

# How did Galileo develop his telescope?

## A ‘new’ letter by Paolo Sarpi

Mario Biagioli

An Italian-born Huguenot, Francesco Castrino was one of the several Protestants with whom Fra Paolo Sarpi maintained regular correspondence – the kind of relationship that fueled the Church’s suspicions that the Venetian Republic had chosen a heretic as their chief theologian. They exchanged letters between Venice and Paris from October 1608 to March 1611 until Sarpi was forced to break off the correspondence after realizing that, for some reason, his letters to Castrino tended to land on the desk of the Papal *Nuncius* of that city.<sup>1</sup> The two started to trade news about the telescope in early December 1608, when Sarpi acknowledged receipt of Castrino’s summary of *The Embassy of the King of Siam Sent to His Excellency Maurice of Nassau*, containing, in an appendix, the news about the invention of the telescope by a Dutch spectacle maker.<sup>2</sup> He added, however, that he had already received that same report from others, around the beginning of November.<sup>3</sup> (It was this report that reached Galileo, most likely through Sarpi himself).<sup>4</sup>

A letter from Sarpi to Castrino dated 21 July 1609 presents, however, a more interesting piece of information:

There is nothing new here in Italy, except that a spyglass has arrived that make faraway things visible. I admire it very much because of the beauty of the invention and the

---

<sup>1</sup> On Francesco Castrino and the Papal interception of his correspondence with Sarpi, see Busnelli, ‘Un carteggio inedito’ (1928).

<sup>2</sup> *Ambassades du Roy de Siam* (1608), 9-11.

<sup>3</sup> Sarpi to Castrino, 9 December 1609: ‘Recevei dalla Haga, un mese e, il riporto che Vosra Signoria mi manda, sopra l’ambasciata al conte Maurizio del re Indo di Siam, e sopra li nuovi occhiali fabricati da quell valent’uomo [...]’ (‘One month ago, I received from The Hague the report that you sent me about the embassy of the King of Siam to Count Maurice, and about the new glasses made by that craftsman’), in: Sarpi, *Lettere ai Protestanti*, 2 (1931), 15.

<sup>4</sup> ‘[...] News came that a Hollander had presented to Count Maurice a glass by means of which....’ Galilei, *The Assayer* (Rome, 1623), cited in: Van Helden, *Invention* (1977), 52.

skill of the manufacture, but don't value it at all for its military uses, either on land or at sea.<sup>5</sup>

First published in 1833, this letter was surprisingly excluded from Galileo's *Opere* and, perhaps because of that, has remained invisible to the current generation of Galileo scholars.<sup>6</sup> It establishes the arrival of a telescope in Venice about two weeks earlier than commonly reported in the literature – not at the very beginning of August but, as I will show, somewhere between the 8<sup>th</sup> and the 20<sup>th</sup> of July.<sup>7</sup> Two or three weeks may not seem like much, but in fact they force us to seriously rethink crucial elements of the chronology and originality of Galileo's development of the telescope, and to reconsider the accuracy of the narratives about these events he offered in the *Sidereus nuncius*, *The Assayer*, and the letter of 29 August 1609 to his brother-in-law, Benedetto Landucci.<sup>8</sup> It also re-opens old debates about Sarpi's role in the development of Galileo's instrument.

In particular, Sarpi's letter to Castrino indicates that, by the time Galileo put his telescope-making efforts in high gear, he may have known a lot more about other people's telescopes than he cared to admit. He always maintained that he had only heard that the telescope existed, but it now seems most likely

---

<sup>5</sup> Sarpi to Castrino, 21 July 1609: 'In Italia non abbiamo cosa nuova: solo e' comparso quell'occhiale che fa vedere le cose lontane; il quale io ammiro molto per la bellezza dell'invenzione e per la dignita' dell'arte, ma per uso della Guerra ne' in terra ne' in mare, io non lo stimo niente,' in: Sarpi, *Lettere ai Protestanti*, 2 (1931), 45.

<sup>6</sup> The virtual invisibility of the letter remains a bit of a puzzle, given that it has been published numerous times – in 1833, 1847, 1863, and 1931 (Sarpi, *Scelte lettere inedite* (1833), 72; Sarpi, *Scelte lettere inedite* (1847), 182; Sarpi, *Lettere*, 1 (1863), 279; Sarpi, *Lettere ai Protestanti*, 2 (1931), 45). In recent times it has been noticed only, to the best of my knowledge, by one Sarpi scholar – Libero Sosio – who, however, did not recognize its relevance to the chronology of the invention of the telescope. (Sosio, 'Fra Paolo Sarpi e la cosmologia' (1996), CLXV). More puzzling is Antonio Favaro's decision not to include it in the *Opere*, despite having known and cited this letter twice early in his career, prior to embarking on the *Opere* project: Favaro, 'Fra Paolo Sarpi fisico e matematico secondo I nuovi studi' (1883), 909; Favaro, 'Il telescopio' (1883, reprinted 1966), 277. In a later article, he even seemed to forget that that letter existed: 'non abbiamo documenti i quali provino che lo strumento abbia fatta la sua comparsa in Padova avanti la fine del Luglio' ('We do not have documents that would prove that the instrument had made its appearance in Padua before the end of July'; see: Favaro, 'La invenzione del telescopio' (1907), reprinted in Favaro, *Galileo Galilei a Padova* (1968), 175).

<sup>7</sup> Lorenzo Pignoria to Paolo Gualdo, 1 August, 1609: 'Uno degli occhiali in canna, di che ella mi scrisse gia', e' comparso qui in mano d'un Oltramontano' ('One of the glasses in a tube, about which you wrote me has appeared in the hands of a foreigner'), in: Galilei, *Opere*, 10 (1900), 250.

<sup>8</sup> Favaro, 'Galilei e la presentazione del cannocchiale alla Repubblica Veneta' (1891); Rosen, 'The Authenticity of Galileo's Letter to Landucci' (1951).

that Galileo had access to a detailed description of the construction and performance of an actual telescope brought to Venice by a northern European artisan or merchant. He might even have inspected the instrument itself.<sup>9</sup> Sarpi's letter to Castrino – together with other evidence about Galileo's movements in that period – places him in Venice on the same days when a foreigner was offering his own telescope to the Venetian Senate and the instrument was being tested and inspected by his close friend Paolo Sarpi. This was, I argue, the instrument Sarpi referred to in his letter of 21 July to Castrino.

Filippo de Vivo has shown that Sarpi timed his letter-writing to the scheduled departures of the couriers rather than to the pace of the news – typically every week or fortnight.<sup>10</sup> Several of his letters to Northern European correspondents bore, in fact, the same dates. On 21 July 1609, for instance, he wrote to both Castrino and Christoph von Dohna, and on 7 July (the date of the previous letter to Castrino) he also posted letters to Jerome Groslot de l'Isle and Von Doha. The telescope mentioned in Sarpi's letter, therefore, could have arrived anytime between 7 and 21 Juli. This is supported by the content and tone of the letter, which give no indication that Sarpi was rushing to report breaking news about the telescope. With the exception of the few lines quoted above, the letter deals mostly with political matters.

Since hearing about the telescope in late 1608, Sarpi's remarks about the instrument oscillated between cautious and skeptical. They were uniformly vague. To Castrino he wrote that: '[the report about the telescope] has given me much to think about. However, because the philosophers teach us that one should not speculate about the cause prior to seeing its effects with one's eyes, I have resigned myself to waiting for this very noble thing to spread throughout

---

<sup>9</sup> This is a hypothesis that, surprisingly enough, has been seriously entertained only in the last few years: Strano, 'Galileo's Telescope' (2009), 19. Favaro, who was initially more open-minded than most, acknowledged the possibility, but brushed it off as irrelevant: 'poco importa il discutere se in Padova od in Venezia, sulla semplice voce, cioe' sine exemplo, oppure dopo aver anche veduto uno di quei volgari tubi, la vista del quale ben poco poteva aggiungere alla sommaria descrizione che ne avesse udita o letta [...]'. ('It matters little to discuss whether in Padua or Venice, on the mere rumour, that is, without an example, or after having also seen one of these common tubes that could add little to the summary description which he had heard or read'; Favaro, 'La invenzione del telescopio' (1968), 176).

<sup>10</sup> De Vivo, 'Paolo Sarpi and the Uses of Information in Seventeenth-Century Venice' (2005), 39.

Europe.<sup>11</sup> He expanded on that in a January 1609 letter to Groslot de l'Isle:

The reports about the new spyglasses [...] are credible enough to make me look and philosophize no further, having Socrates prohibited to speculate over phenomena that we have not seen ourselves. When I was young, I thought about a similar device, and it occurred to me that a glass made in the shape of a parabola could produce such a [magnifying] effect. I had demonstrative arguments, but because they are abstract [by nature] and do not take into account material constraints, I hesitated. For that reason, I did not pursue that work, which would have been labourious. Consequently, I neither confirmed nor refuted my hypothesis through experience...<sup>12</sup>

Sarpi's position had not change much by the end of April, when he wrote to Jacques Badovere:

[...] About the Dutch spectacles, I have given your Lordship my thoughts, but I could be wrong. If you gather more about them, I'd like to hear what is thought there. I have almost stopped to think about physical and mathematical topics. Either because of age or habit, my brain has become a bit thick for those reflections.<sup>13</sup>

The same polite skepticism is found in a letter to Groslot de l'Isle, dated 12 May, thus making Sarpi's statement of 21 July about the 'beauty of the invention'

---

<sup>11</sup> Paolo Sarpi to Giuseppe Castrino, 9 December 1609: '[...] m'ha dato assai da pensare; ma perche' questi filosofi comandano che non si specula la causa prima di vedere con propri sensi l'effetto, mi son rimesso ad aspettare che una cosa cosi' nobile si diffondi per l'Europa,' ('It has given me much to think about, but because these philosophers command not to speculate on the first cause of vision by itself without the effect, I have submitted and wait for such a noble thing to spread through Europe'), in: Sarpi, *Lettere ai Protestanti*, 2 (1931), 15.

<sup>12</sup> Paolo Sarpi to Jerome Groslot de l'Isle, 6 January 1609: 'L'avviso delli nuovi occhiali [...] lo credo per quanto basta a non cercar piu' oltre, per non filosofarci sopra, proibendo Socrate il filosofare sopra esperienza non veduta da se' proprio. Quando io era giovane, pensai ad una tal cosa, e mi passo' per la mente che un occhiale fatto di figura di parabola potesse far tal effetto; aveva ragioni demonstrative, ma perche' queste sono astratte e non mettono in conto la repugnaza della materia, sentiva qualche opposizione. Per questo non [mi] son molto inclinato all'opera, e questa sarebbe stata faticosa: onde ne' confirmai ne' reprobai il pensiero mio con l'esperienza,' ('I believe the news about the new glasses as far as it goes for it suffices not to search further and not to philosophize about it. Socrates prohibits philosophizing about experiences not personally seen. When I was young, I thought about such a thing, and it occurred to me that a glass made in the shape of a parabola could produce such an effect; there were demonstrated reasons. But because these are abstract and do not take into account the stubbornness of the material, some opposition was heard. Because of this, I am not much inclined toward the task – and it would have been tiring; and thus I neither confirmed nor disproved my my idea by experience'), in Sarpi, *Lettere ai Protestanti*, 1 (1931), 59.

<sup>13</sup> Paolo Sarpi to Giacomo Badoer, 30 March 1609, in: Paolo Sarpi, *Opere* (1969) [my translation].

stand out as a distinct shift in his views on the telescope.<sup>14</sup> (It may also indicate his surprise at seeing the instrument's two-lens optical scheme, which Sarpi seemed to have previously imagined to involve a concave mirror).<sup>15</sup> Even his negative evaluation of the telescope's potential as a military instrument marks a shift in Sarpi's views about the instrument. In previous letters he repeatedly abstained from passing judgment on the telescope until he saw one himself, but on 21 July he explicitly commented on its performance. This double shift indicates that Sarpi tested a telescope prior to writing to Castrino. His disparaging remark about the military uselessness of the telescope derive, I believe, from his having noticed the modest enlarging power of the instrument (likely to be in the 4-power range) as well as the narrow field of view typical of all Dutch-type telescopes, which would have made it almost impossible to use on pitching and rolling ships and inconvenient to use on land. (The Dutch authorities' request to Hans Lipperhey – the first to file a patent application on for the telescope on 4 October 1609 – to develop a binocular version of the instrument may have been an attempt to address that same problem).<sup>16</sup>

Sarpi's reference to the instrument's military performance matches the fact that, starting with Lipperhey, early telescopes were consistently presented as tools for military reconnaissance – an application that Galileo was going to stress in great detail in the presentation of his own instrument to the Venetian Senate on 24 August 1609.<sup>17</sup> The foreigner who came through Venice in July 1609 seeking a reward from the Senate in exchange for the 'secret' of his telescope obviously advertized it for that same use. Because we know that the Venetians commissioned Sarpi with the testing the foreigner's instrument (and that he eventually rejected the foreigner's petition), his saying to Castrino that 'I but don't value it at all for its military uses, either on land or at sea: may reflect the negative assessment of the telescope he was about to deliver to the Senate.'<sup>18</sup>

---

<sup>14</sup> Paolo Sarpi to Jerome Groslot de l'Isle, 6 January 1609, in: Sarpi, *Lettere ai Protestanti*, 1 (1931), 79.

<sup>15</sup> Reeves, *Galileo's Glassworks* (2008), 115-138.

<sup>16</sup> 'Minutes of the States General,' 15 December 1608, printed in: Van Helden, *Invention* (1977), 42.

<sup>17</sup> Van Helden, *Invention* (1977), 36; Galilei, *Opere*, 10 (1900), 250-251.

<sup>18</sup> Giovanni Bartoli to Belisario Vinta, 29 August 1609, in: Galilei, *Opere*, 10 (1900), 255.

## *Vague narratives*

In *Sidereus Nuncius*, Galileo wrote that:

About 10 months ago a rumor came to our ears that a spyglass had been made by a certain Dutchman by means of which visible objects, although far removed from the eye of the observer, were distinctly perceived as though nearby. About this truly wonderful effect some accounts were spread abroad, to which some gave credence while others denied them. The rumor was confirmed to me a few days later by a letter from Paris from the noble Frenchman Jacques Badovere. This finally caused me to apply myself totally to investigating the principles and figuring out the means by which I might arrive at the invention of a similar instrument, which I achieved shortly afterwards [‘at once’ in the ms.] on the basis of the science of refraction.<sup>19</sup>

(Sarpi’s name is not mentioned in the *Nuncius*, but Galileo probably heard of both the telescope’s invention and of Badovere’s letter from his Venetian friend).<sup>20</sup> More than two decades later, responding to Orazio Grassi’s challenge to his inventorship of the telescope, Galileo took a few pages of *The Assayer* to flesh out the bare-bone narrative first proposed in the *Nuncius*. He added some chronological specificity to his previous story, while also re-stating a key point, that is, that all the technical information contained in the early reports he heard about the telescope amounted to ‘nothing more’ than the instrument made faraway things look nearby.<sup>21</sup> The implication being that he set his mind on developing his instrument without the help of any specific clue about the manufacture of the telescope – apparently, not even that it had two lenses.<sup>22</sup>

Galileo actually went so far as to propose that the ‘rumors’ he had heard did not help him at all to solve the puzzle of the telescope:

---

<sup>19</sup> Galilei, *Sidereus Nuncius or Sidereal Messenger* (English translation, 1989), 36-37.

<sup>20</sup> In the *Nuncius*, Galileo does not say that Badovere’s letter was to him (which leaves open the possibility that Galileo read a letter sent to Sarpi). In any case, Sarpi had heard of the telescope in early November 1608, and would have been most likely to share the news with Galileo very soon after receiving it. Eileen Reeves presents a more complicated story, arguing that Badovere sent the same report to both Sarpi and Galileo, through the same courier. She argues there were two letters from Badovere in response to the queries from Venice. The first one, she argues, was disappointingly vague, but the second was more detailed (Reeves, *Galileo’s Glassworks* (2008), 133-138). None of these possible letters, however, survive.

<sup>21</sup> ‘Ne’ piu’ fu aggiunto’ (‘That was all’), in: Galileo, *Il sagggiatore* [The assayer] (1623), cited in: Van Helden, *Invention* (1977), 51.

<sup>22</sup> Even the discussion on the telescope with unnamed friends in Venice, which Galileo first reported in *The Assayer* was not described as providing any additional information (Galileo, *Il sagggiatore* [The assayer] (1623), cited in: Van Helden, *Invention* (1977), 51-52).

I say that the aid afforded me by the news awoke in me the will to apply my mind to it; but beyond that I do not believe that such news could facilitate the invention. I say, moreover, that to discover the solution of a known and designated problem is a labor of much greater ingenuity than to solve a problem which has not been thought of and defined, for luck may play a large role in the latter while the former is entirely the work of reasoning.<sup>23</sup>

Unlike the lucky Dutch spectacle-maker who, Galileo argued, stumbled by chance upon an instrument he was not looking for, the rumors of the existence of the telescope had confronted Galileo with a puzzle – a puzzle that could not be solved by chance but only through reasoning or, as he put it in the *Nuncius*, through the ‘science of refraction.’<sup>24</sup> And yet the description of how he discovered the ‘secreto’ of the telescope by ‘means of reasoning’ was, by Galileo’s own admission, surprisingly simple:

My reasoning was this. The device needs either a single glass or more than one. It cannot consist of one alone, because the shape of that one would have to be a convex (that is, thicker in the middle than at the edges), or concave (that is, thinner in the middle), or contained between parallel surfaces. But the last named does not alter visible objects in any way, either by enlarging or reducing them; the concave diminishes them; and the convex, while it does indeed increase them, shows them very indistinctly and confusedly. Therefore, a single glass is not sufficient to produce the effect. Passing next to two, and knowing as before that a glass with parallel faces alters nothing, I concluded that the effect would still not be achieved by combining such a one with either of the other two. Hence I was restricted to trying to discover what would be done by a combination of the convex and the concave, and you see how this gave me what I sought. Such were the steps of my discovery, in which I was not at all assisted by the conception that the conclusion was true.<sup>25</sup>

Galileo’s claim that knowing of the existence of the telescope made the discovery of its secret a more difficult task than the original invention looks like a bit of a stretch. Also peculiar is the gap between his high-sounding claims about his use of ‘reason’ and the ‘science of refraction’ and his description of his actual path to discovery which looks like a series of reasonably simple guesses

---

<sup>23</sup> Galileo, *Il saggiaiore* [The assayer] (1623), cited in: Van Helden, *Invention* (1977), 52-53.

<sup>24</sup> ‘[...] which I achieved shortly afterward on the basis of the science of refraction’; Galileo, *Sidereus Nuncius or Sidereal Messenger* (1989), 37.

<sup>25</sup> Galileo, *Il saggiaiore* [The assayer] (1623), cited in: Van Helden, *Invention* (1977), 53.

– guesses that, contrary to Galileo’s assumption, could have been within the reach of a ‘simple maker of ordinary spectacles.’<sup>26</sup> Taken together, these features of Galileo’s narrative suggest an attempt to maximize the distance between his instrument and those developed in Northern Europe: He had learned nothing from them and, in any case, his had been developed following a method that was utterly alien to theirs. Galileo’s emphatic amplification of the differences may be a sign that the differences were, in fact, too small for comfort.

His chronologies are not straightforward either. Those in the *Nuncius* and *The Assayer* offer no explicit dates, only time intervals between events. Some of those intervals are identified with specific markers (‘the following day...’), but more often with vague expressions (‘for over a month...’). Those interested in the actual timeline of Galileo’s work are left to reconstruct the chronological structure *within* his narrative (the distance between the various events) and to then find an event that can be attached to a specific date *outside* of the narrative to function as the chronological anchor for the whole story. Galileo’s multi-dimensional vagueness about dates, people, and information was, I believe, not accidental but tactical. He did not necessarily report things that had not happened, but omitted important events and people while also ‘loosening up’ the chronological relations between the events so as to render his narrative of inventorship more defensible by making it less falsifiable.

Historians have painstakingly tried to piece together the actual chronology of Galileo’s development of the telescope. Although they have not openly voiced the possibility that these chronologies may be intrinsically incompatible, their efforts have at least shown that serious discrepancies exist, and that reconciling them requires taking several of Galileo’s chronological references

---

<sup>26</sup> ‘Con tutto il debito rispetto per ogni cosa che riguarda Galileo, ci e’ forza riconoscere che quando Galileo affermava speculazioni di prospettiva averlo condotto alla costruzione del cannocchiale, egli non sapeva che cosa dicesse: anzi questa sola affermazione [...] basterebbe a sostenere ch’egli non vi adopero` maggior studio di quello che abbia fatto quell primo occhialaio di Middelburgo. [...] Galileo non era maggiormente sincero quando affermava che speculazioni istituite sulla rifrazione lo avevano condotto al cannocchiale. Galileo infatti non ebbe mai una chiara idea della rifrazione....’ (‘With all the respect due all matters that regard Galileo, one must recognize that when Galileo affirmed that speculations about perspective led him to the construction of the telescope, he did not know what he was saying; on the contrary, that single affirmation would be enough to maintain that he did not undertake greater study than the first spectacle maker in Middelburg. Galileo was no more sincere when he affirmed that speculations on refraction had led him to the telescope. In fact, Galileo never had a clear idea of refraction.’) Cf. Favaro, ‘Il Telescopio’ (1883/1966), 274-275.

somewhat metaphorically.<sup>27</sup> Comparably friendly readings are necessary to resolve discrepancies between manuscript and print versions. For instance, Edward Rosen tells us that replacing ‘eight months’ with ‘ten months’ between the manuscript of the *Nuncius* and its printed version should not be read as evidence of Galileo’s creative interventions on the timeline but rather as the benign trace of his attempt to recalibrate his narrative to account for the fact that it took two months between the writing of the manuscript and the printing of the book.<sup>28</sup>

But aside, from these specific philological issues, why hasn’t Galileo’s remarkable chronological vagueness and ‘elasticity’ been noticed and treated as something to be explained, rather than explained away? Why haven’t we asked why Galileo never provided any specific chronological statement about his telescope-making activities (despite the fact he included plenty of other dates in the *Nuncius*)?<sup>29</sup> As it often happens in philological judgments, the meaning of certain elements of the text depends on the assumptions one makes about the author and his/her intentions. In Galileo’s case, the tendency has been to assume that his chronologies were fundamentally correct, and that one should adjust the meaning of expressions like ‘shortly after’, ‘a few days later’, or ‘afterwards’, so as to match his timelines with the documentary evidence we have about them. This might be a reasonable course of action if one were dealing with chronologies of no particular significance. In this case, however, Galileo’s chronologies were a *means to establish himself as the inventor of the telescope*, not mere descriptions of how and when he invented the telescope.<sup>30</sup> In other

---

<sup>27</sup> For instance Rosen does not believe that Galileo heard about the telescope on the day he reported in *The Assayer* (17 July) because that chronology does not match what Galileo says in the *Nuncius*. (Rosen, ‘When Did Galileo Make His First Telescope?’ (1951), 50). At the same time, Rosen reconstructed the chronology of the *Nuncius* to minimize the discrepancy with *The Assayer*, as when he concludes that Galileo heard of telescope in June 1609 (*ibid.*, 47) when the end of May seems to be a more reliable date. Rosen also remarked on the conspicuous differences between *The Assayer* and *Nuncius* (*ibid.*, 47). In ‘Il Telescopio’, Favaro states that ‘[...] dee riconoscersi che le tre narrazioni non sono interamente conformi; oltrediche’ esse contengono assolute inesattezze [...]’ (‘it must be recognized that the three narrations are not entirely consistent; in other words these contain absolute inaccuracies’). Favaro, ‘Il Telescopio’ (1883/1966), 272.

<sup>28</sup> Rosen, ‘When Did Galileo Make His First Telescope?’ (1951), 45. Analogously, the change between ‘at once’ (in the manuscript of the *Nuncius*) to ‘shortly afterwards’ (in the printed version) should be treated as a mere stylistic change in the pursuit of elegance: ‘Such instantaneity [of ‘at once’] may have sounded out of step, on second hearing, with the preceding slow notes’ (*Ibidem*, 48).

<sup>29</sup> Galileo listed, for instance, the dates of all his observations of the satellites of Jupiter.

<sup>30</sup> For a smart discussion of the relationship between the establishment of discoveries, discovery narratives, and authorship, see: Schaffer, ‘Scientific Discoveries and the End of Natural Philosophy’ (1986).

words, there has been a tendency to assume that Galileo was indeed the author he was representing himself to be, and to then use this assumption as a guiding philological principle to sort through the chronological discrepancies in his narrative. Taking this road, however, has produced literature that confirms the very claim to inventorship that Galileo was trying to establish.<sup>31</sup>

We know that Galileo was not the first inventor of the telescope, and that telescopes were showing up with increasing frequency in both Northern Europe and Italy as he was developing his own. These telescopes were not simply being transported from the Netherlands to other parts of Europe, but were copied and reproduced in situ with substantial ease. (The facility with which telescopes could be copied and the quick diffusion of telescope-making skills were among the reasons for the Dutch States General's decision to turn down Hans Lipperhey's patent application).<sup>32</sup> That Galileo managed to have his name closely associated with the invention of the telescope was a truly remarkable achievement. And because the way he presented his telescope-making program in the *Nuncius* and then in *The Assayer* played a crucial role in gaining that recognition, we need to take such narratives as instruments whose function and functioning we need to investigate. (We also need to be careful about the meaning of 'telescope' and 'to invent').

The first thing we need to notice is that the Venetian Senate had already recognized Galileo as the inventor of the telescope several months prior to his publication of the *Nuncius*. He offered the instrument to the Senate on 24 August 1609 and was rewarded with tenure and a doubling of his salary as professor of mathematics at the University of Padua. Keep in mind that Galileo's self-representation as the inventor of the telescope does not contradict his simultaneous acknowledgment that the 'Hollander' invented it first.<sup>33</sup> In a period in which 'inventor' was construed as the person who put a new technology to work in a certain place (either by developing it *in situ* or bringing it in from elsewhere) and 'invention' was defined by its performance and uses rather than by the idea embodied in it, Galileo was indeed the rightful inventor of

---

<sup>31</sup> Rosen concluded his 'When Did Galileo Make His First Telescope?' (1951) by saying that: 'In his three separate accounts [of his invention], Galileo gives us a period of about two months to be filled with the following intervals: a few days, at once, six days, more than a months, four days' (page 50). I can hardly imagine a better example of a historian assuming the illustration of the author as the ordering principle of philological work: Galileo gives us a period and some intervals of his choosing and it is our job to put together the pieces of the jigsaw puzzle he has designed. But what about considering the possibility that the pieces may not be made to fit the puzzle, or that there may be no coherent puzzle?'

<sup>32</sup> Minutes of the States General, 15 December 1608, cited in: Van Helden, *Invention* (1977), 42.

<sup>33</sup> Biagioli, *Instruments of Credit* (2006), 77-134.

the telescope *in Venice*.<sup>34</sup> (This performance-based notion of invention explains why the foreigner who brought a working telescope to Venice before Galileo's was not recognized as the inventor of the telescope: his instrument was not deemed to perform well enough – at least not for the asking price). The focus on performance rather than absolute novelty also explains why the path that Galileo followed to develop his instrument had no bearing on his claim to inventorship. From the Venetian Senate's point of view, Galileo was the inventor of the 8- 9-power device he showed them, no matter whether he discovered it, copied it from some foreign exemplar, or a bit of both. He was not the inventor of *the* telescope, but of *that* telescope.<sup>35</sup> The evidence in Sarpi's letter to Castrino does not, therefore, challenge the legitimacy of Galileo's claim to his inventorship – that is, *Venetian inventorship* – of the telescope. What it does challenge are the claims Galileo put forward in *his printed books* about how little he relied on information about other instruments as he set out to develop his own telescope.

What he wrote in the *Nunciatus* and *The Assayer* about the history of his telescope-making program was not aimed at the Venetian Senate but a very different credit regime – one of philosophical authorship rather than technological inventorship. (The letter accompanying his gift of the telescope to the Republic did not, in fact, offer any chronology of its development – only a detailed description of its military uses). His printed narratives, instead, were meant for people who were much less interested in the military use of the telescope than in the *discoveries he had made with it*. Through these printed narratives, Galileo was trying to establish his inventorship of the telescope so as to enhance the authorship of his discoveries, but he was also trying to make the connection between authorship of the discoveries and inventorship of the telescope run in the other direction. By establishing that he was the first to discover what he discovered, he was effectively marking his telescope as different from the telescopes of others (implying that the owners of the other telescopes circulating throughout Europe had not been able to make those discoveries). In turn, that helped establish him (in an a posteriori fashion) as the first inventor of a new kind of telescope – the 'discoveries-making' telescope.

---

<sup>34</sup> Biagioli, 'From Print to Patent' (2006), 147-152. More precisely, Galileo was not the inventor of the family of instruments we now call refracting telescopes (or of the specific Dutch design), but of the specific instrument whose performance was much appreciated by the Venetian senators who tested and rewarded it in August 1609.

<sup>35</sup> More precisely, I do not think that the definition of 'telescope' had any legal meaning in so far as patents and rewards were concerned. What was being evaluated and possibly rewarded were *things*, not *ideas embodied in things*.

The dedication of the *Nuncius* shows that, at the time he was writing the book, the Medici were Galileo's privileged audience – the potential patrons he was trying to connect with. And the workings of the patronage system made it virtually necessary for Galileo to cast his work (both the telescope and his discoveries) as something that he did all by himself, perhaps with some divine inspiration, so that he (and he alone) could offer it to his patron, thus establishing the kind of personal relation typical of high-end patronage. This means that, while the Venetians could not care less about how Galileo got his telescope – what mattered was that it worked and worked well – it would have been difficult for Galileo to appear to publicly court the Medici with a gift he had already given to others (as he had), developed in collaboration with others (which he may have), or through the information provided by others (which he most likely did).<sup>36</sup>

It is therefore not surprising that the *Nuncius* remained silent about Galileo's presentation of the telescope to the Venetian Senate and of the rewards he received for it, despite the fact that such a public recognition could have provided evidence of the reliability and quality of the instrument.<sup>37</sup> Nor did Galileo mention anyone who helped him develop the telescope, leading Libero Sosio to speculate (credibly, I think) that Sarpi's name went unmentioned in the *Nuncius* because of patronage *realpolitik*.<sup>38</sup> Furthermore, an acknowledgment of Sarpi's role would have opened a window on a whole series of borrowings – not only from him but also from the foreigner's instrument and the other people the foreigner may have borrowed from. Crediting Sarpi

---

<sup>36</sup> The Medici, of course, knew perfectly well about the widespread presence of the telescope in Europe and that, therefore, Galileo was part of a process of innovation rather than its originator. Still, the story of Galileo's 'invention' of the telescope had to be told – that is, *publicly* told – in a certain way so as to make it appear that the Medici were rewarding Galileo for his unique originality.

<sup>37</sup> Galileo did eventually invoke the recognition by the Venetian Senate as evidence for his inventorship, but that was in the 1623 *The Assayer* in response to Grassi (Van Helden, *Invention* (1977), 52).

<sup>38</sup> Sosio, 'Fra Paolo Sarpi e la Cosmologia' (1996) clxviii. The erasure of Sarpi from *The Assayer*, however, may not have been the result of the same considerations that excluded him from the *Nuncius*. By 1623, Galileo was in the viewfinder of the Inquisition, and it might have been politically wise for him not to mention the name of a notoriously unorthodox theologian like Sarpi at that point in time.

could have popped a rather large bubble.<sup>39</sup>

It was in fact important for Galileo to cast his telescope as different as possible from the many others mushrooming throughout Europe. Without that kind of product differentiation, his gift could have appeared quite generic. I cannot assess the role (if any) that the ‘science of refraction’ may have played in Galileo’s development of the telescope, but it is very clear that such a presentation was effective in casting an aura of distinction around himself and his instrument – a distinction he surely needed to play the patronage game. Effectively, Galileo tried to claim that there were two species of telescopes – one discovered by accident by the Dutch spectacle maker and one discovered through reason by Galileo himself. Galileo’s emphasis on the modality of his discovery of the telescope’s ‘secret’ seeks to achieve something more than simply conferring on Galileo the aura of the natural philosopher (in contrast to Lipperhey’s merely artisanal status). What Galileo was trying to do, I think, was to say that his telescope was different from all others because it was conceived and produced by different means. It was different because it was genea-

---

<sup>39</sup> Also to patronage logic we may trace Galileo’s decision to mention in print only the first telescope presented to Count Maurits in the Netherlands, while skipping the dozens that had been sold and shown around Europe by the summer of 1609 – a population that would have impaired Galileo’s claim to uniqueness. It also seems that, in an attempt to make the origin of the telescope a bit less humble and a little more Medici-compatible, Galileo referred to the original discoverer as ‘a certain Dutchman,’ but refrained from saying that he was an ignorant artisan (which he effectively said years later in *The Assayer*: ‘The Hollander who was first to invent the telescope was a simple maker of ordinary spectacles [...]’ Cf. Van Helden, *Invention* (1977), 53). Disparaging the original maker would have cheapened Galileo’s own gift in 1610, but could be brought up two decades later, when his patronage relationship with the Medici was a long established fact. In sum, Galileo had plenty of good patronage reasons for writing a vague narrative about his development of the telescope.

logically different.<sup>40</sup> And Galileo could try to claim the authorship of that specific genealogy (and of the product that resulted from it). While I am skeptical about Galileo's claims of the role of the 'science of refraction', 'perspective', and 'reason' in his achievement, it is easy to see how crucial those claims were to constitute him as an author.

### *Galileo's chronologies*

Having reviewed Galileo's possible reasons for writing vague narratives about his development of the telescope (including vague gestures toward the role of the 'science of refraction' in that process), we need to look at the narratives themselves and see how they are challenged by Sarpi's letter to Castrino, dated 21 July.

The *Nuncius*' story is not only vague, but also very difficult to reconcile with the one in *The Assayer*. Taking mid-March 1610 (the date on which the *Nuncius* came off the press in Venice) as the chronological benchmark for his statement that, 'about 10 months ago a rumor came to our ears that a spy-glass had been made by a certain Dutchman...' that would place the rumor around 15 May 1609. (This sounds remarkably late, given that his friend Sarpi received the same rumor in early November 1608 and that the two were in

---

<sup>40</sup> If you think this is strange, try Favaro 'La invenzione del telescopio' (1907/1968), 176: 'Quello che a noi parve di poter chiamare il 'periodo eroico' della storia della invenzione del telescopio incomincia il giorno in cui Galileo, poco importa il discutere se in Padova od in Venezia, sulla semplice voce, cioè *sine exemplo*, oppure dopo aver anche veduto uno di quei volgari tubi, la vista del quale ben poco poteva aggiungere alla sommaria descrizione che ne avesse udita o letta, costrui' da se' lo strumento e lo presento' alla Signoria.' ('That which it seems we can call the 'heroic period' of the history of the invention of the telescope began on the day – it makes little difference whether in Padua or Venice – on the simple rumour, that is without an example, or after having also seen one of these common tubes that could add little to the summary description which he had heard or read, constructed 'all by himself' the instrument and presented it to the Senate'). In this article, Favaro constructs a tripartite genealogy of the telescope: 'Fabled,' 'Embryonic,' and 'Heroic' – the latter phase starting with Galileo. That allows Favaro to admit that several, even many, people invented and re-invented the telescope prior to Galileo, but that Galileo was the first inventor of the last phase – the one that really counts, the period in which 'la conquista puo' dirsi compiuta e prelude a quell seguito di meraviglie con le quali gli astronomi, armati di strumenti e di mezzi [...] ci hanno resi oggi familiari' (the conquest can be said to be completed and a prelude to the subsequent miracles with which astronomers, armed with instruments and dimezzi have produced the familiar world of today'). In sum, he uses Galileo's astronomical discoveries (retrospectively) to confirm that his telescope was different (because others did not make those discoveries with other telescopes), and that Galileo, being the inventor of the telescope with which he made those discoveries, invented a 'different' telescope of which he was the first inventor. It is Galileo as the author of his discoveries, who constructs Galileo as the inventor of the telescope.

frequent contact).<sup>41</sup> Instead, Galileo's subsequent statement that 'The rumor was confirmed to me a few days later by a letter from Paris from the noble Frenchman Jacques Badovere' matches reasonably well with other things we know, namely that Sarpi had written Badovere on 30 March 1609 asking about the telescope, and that a complete correspondence cycle between Venice and Paris took about two months.<sup>42</sup> This would have placed Badovere's response in Venice toward the end of May – 'a few days' after 15 May.

It is at this point that, as Galileo put it, Badovere's letter 'finally caused me to apply myself totally to investigating the principles and figuring out the means by which I might arrive at the invention of the instrument, which I achieved shortly afterward on the basis of the science of refraction.'<sup>43</sup> If we take 'shortly after' to mean less than a week, then Galileo had illustrated out how to build the telescope sometime around 5 June. If, instead, we replace 'shortly after' with 'right away' (as it originally was in the manuscript of the *Nuncius*), then we get something like 30 May. It is a real puzzle, then, why Galileo would have kept the telescope to himself from early June until presenting it to the Venetian Senate on the 24<sup>th</sup> of August. (Even if we add up a couple of weeks in case the post was extra slow between Venice and Paris that summer, there would still be nine weeks between invention and presentation – a small eternity to somebody who, like Galileo, was keenly concerned with priority).

In addition to these questions, we need to consider the substantial incongruities between the chronologies of the *Nuncius* and *The Assayer*. For instance, the statement in the *Nuncius* that hearing of Badovere's response, 'finally caused me to apply myself totally to investigating the principle ...' is re-elaborated in *The Assayer* as:

I wrote [in the *Nuncius*] that in Venice [...] news came that a Hollander had presented to Count Maurits [of Nassau] a glass by means of which distant things might be seen

---

<sup>41</sup> Favaro: 'È strano, stranissimo, anzitutto, che la notizia dell'invenzione olandese, pervenuta a Venezia nel novembre 1608, come già abbiamo notato, non sia giunta agli orecchi di Galileo che nel giugno dell'anno successivo, e che il Sarpi, che ne era al fatto, non ne abbia tenuto parola all'amico suo o non gliene abbia scritto[...]' ('It is strange, very strange, very strange, above all that the news of the Dutch invention, which had arrived in Venice in November 1608, as we have already noted, did not reach the ears of Galileo until June of the following year, and that Sarpi, who was up on the facts, did not tell his friend or did not write to him.'). Favaro, 'Il Telescopio' (1883/1966), 277. Add Reeves, *Galileo's Glassworks*, 135 on Galileo's possible contact with Badovere much earlier, in late 1608. Also add that Vincenzo Viviani's 'Life of Galileo' places that rumour a little earlier 'around April or May 1609.'

<sup>42</sup> Paolo Sarpi to Giacomo Badoer, 30 March 1609, in Sarpi, *Opere* (1969), 282.

<sup>43</sup> Galileo, *Sidereus Nuncius or Sidereal Messenger* (1989), 37.

as perfectly as if they were quite close. [...] Upon hearing these news, I returned to Padua [...] and set myself to thinking about the problem. The first night after my return, I solved it, and the following day I constructed the instrument and sent word of this to the same friends in Venice with whom I had been discussing the subject the previous day.<sup>44</sup>

In the *Nuncius* Galileo clearly separates hearing the news of the Dutch telescope, receiving Badovere's confirmation 'a few days later', and developing his telescope 'shortly after' seeing Badovere's letter. In *The Assayer*, however, the whole action is packed in one day: Galileo heard of the presentation of the telescope to Count Maurits in The Hague while discussing with friends in Venice about the telescope (which, one has to assume, included the contents of Badovere's letter), returned to Padua immediately and discovered the 'secret' of the telescope that same night. I am not necessarily questioning this dramatically compressed chronology presented in *The Assayer*, but simply want to point out that if one reconstructs the whole chronology laid out in that book (as Edward Rosen, Stillman Drake, and Antonio Favaro have done) then the day of the Galileo's invention of the telescope would have to be placed around 4 August (Drake) or 18 July (Rosen) or 15 July (Favaro) and *not* at the very beginning of June as implied by the *Nuncius*.<sup>45</sup> Perhaps the chronological vagueness of the *Nuncius*' narrative may have been intended to suggest that Galileo had developed his telescope earlier than he actually did, thus casting him as a relative forerunner rather than a follower, but there is really no way to know.

The chronology of the *Nuncius* loses further credibility when we consider a meeting that Galileo had with Piero Duodo regarding the improvement of his contract at the University of Padua toward the end of June.<sup>46</sup> Had Galileo developed the telescope by then (as *any* reading of the *Nuncius* would imply he should have), he would have brought that up with Duodo as leverage. Of course the *Nuncius*' chronology would become much more tenable and closer to that of *The Assayer* if one tweaked the 'about 10 months ago' mentioned in the printed version with something closer to the 'about 8 months ago' found in the manuscript, but that would only show how unreliable the printed version

---

<sup>44</sup> Galileo, *The Assayer*, in Van Helden, *Invention* (1977), 52.

<sup>45</sup> Rosen, 'When Did Galileo Make His First Telescope?' (1951), 50; Drake, 'Galileo's First Telescopes at Padua and Venice' (1959), 251. The letter to Landucci (29 September 1609) says 'about two months ago.' Galileo *Opere*, vol 10 (1900), p. 253.

<sup>46</sup> Duodo refers to that conversation in a 29 June letter to Galileo from Venice: Galilei, *Opere*, 10 (1900), 247. The letter is discussed in Drake, 'Galileo's First Telescopes at Padua and Venice' (1959), 250.

of the chronology really is.

I agree with Drake that it makes sense to concentrate on the chronology in *The Assayer* because it contains more specific references – ‘the same night’, ‘the following day’, ‘six days later’, etc. Probably Galileo decided to add more details in 1623 because by then the patronage relation with the Medici was already cemented and he no longer needed to stick to his initial minimalist story – not to mention that he needed to invoke some additional evidence to counter what he saw as Grassi’s questioning of his claim to inventorship. He still avoided specific dates but, luckily, he referred to an event whose date we can pinpoint: ‘Finally [...] I presented it to the ruler in a full meeting of the Council. How greatly it was esteemed by him [...] is testified by the ducal letters still in my possession.’ This was Galileo’s presentation of the telescope to the Venetian Senate on 24 August 1609, and the ‘ducal letters’ were written and signed on the 25<sup>th</sup> of August.<sup>47</sup> Anchoring ourselves on these two safe chronological posts, we can then attach specific days to the events listed in *The Assayer*.

Starting with end of the story (in 24-25 August), and moving backwards while considering the dates on Galileo was reliably in Padua (based on letters he wrote or entries he made in his accounting ledger), Drake has reconstructed the following timeline, which include a few interpretive interpolations involving events he could not safely pin on specific dates:

- ca. 19 July Galileo leaves Padua to visit friends at Venice.
- 20 July ff. He hears rumors of the Holland instrument for the first time and listens to discussions pro and con.
- ca. 26 July He visits Sarpi to ask his opinion and is shown corroborating letters, perhaps including one from Badovere.
- ca. 1 August He hears that a foreigner has arrived at Padua with one of the instruments and is exhibiting it here.
- 2 or 3 August He returns to Padua, but learns that the stranger has already departed for Venice to sell the ‘secret.’ He attempts to deduce the construction of the instrument, using information from letters and descriptions by those who have seen it.
- 4 August He verifies by trial that suitably separated convex and concave lenses will enlarge distant objects. He sends word to Venice (probably to Sarpi) that he has the ‘secret.’
- 5-20 August He succeeds in constructing an instrument of about ten diameters

---

<sup>47</sup> Galilei, *Opere*, 19 (1908), 115-117; *ibidem*, 10 (1900), 250-251.

magnification, and sets out again for Venice. [This is the period that Galileo referred to as ‘more than a month’, but that Drake argues that it must have been ‘less than two weeks.’]<sup>48</sup>

21 August He exhibits this instrument to official from the Tower of St Mark.

24-25 August He exhibits the telescope to the Signoria and the Senate.

Notice the strong match between Drake’s placement of Galileo in Venice and hearing rumors about the telescope starting on 20 July, with Sarpi’s saying to Castrino on 21 July that: ‘it has arrived here, that spyglass’ – an event that, as we have seen, could have happened anytime between 8 July and 21 July.<sup>49</sup> This means that what Galileo heard in Venice was not just a ‘that a Hollander had presented to Count Maurice [of Nassau] a glass by means of which distant things might be seen as perfectly as if they were quite close. That was all.’<sup>50</sup> What Galileo must have heard during the conversations he mentions was, at a minimum, Sarpi’s detailed description of an actual instrument.

Sarpi’s letter also allows us to fix a problem in Drake’s reconstruction. Not knowing about this letter, Drake hypothesized that Galileo, about a week after arriving in Venice around 20 July, heard that a stranger was displaying a telescope in Padua. Drake hinged this reconstruction on a letter by Lorenzo Pignoria on that subject, dated 1 August.<sup>51</sup> Based on that, Drake assumed that Galileo rushed back from Venice to Padua around 2 or 3 August to catch a glimpse of the telescope. But according to Drake’s hypothetical narrative, Galileo failed to see the telescope because by the time he got to Padua the foreigner had already moved on. Sarpi’s letter, however, indicates that Galileo had no need to rush back to Padua to catch a glimpse of the telescope because the telescope was right there in Venice when he got there on 19 or 20 July.

As a result of this imagined detour, Drake effectively gave Galileo ‘a late start’ on the telescope. He placed Galileo’s remark that ‘The first night after my return [to Padua], I solved it’ at 2 or 3 August, when in fact Sarpi’s letter shows that those lines must have referred to events that took place around 21 July. But while Drake attributed an incorrect late start to Galileo, he still had to put that together with the 24 August date on which Galileo presented the telescope to the Senate. As a result, he compressed the time between the development of

---

<sup>48</sup> Drake, ‘Galileo’s First Telescopes at Padua and Venice’ (1959), 249.

<sup>49</sup> Sarpi, *Lettere ai Protestanti*, 2 (1931), 45.

<sup>50</sup> Galileo, *The Assayer*, in Van Helden, *Invention* (1977), 52.

<sup>51</sup> Lorenzo Pignoria to Paolo Gualdo, 1 August 1609: ‘[...] Uno degl’occhiali, di che ella mi scrisse già’, e’ comparso qui in mano d’un Oltramontano’ (‘One of the glasses about which you write me has already arrived here in the hands of a foreigner’), in: Galilei, *Opere*, 10 (1900), 250.

the telescope and its official presentation, concluding that Galileo's statement that he showed the telescope around in Venice for 'more than a month' after building it had to be taken to mean 'less than two weeks.' But if we revise Drake's chronology according to the evidence provided by Sarpi's letter of 21 July, we then see that Galileo claim of having had the telescope for more than a month prior to showing it to the Senate was almost correct. Having developed the telescope earlier, he did show it around for longer prior to the 24 August presentation. I propose, therefore, the following revised chronology:

18 July:Galileo in Padua (ledger entry).

ca.19- 20 July Galileo in Venice. Hears full report from Sarpi or perhaps sees the telescope itself.

ca. 21 July Galileo back in Padua: 'Upon hearing these news [in Venice], I returned to Padua, where I then resided, and set myself to thinking about the problem.'

ca. 21 July Galileo uncovers the 'secret' of the telescope: 'The first night after my return [to Padua], I solved it.'

ca. 22 July Galileo builds prototype: 'the following day I constructed the instrument and sent word of this to the same friends in Venice with whom I had been discussing the subject the previous day.'

ca. 27 July Galileo takes his 9-power telescope to Venice: 'Immediately afterwards, I applied myself to the construction of another and better one, which I took to Venice six days later.'

24 August '[The telescope] was seen with great admiration by nearly all the principal gentlemen of the that republic for more than a month on end.' This is not quite the 'more than a month' mentioned by Galileo, but it is much closer to that than the 'less than two weeks' attributed to him by Drake. This period may have been a day longer if Galileo left Padua for Venice on July 18 right after making an entry on his ledger, and returning a day earlier.

- 21 August Exhibits the telescope to some Venetian gentlemen and senators (as described in Priuli's 'Cronaca').<sup>52</sup>
- 24 August 'I presented [the telescope] to the ruler in a full meeting of the Council.'
- 25 August '[...] ducal letters [...] reappointing and confirming me for life to my professorship at the University of Padua.'

### *Rosen amended*

Like Drake, Edward Rosen has offered a reconstruction of Galileo's chronologies, coming up with a substantially earlier date for Galileo's invention – sometime between 5 July and 19 July. The difference between Rosen and Drake has much to do with their sources. Drake looked at both *The Assayer* and Galileo's correspondence, but also at the dates of Galileo's bookkeeping entries, using them as evidence of his presence in Padua. Rosen did not look at Galileo's ledger, thus allowing for the possibility of Galileo being in Venice and performing the tasks described in *The Assayer* when, in fact, he could not have been there. Rosen also tried (and failed) to reconcile Galileo's various chronologies ending up (after some ad hoc adjustments) with a 5-19 July 'window of invention' – 19 July being the latest possible date allowed by his reconstruction.<sup>53</sup>

---

<sup>52</sup> Dalla Cronaca di Antonio Priuli: '21 Agosto. Andai io [Antonio Priuli], Geronimo Priuli Procurator in Campanil di S. Marco con l'Eccellente Gallileo, et [...] l'Eccellente Dottor Cavalli, a vedere le meraviglie et effetti singolari del cannon di detto Gallileo, che era di banda, fodrato al di fuori di rassa gottonada cremesina, di longhezza tre quarte ½ incirca et larghezza di uno scudo, con due veri, uno [...] cavo, l'altro no, per parte; con il quale, posto a un occhio e serando l'altro, ciasched'uno di noi vide distintamente, oltre Liza Fusina e Marghera, anco Chioza, Treviso et sino Conegliano, et il campanile et cubbe con la facciata della chiesa de Santa Giustina de Padoa: si discernavano quelli che entravano et uscivano di chiesa di San Giacomo di Muran; si vedevano le persone a montar e dismontar de gondola at traghetto all a Collona nel principio del Rio de' Verieri, con molti altri particolari nella laguna et nella citta' veramente amirabili. E poi da lui presentato in Collegio li 24 del medesimo, moltiplicando la vista con quello 9 volte piu'' ('August 21. I [Antonio Priuli], Geronimo Priuli, Procurator of the Tower of St Marc, went with the excellent Mr. Galileo, [...] and the excellent Dr. Cavalli to see the marvels and singular effects of the tube of the said Galileo. It was made of tin, decorated on the outside with light red cotton satin, about three quarters and ½ braccia long, the diameter of a scudo, with two glasses, one [...] concave and the other not, on each side. With it, looking with one eye while keeping the other shut, each of us saw distinctly beyond Liza Fusina and Marghera, also Chioggia and Treviso and even Conegliano and the belltower and [...] the façade of the Church of Saint Giustina in Padova. We could see those entering and exiting the Church of Saint Jacob in Murano, and the people who climbed on and off the gondole at the ferry at the column near the beginning of the Rio de' Verieri, and many other truly admirable details in the lagon and the city. [This instrument] was then by him presented to the Senate on the 24th of the same month. It magnifies 9 times.' (Galilei, *Opere*, 19 (1908), 587).

<sup>53</sup> Rosen, 'When Did Galileo Make His First Telescope?' (1951), 50.

According to Drake, 19 July is the earliest date by which Galileo could have arrived in Venice from Padua, thus starting the chain of events ending up with his invention. Rosen assumes instead, that by 19 July at the latest Galileo was already back in Padua with his telescope. The scenario that best matches the accounting schedule, *The Assayer's* chronology, and Sarpi's letter is, I think, the one I have just presented above – an amended version of Drake's chronology. There are, however, two additional scenarios that could technically match Rosen's reconstruction while also taking into account the additional evidence he left unused.

If we assume that the dates on Galileo's accounting ledger match the dates on which he made them, then Galileo was in Padua on 23, 28, 29 June; 6, 11, 18 July; and 3, 10 August.<sup>54</sup> He wrote to Florence from Padua on 3 July, citing an illness.<sup>55</sup> There are, however, two intervals (11-18 July and 6-11 July) in which Galileo could have gone to Venice and quickly returned to Padua after having heard a detailed description of the foreigner's instrument from Sarpi. For the latter window to work, however, the telescope would have had to arrive in Venice right after Sarpi's 7 July letter to Castrino. The second window – 11-18 July – would be more probable in that regard. Both of them, however, would increase the amount of time between Galileo's invention and the presentation to the Senate (a six-week period in which his telescope would have been in Venice without anyone mentioning it).<sup>56</sup>

While technically possible, these earlier windows of invention do not look probable. If Galileo had a telescope as early as 6 July, why did he not rush to present it to the Senate *before* the foreigner had a chance to do so? If he already had an 8- or 9-power telescope by early or mid-July, why would he have risked missing on financial rewards and the recognition of his inventorship? This makes me side with Drake over Rosen. I think Drake got the wrong date but through the right reasoning. He understood that, contrary to Galileo's public narratives, what got his telescope-making program in high gear were not the reports of the invention of the telescope but rather the news of the actual arrival of the instrument in Venice. What I have done here is to show that the

---

<sup>54</sup> Galilei, *Opere*, 19 (1908): 23 June (158), 28 June (145, 165), 29 June (174), 6 July (197), 11 July (145), 18 July (145, 166), 3 August (166), 10 August (166). The page numbers in parentheses refer to the bookkeeping entry for the dates that precede them.

<sup>55</sup> Enea Piccolomini to Galileo Galilei: 'La gratissima di V.S. delli 3 di Luglio [...]. Mi duole poi in estremo della sua indisposizione [...]' ('The most welcome letter of Your Lordship of July 3 [...] It pains me very much to hear of your health problems'). Galilei, *Opere*, 10 (1900), 254-255.

<sup>56</sup> The first independent mention of Galileo's telescope is Priuli's 'Cronaca' entry for 21 August 1609, Galilei, *Opere*, 19 (1908), 587.

news arrived earlier than previously assumed, and that Galileo got more than just the news.

*Galileo & Sarpi revisited*

The long-standing debate over Sarpi's contribution to Galileo's work has been typically framed in terms of philosophical and theoretical influences: suggestions or full-fledged theories that Sarpi may have communicated with Galileo about mechanics, optics, tides, and magnetism. What Sarpi's letter to Castrino brings up, instead, is a less philosophical and more mundane contribution – something like technology transfer.

Until now, there were two main pieces of evidence linking Sarpi to the development of Galileo's telescope – traces that now gain new meaning and robustness in light of Sarpi's letter to Castrino. The first was a letter from Giovanni Bartoli (the secretary of the Medici representative in Venice) who, writing to the Florentine court on 29 August 1609 claimed that:

It is reported that the foreigner who came here with the secret [of the telescope], having heard from I do not know whom (some say from Brother Paolo, the Servite theologian) that he was not going to get anything by pretending 1,000 zecchini, he departed without any making any further effort. And therefore, being Brother Paolo and Galileo friends, and having him given an account of the secret he had seen, people say that Galileo, through his own reasoning and with the help of another similar instrument (but not a very good one) from France, sought the secret and found it..<sup>57</sup>

Bartoli's letter was largely dismissed as motivated by unfriendliness toward Galileo, which Bartoli had indicated elsewhere in his correspondence.<sup>58</sup> Setting aside the issue of bias, Bartoli's remarks have previously seemed irrelevant to the genealogy of Galileo's telescope because by the time he wrote that letter (August 29) Galileo had already presented his telescope to the Venetian Senate on (August 24).<sup>59</sup> Bartoli did mention the foreigner's presence in Venice and his attempt to sell his telescope to the Senate in an earlier August 22 letter to Florence, but we have reliable reports that Galileo was already demonstrating

---

<sup>57</sup> Giovanni Bartoli to Belisario Vinta, 29 August 1609: Galilei, *Opere*, 10 (1900), 255.

<sup>58</sup> Parenthetically, the last part of the report suggests the presence of two telescopes in Venice – one inspected by Sarpi and a second ('French') instrument allegedly used (owned?) by Galileo.

<sup>59</sup> Galileo Galilei a Giovanni Donato [Doge of Venice], 24 August 1609, Galilei, *Opere*, 10 (1900), 250-251; 'Deliberazione del Senato,' 25 August 1609, Galilei, *Opere*, 19 (1908), 115-116; 'Ducale,' Galilei, *Opere*, 19 (1908), 116-117.

his telescope to Venetian patricians on August 21.<sup>60</sup> It was therefore easy to assume that Galileo had already built his telescope by the time Bartoli reported an alleged exchange between Sarpi and Galileo. However, this all changes – dramatically so – once we realize that Sarpi's July 21 letter to Castrino indicates that Bartoli may have been lagging behind in his correspondence with Florence. Some of the events he wrote about on August 22 and 29 could have taken place (or were at least set in motion) significantly earlier.

Furthermore, there is a report of what appears to be the same exchange in the 'Life of Fra Paolo Sarpi' written several years later by one of his closest friends and collaborators, Fulgenzio Micanzio – a scholar who had direct access to Sarpi's documents and recollections:

The manufacture of the spyglass known in Italy as Galileo's (but invented in the Netherlands) was discovered by him when [the instrument] was presented to the Doge with a request of a 1,000-zecchini reward. Brother [Paolo] was put in charge of testing its uses and give a report, but because he was not allowed to open it up and inspect it, he guessed what he could. He then shared this with Mr. Galileo (who thought that Sarpi had got it right), as well as with others.<sup>61</sup>

This passage should be taken seriously. No doubt Micanzio was eager to give Sarpi some posthumous credit for the development of the telescope, but he was by no means an enemy of Galileo's. He supported him during the trial, attempted to publish his *The Two New Sciences* in Venice a few years later and, when that proved unfeasible, he facilitated the transfer of Galileo's manuscript to Amsterdam to have it published by the Elseviers. Furthermore, Micanzio's and Bartoli's reports seem to be independent of each other. As Micanzio would have had no need to rely on Bartoli's information, the remarkable similarity between the two reports indicates that they came from same source, most

---

<sup>60</sup> Priuli, 'Cronaca,' in Galilei, *Opere*, 19 (1908), 587-588.

<sup>61</sup> Fulgenzio Micanzio 'Vita del Padre Paolo': 'L'occhiale, detto in Italia del Galileo, trovato in Olanda, fu da lui [Galileo] penetrato l'artificio quando, presentandone uno alla serenissima signoria con dimanda di mille zecchini, fu al padre dato carico di far le prove a che potesse servire e dirne il suo giudizio; e perche' non gl'era lecito aprirlo e vedere, imagino' cio' che potesse, e lo conferi' col signor Galileo, che trovo' il padre aver dato nel segno; e tanti altri,' in: Sarpi, *Istoria del concilio tridentino*, 2 (1974), 1372-1373.

likely Sarpi himself.<sup>62</sup>

This passage from the 'Life of Fra Paolo' seems to have gone largely unused by Galileo scholars possibly due to the fact that Micanzio failed to attach a specific date to the events he was describing. It did not help, of course, that Favaro decided not to include this text in the *Opere*. (Incorrectly believing it to be an anonymous text of dubious origin – not a biography written by Micanzio – Favaro took the whole 'Life of Fra Paolo' to be untrustworthy).<sup>63</sup> But if we agree that, given their strong resemblance in content and structure, Micanzio's narrative and Bartoli's letter refer to the same events, and that Sarpi is referring to the foreigner's instrument when he writes on July 21 that the telescope has arrived in Venice, then these three pieces of evidence gel with each other (and with the *The Assayer's* chronology) to provide a substantially new picture of Galileo's development of the telescope.

As relayed by Micanzio, Sarpi did not provide Galileo with a full disclosure of the 'secret' of the telescope, but rather with a close description and some thoughts about how it functioned – guesses Galileo seemed to agree with. Still, by reporting to him the overall dimension of the instrument, the approximate diameter of the lenses, and the fact that the objective lens was convex and the eyepiece concave, Sarpi could have put Galileo very close to the 'secret' of the telescope (if there was any secret left at that point), and helped him to narrow down the range of further experimentation to the focal length of the two lenses or, if we follow Rolf Willach's recent work, the diaphragm applied in front of the objective lens.<sup>64</sup> Sarpi's detailed input may account not only for Galileo's initial development of the telescope, but also for the exceptionally short time – about 24 hours – he claimed it took him to get there.

What Sarpi's technology transfer does not account for, however, is the development of Galileo's subsequent higher-power instruments – 9X, 20X, and finally 30X. Still, as discussed by Albert Van Helden in this volume, those developments were much more material than theoretical – expanding grinding and polishing techniques beyond those of traditional spectacle-makers to handle larger blanks and produce weaker convex lenses, selecting the best kind of glass (flat mirror glass), and produce tens of lenses from which to select only

---

<sup>62</sup> A recent book by Filippo de Vivo mentions a Giovanni Bartoli – a lawyer active in Venice in this exact period – connected to Sarpi's unorthodox religious networks and its nodes, including the 'Golden Ship' (De Vivo, *Information and Communication in Venice* (2008), 125. The Golden Ship was the shop of Bernardo Sechini, where Sarpi, Galileo, Acquapendente, and Asselinau regularly convened. (Favaro, 'Galileo e Venezia,' 2 (1966), 87).

<sup>63</sup> Favaro, 'Il telescopio' (1883/1966), 268.

<sup>64</sup> Willach, *The Long Route* (2008), part 5.

a handful of suitable ones, and so on.<sup>65</sup> The ‘secret’ of the telescope, therefore, appears to have been closer to a ‘guild secret’ than to a theoretical understanding of telescope optics.<sup>66</sup>

Finally, if we properly understand Sarpi’s role in this process we do not need to speculate – as Drake did – that Sarpi may have blocked the foreigner’s application to favor his friend.<sup>67</sup> Sarpi was, no doubt, a friend of Galileo’s but he was first and foremost the *Consultore* of the Republic doubling as technical expert on *res telescopica*. Having written Castrino that, ‘[I] don’t value it at all for its military uses, either on land or at sea,’ it would seem that Sarpi ended the foreigner’s bid not because of his friendship with Galileo, but because of his telescope’s poor performance relative to the 1,000 *zecchini* he demanded. Furthermore, being an *ex parte* examiner for the Republic, it would have been expected of Sarpi (and ethical according to the technology transfer customs of the time) to pass on to Galileo (as local talent, not just a personal friend) whatever information could have enabled him to come up with a better instrument that could then be offered to the Senate.<sup>68</sup> Sarpi may have viewed Galileo as a means for achieving the (Venetian) common good.<sup>69</sup> And indeed, he ended up helping them both.

#### *Galileo and the ‘oltramontano’*

Sarpi’s letter connects Galileo’s invention of the telescope to the foreigner’s instrument, but it says little about the timeframe of that technology transfer.<sup>70</sup> For instance, did Sarpi view and look through the foreigner’s telescope prior to being asked by the Senate to evaluate it? How long did the foreigner stay in Venice? Were Bartoli’s reports of the demise of the foreigner’s application as out of date as they appear to be, or did they indicate that the evaluation process of the foreigner’s telescope did indeed drag into August? (This is not unreasonable, as it would have taken some time for the *Oltramontano* to develop

---

<sup>65</sup> Van Helden, ‘Galileo and the Telescope,’ this volume.

<sup>66</sup> Biagioli, *Galileo’s Instruments of Credit* (2006), 116, 120.

<sup>67</sup> Drake, ‘Galileo’s First Telescopes at Padua and Venice’ (1959), 250-note 15.

<sup>68</sup> ‘Finally, at the suggestion of one of my friendly patrons, I presented it to the ruler in a in a full meeting of the Council.’ (Galileo, *The Assayer*, cited in: Van Helden, *Invention* (1977), 52). It is possible that the ‘patron’ mentioned here was Sarpi.

<sup>69</sup> This fit the logic (and ethics) of early modern patent law, as first promoted and then articulated in Venice.

<sup>70</sup> Based on other letters, we know that Venice was quickly becoming populated with more telescopes in August, suggesting that Galileo may have seen or heard about other telescopes as well, as suggested by Bartoli’s report of 22 August.

the appropriate connections with the Venetian bureaucracy and Senate to float his proposal).

Sarpi could have already recommended the Senate against the foreigner's offer by the time he wrote to Castrino on 21 July. But it is as likely that he was still in the process of evaluating the instrument, and passing crucial information to Galileo along the way. If that were the case, it could explain the remarkable rush with which Galileo got to work on the telescope, and the urgency with which he immediately sent news back to Venice about his invention: 'the following day I constructed the instrument and sent word of this to the same friends in Venice with whom I had been discussing the subject the previous day.'<sup>71</sup> Perhaps he wanted to let Sarpi and other officials know that he was in the running too, and that they should wait before deciding on the foreigner's device?<sup>72</sup>

Given the circumstances, a 'race to the Senate' might have then developed between the foreigner and Galileo. If, for instance, Bartoli's report of 22 August that 'many have seen and tested [the foreigner's telescope] from St Mark's bell-tower' is chronologically accurate, that would make that test virtually contemporaneous with Antonio Priuli's report of having seen 'those marvelous and singular effects of Galileo's tube' together with some Venetian notables on 21 August.<sup>73</sup> Up and down St Mark's tower, the two telescopes may have been publicly tested in the same days.

### *Conclusion*

These last remarks are hypotheses that we may be able to test in the future, if new documents surface. Still, the fact that Sarpi's letter to Castrino has been hiding in plain sight for almost two centuries suggests that we may not have asked all the questions we could have. In particular, we have been too eager to accept Galileo's narratives as descriptions rather than discursive instruments. Sarpi's letter has brought up some of the chronological and empirical problems in these narratives, but one can find other tensions as well. Consider, for instance, Galileo's predicament in the narrative of invention he presented in *The Assayer*.

---

<sup>71</sup> Galileo, *The Assayer*, cited in: Van Helden, *Invention* (1977), 52.

<sup>72</sup> It would seem, in any case, that those 'same friends in Venice' mentioned by Galileo must have been very few and quite tight-lipped to account for the 'media silence' over Galileo's telescope for the six weeks until the test on 21 August witnessed by Priuli.

<sup>73</sup> Galilei, *Opere*, 10 (1900), 250; *Ibidem*, 19 (1908), 587.

In it, Galileo is caught between rebuffing Grassi's accusation that the telescope was not his child but only his pupil, while also having to acknowledge that the telescope did have a Dutch father already. This would not have been a problem in the economy of inventions, where there could be as many inventors of the telescope as there were countries. Claiming local (that is, Venetian) inventorship of the telescope would have allowed Galileo to acknowledge extensive borrowings from foreign inventors (as they had no relevance for that definition of inventorship). But Galileo, trying to develop the right profile for a recipient of princely patronage, decided to cast himself as a 'purer' inventor. What Grassi did was to force Galileo to confront the problems he had created for himself by adopting that illustration.

In turn, Galileo tried to evade the paradox of claiming to be the biological father of a child who already had a biological father by positing the existence of two types of telescopes – one accidentally fathered by the Dutch spectacle maker, and a very different one fathered by Galileo through reason. That is, in *The Assayer* he did not argue that he was the inventor of a telescope that was unique by virtue of having better resolution and enlarging power than all previous instruments. (That would have been an engineer's argument, and Galileo, eyeing the court, did not want to cast himself as an engineer, not even a very good one). He claimed, instead, a kind of inventorship defined by a specific process of invention (a reason-based one) rather than by the quality of the product resulting from that process.

The issue here is not whether these two breeds of telescope existed or not, whether one could tell them apart, or whether they were twins or distant cousins. The point is to recognize that Galileo's narrative is not an empirical answer to Grassi's accusation, but rather an attempt to reframe it in terms that would allow Galileo to come up with an answer – not necessarily a good answer, but something that looked like an answer. In other words, that Galileo's telescope was unique by virtue of having been produced not by chance but through 'reason,' 'the science of refraction,' and the 'knowledge of perspective' is a kind of conceptual product differentiation aimed at defining an object that Galileo (and, in his narrative, only Galileo) could then claim inventorship for. In doing so, he was creating an opposition between him and his telescopes and the 'simple spectaclemakers' and theirs. But while there were of course substantial differences between Galileo's instruments and the others, there is no guarantee whatsoever that those differences could be reduced to the kind that Galileo had posited.

The same applies to the 'secret' of the telescope. No doubt, there were all sorts of steps and problems that needed to be sorted out in order to produce the kind of telescope Galileo was able to produce – problems that could easily

straddle the line between so-called practical and theoretical knowledges. But there are very good reasons to doubt that the concept of 'secret' would be able to adequately describe the nature of these challenges. As a concept, 'secret' seems overdetermined as Galileo's claims to inventorship based on the 'science of refraction': it is precisely the kind of object Galileo needed to be the inventor of in order to be able to cast himself as the kind of inventor he wanted to be.

As Galileo was 'inventing' the object we now call the 'telescope,' he was effectively inventing a new notion of invention and a new illustration of the inventor to go with it. That adds to the fun of tracing and retracing these materials, especially if we pay as much attention to his narratives and concepts of invention as we do to the material results of his innovation.