The Neapolitan Francesco Fontana inventor of the *astronomical* telescope

Paolo Molaro - INAF Osservatorio Astronomico di Trieste - molaro@oats.inaf.it

Abstract: Francesco Fontana in his *Novae Coelestium Terrestriumque rerum Observationes* (1646) repeatedly claimed to have conceived the first positive eyepiece in 1608, and produced a testimony by Zupus who declared to have used his telescope since 1614. This represents the oldest record of such a device. Fontana made also the first observations of the sky using a telescope with two convex lenses that he had manufactured himself. In the late 1620s he observed the Moon's main craters with their radial pattern and succeeded in drawing the most accurate maps of the Moon of his time, which were reproduced in a number of publications without acknowledging him as author. However, it is only at the end of 1645 that Fontana, pressed by the need to defend his discoveries' authorship and in a state of declining health, carried out an intense observational campaign whose results were published in the only book he left to posterity.

Keywords: Telescope, Francesco Fontana.

1. The genesis of the *astronomical* telescope

We still do not know precisely the genesis of the Galilean telescope, but even more mysterious is that of the *astronomical* telescope, i.e. the one made by two convex lenses, called also *keplerian*, which became "the" telescope since the second half of the XVII century (van Helden 1976; 1977a, b). After the first observations by Galileo and the publication of the *Sidereus Nuncius* (1610), Johannes Kepler wrote *Dioptrice* (1611), which was devoted to the explanation of the functioning of the Galilean telescope. In this book Kepler considered also all other possible combinations of lenses, including two and three convex lenses. However, these propositions were inserted in a section of the *Dioptrice* that was not dealing with the telescope. Moreover, in discussing the image formation, Kepler did not mention the magnification, which is the main characteristic of a telescope. As a matter of fact Kepler did not make a telescope and we have to wait till De Reitha (1645) for the first "keplerian" telescope apparently made on the basis of his propositions. As argued by Malet (2010), "the idea of turning his theoretical combination of two convex lenses into a working telescope may have never crossed Kepler's mind".

Already in 1538 Girolamo Fracastoro wrote that "if someone looks through two eye-glasses of which one is placed above the other, he shall see everything larger and closely". However, the real issue was not to see bigger but to be able to see more

details, which requires very high quality lenses not available in those years. In 1655 the Middelburg City Council set up an investigation to clarify the origin of the telescope. During this investigation a claim for primogeniture in the construction of a *long tube* in the year 1618 was made by Johannes Sachariassen in favour of his father Sacharias Janssen.[1] However, several inconsistencies were noted in his declaration (van Helden 1976). He was born in 1611 and not in 1603 as declared, and in 1618 his age was only 7. Probably the definition of "long tubes" did not refer to a keplerian telescope but to a Galilean one with longer focal length (van Helden 1976).

The first printed mention of a telescope formed with two convex lenses appeared in *Rosa Ursina sive Sol* (1631) by the Jesuit Christoph Scheiner. When he described a Galilean telescope projecting the solar image he mentioned that a different arrangement, which made use of two convex lenses, was also possible.[2] At page 130 Scheiner also wrote: "thirteen years ago, I made erect the images intercepted for the most Serene Maximilian, Archduke of Austria". Since it took 4 years for the publication of *Rosa Ursina*, thirteen years before the publication date could correspond to the years 1613-1617 (van Helden 1976). However, a document of 1616 in the Tyrolean State Museum Ferdinandeum states that: "*opticum quodam instrumentum acquirerat admirandi usus, ita tamen ut imagines inversas redderet; quos cum Ser.mus [Serenissimus Maximilian III] rectas videre cuperet, nec que ratione id perficeret vel per alios reperiret*" (Daexecker, Molaro 2017). This is the first document that makes reference to an astronomical telescope. In our view this document confirms Scheiner's reconstruction of the episode and fixes its date at the year 1616. Moreover, it does not say that Scheiner was the inventor of the device but only that he had added a lens to a pre-existing telescope to rectify the image for the benefit of Maximilian III. Thus neither in this document nor in *Disquisitiones Mathematicae* (1614), nor in the manuscript *Tractatus de Tubo Optico* (1616), nor in *Oculus hoc est fundamentum opticum* (1619), nor in the *Rosa Ursina* (1631), Scheiner made reference to himself as the inventor of a "keplerian" telescope. An omission that would be very strange, if he were indeed the inventor of a new kind of telescope. So very little was known of Kepler's telescope that when Antonio Maria Shyrle de Rheita mentioned it in his *Oculos Enoch et Eliae* (1645) he was generally credited with this invention (King 1955).

The Neapolitan Francesco Fontana in his *Novae Coelestium Terrestriumque rerum Observationes* (1646), throughout the whole book, repeatedly claimed, in an obsessive way, the primogeniture of the construction of the first positive eyepiece already in 1608. In the book he also produced a testimony by Zupus who declared to have used, together with his master Jacobo Staserio, his telescope since 1614.

---

[1] "In the year 1590 the first tube was made and invented in Middelburg in Zeeland by Sacharias Janseen, and at that time the longest were 15 to 16 inches […]. The length of 15-16 inches was in use until the year 1618; then I and my father invented the long tubes which are used at night for seeing the stars and the Moon" (van Helden 1977, p. 55).

[2] "If you fit two like [convex] lenses in a tube in the same way, and apply your eye to it in the proper way, you will see any terrestrial object whatever in an inverted position but with an incredible magnitude, clarity, and width" (van Helden 1976, p. 25).

> I, Jo. Baptista Zupus of the Society of Jesus in the kindly Neapolitan College, Professor of Mathematical Sciences, assert that many, if not all the phenomena, which Dom. Francesco Fontana is bringing to the public domain in print, not once or twice but on several occasions by me and by others of our Society by means of the very optic tubes constructed by the same Dom. Fontana […]. I assert that he was he who first employed two convex lenses in optical tubes, beginning in the fourteenth year of this century when he displayed for inspection a tube equipped with such lenses both to Jacobo Staserio**,** my Master, and to me, to the surprise and delight of us both (Fontana 1646; Beaumont, Fay 2001).

There are no apparent reasons to question about the testimony of father Zupus since he was still alive when the book was published. The book was granted permission by Gregory Peccerillus, vicar general of Naples and by F. Joseph de Rubeis of the Conventuals, theologian of the Cardinal Philamarini. Thus allowing a certain time to improve the quality of the lenses, which is the critical aspect, the year 1608 does not seems so implausible, though we admit we rely only on his own words. In the following we analyse in more detail the section of Fontana's book dealing with the telescope.

Fig. 1. Engraving of Fontana self-portrait printed in the *Novae Observationes*. The oval framework holds the inscription "*Franciscus Fontana Neapol. novi optici tubi astronomici inventor A. Dom. M.DC.VIII Aet. suae 61*", where Fontana identified himself as the telescope inventor (Source: Perkins Library of the Duke University)

2. *De Tubo Optico*

The first section of the *Novae Coelestium Terrestriumque rerum Observationes* (1646) is entitled *De Tubo Optico* and it is completely dedicated to a discussion about the telescope. According to Fontana, the telescope has been theorized by Giovanni Battista Della Porta and then realized in practice by Galileo.[3] He endorsed the verses by the Lyncean Johan Faber, doctor and herbalist of the Pope, who celebrated Galileo as the first scientist of his times.[4] This is noteworthy considering that Fontana was close to the Jesuits of Naples, notably hostile to Galileo and from whom he was seeking permission to publish. Fontana's claim to have invented the telescope in 1608 referred exclusively to that made by two convex lenses, since he thought that Giovanni Battista Della Porta invented the telescope already in 1589.

Further in the book is a brief excursus on the history of the telescope from antiquity. Fontana rejected the possibility that the ancients knew the telescope on the grounds that they did not reveal any new details of the Moon and the stars. Fontana declared that all-important discoveries about planets and stars were made by Galileo and that he had confirmed all of them with his own made telescope. After Galileo the only significant discovery (in 1645) was the presence of dark spots in the map of Moon by Langrenus. However, Fontana added that this map could be "derived possibly from my maps […] first done in 1629 […] since Langrenus never reveals the designer of his telescope" (van de Vijver 1971).

The difficulties to work the lenses as to give them a perfect spherical shape – which is required in the construction of a good *Optical Tube* – were then described, including the role played by bubbles and air holes in the glasses. He stressed the importance of having a testing tool to check the lenses' shape and he proposed to look at the projected image of a candle as a testing procedure to judge the lens' quality, which he called his first invention.

The seventh chapter is entitled *Concerning the Astronomical telescope invented by the author*, the author's second invention, where he described the construction of the instrument. Fontana clarified that when he conceived his telescope he did not know Kepler's *Dioptrice*:

> Although that model seems to be proposed by Johann Kepler in his *Dioptrics*, Question 86, p. 42 printed in 1611. However, I had in truth no knowledge of this book earlier than the present moment when I am publishing this treatise, and I have received it in return from the aforementioned Johan Baptiste Zupus. […] It is surprising that it is not recorded that Kepler was the inventor of this device in

[3] "The theory of its construction is to be found in no earlier author than in Book 17 of Johann Baptist Porta's *Magic of Nature* Chapter 10, printed 1589, which says this: 'Concave lenses make distant objects clearly visible, convex lenses near objects […]. And that either Galileo put Porta's into practice, or he perfected it'" (Fontana 1646; Beaumont, Fay 2001).

[4] "Porta holds the first realm; German, you may have the second; your work, Galileo, gives you the third realm of the stars. But as far as the heavens are distant from the earth, you, Galileo, shine more brightly than the rest" (Fontana 1646; Beaumont, Fay 2001).

> Germany and myself at Naples […] also his method is quite different from the method suggested here, read it (Fontana 1646; Beaumont, Fay 2001).

The last sentence, *legite ipsum*, inviting the reader to read Kepler's book, seemed to doubt about the real intentions of Kepler to propose a new device as also argued by Malet (2010). Fontana described also how to correct inverted images by the use of a third lens with the same diameter of curvature, his third invention, apparently ignoring a similar proposition in the *Dioptrice*.

The last chapter was concerned about the possibility to construct very long telescopes with a length up to 50 palms, i.e. about 13 m since the Neapolitan palm corresponds to 0.2637 m. For such a length the radius of curvature of the lenses is so high that their surface becomes almost flat and therefore extremely difficult to work out. Fontana described his solution to this problem by introducing for the first time the concept of the optical meniscus: "This inconvenience will be avoided, if the glass is figured on one side in a convex shape and on the other side in a concave one" (Fontana's fourth invention).

The first mention of Fontana's telescope is contained in the letter by Fabio Colonna to Federico Cesi of 30 November 1629 (Gabrieli 1996). In 1637 Fontana came into contact with Benedetto Castelli who also informed Galileo celebrating the virtues of Fontana's telescopes.[5] In the following year Fontana improved his telescope making a 14 Neapolitan palms (i.e. 3.7 m) long telescope. This was documented by a letter of Cozzolani to Manzini of 11 September 1638 and by two letters that Castelli wrote to Galileo in July 1638. In the first Castelli writes: "I am holding a glass of Naples that is for a telescope long fourteen Neapolitan palms, […] magnifies the object ninety times"[6] and in the second the magnification became "160 times […] a monstrosity". On 23 October 1639, Fontana addressed directly the Grand Duke proposing a 22 palm, i.e. 5.8 m, long telescope (Paolo del Santo 2009).

Fontana's way to grind and polish the lens remains unknown and it was only partially disclosed in his book. On 3 January 1638 Fontana approached the Grand Duke of Tuscany offering the exclusive deal of his secret way to work the lenses at a price of 2000 *piastre*. An offer that the Grand Duke declined in the same month (Arrighi 1964). On 10 July of the same year, Castelli wrote to Galileo saying that he thought he had understood Fontana's secret way of grinding the lenses. Apparently Fontana was working only the central part of the lens, a procedure that somewhat puzzled Galileo.[7]

---

[5] "Mi ritrovo un occhiale di quelli di Napoli di gran perfezzione, e tale che non ho mai visto il meglio assolutamente" (Castelli to Galileo, 31 October 1637) and "Mi vado intrattenendo con adorare l'occhiale meraviglioso veramente […] centossessanta volte, cosa mostruosissima" (Castelli to Galileo, 17 July 1638).

[6] "Io mi ritrovo in mano un vetro di Napoli che serve per un cannone lungo quattordici palmi napoletani […] ingrandisce l'oggetto novanta volte" (Castelli to Galileo, 3 July 1638).

[7] "Quanto al modo di lavorare le lenti napoletane; il vederle pulite esquisitamente non in tutto il disco, ma nella parte di mezzo, lasciando a tondo come una ciambella non bene lustra, confonde il cervello a questi artefici quà. Io ho pensato a qualche cosa di non triviale, ma non ardisco di aprir bocca, havendo altro per il capo (Galileo to Castelli, 20 July 1638).

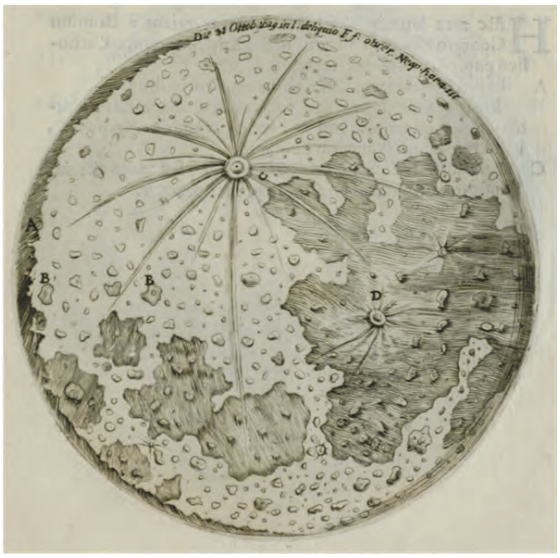

Fig. 2. Moon of October 31, 1629, 3 hours after the sunset. The Moon is upside-down, as seen with an *astronomical* telescope. Some features are marked with letters: A) highlighted that the Moon was not perfectly spherical at the border; B) a new small spot; C) Tycho crater seen for the first time together with the rays formed by splashed materials. Fontana named it *Fons Major*, i.e. "biggest fountain", echoing his name Fontana, which in Italian means fountain; D) Copernicus crater also seen for the first time (Source: Perkins Library of the Duke University)

3. Fontana's first observer of the Heavens with an *astronomical* telescope

In the late 1620s Fontana was the first to observe the sky using a telescope with two convex lenses, which he himself had manufactured. Fontana succeeded in drawing the most accurate maps of the Moon's surface of his time showing the technical superiority of his instrumentation probably including the Galileo's telescopes (Fig. 2).

A detailed description of Fontana's discoveries is accounted by Molaro (2017) who, by means of historical simulations, shows that they are more accurate than what generally assumed. Fontana observed the Moon's main craters with their radial pattern, such as Tycho crater which he named *Fons Major* (Big Fountain), and noted the change in their positions due to the Moon's motions. He observed the gibbosity of Mars at quadrature and together with the Jesuit Giovanni Battista Zupus, the phases of Mercury. He observed the two – and occasionally three – major bands of Jupiter, and he came close to revealing the ring structure of Saturn. He inferred the rotation of the major planets Mars, Jupiter and Saturn arguing that they could not be attached to the sky. He also suggested the presence of additional moons around Jupiter, Venus and Saturn, which prompted a debate that lasted for more than a century (Kragh 2008).

In the end of his *Novae Coelestium Observationes*, Fontana describes his fourth invention he made in 1618. A new instrument by which the smallest and virtually

invisible things are so magnified that they can clearly and distinctly be examined. To support this claim he inserted a testimony from the Jesuit Gerolamo Sersale, who stated that he had being using the Fontana's microscope since 1625. The word *microscope* was coined by G. Faber in 1625 and the first printed microscopic illustrations were published five years later in the *Persio tradotto in verso sciolto e dichiarato* (1630) by Francesco Stelluti. On page 52 there is a reproduction of three bees which closely reminds of the Greuter's *Melissographia* and at page 47 Stelluti writes that the bees' drawing was observed and drawn by Francesco Fontana,[8] thus confirming that Fontana had a major role in the first microscopic observations. Like the telescope, also the microscope can have two optical configurations and it is quite possible that Fontana was the first to conceive a compound microscope made only with convex lenses.

4. Fontana and contemporary paintings

It has been suggested that the telescopes depicted in the two paintings *Allegory of Sight* by J. Brueghel the Elder around 1617-1618 are keplerians (Molaro, Selvelli 2011). Since Fontana was the only one who could manufacture a keplerian telescope in those years, Molaro (2017) suggested that they may come from Fontana. We also noted a likeness of the unknown sitter depicted in the *Allegory of Sight* by Jusepe Ribera (c. 1616) and the self-portrait Fontana inserted in his book. Thus, though it is generally believed that Ribera took his models from everyday life, it is quite possible that Ribera, who arrived in Naples in 1616, could have been inspired by the figure of the Neapolitan Francesco Fontana who, in those years, was a renowned telescope maker (Molaro 2017).

References

Arrighi G. (1964). "Gli occhiali di Francesco Fontana in un carteggio inedito di A. Santini". *Physics*, VI, pp. 432-448.

Beaumont S., Fay P. (2001). *Translation of the Novae coelestium, terrestriumq[ue] rerum observationes by F. Fontana*. Private publication.

Daxecker F., Molaro P. (2017). In preparation.

Del Santo P. (2009). "On an unpublished letter of Francesco Fontana to the Grand-Duke of Tuscany Ferdinand II De Medici". *Galilaeana*, 6, pp. 235-251.

Favaro A. (1903). "Galileo e il telescopio di Francesco Fontana". *Atti e Memorie dell'Accademia di Scienze Lettere e Arti di Padova*, XIX, pp. 61-71.

Fontana F. (1646). *Novae coelestium, terrestriumq[ue] rerum observationes, et fortasse hactenus non vulgatae. A Francisco Fontana, specillis a se inventis, et summam perfectionem perductis.* Neapolis: Gaffarum.

Gabrieli G. (1996). *Il carteggio linceo*. Roma: Accademia Nazionale dei Lincei.

[8] "Il tutto ancora esquisitamente osservato e disegnato il Signor Francesco Fontana: onde feci qui in Roma intagliare in rame tre Api rappresentati l'Arme di Nostro Signore Papa Urbano VIII" (Stelluti 1630, p. 47).

King H.C (1955). *The History of the Telescope*. New York: Dover.

Kragh H. (2008). *The Moon that Wasn't: The Saga of Venus' Spurious Satellite*. Basel: Birkhäuser.

Malet A. (2010). *History of Science and Scholarship in the Netherlands*, vol. 12. Amsterdam: Amsterdam University Press.

Molaro P., Selvelli P. (2011). "A Telescope Inventor's Spyglass Possibly Reproduced in a Brueghel's Painting". *Astronomical Society of the Pacific Conference Series*, 441, pp. 13-21.

Molaro P. (2017). "Francesco Fontana and the astronomical telescope". *Journal of Astronomical History and Heritage*, in press.

Schyrleus De Rheita A.M. (1645). *Oculus Enoch et Eliae Sive Radius Sidereomysticus*, Antwerp: Hieronymus Verdussen.

Stelluti F. (1630). *Persio tradotto in verso sciolto e dichiarato*. Roma: Mascardi.

Van Helden A. (1976). "The astronomical telescope 1611-1650". *Annali dell'Istituto e Museo di Storia della Scienza di Firenze*, 1 (2), pp. 13-36.

Van Helden A. (1977). "The invention of the telescope". *Transactions of the American Philosophical Society, New Series*, 67 (4), pp. 1-67.

Van de Vijver S.J. (1971). "Original sources of some early lunar maps". *Journal for the History of Astronomy*, 2, pp. 86-97.