici del Cimento e presso alcuni studiosi attivi negli ambienti culturali del Granducato.[9] Tra la prima e la seconda generazione dei galileiani, la fisica della luce e le sue dinamiche corpuscolari costituirono un assunto basilare e condiviso di indagine anche riguardo lo studio dei processi di vegetazione, di maturazione delle uve e quindi di definizione di una sorta di proto-chimica del vino.

Così scrive Magalotti a Dati, spiegando la materia luminosa e, soprattutto, come questa porti a maturazione ogni frutto e nello specifico il grappolo d'uva:

> Diremo adunque con queste ragioni che la luce non solo tocca, ma penetra i corpi, sì anche diremo, che l'uva mentre sta in sulla vite allo splendore del Sole, non solo è tocca esteriormente, ma riceve dentro i suoi raggi, che son la luce. Ma infin qui niuna cosa accade all'uva, che agli altri frutti parimente non accada, imperciocché anche il moro, e 'l fico, e 'l melagrano, e 'l melo, e l'ulivo, e tutte le generazioni de' fruttiferi arbori, mettono i loro frutti al Sole,

[6] Su Magalotti vd. Preti e Matt, *Magalotti Lorenzo,* 300-305; Miniati, *Lorenzo Magalotti (1637-1712): rassegna di studi e nuove prospettive di ricerca,* 31-47; Stefani, *Lorenzo Magalotti and the animal soul,* 131-153.

[7] Ne *Il Saggiatore* Galileo definisce la natura corpuscolare della luce: "E forse mentre l'assottigliamento e attrizione resta e si contiene dentro a i minimi quanti, il moto loro è temporaneo, e la lor operazione calorifica solamente; che poi arrivando all'ultima ed altissima risoluzione in atomi realmente indivisibili, si crea la luce, di moto, o vogliamo dire espansione e diffusione istantanea, e potente per la sua, non so s'io debba dire sottilità, rarità, immaterialità, o pure altra condizion diversa da tutte queste ed innominata, potente, dico, ad ingombrare spazii immensi" (OG, VI, 352).

[8] Magalotti, *Lettere scientifiche ed erudite di Lorenzo Magalotti (1637-1712)*. Nello specifico la *Lettera V: Sopra il detto del Galileo: il vino è un composto di umore e di luce,* 45.

[9] Sugli sviluppi della scienza galileiana relativamente alle teorie corpuscolariste vd. Redondi, *Galileo eretico*; *Geometria e atomismo nella scuola galileiana,* a cura di M. Bucciantini e M. Torrini; Gòmez Lòpez, *Le passioni degli atomi. Montanari e Rossetti: una polemica tra* galileiani; Gòmez Lòpez, *Redi, arbitro tra i galileiani,* 129-139; Clericuzio, *Elements, principles and corpuscles: a study of atomism and chemistry in the seventeenth century;* Nonnoi, *Galileo Galilei: quale atomismo?,* 109-149. Gòmez Lòpez, *The mechanization of light in Galilean science,* 207-244; Camerota e Giudice, *Comete, atomi, eucarestia: a quattrocento anni dalla pubblicazione del Saggiatore di Galileo,* 269-286.

il quale a tutti dona maturamento, e perfetta digestione.[10]

Tuttavia le particelle della luce hanno un effetto originale e unico sugli acini d'uva; agisce infatti nel frutto della vite uno straordinario fattore di maturazione, e Magalotti si avventura in un'ipotesi che vuol confermare una teoria riconducibile al grande maestro della scienza moderna:

> converrà dunque dire, che il granel dell'uva sia d'una struttura così artifiziosa, che quel raggio di luce, che vi da dentro, vi resti preso, né trovi poi più la via d'uscirsene, e sì anche trapassi nel sugo, che se ne preme, ch'è il vino; il che forse negli altri frutti non addiviene, dalla carne de' quali, o diritto menando il raggio per la rettezza delle vene, e de' pori, o per vari seni, e diversi andirivieni, un gran pezzo aggirandosi, pure una volta se ne distriga, e si parte; viene imperciò da favellare di quest'ordigno, che è nell'uva, e di come egli stia fatto dentro, e degl'ingegni, che vi lavorano, e di come essi lavorano, e delle potenze, che gli muovono.[11]

Attraverso le vene, i canali, i tessuti e i meandri del "granel dell'uva", i corpuscoli della luce vengono imprigionati e meglio trattenuti, molto più rispetto a ciò che accade negli altri frutti. Tali regolatori richiamano le valvole delle vene nei corpi umani e animali: nei "canali", nei "ricettacoli d'umore", ovvero "ne' condotti dell'acqua, o del chilo, o del latte, o del sangue" sono presenti "a ritenimento degli umori, alcuni uscioletti, formati di membrane delicatissime, le quali non altramente aprendosi, che a seconda di quell'umor, che vi corre, ne vengono ad impedire il ringorgamento".

A questo modello idraulico e meccanico, che si fonda sull'analogia tra gli apparati fisiologici dei corpi organici animali e vegetali, Magalotti affianca un'altra possibile congettura per spiegare il fenomeno dell'accrescimento dovuto alla luce che matura i grappoli. Si riferisce a un'osservazione di Benedetto Castelli, chiamando in causa questa volta un importantissimo allievo diretto di Galilei, che aveva sperimentato il diverso assorbimento del calore su laterizi bianchi e neri e ne aveva ricavato che gli atomi dei colori consentissero un differente grado di permeabilità agli atomi del calore;[12] così come probabilmente doveva avvenire anche alle particelle della luce capaci di una migliore combinazione proprio nel mescolarsi in particolare con i fluidi della vite e dell'uva.

10 Magalotti, *Sopra il detto del Galileo: il vino è un composto di umore e di luce*, 45.

11 *Ibid.*

12 Le tre lettere di Benedetto Castelli a Galilei sopra il differente riscaldamento che riceve dai raggi del sole la metà della faccia d'un mattone tinta di nero dall'altra metà del medesimo tinta di bianco sono del 27 giugno, 9 e 15 agosto del 1637, e si inseriscono nell'indagine galileiana sulla natura della luce, sulla scia della scoperta delle macchie solari, sviluppata in chiave corpuscolaristica da Benedetto Castelli. Vd. Longo e Campogalliani, *Mattoni al sole. Benedetto Castelli, la luce e il calore,* 15-31.

Magalotti si era espresso sulla corporeità della luce in un'altra importante epistola a Vincenzo Viviani, *Sopra la luce,*[13] nella quale, respinte le soluzioni che richiamavano le qualità, le facoltà, le inclinazioni, le passioni e altre simili, a suo avviso, vuote espressioni, il segretario del Cimento optava per una spiegazione riconducibile alla gravità o alla leggerezza degli elementi posti in moto dalla forza attrattiva del magnetismo terrestre, per cui il fuoco, sempre spinto nell'atmosfera dagli elementi più densi e pertanto in perpetuo movimento, viene come sminuzzato dall'aria e ridotto infinitesimamente in sottilissimi raggi, in particelle minutissime – la luce appunto – capaci di penetrare attraverso minuscoli pori e meati in ogni corpo per determinarne i cambiamenti. Così la "polvere minutissima" degli atomi che costituiscono la luce spiega la crescita, la vegetazione, la fisiologia degli organi di senso, in particolare della vista e del tatto, e tutti gli altri innumerevoli fenomeni che derivano al mondo organico e inorganico dall'agire ubiquo dell'elemento corporeo luminoso.

La struttura del vino, nella quale si combinavano i meccanismi aggregativi delle particelle della luce e dei fluidi nutritivi del suolo, della pianta e dei frutti, era stata oggetto di ipotesi e di indagini che avevano coinvolto noti personaggi della scuola galileiana. La citata lettera di Magalotti sul detto di Galilei allude ai nomi di pupilli e allievi diretti, come Benedetto Castelli o Raffaello Magiotti, per tracciare un percorso poi giunto fino alla seconda generazione degli scienziati e letterati che si fecero eredi e prosecutori dei dibattiti e dei progetti inseriti già nelle pieghe della ridefinizione della fisica dei corpi compresa nella rivoluzione di Galilei.

Francesco Redi fu assiduo interlocutore di Magalotti anche in tema di vino.[14] Ambedue avevano animato nel settembre del 1666, a suon di versi improvvisati e di calici alzati, lo "stravizzo" dell'Accademia della Crusca da cui prese avvio la stesura del ditirambo *Bacco in Toscana,* che Redi avrebbe pubblicato nel 1685.[15] Il componimento poetico in lode dei vini toscani, pur nella sua straordinaria originalità, non fu certo tuttavia l'unica occasione di confronto con l'argomento enoico da parte di Redi, dal momento che lo scienziato e letterato aretino, nella sua indefessa ricerca naturalistica, medica, linguistica, ebbe in più situazioni a misurarsi con l'esperienza e la scienza del vino. Sia Redi che Magalotti – uniti da un condiviso riferimento al corpuscolarismo – riconoscono in quel "composto di umore e luce" di galileiana definizione le componenti giunte al chicco d'uva attraverso i pori della superficie dell'acino, che attribuiscono al vino l'inconfondibile sapore pungente e inebriante. È ancora Magalotti nella lettera a Dati a distinguere nella formazione del chicco d'uva i corpuscoli di luce che hanno maturato gli acini durante l'estate da quelli

13 Magalotti, *Sopra la luce,* 25-35.

14 Sulla figura e l'opera di Francesco Redi si rimanda ai contributi contenuti negli *Atti* di due convegni svolti ad Arezzo, nel 1997 e 1998, in occasione del terzo centenario della morte: *Francesco Redi, un protagonista della scienza moderna. Documenti, esperimenti, immagini*; *Francesco Redi Aretino*. Vd. anche Stefani, *Francesco Redi,* 267-271; Bucchi e Mangani, *Redi Francesco,* 708-712.

15 Bucchi, *Introduzione*, in Redi, *Bacco in Toscana,* XXIII.

assimilati all'inizio dell'autunno, cioè alla fine del processo di maturazione, per poi spiegare come gli ultimi attivano la fermentazione e i primi invece si liberano solo "per entro il vino, e solamente allorch'e si bee, fannosi sentire alla lingua, e al palato, colle graziose punture de' loro tanti angoli, e serpeggiamenti. I quali secondoché saranno più, o meno fitti, e spessi, più o meno piccanti faranno i vini, che è la qualità, che tanto a noi piace, e che produce in noi quel maraviglioso effetto di dolcezza, e di lagrime".[16]

"Lagrime" che non sono solo di piacere gustativo, poiché Magalotti non perde occasione di scrivere ancora sugli effetti del vino in un'altra famosa lettera a Orazio Ricasoli Rucellai,[17] e questa volta per associare la natura corpuscolare del "licor dell'uva" ai fattori patologici di "un ribollimento di sangue" che lo affligge mentre si trova a Roma, dove le libagioni di buon Siracusa sono state causa tuttavia della malattia. Il testo della lettera cita ancora una volta il detto di Galileo per indagare sulle particelle indivisibili e insolubili nelle quali si risolve da ultimo la materia delle differenti uve; particelle differenti per figura e per dimensione che Magalotti attribuisce alle molteplici forme e strutture dei sali ai quali si riduce ogni corpo sottoposto a scomposizione.

> Se tutte le cose adunque hanno il loro sale di differente figura dall'altre, anche i sali di diverse sorte d'uve dovranno essere diversamente figurati. Di questa diversità di figure, ce ne può dare assai chiaro argumento quello de' sapori, i quali per avventura non sono altro che diversi modi di pugnere di cotali particelle, secondo che sono in questo, o in quell'altro modo lavorate; che se per le differenze, particolarmente de' sapori, s'estimerà diversamente figurato il sal delle melagrane, da quel dell'uva, diversissime non meno reputar si dovranno le figure de' sali di due sorte d'uve.[18]

E come la varietà dei sapori dei vini deve la sua causa alle differenti particelle figurate che si incontrano e si incastrano negli organi del gusto, nello stesso modo tali corpuscoli salini trapassano con il "chilo nelle vene lattee del mesenterio, ne' vasi lattei del torace, e finalmente [...] nell'ordinario corso del sangue". Il moto circolatorio non liquefà né dissolve le particelle saline dentro i vasi sanguigni, bensì tende ad accumularle nelle vene più sottili, "nelle vene minutissime Capillari", scrive Magalotti che aveva chiara la recente lezione di Marcello Malpighi,[19] per poi procurare i sintomi irritanti e pruriginosi che contraddistinguono il ribollimento del sangue, con le sue piaghe e le stille di sangue fin nella superficie della pelle:

16 Magalotti, *Sopra il detto del Galileo,* 54.
17 Magalotti, *Sopra il ribollimento del sangue,* 10-20.
18 *Ibid.,* 17.
19 Il testo di Magalotti è del 1663, l'opera di Malpighi *De pulmonibus* fu pubblicata nel 1661. Magalotti si iscrisse all'Università di Pisa nel 1656, nello stesso anno in cui arrivarono come docenti nello Studio pisano Marcello Malpighi, Giovanni Alfonso Borelli e il lorenese Claude Aubry.

> quindi avviene che e' si sente il prurito e le punture di quegli aculei di sale, i quali moltissime delle più tenerelle vene, anzi che formarle della loro figura, sdrucono, e squarciano, perloché trovandosi fuori del corso, e perciò restando di correr con l'altro sangue, presi rimangano sotto il velo sottilissimo dell'epidermide, con qualche stilla di sangue derivata da' piccoli squarcetti di quelle fibre, e infiammano, e pungono, onde noi di grattare, rompendo il suddetto velo, caviamo, dico così con quella particella di sale, quella spina, che punge.[20]

Alla fisiologia dei sensi e del funzionamento degli organi magalottiana, definita con sì fatta propensione verso l'ipotesi di un dinamismo che chiama in causa la forma, il moto e la quantità dei corpuscoli risolutivi della materia, corrispondeva anche in Redi un'immagine analoga del funzionamento degli apparati vitali, implicita nella teoria e nella pratica medica e che si esplicitava prevalentemente nei consigli terapeutici. Redi imputava alle particelle minime, assorbite dagli organi attraverso la nutrizione e veicolate tramite il sangue e gli altri umori, un grande peso nel delicato equilibrio della salute. I consigli medici abbondano di riferimenti a un'eziologia che chiama in causa le "particelle acide con le particelle salsugginose e lissiviali, e biliose, dalla qual mescolanza nasce bollore ne' vasi sanguigni, turgenza, e rigonfiamento, e distensione".[21] Non sorprendono in tale prospettiva i moniti ripetuti del medico che raccomanda soprattutto misura e parsimonia nel regime alimentare, convinto come era che la "regola del vitto", ancor più della "chirurgia" e della "spezieria", fosse il migliore rimedio e la vera prevenzione. Per ovviare a certa gravezza degli umori vitali occorreva dunque umettare, idratare per dissolvere e contenere fino alla minima e innocua presenza quei corpuscoli ultimi in cui si risolve ogni materia. Il sangue e il "sugo nerveo", se "affollati di quantità di minime particelle acidosaline", sono veicoli di svariati morbi, la cura dei quali prevede sempre assunzione di cibi liquidi, di bevande semplici, di brodi e di acqua in modo che le eccessive minime parti siano "addolcite, messe in quiete, e sminuite". È noto infatti che il giudizio del protomedico granducale sul vino come alimento raramente si concilia con le prescrizioni dietetiche e terapeutiche:

> Io son di parere che il vino sia più difficile a passare, e più difficile a digerirsi dell'acqua, che il vino offenda più lo stomaco, e la testa, e 'l genere nervoso di quello che si faccia l'acqua; e che il vino in somma faccia maggiori ostruzioni, e lasci più tartaro ne' canali del nostro corpo di quello, che si faccia l'acqua.[22]

La natura particellare del vino illustrata da Magalotti nella citata lettera a Dati era stata motivo di lode e di confronto con Redi, anzi, il medico aretino aveva anche lui sfoggiato

20 Magalotti*, Sopra il ribollimento del sangue,* 17.
21 Redi, *Opere*, IX, 56.
22 *Ibid.*, 292.

la sua erudizione nel ricordare a Magalotti che molto prima di Galilei la composizione del vino era già sottesa nei versi di Dante:

> Sentii quella vostra lettera dotta, e meravigliosa, dottissima, ed elegantissima, scritta a Carlo Dati intorno a quel detto del nostro Galileo, che il vino altro non è, se non luce del Sole mescolata con l'umido della vite.
> Or s'i vi dicessi, che molto prima di Galileo, vi fu uno de' nostri autori, che ebbe una così bella opinione, che paghereste voi? Non voglio che paghiate cosa alcuna.
> Leggete Dante, quel Dante che quasi tutto sapete a mente, quel Dante, con tanti bellissimi passi del quale ornata avete la vostra lettera. Leggete Dante, vi dico nel 25 del Purgatorio, e troverete
> *E perché meno ammiri la parola, / Guarda il calor del Sol, che si fa vino, / Giunto all'umor che dalla vite cola.*
> Come diavolo può essere, che non abbiate veduto questo luogo?[23]

La chiosa di Redi viene recepita come valida indicazione nella successiva trattazione di Magalotti sul "ribollimento del sangue", dove l'autore, citando ancora il detto di Galileo, aggiunge che lo scienziato pisano lo aveva "peravventura imparato dal Poeta maggiore",[24] dimostrando così che il confronto con Redi sull'argomento doveva essere assiduo e condiviso.

Anche circa la struttura corpuscolare della luce la convinzione di Redi non doveva divergere da quella esplicitata da Magalotti, dal momento che l'archiatra, pur ostentando prudenza filosofica e volontà di non contravvenire ai veti che si sarebbero poi abbattuti in Toscana contro il rinnovato atomismo, tuttavia dispensava sottobanco agli amici letterati copie manoscritte del *De rerum natura* tradotto in quegli anni da Alessandro Marchetti e inoltre aveva egli stesso scritto una prefazione a favore degli atomi nel componimento poetico di Giovanni Michele Milani intitolato, per l'appunto, *La luce*, che conteneva un'evidente condivisione delle teorie democritee.[25] La corrispondenza tra Redi e Milani aggiunge dettagli importanti e allarga il cerchio di quanti si erano già rivelati diretti estimatori delle filosofie "del Galileo e del Borelli", dalle quali derivava, scrive Redi, la dottrina atomistica sottesa al componimento sulla luce. A Pisa, nelle stanze che il protomedico occupava quando seguiva la trasferta della corte in quella città, si riunivano ogni sera "molti

23 Redi, *Opere*, V, 214-215.
24 Magalotti, *Sopra il ribollimento del sangue*, 15.
25 A Giuseppe Lanzoni, il 18 aprile 1694, Redi scrive a proposito della traduzione di Marchetti del *De rerum natura*: "ma questa non è per anche stampata, e solamente va girando manuscritta per le mani de' virtuosi. Merita bene d'essere stampata a caratteri d'oro" (Redi, *Opere*, IV, 478). A Egidio Menagio (Gilles Ménage) invia "il Lucrezio volgarizzato in nostra lingua dal Sig. Alessandro Marchetti" (Redi, *Opere*, V, 373-374).

valentuomini" per leggere la canzone di Milani, di cui Redi era strenuo promotore, e tra loro figuravano i nomi dei più importanti docenti dello Studio pisano, nonché i più appassionati prosecutori dei progetti di rinnovamento della scienza stimolati dalla lezione di Galileo e dei suoi primi allievi.[26]

Da questo clima di confronto, di proficue letture e di suggestive speculazioni sulla corporeità della luce, nella prospettiva più ampia del rinnovato atomismo, già negli anni '70, erano maturati gli studi e gli scritti di Giuseppe Del Papa,[27] medico, lettore a Pisa, grande amico e assiduo frequentatore di Redi e di Magalotti, che anche nel decennio successivo non mancava di partecipare a quelle utili conversazioni di cui parla Redi e alle nuove prospettive già tracciate dalle indagini di Marchetti, di Donato Rossetti, di Lorenzo Bellini.

Del Papa aveva pubblicato nel 1674 la *Lettera intorno alla natura del caldo e del freddo*, quando dette alle stampe un anno dopo la *Lettera nella quale si discorre se il fuoco e la luce sieno una cosa medesima,*[28] in quest'ultima la corporeità della luce è principio incontrovertibile:

> la Luce è da me stimata corporea, e come tale altresì presentemente io la ricevo, e la stimo, conforme la giudicarono Leucippo, Democrito, Platone, Epicuro, ed altri grandissimi Uomini con le loro seguaci famosissime squole; onde se di presente ven'à alcuno, il quale persuaso soverchiamente dalla autorità del grande Aristotile reputi la Luce una semplice accidentale qualità, incorporea di sua natura, io mi dichiaro eziandio, che con esso per ora io non intendo favellare.[29]

[26] Redi scrive a Federico Nomi il 7 giugno 1686 su *La luce* di Giovanni Michele Milani, "mi è stata mandata di Roma una Canzona filosofica sopra la luce. È una delle belle cose, che mai in questo genere sia stata fatta; perché l'Autore vi ha messo tutta la moderna, e l'antica filosofia con una evidenza e chiarezza miracolosa" (Redi, *Opere*, VI, 289). Nei primi giorni del 1686, Redi aveva riempito di lodi Milani: "Qui in Pisa alle mie stanze ogni sera si fa una veglia di molti valentuomini, ed ogni sera si legge essa Canzone, e sempre con applausi di ammirazione, che tanto più sono considerabili, quanto che tutti provengono da uomini eminenti e nella Filosofia, e nella Poetica, e tutti seguaci delle migliori dottrine, e particolarmente di quelle del Galileo, e del Borelli, come sono il Sig. Lorenzo Bellini, il Sig. Alessandro Marchetti, il Sig. Diego Zerillo, il Sig. Giuseppe del Papa, il Sig. Frosini, il Sig. Zambeccari, il Sig. Averani, il Sig. Giannetti tutti famosi Lettori in questa Università" (Redi, *Opere*, VIII, 160-161).

[27] Sulla figura e l'opera di Giuseppe Del Papa vd. Baldini, *Del Papa Giuseppe*, 212-215. Un ampio studio e una ricca documentazione sono nella tesi di Laurea in due volumi di Bagnai, *Le tre lettere atomistiche di Giuseppe Del Papa* (v. I). *L'epistolario inedito con Francesco Redi* (v. II), da qui in poi Bagnai I e Bagnai II. Ringrazio Marta Stefani per avermela segnalata.

[28] Le tre lettere atomistiche di Del Papa, tutte dedicate a Redi, sono le seguenti in ordine di pubblicazione: Del Papa, *Lettera intorno alla natura del Caldo e del Freddo, scritta all'Illustrissimo Sig. Francesco Redi, gentiluomo aretino*; Del Papa, *Lettera nella quale si discorre se il Fuoco, e la Luce sieno una cosa medesima, scritta all'illustrissimo Sig. Francesco Redi*; Del Papa, *Della natura dell'umido e del secco, Lettera all'Illustrissimo Sig. Francesco Redi.*

[29] Del Papa, *Lettera nella quale si discorre se il Fuoco, e la Luce*, 10-11.

All'atomismo dei classici danno conferma "mille ragioni, ed esperienze" che, con la loro evidenza, attestano "la Luce essere una cosa corporea, o vogliamdire un'effluvio di minimi, ed impercettibili corpicciuoli".[30]

Posta questa premessa, Del Papa procede con l'intento di affermare che la luce e il fuoco sono un'unica sostanza, fondando il corollario su un presupposto filosofico chiaramente ispirato alla semplificazione della fisica del mondo e alla possibilità di comprenderla attraverso poche e solide leggi; egli ribadisce infatti che la Natura non moltiplica "le cose, e gl'istrumenti senza alcuna necessità". A chi obietta che talvolta il caldo non ha luce e la luce non ha calore per negare che gli atomi della luce e gli ignicoli del fuoco sono la stessa cosa,[31] così argomenta:

> I medesimi ignicoli, secondo che variamente si muovono secondoche sono pochi, o molti, che sono puri, o impuri, poter produrre due diverse affezioni or separatamente, ora unitamente; poter commuovere ora il senso della vista, or quello del tatto, ora ambedue insieme, e dalla perfine poter eglino, qualchevolta generar la Luce senza il Calore, il Calore senza la Luce, e spesso l'una, e l'altro nel tempo medesimo, avvegnache per servirmi delle parole dell'inclito Poeta, e Filosofo Lucrezio, mirabilmente tradotto dall'altre volte da me celebrato Signor' Alessandro Marchetti, circa agli effetti, i quali produr si possono dai primi semi delle cose … *importa molto con quai sien misti, come posti, e quali movimenti tra lor diano e ricevano.*[32]

Del Papa non teme certo di rivelare le fonti del suo atomismo che, oltre a contemplare i classici, da Leucippo a Democrito, da Platone del *Timeo* a Epicuro e Lucrezio, ha trovato di recente prove nel "non mai a bastanza lodato nostro Galileo nel *Saggiatore*", al grande nome del quale egli aggiunge "il dottissimo Piero Gassendo in più luoghi delle sue opere, il virtuosissimo Claudio Beriguardo nel *Circolo Pisano*, l'ingegnosissimo Donato Rossetti [ … ] nell'*Antignome*, e tanti, e tanti altri celebri Scrittori".[33] Le pagine manoscritte della traduzione di Marchetti del *De rerum natura,* che circolavano quasi clandestinamente, trovano frequenti citazioni nelle opere di Del Papa, evidentemente non disposto a tacere la versione che il professore di filosofia dello Studio pisano, suo maestro, aveva voluto destinare al rinnovamento del sapere e della scienza.

La *Lettera nella quale si discorre se il fuoco e la luce sieno una cosa medesima* – come del resto le altre due che il medico empolese dette alle stampe – è dedicata a Francesco Redi e sembra così chiudere il cerchio di una compagine di studiosi che tra l'ufficialità dell'uni-

30 *Ibid.*, 12.
31 *Ibid.*, 16.
32 *Ibid.*, 35-37.
33 Del Papa, *Lettera intorno alla natura del Caldo e del Freddo,* 31.

versità pisana e gli ambienti culturali fiorentini condividevano precise filosofie atomistiche avverse al sostanzialismo aristotelico e al qualitativismo della tradizione.

Del Papa ebbe in Redi un interlocutore privilegiato e un patrocinatore, così come si evince non solo dalle dediche allo scienziato aretino delle tre lettere atomistiche pubblicate, ma soprattutto dai contenuti del fitto carteggio in cui egli informa costantemente l'archiatra sui vivaci confronti presso lo Studio pisano tra innovatori e tradizionalisti, sulle opere da lui scritte e sulle polemiche che queste suscitarono sopratutto negli ambienti culturali retrivi al corpuscolarismo e a certi aspetti della fisica galileiana, chiedendo a questo proposito consigli a Redi ma rivolgendo al potente corrispondente anche suppliche per ottenere vantaggi e favori.[34]

In alcune lettere inviate a Redi, tra il settembre e l'ottobre del 1680, desta attenzione la descrizione puntuale di certi esperimenti condotti da Del Papa sul vino e sul mosto,[35] che poi troveranno spazio e approfondimenti nella lettera *Della natura dell'umido e del secco* pubblicata l'anno dopo.[36] Le reiterate e controllate esperienze termometriche compiute comparando la temperatura del vino in fermento con quella del vino fermo, dell'olio e dell'acqua – posti tutti e quattro i liquidi in recipienti vicini tra loro e nello stesso ambiente – sembrano dare prova al medico empolese che i liquidi in fermentazione producano calore, visto che il mosto, dopo 96 ore di ebollizione, "è caldo come l'aria, ma ciò proprio perché bolle, infatti come capita all'acqua il mosto fermo avrebbe temperatura inferiore all'aria", e ciò dal momento che le esperienze hanno sempre dimostrato che ogni tipo di fluido risulta più freddo dell'aria in ogni ambiente. E perché le prove sperimentali possano dare conferma alle congetture, l'allievo di Redi, dubitando di ogni esito non comprovato, chiede al protomedico il favore di ripetere anch'egli lo stesso esperimento termometrico sui differenti liquidi:

> V.S. Ill.ma avesse tempo da perdere mi farebbe sommo onore a provare anch'ella questa cosa, cioè se tenuti e acqua e vino e altri liquori di diverse spezie e di diverse grossezze per lungo tempo in una stanza nel medesimo luogo, si trovi poi in loro diversità di calore in comparazione dell'aria di quella stanza e in comparazione di loro medesimi.[37]

La richiesta di Del Papa ebbe probabile riscontro, visto che in un'altra occasione egli ringrazia Redi "delle due lunghe lettere piene di bellissime esperienze", promettendogli di "farne capitale" nell'opera sull'umido e sul secco,[38] e con ciò palesando il coinvolgimento

[34] Si veda l'accurato lavoro di ricognizione dell'epistolario in Bagnai II, al quale si fa riferimento.
[35] *Ibid.*, 196-224.
[36] Del Papa, *Della natura dell'umido e del secco*, 190-193
[37] Bagnai, II, 200-201.
[38] *Ibid.*, 199.

attivo di Redi negli studi e nella pratica sperimentale dell'allievo.[39] Nella collaborazione si inserisce anche un terzo personaggio, il dottor Lapi, citato da Del Papa come studioso informato, o da informare, sui vari sviluppi delle prove e delle osservazioni.[40]

Nell'opera stampata *Dell'umido e del secco,* le esperienze descritte nel carteggio si arricchiscono di dettagli rilevanti, come ad esempio la dichiarata avvedutezza dello sperimentatore nel filtrare con cura il mosto per raffinarlo da eventuali residui solidi,[41] e con ciò per dare riprova che l'aumento di temperatura accade nel liquido in fermento anche se separato dalle scorie e dalle vinacce, dato che è cosa certa che nei tini, mescolati alle vinacce, "i mosti, o vini nuovi [...] sono caldi caldissimi manifestamente non solo al senso, ma al riscontro de i termometri ancora".[42] Nel ribadire di aver ripetuto più volte gli esperimenti di misurazione della temperatura dei liquidi studiati e dell'aria-ambiente, riscontrando sempre meno gradi nell'acqua di pozzo, nel vino vecchio e nell'olio rispetto invece al maggior calore del mosto a confronto con i gradi dell'aria, Del Papa si compiace di descrivere un'ulteriore prova:

> Io avea pregato un'uomo molto diligente, ed accorto, che nella villa di Castello, nel farsi i vini del Sereniss. Gran Duca egli osservasse con termometro, se i vini vergini bollendo avevano maggior calore di quel che fusse nell'Aria della stanza, in cui si trovavano. Fece egli le prove, e me ne diede le infrascritte relazioni.
> *Il termometro nel Trebbiano ordinario si è trovato ascendere da gradi ventinove a i trenta, e mezzo. Nel Greco da gradi ventinove a gradi trentuno buona misura. Nel Claretto alla Franzese da gradi ventiotto a gradi trenta e mezzo. Nel Vin rosso da gradi ventiotto a gradi trentuno, e mezzo.*[43]

Nella lettera inviata a Redi il 10 ottobre 1680, ormai a conclusione degli esperimenti termometrici, Del Papa è confortato dai risultati nella convinzione che la fermentazione

39 È certo che Redi svolgesse un ruolo di regia nelle ricerche scientifiche e naturalistiche di molti giovani ricercatori. Vd. Mangani, *Zootomia, anatomia e studio della natura vivente nell'opera dell'aretino Giovanni Caldesi,* 233-271; Stefani, *Alla scuola di Redi: Pietro Paolo da Sangallo,* 487-497.

40 Il dottor Lapi è Jacopo Del Lapo, con il quale Redi corrisponde. Le lettere di Redi a Del Lapo trattano spesso di esperienze zootomiche di verifica degli autori di anatomia animale, come Gerard Blaes e Marco Aurelio Severino (Redi, *Opere,* V, 147-171; VI, 192-197). Nel carteggio tra Del Papa e Redi sul mosto e sul vino, il medico empolese chiede al suo corrispondente di informare anche il Lapi, che a sua volta sembra partecipare attivamente agli esperimenti condotti: "volendo io dire del vino, s'io debbo dire quello ch'è riuscito a me, è che il vino nei fiaschi bollente riscalda tutto o quanto come dimostrano i termometri, tanto essendo chiuso, quanto essendo aperto. Eppure il S.r Lapi mi scrisse di non l'aver ottenuto nella sua esperienza, io però la feci esattissimamente" (Bagnai, *L'epistolario inedito con Francesco Redi,* II, 224).

41 Del Papa, *Della natura dell'umido e del secco,* 191.

42 *Ibid.*

43 *Ibid.,* 193.

produca sempre calore, tant'è che nei liquidi posti accanto al mosto nello stesso ambiente – l'olio, l'acqua e il vino fermo – il termometro registrava identica temperatura tra loro, inferiore di un grado rispetto all'aria del comune ambiente, ma non del mosto, che invece rispetto all'aria indicava un livello termico superiore "poco meno di un grado".[44]

Dalle prove effettuate si poteva pertanto evincere che la fermentazione poteva attivarsi sia intrinsecamente in un liquido isolato, sia dalla mescolanza di due liquidi, nonché dalla combinazione di liquidi e solidi.

La serie di esperimenti condotti sul mosto e sul vino offriva allo scienziato la soluzione ai quesiti fondamentali sulla struttura, la costituzione delle parti e la fisiologia dei corpi viventi. La trasformazione del mosto in vino era comparabile alla formazione del sangue, al suo ribollimento e alla produzione del calore animale. Il vino, la cui principale materia è "l'Acqua, e il Fuoco, o la Luce, che vogliam dire",[45] è soggetto a fermentazione intrinseca, al ribollimento a contatto con le vinacce ed è inoltre capace di rinnovare l'ebollizione quando da fermo viene mescolato di nuovo al mosto. Al pari del sangue, "liquore di diversissime parti composto", dotato di intrinseco ribollimento, dalla fermentazione ancor più viva nel mescolarsi con gli altri fluidi dell'organismo – tra i quali il chilo, che ha una funzione prevalente nell'ematopoiesi -, e infine dalla fervida ebollizione che deriva, come quella del mosto con le vinacce, dall'essere il sangue mischiato, contenuto e racchiuso nelle parti solide, come le vene, le arterie e tutti gli organi resistenti.

Il calore nei viventi non poteva che originarsi dalla fermentazione, così come avevano dimostrato anche gli esperimenti termometrici sul mosto in ebollizione. La "naturale calidità", complementare alla altrettanto necessaria "umidità radicale",[46] poteva alterarsi nella febbre, divenendo appunto "calore febrile". Ciò in disaccordo con lo scienziato inglese Thomas Willis, che negli autorevoli contributi sul sangue e sulle febbri[47] aveva negato ogni aumento di calore nei liquidi in fermentazione, facendo derivare sia il calore naturale dei corpi sia quello accentuato dalla febbre dalla combustione delle parti aeree e nitrose del sangue, accese da una sorta di fiamma intrinseca al vivente fin dall'embriogenesi e permanente negli organismi per la durata della vita.

Del Papa nella *Lettera sull'umido e sul secco* aveva mosso all'inglese molte obiezioni, in primo luogo provando con gli esperimenti sul mosto che il calore derivava dalla fermentazione, mettendo, inoltre, in dubbio la presenza dell'aria nel sangue e richiamando a tal proposito le esperienze condotte da Redi sull'esito mortale in animali sottoposti a insufflazione di aria nelle vene. Per concludere, egli contestava a Willis la tesi

44 Bagnai, II, 202-203.
45 *Ibid.*, 175.
46 *Ibid.,* 162-163.
47 Willis, *De sanguinis incalescentia sive accensione. De motu musculari. Affectionum quae dicuntur hystericae et hypocondriacae pathologia.*

che dalla mescolanza dei liquidi non derivasse fermentazione, citando sia gli esiti degli esperimenti svolti dagli accademici del Cimento, come ad esempio la prova che "l'Olio cavato dal Tartaro del Vetriolo, mescolato con Acqua in certa proporzione vi produce immediatamente calore",[48] nonché le numerose prove termometriche sulle mescolanze di fluidi che avevano generato calore condotte proprio da Redi e riportate direttamente nelle pagine scritte dall'allievo.[49]

La spiegazione del calore naturale, così come di quello febbrile, per Del Papa doveva essere ricondotta alla mescolanza del sangue con gli altri liquidi dell'organismo, tra i quali il chilo era determinante perché rinnovato quotidianamente e veicolo di particelle che introducendosi con il movimento negli interstizi degli altrettanto minimi corpuscoli del fluido sanguigno e frantumandoli generava così il calore, dovuto pertanto non alla combustione ma invece alla fermentazione e al ribollimento del sangue stesso.

La spontanea fermentazione del mosto e la sua trasformazione in vino avevano fornito a Del Papa un modello esplicativo del calore vitale, della fisiologia nutritiva, delle dinamiche emopoietiche all'interno di una prospettiva saldamente corpuscolaristica, per la quale ogni funzione doveva essere ricondotta alla quantità, alla forma, al movimento, all'incastro e alla frantumazione delle particelle ultime. La salute del corpo consisteva nell'equilibrata proporzione di calore e di umidità consentita dalla bilanciata presenza degli atomi del calore, ovvero della luce, gli ignicoli, e dai minimi corpuscoli acquei che componevano ogni tessuto e ogni nutrimento delle parti organiche.

Pertanto anche nel medico empolese, così come in Redi, l'assunzione degli alimenti doveva evitare ogni squilibrio che lasciasse prevalere sia i "minimi della luce e del fuoco", con i loro conseguenti irrigidimenti, secchezze e riscaldamenti anomali,[50] sia la sovrabbondanza di particelle acquee, con i loro inevitabili effetti patologici di "freddezza", "pigrizia" e "ottuosità".[51]

Il vino, al pari del sangue, era il composto di ambedue i tipi di corpuscoli ignei e acquei, sull'equilibrio dei quali si fondava la salute, e ciò, oltre a motivare la scelta di osservare e sperimentare la vinificazione come modello delle fondamentali funzioni organiche dei corpi viventi, si traduceva nei consulti e nelle prescrizioni del medico empolese in un inevitabile invito alla ponderazione e alla misura nel bere alcolico che condivideva con la sobria prudenza rediana. Al medico aretino Del Papa attribuiva il merito di aver ribadito (vista la matrice galileiana) l'idea che il vino risultasse dalla combinazione di

48 Del Papa, *Della natura dell'umido e del secco,* 176. Sugli esperimenti del Cimento, così Del Papa aveva scritto a Redi nell'ottobre del 1680: "Mi sovviene che nei Saggi di naturali esperienze si favella non so che di questi ribollimenti, riscaldamenti e raffreddamenti dei liquidi per miscuglio loro ed in spezie si ragiona dell'olio di vetriolo; ma io adesso non ho il libro" (Bagnai, II*,* 201).

49 *Ibid.*, 177-179.

50 *Ibid.,* 160.

51 *Ibid.,* 161.

particelle ignee, o luminose, e acquee, e di aver dato lustro a tale felice intuizione anche attraverso i mirabili versi del *Ditirambo*:

> E V. S., altresì Dottissimo Sig. REDI, nel suo nobile Ditirambo, ormai celebre per tutta Europa, e da tutti ammirato, ed applaudito, [ … ] gentilmente confermò con la sua autorità la mentovata Sentenza, facendo ella quivi cantare al suo Bacco.
> *Se dell'Uve il Sangue amabile / Non rinfranca ognor le vene / Nostra vita è troppo labile / Troppo breve, e sempre in pene. / Questo Sangue è un raggio acceso / Di quel Sol, che in Ciel vedete. / E rimase avvinto, e preso / D'un bel grappolo alla rete.*[52]

E così Del Papa riconduceva al suo maestro e destinatario la convinzione che l'umore e la luce componessero il vino e l'opinione che i fluidi organici, in particolare il sangue, contenessero prevalentemente quelle medesime particelle ignee e luminose.

È noto che la fisiologia rediana era fondata sulla convinzione che l'equilibrio del corpo fosse il risultato del dinamismo dei fluidi, dei corpuscoli e delle particelle da essi veicolati ai tessuti e agli organi, perciò la genesi delle malattie era comunque riconducibile, come nella tradizione ippocratico-galenica, allo squilibrio umorale. Tuttavia a questa tradizione Redi univa un'eziologia chemiatrica, per la quale corpuscoli acidi, salini, sulfurei venivano indicati costantemente per spiegare la genesi delle discrasie morbigene. Nei consulti molte malattie sono imputate a "particelle sovrabbondanti di fuoco e di sale presenti nel sangue",[53] a "particelle de' fluidi acide e salse", a "materie viscose crasse e tenaci". Così descrive a un anonimo paziente una certa "serosità del sangue":

> una serosità salsugginosa, acre, e mordente, e che il sangue stesso sia tutto pieno di minime particelle salate sulfuree, e focose, le quali lo mettono in moto, e lo stimolano continuamente e lo irritano.[54]

Se le malattie sono spesso riconducibili a un tale assalto morbifero di corpuscoli eccedenti, trasportati negli organi vitali dai fluidi organici, il vino doveva essere assunto con prudenza proprio perché esso stesso era, nella prospettiva rediana e post-galileiana, un composto delle medesime particelle che, se in eccesso, potevano essere cagione di molte affezioni.

Il vino, "composto di umore e di luce", era anche nell'opinione di Redi una bevanda complessa, le cui componenti ultime, quelle che lui definiva "salsugginose" o "sulfuree", erano tanto adatte a deliziare il palato quanto insidiose per la salute:

52 *Ibid.*, 175.
53 Redi, *Opere*, IX, 253.
54 *Ibid.*, 76.

> I vini generosi saranno sempre nocivi, perché mescolati tra' fluidi, che corrono, e ricorrono per li canali del nostro corpo, gli mettono in moto di turgenza, onde rigonfiano in se stessi, e ribollono, e per conseguenza occupano maggior luogo.[55]

E ancora:

> Io non biasimo, a luogo e tempo, l'uso di un sorso di vino generoso, ma metto in considerazione, se fosse opportuno alle volte lo innacquare e la bile, e il sugo acido dello stomaco con qualche liquore men caloroso del vino, e meno purgante.[56]

Numerosi sono i consigli di tal genere, dai quali sembra insinuarsi il sospetto di un'ambivalenza non risolta tra il Redi letterato, che da una parte intesse nel *Bacco* l'elogio sviscerato del vino, e dall'altra, invece, da medico prudente, proibisce nella dieta dei pazienti l'assunzione alcolica.

Redi, negando il vino ai malati, ripete suggerimenti analoghi a quello rivolto a Vincenzo Viviani, affetto da "ardori dell'urina" ma sollecitato a diffidare dei rimedi propinati "da coloro che o per ignoranza, o per misteriosa malizia affoltano i poveri ammalati con le bigonce de' medicamenti", indicando invece un solo rimedio: "di proccurare, per quanto comporta la possibilità umana, di temperare e raddolcire l'acrimonia del sale dell'orina con la buona regola del vivere", e tale regola comprende di evitare la fatica, di concedere riposo e sonno, ma soprattutto di moderare il cibo e ancor di più il bere. Cosa bere, dunque?

> Ma che ha da bere Vostra Signoria? Poco vino poco poco poco ben innacquato anzi largamente innacquato, e se anco ritornasse per qualche tempo ad astenersene io non lo giudicherei per mal fatto.[57]

L'acqua è il vero rimedio: "l'acqua d'orzo è ottima. Ottima è l'acqua pura, l'acqua cedrata, l'acqua di viole mammole, l'acqua nella quale siano bollite delle mele o dell'uve passute". Idratare con acqua pura per rimuovere particelle "salate, sulfuree, e focose", di cui invece il vino è veicolo.

C'è dunque un veto categorico nella terapeutica librediana che proibisce il vino nella dieta dei malati? Di certo i numerosi consulti in cui si consigliano al massimo "vini piccoli, e ottimamente innacquati" sembrano far propendere per l'esclusione, sebbene non facile da conciliare con il pur esistente apprezzamento di Redi delle migliori varietà vinicole. Tutta-

[55] *Ibid.*, 89.
[56] *Ibid.*, 132.
[57] Redi, *Consulti medici*, 187.

via, per sciogliere la falsa aporia è opportuno rammentare un dato scontato ma forse non sufficientemente ponderato: i consigli medici sono indicazioni terapeutiche indirizzate a soggetti ammalati e rispondenti alla precisa esigenza di ripristinare un equilibrio interrotto in quadri anamnestici turbati dai fattori patogeni. Sarebbe abbastanza curioso e in questo caso, sì, perfino contraddittorio se il medico, così attento al regime e propugnatore di cure fondate sulla corretta alimentazione, non avesse espresso interdizioni dietetiche specialmente in materia *de potu* e *de vino*.

Analoga prudenza e misura è nei consulti di Del Papa, che alla morte dell'aretino gli succederà come archiatra di Cosimo III.[58] Anche il medico empolese, come Redi fiero avversario della bizzarra farmacopea e della inefficace terapeutica del suo tempo, si prodiga in consigli e cure che si basano sull'equilibrio dettato dal regime.

Eppure, leggendo attentamente i consulti di Redi e di Del Papa, si può intravedere il sostrato di una filosofia medica in cui le teorie ippocratiche si rinnovano alla luce di un tenace empirismo, di una vocazione a rilevare ogni minimo dettaglio che colga le singolari peculiarità del paziente a cui è rivolta la terapia e, non da ultimo, ambedue accolgono la ricerca – ancor più esplicita in Del Papa rispetto a Redi – delle cause fisiche, meccaniche, insite nella struttura particellare di ogni sostanza e di ogni fluido organico che sono all'origine della salute e della malattia. Così Redi, vietando il vino nelle malattie, intende ridurre la concentrazione e il movimento incessante e pervertitore dell'equilibrio che le particelle saline e sulfuree in eccesso producono negli organi a cui giungono attraverso il sangue, il sugo nerveo e altri fluidi. Del Papa, ancor più esplicito nel contenere l'umoralismo della tradizione, ricerca spesso il "meccanico sconcerto", ovvero il "disordine e guastamento di quei piccoli vasi esistenti nella parte ammalata" di solito dovuto all'alterazione del movimento dei corpuscoli organici e spesso causato, come abbiamo visto, dalla fermentazione.[59]

L'approccio diagnostico di ambedue, che pur ricerca canoni di indubbia obiettività, è sempre aperto nondimeno a inserire nel profilo della patologia gli elementi soggettivi, comportamentali, caratteriali che orientano nello specifico la prognosi e la declinano secondo le variabili della individuale complessione organica e della peculiare condizione esistenziale di ogni singolo paziente. Pertanto il vino non scompare definitivamente neppure dai consulti. Redi e Del Papa sono quasi sempre disposti a concederne, seppur in piccola quantità o preferibilmente annacquato, a coloro ai quali la malattia ha prodotto fiacchezza e prostrazione. Oltre agli innegabili effetti nutritivi e ricostituenti del vino, la scelta dei due medici evidentemente teneva conto della proprietà letificante della bevanda voluttuaria, polifunzionale e adatta a contribuire al ripristino dell'intimo impulso vitale indispensabile al mantenimento e al recupero della salute.

58 Del Papa, *Consulti medici del Signor Dottore Giuseppe Del Papa*.
59 *Ibid.,* 8.

Del Papa ritiene "non improprio l'uso d'una modesta quantità di vino passante, e gentile; ed ottimo sarà il claretto d'Avignone"[60] per l'arcivescovo di Lucca, sofferente di difficoltà di respiro dovuta a idrope pettorale. Così anche un paziente afflitto da renelle urinarie, da "un tumor duro nella regione del fegato" e da gonfiore degli arti, quindi in una condizione fisiopatologica non perfettamente compatibile con l'assunzione etilica, di fatto riceve da Redi consigli dietetici che contemplano anche il vino:

> La bevanda del desinare della mattina sia un vino a gusto di Monsignore Illustrissimo e Reverendissimo; ma però sempre mai bene innacquato mezz'acqua e mezzo vino.[61]

Ancor più esplicito il consulto rivolto da Redi al cavaliere Consiglio Cerchi, la cui malattia richiedeva un ripristino dell'equilibrio anche "delle passioni dell'animo", ed è proprio per questo obiettivo che il medico aretino unisce nell'*ars medendi* l'apparato professionale (epurato dagli eccessi della farmacopea del suo tempo) a un approccio empatico, comprensivo, capace di ridurre la distanza tra salute e malattia e di dare rilievo innanzitutto a una sorta di partecipazione affettiva che il terapeuta vuol condividere con il paziente.

> Mi creda Signor Consiglio amatissimo e riveritissimo, – scrive il protomedico – che le scrivo in termini non di medico, ma come se io le fossi fratello. E per l'amor di Dio, per l'amor di Dio mi perdoni, se forse le scrivo con termini di troppa familiarità, ed a me non convenevole; l'amore mi fa commettere questi mancamenti.[62]

E il tono empatico pervade la prescrizione delle regole terapeutiche che riparino soprattutto gli *accidentiae animi*. Per questo non può mancare il vino dalla dieta:

> Se io fossi a Firenze le donerei un fiasco di squisitissimo Montepulciano e così sarebbono finite le disputazioni, perché venendo dalla mano di un medico amico, e servitore si potrebbe credere, che fosse uguale al nettare all'ambrosia, o per meglio dire fosse una panacea.[63]

Il vino, che fa la sua comparsa anche nel regime terapeutico, esprime una rinnovata immagine della moderna civiltà del bere, nella quale ormai è superata la valenza prevalentemente alimentare e il consumo va affrancandosi dalla sfera dei bisogni nutrizionali che ne avevano caratterizzato la produzione e l'assunzione in epoche precedenti, specialmente in alcuni momenti dell'età medievale,[64] per attribuire invece a questo prodotto lo scopo non

60 *Ibid.*, 41.
61 Redi, *Consulti*, 113.
62 *Ibid.*, 119.
63 *Ibid.*, 120.
64 Pinto, *La vitivinicoltura nella Toscana medievale,* 27-61.

solo di liberare dalla sete, e all'occorrenza dalla fame, ma di procurare benefici che il corpo e lo spirito unitamente possono trarre da un uso accorto e regolato di un composto di cui si conoscono, grazie alla fisica e alla chimica dei corpi, le parti ultime, i loro moti e quindi i loro effetti sulla salute. Pertanto, seppur nei limiti rigorosi della quantità e nella scelta della qualità, il vino può essere bevuto anche dai malati. Anzi, il medico può addirittura consigliare, decidere la qualità dei vini da indicare ai pazienti, proprio perché la scienza del vino comincia a farne intravedere la struttura, la complessità e le molteplici varietà a coloro che sanno comprendere come i diversi "sali" delle differenti uve, aveva scritto Magalotti, derivano da una pluralità di "terreni", di "miniere" e d' "invisibili semi". Ed è ancora la suggestiva prosa di Magalotti a restituire l'intuizione che sono gli elementi molteplici del suolo, le componenti minerali del terreno (oggi diremmo il *terroir)* a determinare la specificità delle uve e le peculiari caratteristiche delle varietà enologiche:

> gl'invisibili semi d'infinite cose, per essi terreni sparsi, i quali dalle cieche vene delle viti confusamente succhiati, si portano dentro all'uve, onde il sugo, che se ne preme, ch'è il vino, rimane anch'egli alterato di più sorte sali, e sì diversi vini, o per le varie figure di quelli delle madri loro, o per lo finissimo permischiamento di tinture diverse, di terreni, di miniere, o di fumi di differenti sali imbevuti saranno.[65]

Così tanto interesse aveva destato il detto di Galileo che i suoi seguaci ritennero necessario ipotizzare forme, moti, testure e combinazioni dell'"umore" e della "luce" per delineare ulteriori scenari alla conoscenza della composizione del vino improntata dalla nuova fisica; ma i processi di maturazione, di trasformazione e di perfezionamento del liquore dell'uva, osservati e descritti nell'ottica delle rinnovate teorie della materia, offrirono a loro volta congetture, indicazioni e modelli alla comprensione degli innumerevoli quesiti che nell'universo della natura vivente restavano aperti all'indagine sperimentale, allo studio degli apparati vitali, alle ricerche sulle funzioni organiche dei corpi e sulle buone pratiche dietetiche e terapeutiche per preservarne la salute e il benessere.

[65] Magalotti, *Sopra il ribollimento*, 17.

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– ESSAY REVIEWS –

# Networks, contexts, institutions: An enduring legacy in the historiography of science

Carmen Schmechel
Royal Netherlands Academy of Arts and Sciences;
carmen.schmechel@gmail.com

Essay review of Roos, Anna Marie, and Gideon Manning, eds. *Collected Wisdom of the Early Modern Scholar: Essays in Honor of Mordechai Feingold*. Vol. 64. Archimedes. Cham: Springer International Publishing, 2023. https://doi.org/10.1007/978-3-031-09722-5.

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## *Introduction*

This engaging *Festschrift* is dedicated to Mordechai "Moti" Feingold on his seventieth birthday. Feingold is renowned for his wide-ranging contributions as a historian of early modern science, hailed as "one of the premier historians of the Royal Society, of Newton and his long reception, of European universities, [and] of Jesuit science … and more".[1] Beyond celebrating a lifetime of achievement, the Festschrift also portrays Feingold as a hub of a scholarly community – active in the "Republic of Letters" by connecting like-minded scholars, sharing knowledge, and, in the words of colleagues, "making the work of others possible" through initiatives like editing volumes, journals, and book series. The title of this volume, accordingly, hints at how the honoree "collected wisdom, but also made that wisdom part of a collective".[2] Indeed, for many of the contributors, Mordechai Feingold has been a mentor and a trusted colleague with a "very personal impact".[3]

A unifying commitment of the volume lies in perceiving the making of science as a vector result of multiple agents: institutions, individuals, social networks. The essays consistently reject narrow, single-track historiography – instead embedding scientific developments in broader intellectual currents and societal frameworks. This is a ripple effect of Feingold's own scholarly ambit; Feingold himself "has studied individuals and insti-

1 Roos and Manning, *Collected Wisdom*, 2.
2 *Ibid.*, 5.
3 *Ibid.*, 1.

tutions, cultural movements and social history", leaving a lasting imprint on each.[4] The essays mirror this breadth of inquiry.

In terms of broad themes, the four "Parts" of the volume – the history of universities, intellectual history, Newton, and the history of the Royal Society – address realms of inquiry dear to Feingold's scholarly heart, transforming them into structuring principles for the book. Each "Part", in its turn, is composed of three to five essays, where various scholars explore specific topics often directly linked with Feingold's own work. This convergence of content is intentional and explicit, and the strategy proves successful in creating a unified whole, testifying to a collective commitment to deepen and broaden Feingold's approaches.

## *Part I: Universities. Where the old science meets the new*

Part I is dedicated to the history of universities. Feingold's work in this realm – his own output, as well as that of others which he fostered indirectly in collaborations – had been sustained and groundbreaking.[5] Feingold convinced a generation of scholars that "it [is] impossible to do early modern intellectual history of any sort without a profound understanding of the pedagogical worlds from which emerged the ideas that we study".[6] His own careful reconstruction of institutional and intellectual contexts uncovered how early modern universities were a mainstay of progress and innovation.[7] Feingold's work also converges with historiographical work being done in Germany and Europe; in the 1980s, Christoph Meinel established the importance of German universities as societal *loci* of science production in the late eighteenth century, as chemistry slowly solidified as a scientific discipline. Thus Meinel similarly situated the university as a functional interface between society and modern science.[8]

The present volume offers us five contributions in which new generations of scholars take on this popular topic with new energy. The first essay, by Richard Serjeantson, uncovers a previously unknown treatise on theology by the Oxford philosopher John Case (1540?-1600), entitled *Epistola quædam ad reverendum præsulem conscripta adver-*

4 *Ibid.*, 2.

5 See, for instance, Feingold and Navarro Brotons, eds., *Universities and Science in the Early Modern Period.*

6 Dmitri Levitin, quoted in Roos and Manning, *Collected Wisdom*, 5.

7 For instance, in Mordechai Feingold, *The Mathematicians' Apprenticeship: Science, Universities and Society in England, 1560-1640.*

8 "Die Universität ist der soziale Ort neuzeitlicher Wissenschaft schlechthin. Sie ist Schnittstelle des Austauschs zwischen Gesellschaft und Wissenschaft": Christoph Meinel, "Zur Sozialgeschichte des chemischen Hochschulfaches im 18. Jahrhundert", 147-168. https://doi.org/10.1002/bewi.19870100305, 148.

*sus Baroistas* ('A particular letter to a reverend prelate, written against the Barrowists'), a text hitherto ignored by scholars including Charles Schmitt. Case was an independent lecturer at Tudor Oxford, but also "the most prominent philosopher in the Elizabethan university".[9] The letter illustrates a powerful negative sentiment against Protestant Reformation and against separatists, while placing it in an institutional context and within the broader intellectual landscape of the time. A following essay, by Leen Dorsman hailing from Utrecht, aims to track down the origins of student 'initiation' rituals (hazing, a social phenomenon which persists today) back to a structural change that happened at early modern universities in the Dutch republic: the transformation of student associations from medieval 'nationes' to modern student corpora. Shifting the reader's focus to Padua, Pietro Daniel Omodeo explores the correspondence between members of this Italian university and Daniel Sennert (1572-1637), the renowned physician and professor of medicine in Wittenberg. By tracing Sennert's concerns with intellectual, but also other more worldly matters, Omodeo's essay beautifully illustrates how the production of medical theory is embedded in the context of the life of the scholar which includes the lively intellectual exchange with contemporaries at other institutions. Omodeo thus sets out to answer Mordechai Feingold's call of 2016 for more exploration of the "confabulatory life" of the scholar.[10] William Poole takes on the seventeenth-century undergraduate Arts curriculum at Oxford, showcasing the genre of what he dubs the "curricular crib": short, often tabular "skeleton summaries of the traditional undergraduate subjects", usually left in manuscript as "*systema*, *compendium*, *epitome*, or *elementa*".[11] The genre had also caught Mordechai Feingold's attention. Poole masterfully shows that "while the 'crib' tradition in many ways sustained the traditional Aristotelian curriculum, it was at least in some hands also open to manipulation and modernisation" in accordance with more innovative trends in the field, such as Gassendian physics.[12] The last chapter in Part I, by Elizabethanne Boran, investigates the teaching of the science curriculum at Trinity College Dublin, focusing on the "dominance of Ramism" as well as on the influence of the Hartlib circle and their Baconian experimental program. Boran uses library loan records to reconstruct the availability of the "new science". Responding to, and continuing, Feingold's work on "students' notebooks and other records of unofficial teaching at early modern universities", Boran draws on previously unstudied student and staff notebooks to reconstruct the intellectual environment and the vision of those who built the TDC library.[13]

Perhaps the most overt tribute to Feingold's career, the Festschrift's university history section extends his methodology and interests into new terrain, while echoing his

[9] Serjeantson, 18.
[10] Omodeo, 62.
[11] Poole, 80.
[12] Poole, 80, 87.
[13] Boran, 105.

empirical rigour and emphasis on primary sources. It also validates Feingold's conviction that university history is integral to intellectual history, and points to fertile paths forward in the study of the history of higher education institutions.

## *Part II: Mind and matter. Galileo, Descartes, and the rainbow (Intellectual history)*

In Part II, aspects of intellectual history are brought to the fore in four papers. Nicholas Popper examines the relationship between belief and evidence in the sixteenth century, and tests whether the standards for credibility might have been developed, as is (was) the consensus, in confrontation with stories that were exaggerated and (from a modern standpoint) quite obviously fake. He concludes that the role of empirical evidence in early modern historical writing was a matter of debate, and discusses how various actors handled uncertain evidence. Anita Guerrini in turn dwells on a section from Galileo's *Discourses concerning Two New Sciences* (1638), which had previously received little attention. The section debates the anatomical conditions of possibility for giant humans or animals, supporting with mathematical evidence the then relatively common claim that "giants are frail"[14] due to a mismatch between a certain body size and the necessary bone weight needed to support the body. Guerrini centers Galileo, another "giant" on par with Feingold's Newton, and his imbrications with the Accademia dei Lincei (via Galileo's correspondence with Nicolas-Claude Fabri de Peiresc) as another important knowledge network of the time. The paper by Noel M. Swerdlow investigates Galileo's arguments for planetary motion in the context of Copernican theory, and discusses the later evaluation and critique of these arguments by Newtonian science. As ever, he does not shy away from technical detail; readers somewhat familiar with mathematical physics will be delighted by Swerdlow's exposition and interpretation of Galileo's (erroneous) mathematical calculations to determine the distances between various celestial bodies. The presence of this essay is bittersweet: no sooner had this esteemed colleague sent in his contribution, than he passed away. The fourth paper is penned by Jed Buchwald, a long-time collaborator of Feingold. Buchwald reconstructs the intellectual journey that, many years ago, resulted in one of his own most prominent papers, "Descartes' Experimental Journey Past the Prism and Through the Invisible World to the Rainbow". The reflections that were to guide the genesis of this paper had begun in an interaction with Feingold. Buchwald reconstructed some of Descartes' experiments with prism and light, in order to better understand how these experiments shaped Descartes' optical theory and his hypotheses about the behaviour of light, refraction, and the formation of the rainbow. The essay is an ode to an indefatigable intellectual curiosity that does not stop at texts but en-

[14] Guerrini, 158.

gages in the materiality of experiment in order to "see" through the eyes of scientists of the past. It also attests to the fruitfulness of intellectual friendships and the emergent synergy of intellectual endeavour, as Feingold and Buchwald add their contribution to that of their colleagues Garber and Schuster in deciphering Descartes and his science.

## *Part III: Newton, Newtonianism, and beyond*

Isaac Newton and his contribution to seventeenth-century science dominate Part III. Feingold's impact on Newtonian studies was transformative. In their introduction to the Festschrift, Roos and Manning observe that Feingold consistently "resist[s] the temptation to treat Newton as a superhuman icon of science" and instead reveals Newton as "a man of his time… [whose] interests in philosophy, mathematics, physics, alchemy, optics, and theology co-existed and supported one another".[15] The metaphorical sanctification of Newton is, argued Feingold, a result of the postmortem perception and reception of his works; as many people employed Newton's image or invoked him in order to suggest an intellectual connection, Newton himself, or rather his own legend, "metamorphosed into science personified".[16] By contrast, Feingold set out to unveil Newton not as the legend but as the historical person and scientist, by exploring Newton's multifaceted legacy – his physics or mathematics, yes, but also his theology, alchemy, and institutional roles. Contextualizing Newton sheds light not just on his own discoveries but also, crucially, on the seedbed that nurtured them. This was central to Feingold's scholarly creed and quest, who, in the *Preface* to an edited volume about Newton's mentor Isaac Barrow, had written that "all discoveries and breakthroughs in science, irrespective of the unique contribution of the individual who inaugurated them, cannot be considered in isolation, independent of a large community of teachers, fellow students, and scholars of the second order".[17] By reintegrating into the narrative the contributions of orbital figures like Isaac Barrow or Newton's successor William Whiston – figures peripheral from our perspective, but important or even central in their own times – Feingold's scholarship presented Newton and Newtonianism as a complex tapestry of interwoven roles, rather than a straight tale of scientific triumphalism.

The three essays in this section of the volume align closely with Feingold's Newtonian pursuits. The first essay, by Sarah Hutton, focuses on the Cambridge Platonist Henry More and his not-so-straightforward relationship with Cartesianism, as a piece of the context puzzle of Newton's formative years at Cambridge. Feingold had already suggested that Descartes' works, and Cartesian science, along with other newer currents such as the

15 Roos and Manning, *Collected Wisdom*, 4.
16 Feingold, *The Newtonian Moment*, xiv.
17 Feingold, *Before Newton: The Life and Times of Isaac Barrow*, ix.

natural philosophy of Gassendi, exerted an influence on the Cambridge Platonists.[18] Hutton's study of More's reception of Cartesianism in the time of Newton's early education echoes Feingold's insistence on the presence of new philosophies in the university system, casting universities as incubators of new knowledge. This is a role that universities can fulfil even while nurtured by the turf of older ideas and natural-philosophical frameworks such as Aristotelianism; or by the oldschool type of polymaths who had emerged out of, and adhered to, the classical tradition, and who in principle looked on Descartes' new mechanical philosophy with suspicion. Hutton shows successfully that More's "concern was to make Cartesian physics work, to salvage the best system of which he was aware which 'saved the phenomena' of nature" – while making sure that certain ideological pitfalls such as atheism were avoided.[19]

The second essay, by Dmitri Levitin and Scott Mandelbrote, unveils newly discovered letters Newton wrote to his friend and Trinity chamber-fellow John Wickins between 1677 and 1682. The letters, which shed light on Newton's theological interests, are here printed in full for the first time. Levitin and Mandelbrote carefully examine the available textual evidence to reconstruct certain puzzles related to Newton's correspondence more generally, and also to instruments that he constructed during that time period, such as the "two-foot reflecting telescope" in the construction of which Newton was aided by an artisan, a tool-maker referred to as Mr. Cooper.[20] In turn, two letters that address theology reveal that Newton, according to the authors, must have begun thinking about theological matters in 1675 or 1676; by 1677 he was "engrossed in patristic literature specifically", which shows that "he was approaching theology in the manner then recommended in Cambridge", going initially along the same path as his peers even as he later famously reached unorthodox conclusions.[21]

Finally, Marius Stan's essay investigates Émilie du Châtelet's interpretation of Newtonian mechanics, highlighting the distinctions between Newton's original ideas and du Châtelet's own work. In doing so, he tackles the very much Feingoldian historiographical issue of what "Newtonianism" truly means, how we should define it, and which philosophers can be said to conform to it. For one, not Madame du Châtelet – argues Stan. As he concludes, "'Newtonian' is not a useful category for her science", in spite of overall consensus to the contrary among historians of science.[22] Instead, "Du Châtelet really aimed to solve certain [...] problems in the fundamental physics of her time, irrespective of its au-

18 Feingold, *The Mathematicians' Apprenticeship*, see esp. chapter "The nature and quality of scientific instruction: the teaching community", 45-85.

19 Hutton, 244.

20 Levitin and Mandelbrote, 258.

21 *Ibid.*, 264.

22 Stan, 278.

thorship".[23] This revisionist argument echoes Feingold's inclination to question sweeping generalizations. Written from the perspective of a philosopher historian of science who is meticulous with definitions both from a logical and a historical point of view, Stan's essay provides a solid background for a rehabilitation of du Châtelet's physics in her own right.

To sum up, the seamless way these essays integrate Newton's scientific ideas with his religious and institutional life – a hallmark of Feingold's Newton studies – lives on in the work of scholars in this volume, many of whom owe their intellectual formation in part to Feingold's guidance.

## *Part IV: Academic societies and other hubs of learning*

Part IV of the Festschrift, titled "Royal Society Luminaries", is dedicated to the history of the Royal Society, another topic where Feingold's contributions have marked the scholarly landscape. Exploring how institutional affiliations, religious constraints, and patronage networks affected the careers of scientists, Feingold supported the idea that in early modern Europe the university world and the world of academic societies were permeating and informing each other and that these types of institutions of learning co-evolved.[24] Essentially, Feingold's body of work supports the stance that scientific ideas are shaped and promoted through such institutional structures, which are inherently social.

The essays in this section highlight both prominent and lesser-known figures associated with the Royal Society. In his contribution on the early Royal Society's attitudes towards language and verbal communication, Rhodri Lewis sets out to reexamine the existing consensus regarding the Society's culture of polite discourse. For decades, historians have claimed that the Society's fellows were invariably civil and restrained in their communications, adhering to a Baconian ethic of genteel cooperation. While this was an outward, explicit normative strategy, it was not necessarily an accurate depiction of everyday reality. Lewis argues that "it is only by marginalizing the Society's engagements with the cultures of correspondence and scribal publication that one could come to the view that plainness, propriety, modesty, disinterest, and the rest were its Fellows' primary manner of discourse".[25] Consequently, an exploration into the correspondence of Sir William Petty – a founding fellow of the Society – allows Lewis to paint a more complex picture of the Society's daily interactions, where members did not eschew from vigorous and even rude discussions, such as calling rival ideas "nonsense". This reveals the importance of drawing

23 *Ibid.*, 295.

24 As argued in Giulia Giannini, "Preface", and Mordechai Feingold, "Between Teaching and Research: The Place of Science in Early Modern English Universities", both contributions in: Feingold, Mordechai, and Giulia Giannini, *The Institutionalization of Science in Early Modern Europe*. https://doi.org/10.1163/9789004416871.

25 Lewis, 304.

upon primary sources beyond those published in print, and of examining informal communications between scientists, such as letters or notes – an approach which Feingold had long championed.

The next essay, by Anna Marie Roos, analyzes Nehemiah Grew's (1641-1712) doctoral dissertation *Disputatio medico-physica, inauguralis, de liquore nervosa* and its place in the development of iatrochemistry. The main focus is Grew's theory of nervous fluid in its seventeenth-century intellectual context. Influenced by Franciscus Sylvius (1614-1672) and Francis Glisson (1597-1677), Grew's medical theory was an eminent example of chemical medicine; and yet it was a version of chemical medicine which distanced itself from one of coeval iatrochemistry's most influential proponents, Jan Baptista van Helmont (1579-1644). While van Helmont underscored what we might call a more spiritual vision of disease etiology, Grew's approach was more naturalistic. Grew had "embarked on a series of distillations, including the blood and brain tissue", in order to understand the matter of nervous fluid and to possibly determine its chemical composition.[26] An adherent to Sylvius' iatrochemical school, Grew also engaged direct experimental evidence to draw conclusions about the acidity and alkalinity of bodily fluids, and posited a central role for "oil" as a component of blood. Remarkably, Roos argues, "Grew's insistence on inalterable principles in his dissertation may also have stemmed from his religious beliefs": the Calvinist position holding that God created immutable chymical principles whose mixtures we may experience and manipulate, but without altering the primary principles.[27]

The last chapter, by Stephen Snobelen, focuses on William Whiston, an astronomer and theologian excluded from Cambridge for anti-Trinitarianism and who was never admitted to the Royal Society because of his heterodox religious views. After losing his professorship, Whiston "remade himself in London as a natural philosophical entrepreneur", delivering lectures in coffeehouses and teaching philosophy as an independent tutor.[28] Snobelen pieces together various less conventional primary sources, such as newspaper advertisements, to "recreate [] Whiston's efforts to establish himself in the metropolis as he moved from a fixed university income to operate in the dynamic yet financially precarious world of public science".[29] In our own day and age, as financial instability in academia due to precarious employment affects a large, silent proportion of early and mid career scholars, this reader finds it refreshing to see Stephen Snobelen shining a light on such worldly topics, and drawing attention to how the parameters of income or wealth have always impacted the ways in which scientists and philosophers can (or cannot) practice their calling.

26 Roos, 328.
27 *Ibid.*, 336.
28 Snobelen, 349.
29 *Ibid.*, 349.

## *Methodological approach and implicit scholarly ethos*

The scholarly values espoused in *Collected Wisdom* echo Feingold's own. Four years after his DPhil at Oxford with Charles Webster as a supervisor,[30] Feingold published his first book, *The Mathematicians' Apprenticeship* (1984), which "took a stand against an older history of science and history of universities that placed all the credit for progress and innovation outside the institutions of higher learning".[31] Far from flaunting gratuitous revisionism for its own sake, Feingold's drive to challenge received narratives emerged from exacting archival research and textual evidence. By working with primary sources – university statutes, student notebooks, institutional records – Feingold demonstrated that Oxford and Cambridge played a significant role in the so-called Scientific Revolution, especially in fostering the "Copernican 'marriage' between mathematics and astronomy". [32] As Roos and Manning remark, he "made his case in exacting detail… and announced himself as a gifted and creative researcher willing to correct the record when the evidence required it".[33] His commitment to empirical rigor and to revisiting received narratives through fresh documentation became hallmarks of his scholarship.

The present volume reflects Feingold's methodological rigour, use of primary sources, and legacy as a mentor, as well as echoing his bold and refreshing "willingness to cast aside old truisms".[34] The Festschrift's contributors adopt similar textual-empirically grounded methods, with most essays analyzing primary sources (e.g. newly discovered manuscripts, correspondence, library catalogs) to reconstruct scholarly networks, pedagogical practices, or intellectual filiations. By upholding meticulous research standards, a broad intellectual compass, and a commitment to understanding institutions and ideas in context, the essays show implicitly that Feingold inspired researchers to argue constructively, grounding controversy in factual evidence rather than bias. This commitment to critical debate is one of Feingold's great strengths, and the Festschrift's willingness to include essays that stir the pot is a bow to that legacy of responsible revisionism. Thus, the community of scholars he fostered is carrying forward the torch of a pluralistic and deeply contextual history of science.[35]

The book also includes a helpful *list* of Feingold's over one hundred works – monographs as well as edited volumes, single-authored as well as in collaboration – testifying

30 See Robert Fox, "The History of Science, Medicine and Technology at Oxford": 69-83, here on p. 73. https://doi.org/10.1098/rsnr.2005.0129.

31 Roos and Manning, *Collected Wisdom*, 2.

32 *Ibid.*

33 *Ibid.*

34 *Ibid.*

35 On the importance of pluralism in science, especially in the history of chemistry, see among others: Morris and Seeman, "The importance of plurality and mutual respect in the practice of the history of chemistry"; Seeman, "Moving beyond Insularity in the History, Philosophy, and Sociology of Chemistry": 75-86. https://doi.org/10.1007/s10698-017-9290-7.

to his talent of cultivating the kind of synergistic intellectual curiosity that thrives in the commerce of the minds. Lastly, a convenient *Index* includes not only names of historical persons and toponims mentioned, but also some topics with broad echoes in the history of science: from plague to madness, wine, or vinegar.

## *Conclusion*

Even beyond early modern topics, Feingold's insistence on grounding grand narratives in hard evidence is a transferable lesson, and one that is evergreen. In more recent times, the history of science, together with most humanities disciplines, has undergone a pivotal transformation. The advent of digital and computational methods has triggered a restructuring in the ways in which we come by our knowledge. There are some clear advantages. Fortunately, a careful implementation of digital and computational methods in the humanities is fully compatible with an approach that prioritizes empirical data and primary sources. After all, with the help of such new methods we can access, and process, an incomparably higher number of such primary sources, increasing the reliability of our interpretations beyond anecdotal evidence. We can comb through an unprecedented array of documents, making it more feasible than ever to, for instance, include sources or voices that have previously been neglected by scholars – whether intentionally or unintentionally; or simply as a consequence of there being only a certain number of work hours in a day, and only a relatively small number of articles and books to be written in a human lifetime. Some of these limitations can now, in part and with measure and due diligence, be transcended.

A side effect of this restructuring is that many of us now work in larger teams to pool our expertise not only in various historical eras as defined by traditional disciplinary boundaries, but also in various aspects of the data gathering and exploration. For certain phases in their work, the early modernist may be aided by the "data curator", the medievalist by the OCR transcription expert, the classicist by the Python programmer. The knowledge acquisition is now truly "collective", in a Feingoldian sense of synergy. Many of the contributors in this Festschrift - colleagues or former students of Feingold's – are now training students of their own, spreading his ethos of meticulous scholarship. This genealogical influence, combined with new approaches, means the 'Feingold School' of history of science – characterized by its empirical depth and breadth of vision – will likely thrive in coming decades. Feingold's work has also modeled an ethos of intellectual generosity and collaboration, vital back then but perhaps even more so today, in times when historical projects have gone large-scale and often require teamwork (e.g. large database projects or international research teams). In that sense, this Festschrift is not an endpoint but a launching point – uniting personal tribute with forward-looking scholarship.

One final reflection: The editors note Feingold's "contagious commitment to learning". While likely meant as a metaphor, and possibly inspired by the vocabulary of the recent pandemic (but turned, of course, into something positive and desirable), it highlights how this kind of intellectual commitment carries an emotional, one might say irrational undercurrent. It is almost as if one has to succumb to it, much in the manner of an infectious disease. In that (for us rather poetic) sense, the idea of the influence of a mentor echoes a very early modern concept, that of "celestial influence" which among its manifestations included the phenomenon of contagion. This volume is proof that indeed, the influence of a mentor has permeated scholarly minds up to our own generation – with all contributors being born, however, still in the twentieth century. But what about the next generations of students and scholars, who shall live in a world much different from the one we ourselves grew up in, in the past century? Can we still contaminate our children with the thirst for learning, in our own day and age? Can we contaminate our students with the thirst for evidence? Time will tell. This reader surely hopes so.

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