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THE DEVELOPMENT OF ASTRONOMY IN NAPLES: THE TALE OF TWO LARGE TELESCOPES MADE BY WILLIAM HERSCHEL

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Abstract: Mirrors and telescopes produced by William Herschel were popular in Europe, due to the opportunities they offered for deep sky observations. Leading public and private observatories acquired them to observe new objects in the Solar System, such as planets and asteroids, and strange stellar structures, stellar nebulae and clusters. After the establishment of the Chair of Astronomy at the University of Naples, it took thirty-four years before an observatory was built. Due to the commitment of Lord Acton, Naples became the first Italian city to host a telescope made by William Herschel. A few years later, Count von Hahn also bought a Herschel telescope for his private observatory in Germany, and at the time this was the largest telescope made by Herschel in mainland Europe. In this paper we recount the remarkable story of these telescopes by way of the scientific activities of the two astronomers who were associated with them, and how von Hahn's telescope eventually also ended up in Naples.

Keywords: Naples, Giuseppe Cassella, Friederich von Hahn, William Herschel, speculum mirrors

1 WILLIAM HERSCHEL AND THE PRODUCTION OF TELESCOPES WITH SPECULUM METAL MIRRORS

When he moved to Bath in England, the distinguished German-born astronomer and musician, Sir William Herschel (1738–1822), bought a small Gregorian telescope of 2.5 feet focal length not only to observe the sky with but, especially, to learn something about the construction of telescope mirrors. By October 1773 he had built his first Gregorian telescope (Hoskin, 2011) and on 1 March 1774 he observed the Orion Nebula and Saturn. The following year, he produced a Newtonian telescope, with an aperture of 4.5 inches and giving a magnification of up to 222×, with the aim of observing planets and stars. Soon Herschel turned his home into a workshop in order to construct his own telescopes. In 1778 he was able to manufacture excellent instruments with apertures as large as 10 inches. In comparison, at that time large and small European observatories were using Gregorian and Newtonian telescopes up to 9.4 inches in aperture and 6 feet in focal length made by Short and achromats up to 3.6 inches in aperture and 46 inches in focal length made by the Dollonds (see Holden, 1881). In 1780, Herschel (1780a) communicated his first paper to the Royal Society on observations of the variable star Mira Ceti, and in a second paper to the same Society he referred to one of his telescopes:

> I will now give an account of my own observations relating to the mountains in the Moon; but, perhaps, it may not be amiss to mention the instrument they were made with … that it may appear how far their accuracy may be depended upon. (Herschel, 1780b: 513).

The following year, on 13 March 1781, he wrote: "… in examining small stars in the neighbourhood of H Geminorum, I perceived one that appeared visibly larger than the rest ... I suspected it to be a comet." (Herschel, 1781: 492). In fact, he had discovered Uranus, or *Georgium Sidus* as he wanted to name it, in honour of King George III.

In 1795 Herschel wrote about his telescope-making exploits from 1781 onwards:

> In the year 1781 I began also to construct a 30-feet aërial reflector; and after having invented and executed a stand for it, I cast the mirror, which was moulded up so as to come out 36 inches in diameter. The composition of my metal being a little too brittle, it cracked in the cooling. I cast it a second time, but here the furnace, which I had built in my house for this purpose, gave way, and the metal ran into the fire.
>
> These accidents put a temporary stop to my designs, and as the discovery of the georgian planet soon after introduced me to the patronage of our most gracious King, the great work I had in view was for a while postponed.
>
> In the year 1783 I finished a very good 20-feet reflector with a large aperture, and mounted it upon the plan of my present telescope ... His Majesty was graciously pleased to approve it, with his usual liberality to support it with his royal bounty.
>
> In consequence of this arrangement I began to construct the 40-feet telescope, which is the subject of this paper, about the latter end of the year 1785. (Herschel, 1795:348-349).

Mirrors and telescopes[1] made by Herschel were an immediate success among amateur and professional astronomers in Britain and Europe. João Hyacintho de Magalhaens (1722–1790) was a good friend of Herschel and the High Deputy at the Courts of Spain and Portugal, and he had a mandate to buy several telescopes in London and Paris that would enrich the instrumental collections of some institutes on the Iberian Peninsula. In 1785 he wrote a letter to Johann Elert Bode (1747–1826), Director of the Berlin Observatory and President of Berlin's Science Academy, exalting and pronouncing the absolute integrity and reliability of Herschel's mirrors. In this letter, he invited all European observatories to acquire these extraordinary instruments for their observations of the sky:

> [Herschel] … promised me that he would produce under his supervision (merely to support the work of astronomy and not for his own interest) this sort of telescope of his own invention, which may be ordered for European observatories through me, and also that he will finish the mirrors with his own hands. A telescope of 7 foot focal length with all of the accessories of eyepieces and micrometer costs about 200 Guineas. They are very light and the mounting can be moved by a single person. The 10ft [focal length] telescope, of

> which he's making four for the King now, requires an expenditure of about 600 Guineas, and one of 20 feet, with all the needed movements included, costs 2500 to 3000 Guineas. I ask you to make this news of astronomical science known. (Magalhaens, 1785: 164).[2]

Nevil Maskelyne (1732–1811) for the Royal Observatory at Greenwich, James Archibald Hamilton (ca. 1748–1815) for Armagh Observatory and, on the European mainland, Bode for the Königsberg Observatory and Baron Franz Xaver von Zach (1754–1832) for Seeberg's Observatories, just to cite a few, were able to count on Herschel telescopes for their observations. In Italy, Father Giuseppe Piazzi (1746–1826) and Barnaba Oriani (1752–1832), Directors of the Observatories of Palermo and Milan, respectively, also bought Herschellian mirrors for their observatories (Spaight, 2004).

In collaboration with some laboratories in Bath run by Quakers, which smoothed down mirrors and metallic surfaces, Herschel was able to produce large mirrors with good reflectivity using speculum metal. James Gregory (1638–1675) and Isaac Newton (1642–1727) had not been able to achieve such results. Giovanni Santini (1787–1877), Director of the Padua Observatory, explained in his *Teorica degli Stromenti Ottici*, the construction techniques of the different kinds of telescopes. He wrote: "No doubt the goodness of a telescope depends on the accuracy of the mirror's shape, but the quality of the metal used plays a large and essential part." (Santini, 1828: 241).

The metal cast was speculum, an alloy of copper and tin, usually two parts of the former and one part of the latter, which was quite fragile. The use of speculum, with the same metals and similar proportions or diversifying the alloy composition, dates back to the ancient Chinese and Roman traditions of making sculptures of great value, and luxury mirrors, which were more reflective than those made of bronze.

The complete fusion of the alloy into a sheet of about one inch needed around 12 hours of cooking. Then, the speculum underwent an annealing process which consisted of heating it up to a temperature usually lower than its melting point. Then, the furnace temperature was slowly lowered. This cooling process could last for about 16 weeks. The annealing process allowed for the chemical and mechanical alteration of the material's microstructure by removing the defects in the crystalline structure and making the alloy more homogeneous and ductile for the subsequent stages of sanding and polishing. First, the surface was cleaned of iron rust using sesquioxide of iron, then it was ground to a parabolic shape, and finally the metal mirror was washed and treated with aqua regia, nitromuriatic acid. In this way, the surface would have a high degree of reflectance, of about 68% (Herschel, 1861).

To avoid a significant loss of light, Herschel thought to remove the secondary mirror from his telescopes. The primary was, therefore, slightly tilted with respect to the optical axis in order to focus the image at the top edge of the telescope tube. Image distortion produced by this tilt was made negligible by the long focal lengths of his mirrors. The exposure of the mirror to the air, however, produced strong oxidation of the surface. At night, the intense humidity amplified the oxidation. Thus, the mirrors required a continuous repolishing to maintain top performance. They had to be removed and polished without changing their curvature. For these reasons, telescopes often had two or more mirrors, which could be used alternately.

One of the first telescopes produced by Herschel was bought by Johann Hieronymus Schröter (1745–1816). Schröter, who was the Royal Secretary of George III of Hannover and was keen on music, knew Isaac Herschel, William's father. Schroeter's passion for astronomy translated initially into frequent successful observations of the sky: the Sun, the Moon and the planets. He moved to Lilienthal and in his garden he built an observatory, which he called the *Urania Tempel*. In 1791 he published *Selenotopographischen Fragmente*, with 43 plates of the lunar surface; in 1796 *Aphroditographischen Fragmente*, about Venus; in 1800 *Hermographischen Fragmente*, about Mercury; and in 1803 *Aerographischen Beiträge zur genaueren Kenntnis des Planeten Mars*, with detailed drawings of the red planet (Sheehan and Baum, 1995).

In 1783, Schröter bought the optics for a reflector of 4¾ inches diameter and 4 feet focal length for just 5 guineas, and three years later he purchased a mirror of 6.5 inches aperture and 7 feet focal length for 23 guineas.

"Actuated solely by an irresistible impulse to observe ….", Schröter (1785: 156) tried to make his own mirrors for his telescopes. In 1792, he met Johann Gottlieb Friedrich Schrader (1763–1833), Professor of Physics and Chemistry at Kiel University, who was also an amateur astronomer and studied methods of creating reflective metal mirrors. Schrader had experimented with some techniques that would increase their reflectivity, and he found the use of a thin coating of arsenic vapour on the surface of the speculum resulted in a considerable increase in reflectance. Schröter and Schrader then worked together on several mirrors, with focal lengths of 10, 12 and 13 feet.

Schröter placed Herschel's 7-ft telescope and his own 13-ft telescope (which he had manufactured with Schrader) on the ground floor of the octagonal tower of the *Urania Temple*, while upstairs were Herschel's 4-ft telescope and the 7-ft telescope made by Schrader. Schröter involved a gardener named Gefken in the fabrication of these telescopes. Gefken had learnt how to melt and polish metal mirrors which rivalled in size and reflectivity those made by Herschel, but his prices "… were very moderate and lower than those of British telescopes." (Notizie letterarie, 1810).

In 1793, Schrader and Schröter built a telescope with a mirror of 25 feet focal length for the *Urania Temple*, and the following year Schrader went back to Kiel and ground a mirror of 26 feet focal length for his own observatory. But Schröter's appetite for telescopes was insatiable, and he and Gefken then made a telescope with a mirror that had a diameter of 20 inches and a focal length of 27 feet (Schröter, 1796). This instrument is shown in Figure 1, and was the largest telescope in continental Europe, surpassed only by the gigantic 40-ft reflector that Herschel had installed near his home at Slough.

At about the same time in Italy there were also experiments to produce metallic mirrors that could compete with the German and British ones. Carlo Isimbardi (a cousin of the well-known poet and novel-

ist Alessandro Manzoni), who was appointed General Director of the Royal Mint by Napoleon, was a very well-read scholar of optical and mechanical sciences, and he did all he could to melt and work good metal mirrors. Then in 1810 Giovanni Battista Amici (1786–1863) completed a 5-ft Newtonian telescope in Milan.[3] The alloy used by Amici produced a more reflective surface than those obtained by Schrader and Herschel, but, it was much more fragile. Therefore, it was used almost exclusively for small mirrors.

From many experiments, Schrader was able to confirm that coating the surface with arsenic vapours could somehow reduce the continuous oxidation of the metal mirrors, and this technique also increased the mirrors' power. The development of the silvering process by Justus von Liebig (1803–1873) allowed for the use of glass mirrors, which were lighter than the metallic ones, and when the surface was covered by a thin layer of silver they gave far better performance. The last large speculum mirror was cast in 1867 for the 1.22-m Great Melbourne Telescope (Gillespie, 2011).

2 OBSERVATIONS BY GIUSEPPE CASSELLA WITH THE FIRST TELESCOPE MADE BY HERSCHEL THAT WAS BROUGHT TO ITALY

The last decade of the eighteenth century and the first decade of the new century were intense times, characterized by a remarkable sensitivity to astronomical investigations by Neapolitan institutions. Swayed by the great passion of the Royal scientists and notable men, Charles of Bourbon (1716–1788), the first King of Naples after centuries of Spanish Viceroyalty and Austrian rule, introduced the Chair of Astronomy in 1735, following his major reform of the University of Naples. The mathematician, Pietro di Martino (1707–1746) and his successors, having no instruments and rooms to observe from, were confined to a strictly theoretical teaching role:

> There were also men who were disciples of Galilei and Descartes, but unfortunately they also were missing a temple, supported by the King, where they could collect and disseminate the fruits of their knowledge, honouring the King and working for the common good. Charles of Bourbon encouraged the Arts, favouring the scientific gatherings of Celestino Galiani and the Ercolanense Society. (Mininni. 1914: 99).

Nevertheless, some Neapolitan colleges were devoted to the teaching of astronomy and to observation of the sky. A large collection of astronomical instruments was owned by the Royal College of Scuole Pie at San Carlo alle Mortelle and the Jesuit College, where the geocentric theories were taught. The Royal College, founded in 1737 by F. Nicola Severino, was an educational facility for fifty young gentlemen (von Zach, 1819)

> ... noble in lineage or fame, from six to ten years old, provided they have not been educated in another school, even briefly. They leave the college after turning sixteen, or nineteen at most. They are separated, according to age, in different dormitories, each one watched over night and day by one or two religious prefects and one assistant, and all of them are then overseen by the f. Minister. (Ajello, 1845: 42).

In 1751, Nicola Maria Carcani (1716–1764) became Rector of the Royal College. He reorganized the academic courses and assigned a room for an observatory, furnishing it with many good instruments, including telescopes, a quadrant and pendulum clocks. Among the observations made at the observatory, the solar eclipse of 25 October 1753 and the 6 June 1761 transit of Venus (Carcani, 1761) were notable. A report on the eclipse was presented at a meeting of the Royal Society of London and was published in *Memorie per Servire All'istoria Letteraria* (Carcani, 1753).

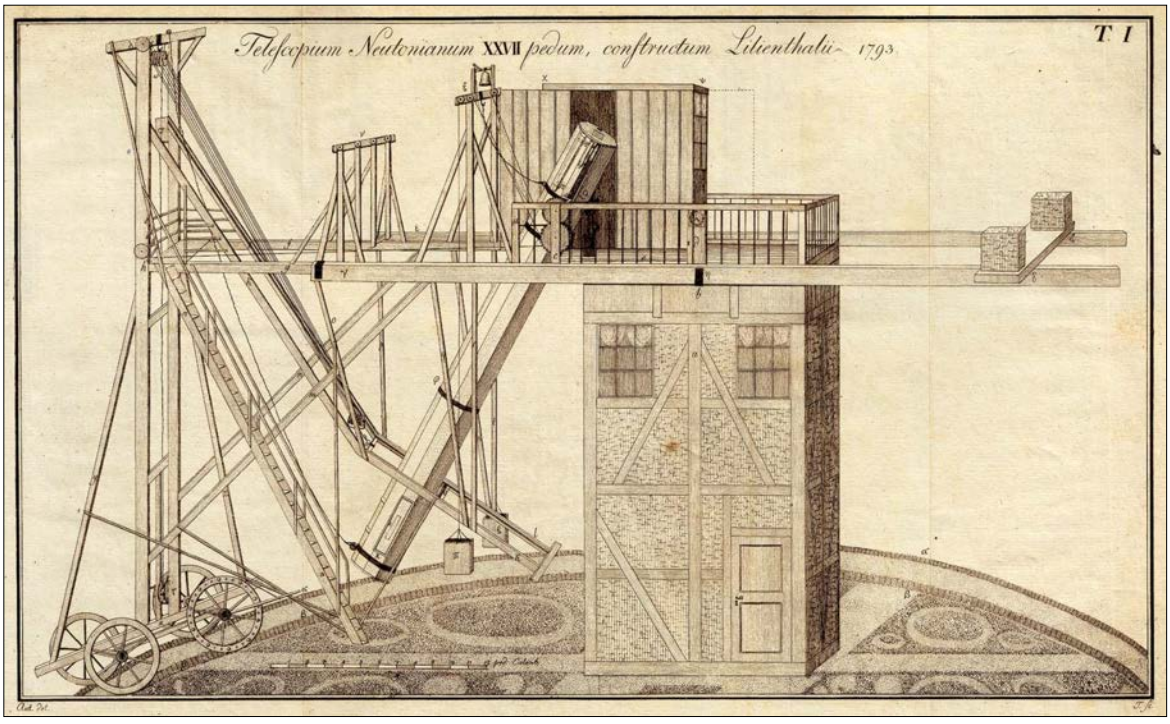


Figure 1: The 20-in aperture telescope manufactured by Schröter and Gefken and installed at the *Urania Tempel* in Lilienthal (courtesy: Library of Astronomical Observatory of Brera).

Other scientific facilities highly regarded by the astronomer Joseph-Jérôme de Lalande (1732–1807) when he visited Naples were the scientific room of the King in the Royal Palace and the observatory of Sir John Francis Edward Acton (1736–1811)—better known as Lord Acton. Equally impressive was the library of Prince Ferdinando Vincenzo Spinelli of Tarsia (1691–1753), which Lalande (1769: 200) described as "… unique for the number of good books, and for the richness and the ornaments of the rooms housing them …", while Troyli (1752: 241) commented: "… the eye has nothing more beautiful to desire." Lord Acton's Palace was near the College of Scolopi, and its "… open and wide horizon [was] a good reason to consider it very suitable to cultivate Astronomy." (Cassella, 1790: 145).

Giuseppe Cassella (1755–1808), a disciple of the mathematician Felice Sabatelli (1710–1786), specialized in astronomy at the Observatory of Padua, which was directed by Abbé Giuseppe Toaldo (1719–1797). Because of his skills he was offered a position to teach astronomy at the Episcopal Seminary of Padua. Cassella observed an occultation of τ Tauri on 5 May 1784 and published a report on this in *Saggi Scientifici e Letterarj dell'Accademia di Padova*. Toaldo referred to Cassella as "The Neapolitan young man highly expert in astronomy." (Occultatio, 1789: 310). In 1786, Cassella returned to Naples to accept the Chair of Nautical Astronomy at the Royal Navy Academy.

Although in Padua Cassella could collaborate with Toaldo and his assistant Vincenzo Chiminello (1741–1815) in observing from the tower of the observatory, he could not make astronomical observations in Naples. The Royal Navy and Science Academies, as well as the University, had not yet assigned any room for an observatory.

In 1791 King Ferdinando IV of Bourbon, on the initiative of Lord Acton and the Prince of Belmonte, Antonio Pignatelli, granted Cassella permission to install an observatory at the Palace of Cavallerizza which housed the University and the Academy of Science. Even before the project was completed Cassella managed to get some astronomical instruments for the education of the students and for his scientific studies. These were obtained from Pietro Napoli-Signorelli (1731–1815), the "… perpetual secretary of Sciences and Fine Letters combined …" (Napoli-Signorelli, 1788: 78). Since the creation of the Chair of Astronomy at the University of Naples, Cassella was the first royal astronomer to have access to telescopes for observing and teaching applied astronomy.

Following his return to Naples, Cassella could also count on using the private observatory of Lord Acton. The collection of instruments it housed was

> … one of the most valuable among others concerning the Navy. What must be mentioned ... among others, is a chronometer by Arnold, the famous craftsman, many good achromatic telescopes by Dollond and Ramsden, an Equatorial by one of the same Craftsman, several Compasses, many azimuth Compasses, Sextants by Ramsden, and Dollond; but, above all, an excellent Newtonian Telescope manufactured by Herschel, famous Craftsman and expert Observer at the same time. Acton purchased it in London not so long ago. *It is a particular and rare instrument, the only one owned in Italy*, and very few are found in Europe; it is surely at the top of this collection. However it should not be thought that these instruments were held for show, or in a cabinet, as they were definitely obtained so that they could be used for observations ... (Cassella, 1790: 145-146; my italics).

Even in *Dei Principali Movimenti e Fenomeni de' Corpi Celesti*, the first ephemeris journal published in Naples in 1788, Cassella described the new astronomical observations, the technological developments introduced by Herschel with his powerful telescopes, and the observations that he made which were published in the *Philosophical Transactions of the Royal Society*. Cassella (1788: 93) also talked about the new powerful telescope purchased by Lord Acton:

> H. E. the Chev. Acton, watchful Minister of War and Navy, ordered up one of the largest Herschellian telescopes of 7 feet focal length with 9 different magnifying eyepieces from London. He takes care mainly of the progress of Navigation, and then of Astronomical Science. He loves, relishes and protects them. He also derives great pleasure from observing all the features of the fixed stars visible at the time in the beautiful clear skies of Naples.

This telescope, according to Cassella (1790: 146), was "… the only one hosted in Italy." It was bought by Lord Acton at William Herschel's house in England in 1787, and cost 110 guineas (Toaldo, 1788). The telescope arrived in Naples on 4 March 1788:

> A new magnificent telescope made by Professor Herschel arrived on the frigate *Cerere* commanded by Kt. Forteguerri. It was manufactured on the basis of the latest developments. Toaldo, the famous astronomer, was leaving this City but he stayed for a few days in order to examine it. Toaldo made some observations with the telescope and he found it better than any other telescope he had used. (Gazzetta, 1788: 168).

Cassella planned to use this telescope to compile a star catalogue, like Herschel's, and list all the stars that could be observed from the latitude of Naples (which included many stars in the southern sky). The first star he observed was β Sagittarii, which was a double. Cassella (1788: 95) noted that

> The ancient astronomers indicated the star β, the northern-most among the three bright stars on the forehead of the Scorpion, was a double star. By observing with our telescope, it appears composed of two quite separate stars, distant from each other by a few seconds.

As soon as Cassella had this excellent instrument at his disposal, thanks to the Minister's munificence, he used it to observe other double stars in Aquarius, Capricornus, Corona Borealis, Sagittarius, Scorpius and Serpens (Amodeo, 1924). He also made many observations of Saturn's satellites, and

> ... thanks to our continual observation of the fifth satellite we have seen and have confirmed the same phenomena which are usually seen in the period of this satellite, and were once observed by the famous Cassini ... (Cassella, 1790: 146).

Some observations made by Cassella between 1793[4] and 1797, including an occultation of Jupiter,[5] were published by Bode in the *Astronomical Ephemeris of Berlin* and some by Lalande (1783) in the *Ephemeris of 1788*. Other observations were presented at the Royal Science Academy of Turin, of which Cassella had been a member since 1797. In a memoir presented

by Antonio Cagnoli at the Italian Society of Science, Cassella lists a series of "Occultazioni di stelle per la Luna" observed between 21 October 1793 and 21 August 1798, both at the Palace of Studies and at Lord Acton's observatory.

Cassella's enormous passion shone through in these publications, and he was appreciated as a scientist both in Italy and abroad:

> It was known Cassella could make very important observations without an observatory, with very few instruments, and without communication with astronomers in other countries, meriting Bode to talk about them in his Berlin Ephemeris. (Orloff, 1821: 28).

Despite Cassella's undoubted skill and dedication, the University did not have any observatory, let alone a well-equipped one, where he could carry out observational campaigns and educate a new generation of students in astronomy. The impossibility of offering contributions in the main fields of astronomical research at that time, such as observations of the planets, their satellites and new minor planets, or hypotheses about nebulae, made the royal astronomer of Naples a rather ineffective scientist. Maybe Cassella had hoped that Lord Acton might have played the same role that Francesco Maria Venanzio d'Aquino, the Prince of Caramanico, played in Palermo, which had allowed Piazzi to quickly organize a centre for astronomical studies. Instead, Lord Acton offered the use of his private observatory and its first-class instruments, which was the only real opportunity Cassella had to make reliable celestial observations.

Using Lord Acton's telescope (which for a short time was the only Herschelian reflector in Italy),[6] Cassella (1796) enthusiastically observed not only double stars but also Enceladus, a satellite of Saturn discovered by Herschel on 28 August 1789. In January 1793 Cassella observed the comet discovered on 15 December 1792 by Caroline Herschel (ibid.; Bode, 1792). On 21 October 1793 he used an achromatic telescope of 3½ feet focal length to time the lunar occultations of γ and α Tauri, and on 21 January in the following year he used the same telescope to observe an occultation of γ Scorpii. On 5 March 1794 he timed the occultations of μ Ceti and α Tauri using a Gregorian telescope of 1½ feet focal length, while on 21 August 1798 he noted the true times of immersion and emersion of φ Sagittarii, θ and γ Virginis, γ Tauri, γ Librae, μ Ceti and Aldebaran (Cassella, 1795) while using "… a Newt. Telesc. by Herschel of 7 English feet focal length; power of 84." (Cassella, 1799b).

Cassella also observed the solar eclipses of 28 August 1802 and 17 August 1803 from Lord Acton's observatory, using the 7-ft Herschel telescope (Cassella and Cagnoli, 1804), and the published record of these events is shown in Figure 2. But the solar eclipse of 11 February 1804 was a totally different event, for "Her Majesty the Sovereign of Two Sicilies and her Royal Prince D. Leopoldo are also in attendance, specifically for this purpose, besides many Lords of the Court, at the Observatory of H. E. the Captain-General Acton." (Cassella and Cagnoli, 1804: 620). Despite their presence, Cassella had arranged it such that the instruments could obtain precise scientific data. Unfortunately the sky was cloudy at the time of the eclipse, but he did manage to record the following

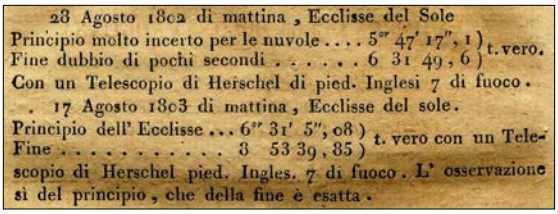

28 Agosto 1802 di mattina, Ecclisse del Sole
Principio molto incerto per le nuvole . . . . 5ʰ 47′ 17″, 1) t. vero.
Fine dubbio di pochi secondi 6 31 49, 6)
Con un Telescopio di Herschel di pied. Inglesi 7 di fuoco.
17 Agosto 1803 di mattina, Ecclisse del sole.
Principio dell' Ecclisse . . . 6ʰ 31′ 5″, 08) t. vero con un Tele-
Fine 8 53 39, 35)
scopio di Herschel pied. Ingles. 7 di fuoco. L' osservazione
si del principio, che della fine è esatta.

Figure 2: Published record of the solar eclipses of 28 August 1802 and 17 August 1803 (courtesy: Library of Science Academy of Turin).

observations towards the end of the event:

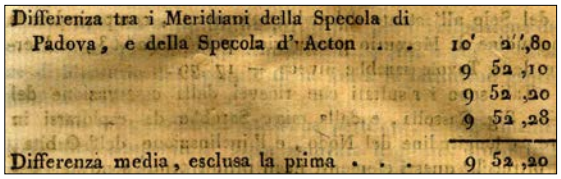
> Latitude 40° 49′ 40″ ... End of the Eclipse $2^h\ 25^m\ 10.7^s$ mean time ... with a Dollond achromatic of 5 feet foc. and a great objective.
>
> The recorded time may differ from the actual time by a few seconds.
>
> A mountain on the Moon was the last one to be observed coming out of the disc; and the irregularities of the Moon are clearly seen on the Sun; these were also seen by others attending the observation, particularly by the frigate captain Mr. Carlo Acton. Just before the eclipse finished, the edges of the Moon and the Sun seemed to be swaying due to the amount of vapour in the atmosphere, with which it was saturated. (Cassella and Cagnoli, 1804: 621).

This eclipse was also observed by Cassella's students at the Palace of Studies: "End of the Eclipse $2^h\ 24^m\ 55.0^s$ Mean time: doubtful … With an achromatic of Nairne, but weak power." (Cassella and Cagnoli, 1804: 621-622). This is the first publication that indicates that some of Cassella's students were carrying out astronomical observations in Naples.

In 1802 Cassella and Chiminello observed a transit of Mercury between 8 and 9 November from Lord Action's and Padua Observatories, respectively. Cassella "… during the egress of Mercury, accurately timed the inner contact with the edge of the Sun at $0^h\ 54^m\ 7.6^s$ t. t. and the external doubtful $0^h\ 55^m\ 49.6^s$ t. t. with a 5 English feet achromatic telescope by Dollond." (Chiminello, 1804: 187-188). By comparing measurements made in Naples and Padua, Chiminello (ibid.) could determine the difference in longitude between Padua Observatory and Lord Acton's observatory (see Figure 3). In his memoir, Chiminello pointed out that the measurements and results from Naples did not come from a public observatory but rather from a private observatory that was kindly made available by its owner for scientific purposes. In this context, Chiminello (1804: 621) referred to Lord Acton as the "… Magnificent Patron."

3 COUNT VON HAHN'S OBSERVATORY AND THE LARGEST HERSCHEL TELESCOPE IN MAINLAND EUROPE

Count Friederich von Hahn was born in 1742 into an ancient family from Mecklenburg, and attended the University of Kiel from 1760 to 1763 where he studied mathematics and astronomy. In 1779, the Count became the sole heir to the Hahn family properties, including the Remplin Estate which had been in the family's possession since 1405. The Count then moved into the residence at Remplin, expanded the house, and built greenhouses in order to grow exotic fruits and flowers. Far from the grandeur of the Imperial Court,



Differenza tra i Meridiani della Specola di Padova, e della Specola d'Acton . . .	10'	2'',80
	9	52 ,10
	9	52 ,20
	9	52 ,28
Differenza media, esclusa la prima . . .	9	52 ,20

Figure 3: Published record of the longitude difference between Padua and Naples calculated by Chiminello (courtesy: Library of Science Academy of Turin).

Friederich von Hahn was an Enlightenment follower, and he devoted himself to the education of local children and financed a foundation for the sustenance of poor girls. He also supported the studies and scientific projects of many young people.

The Count built a new castle in Faulenrost, modernized the one in Basedow, restructured the church of Graves, and built the bell tower in Bristow. The German philosopher Moses Mendelssohn (1729–1786), grandfather of the famous musician, considered the Count the most intelligent person he ever met. Von Hahn maintained an on-going correspondence with Count von Bernstorff, the Danish Foreign Minister; the philosopher Johan Gottfried Herder (1744–1803), who celebrated their friendship by dedicating the poem 'Orion' to him; and Johann Bode, who dedicated the *Uranografi*a to him. Louise of Prussia with her entourage and Johann Friedrich Zöllner (1753–1804), head of the Royal Prussian Consistory and a member of the Berlin Science Academy, were among his welcomed guests. During a stay in Remplin, Zöllner described in his travel diaries von Hahn's impressive library (which contained about 12,000 volumes), and the observatory, that was built between 1792 and 1793. This was

> ... located all by itself in the beautiful garden. The lower floor is a large hall. The second floor has a little room with 4 doors, each one is paved with stones and leads onto a large balcony. The astronomical equipment is as significant as it is beautiful. (Zöllner, 1797: L.23).

In 1801, the Count also built the 14-m high 'ox tower', which was surmounted by an observatory with a rotating dome (see Figure 4). He equipped the observatory with first class instruments, such as a 25-in Cary vertical circle with a telescope of 33 inches focal length and 2-in in aperture. He also bought a 1-ft equatorial and a 4-ft transit telescope by Dollond. A comet finder by Blunt and Nairne, sextants by Dollond and Troughton, a pendulum clock by Klindwort, a chronometer by Arnold[7] and many other smaller instruments and attachments completed the Count's valuable collection. Besides the astronomical equipment, he also had other instruments that were used for experiments in physics and chemistry (Fürst and Hamel, 1999).

In 1793, von Hahn enriched his observatory with three reflectors made by Herschel, two with mirrors of 20 feet focal length and apertures of 18-in and 12-in and a smaller mirror 8-in in diameter with a focal length of 7 feet.[8] The telescope with the 18-in mirror was the largest reflecting telescope in mainland Europe after the great reflectors of Schröter at the *Urania Tempel* in Lilienthal and Schrader at the Kiel Observatory. Von Hahn's observatory at Remplin also boasted the largest telescope in mainland Europe made by Herschel. However, by this time Herschel had installed a gigantic 40-ft telescope at his observatory at Slough, which was completed thanks to £2,000 that King George III assigned to him. When the King visited Herschel with the Archbishop of Canterbury he walked inside the enormous tube and said: "Come, my Lord Bishop, I will show you the way to Heaven!"

Figure 4: A painting done in 1857 of Count von Hahn's observatory (courtesy: Rosmarie Schöder).

(Mullaney, 2007: 14).

Zöllner described von Hahn's largest telescope (see Figure 5) in his travel book:

> You will be certainly surprised if I did not write any detail about the great telescope of Herschel ... I don't want to bother you with a description of the mechanism, I tell you just that it is placed under the open sky close to the observatory, and it is cleverly set up in order to orientate the big telescope in any wanted direction and to move the tube of the ocular aperture with a portable staircase ... any movement takes place very easily without any obstacle. They observe to the side through a small tube. And on the bottom, where the mirror is placed, there is a small finderscope. (Zöllner, 1797: L.23).

Von Hahn reported his observations in about twenty papers, which were mainly published in the *Astronomisches Jahrbuch*, where he also was in charge of translating and communicating Herschel's memoirs (see Herschel, 1798). The Count was very interested in the study of the planets and the lunar surface, and he also investigated the Sun (Hahn, 1792) and nebulae in Hydra and in Orion (Hahn, 1799). In 1796 he wrote:

> If we wanted to represent the night sky as an infinite space in which countless suns surrounded by their planets describe their paths ... this concept of the universe would be really great and sublime, but at the same time it would not properly indicate the vastness of nature. The largest telescopes can observe celestial objects that cannot be considered as star clusters. Among these oddities the famous Orion Nebula is especially distinguishable ... I troubled myself to search the left edge (west) of this black cloud with the 20 feet reflector... (Hahn, 1796: 235-236).

In 1800, von Hahn discovered the faint central star in the Ring Nebula M57 in the Messier catalogue, which is a compact white dwarf of magnitude 15. Von Hahn carefully studied this star and found that it varied in magnitude. In the research paper, "Gedanken über die Ursachen der Lichtabwechselungen veränderlicher Sterne" von Hahn (1795) gave a theoretical explanation of the Doppler Effect fifty years before Christian Doppler. He assumed that there was a close relationship between the movement of the light source and the changes occurring in two successive light events: if a star is approaching the Earth at a certain velocity, the light has a shorter path, its particles follow each other quickly and then the object appears brighter to the eyes. He supported the theory of the solar photosphere proposed by Herschel, considering the Sun a cool body like the planets, with a habitable surface under the flames (Crowe, 2011). Like Herschel, he argued that stars evolve.

Count von Hahn died in 1805 and was buried in the church of Graves. The Remplin Estate passed to Carl, his youngest son, who squandered much of his paternal heritage because of his unrestrained passion for the theatre. The precious volumes in the library were used mostly by war refugees to light fires, while the scientific instruments were put up for sale. In 1811 the *Astronomisches Jahrbuch für das Jahr 1811* mentioned that some of the instruments in the collection were for sale:

> The excellent astronomical, physical, and chemical instruments heritage of the late Land Marshal Count von Hahn of Remplin in Mecklenb. Strelitzschen, must now be sold individually, according to the will of the heirs. The astronomical ones will be offered to amateurs at the

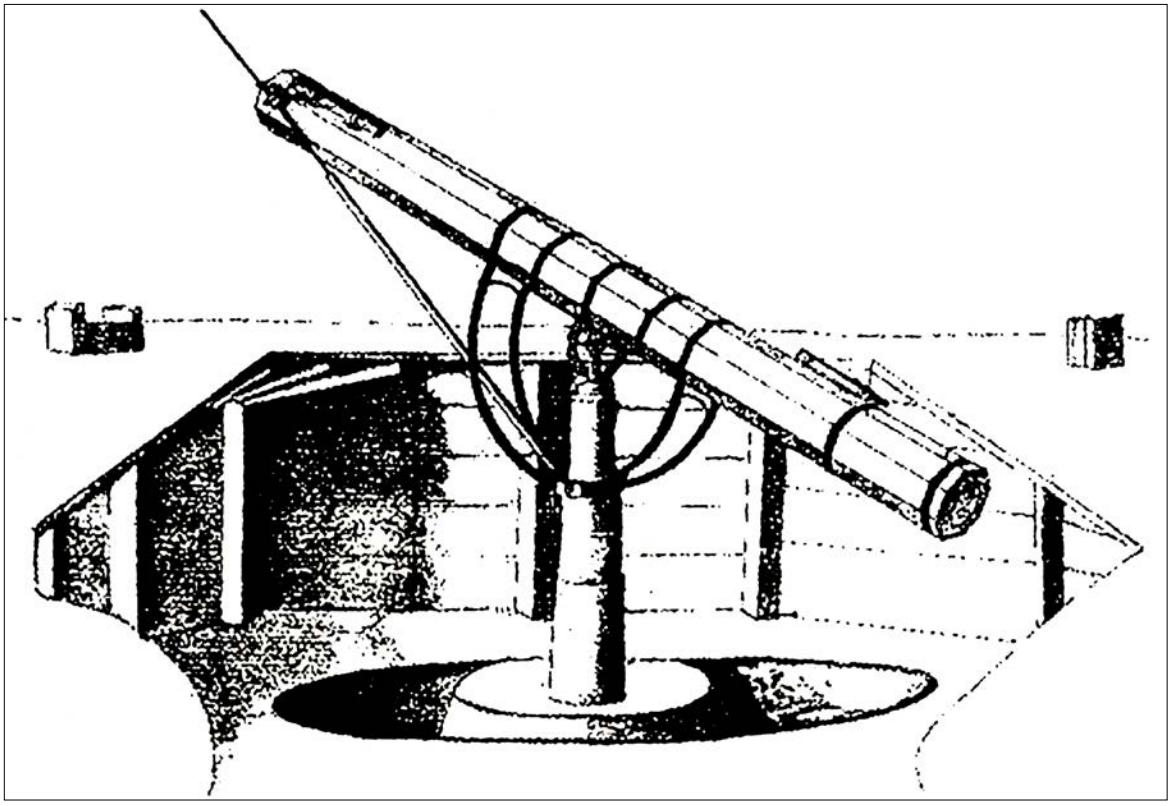


Figure 5: A sketch of the 18-in aperture Herschel telescope mounted on its framework in the garden of the Remplin Estate (courtesy: Wolfgang Steinicke).

following prices and to this aim I was asked to write a public note for the *Astronomisches Jahrbuch*. The numbers are in accordance with the printed list, the prices are in Crowns of Mecklenburg.

No.	Rthlr.
1. One Herschelian reflector telescope of 20 feet length and 18 inches aperture, 3 oculars, and a mirror cover. The tube is of wood with iron bands and covered with a sail cloth. The frame is very comfortable using method indicated by the late Count.	1500
2. One Herschelian reflector telescope of 20 feet length, 12 inches aperture, 2 oculars. The tube as above	900
3. One Herschelian reflector telescope of 7 feet length, 8 inches of aperture, 7 magnifying glasses, and a comfortable frame	600

[Another 47 objects follow.] …

The instruments were evaluated based on their present value by Prof. Droysen of Greifswalde.
The amateurs can refer to Secr. Ortmann in Remplin. (Bode, 1808).

Some of the instruments were acquired by the Königsberg Observatory, where Friedrich Wilhelm Bessel (1784–1846) led the main stellar observing campaigns for many years.

4 THE TRANSFER OF ONE OF VON HAHN'S HERSCHEL TELESCOPES TO NAPLES

Cassella died in Naples in 1808, after partly realizing his lifetime dream which was to have a public observatory. This was the Observatory of San Gaudioso:

> H. M. (King Joseph Bonaparte) determined by Royal Decree on the 29th day of the previous month, that the ancient Belvedere of the Nuns of S. Gaudioso, which now belongs to the Friars of S. Girolamo, should be converted into an Astronomical Observatory. (ASNa, 1807b).

More specifically,

> ... the ground-floor room that serves now as a pantry and the little apartments of the 3rd, 4th and 5th Floors will be made available to the Astronomers, after making the necessary renovations to convert this site for use as an Observatory and to house the apparatus there. (ASNa, 1807a).

On 11 August 1811, Joachim Murat, the new French King of Naples, appointed Federigo Zuccari (1784–1817) as the new Director of the Observatory. Zuccari was the Professor of Mathematical Geography at the Royal Academy of Nunziatella. In 1809, he moved to Milan in order to specialize in astronomy under the guidance of Barnaba Oriani. Returning to Naples in 1812, Zuccari brought with him an impressive set of instruments which Oriani had made available to him,[9] after re-equipping the Brera Observatory. The instruments were expected to arrive in Naples "… just in time to observe Polaris … during December and January, and the Iemale (winter) solstice." (Zuccari, 1812d). A skilled engineer named Augusto Aenhelt (b. 1785) arrived in Naples together with Zuccari, and assisted him in installing the instruments in the Observatory at San Gaudioso.

On 8 March 1812 Murat approved the erection of a new observatory for Naples on the Miradois hill, close to the Royal Palace of Capodimonte. Zuccari suggested this site "… because it has an open meridian, and the rest of the horizon is free with respect to other

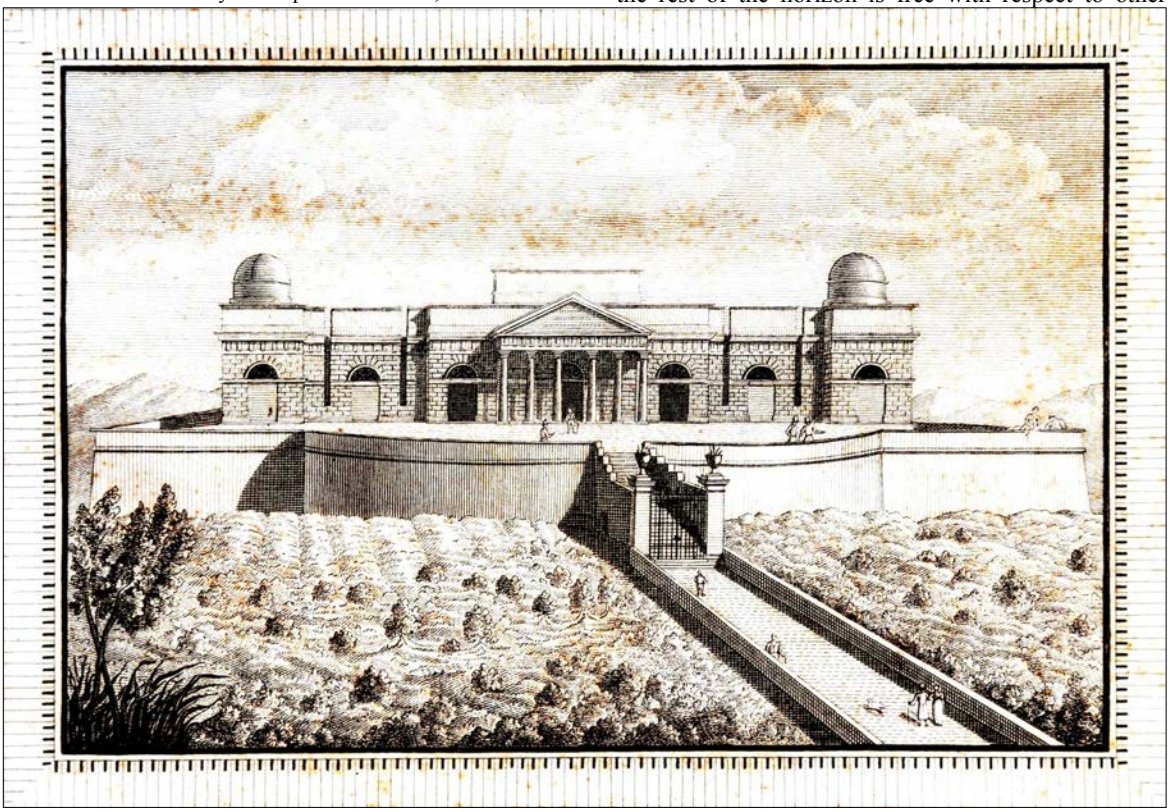


Figure 6: A print by Cerasoli (1819) of the new Astronomical Observatory at Capodimonte (courtesy: Astronomical Observatory of Capodimonte).

hills: moreover among all the suburban hills, Miradois is near both the University and the Naples' city centre." (Zuccari, 1812a). The impressive-looking observatory building was designed by Zuccari and the architect Stefano Gasse (1778–1840). Although the foundation stone was laid on 4 November 1812, work was only completed in late 1819 (see Figure 6).

Once construction of the new building was approved, Murat also agreed to equip the upcoming Osservatorio Giovachino (see Figure 7) with some new instruments, such as a meridian circle and a pendulum clock from Reichenbach, a chronometer from Breguet and an 8-ft telescope from Amici. Furthermore, the Minister of the Interior, Count Giuseppe Zurlo (1759–1828), proposed the purchase of a Herschel telescope like the one owned by Lord Acton. Zuccari (1812a) regarded Zurlo as "… a very suitable and effective Patron of all the finest disciplines, especially astronomy …", and informed him that in Berlin there were two 20-ft Herschel telescopes for sale. Zuccari (1812b) then wrote to Oriani seeking information about the instruments owned by the late Count von Hahn and mentioned by Bode in the *Astronomisches Jahrbuch*. Oriani recommended the powerful Herschel telescope which von Hahn had used to conduct research and some other astronomical instruments that were also on sale in Berlin. Zuccari wanted to complete the Naples collection of instruments with one of the greatest telescopes created by Herschel, so he asked the Government to buy both the 20-ft and the 7-ft Herschel telescopes, remarking that

> The price of the large telescope is 6,000 francs, the smaller is 2,400 francs. They would be great ornaments for any Observatory, the first for its uniqueness and perfection, the second for its ease of use and comfort. (Zuccari, 1812c).

The Minister of Interior approved the expense, but in June 1812 Zuccari pondered his decision and changed his request, suggested to Zurlo instead of the 7-ft telescope

> … to buy in Berlin an excellent 4-ft Short Telescope with a 7-in aperture at a cost of 60 golden Friderics, and an 8-in Dollond reflecting sextant, well executed and preserved, at a cost of 25. golden Frid:^{s}, including the costs of the crate and packing, 1,540- Lire in total … [Zuccari] ensures that when commissioning the Astronomer of Berlin he will urge him to arrange for the prompt and safe means of their transport to Vienna; and to address the crates to Cav: Gargani Secret.^{y} of the Neapolitan Legation at that Court. In the meantime he asks H. E. to pass his authority to the Min:^{y} of Foreign Affairs so that Mr. Gargani takes charge of bringing them to Naples, and to have laissez-passer, so that the objects do not suffer a long customs inspection. (ASNa, 1812).

In December 1812 Zurlo (1813) informed Zuccari that Bode had sent Gargani "… three boxes containing a Telescope and some books." The Duke of Gallo, Marzio Mastrilli, who was Minister of Foreign Affairs, informed Zurlo that on 27 January 1813 the crates were sent to Naples via Bolzano, and Bode (1813) also wrote a letter to Zurlo on 9 February informing him of the purchase. The latter letter arrived in Naples at the beginning of March and was translated by Zuccari. Bode stated that after receiving pledges of payment he asked Mr Hansen, the Legation Secretary in Mecklenburg, to take care of the packing and to send the Herschel telescope to Berlin. He also wrote:

> The Herschel telescope consists of a wood tube 20 feet long and 1½ in diameter. It is mounted on a great framework with wheels and pinions. The transport of the tube to Naples would cost much more than its value. Mr. Zuccari wrote me to not send the tube if the cost of transportation was high. Fortunately the owner had a model of it made, and I purchased it. This may be used for mounting the Telescope on a great framework in Naples. Therefore, two modest sized crates will be sent to Naples. They contain the great mirror, and three eyepieces with their apparatus, and the model of the framework. The price of the Telescope was 300 golden Friderics, as Mr. Zuccari knows from my Ephemeris of 1811. I deducted 20 and consequently the telescope costs just 280. (ibid).

At about the same time, Gargani informed the Minister of Interior that three crates had arrived at the Neapolitan Embassy in Vienna, containing books and astronomical instruments for the Observatory in Naples (Mastrilli, 1813a). In May, Zuccari (1813) was informed that the crates had arrived in Giulianova for the attention of "il Sig:^{ri} Angeli e Simeoni" and he undertook to ask the Minister of the Interior to arrange with the Minister of Finance, Jean-Antoine-Michel Agar, Count of Mosbourg, for the passage of the crates to the Customs of Naples,

Figure 7: The Murat gold medal minted to mark the laying of the foundation stone of the Osservatorio Giovachino on 4 November 1812.

and subsequent delivery to the receiver. However, besides some books, these crates only contained the telescope made by Short, not the one made by Herschel.

In June 1813, a new letter from the Duke of Gallo informed the Minister of the Interior that in the previous month Bode received "… two Crates purchased some time ago by the above-mentioned Astronomer. They contain the Great Mirror of Herschel with all the other objects pertaining to it ..." (Mastrilli, 1813b). In August, the crates finally arrived in Vienna, but they had to remain there until the following year because of the war between Napoleon's troops and the armies of the Sixth Coalition, formed by Great Britain, Russia, Spain, Portugal, Prussia, Austria and Sweden. The war finally ended in October 1813 with the Battle of Nations in Leipzig.

Figure 8: The 20 feet focal length Herschel mirror (photograph: E. Cascone, 2010; courtesy: Astronomical Observatory of Capodimonte).

Understandably, Zuccari (1814a) was concerned about the fate of the crates and in March 1814 he wrote to the Minister of Interior "… about the further fate of same objects … now that communication with that Capital is re-established." The crates were deposited by the Minister Gennaro Spinelli, Prince of Cariati, at the office of Geymuller's bankers, who thought that it was not convenient to send them, because of "… the lack of safety on the road." (Mastrilli, 1814b). On 23 May 1814, the boxes finally were sent to Trieste, to the attention of the shipper Gadolla, who would forward them to Naples (Mastrilli, 1814a). On 4 August, the Foreign Office Minister wrote to Zurlo: "Mr. Bankers Meuricoffre, and Comp. of this City inform me that the two boxes, containing Astronomical Instruments purchased by Mr. Bode for this Royal Observatory, have already arrived at the Customs of Manfredonia." (Mastrilli, 1814c). On 12 August the Count of Mosbourg asked the Customs of Manfredonia to send the crates to Naples for the customs formalities.

Figure 9: A hall of the "Museum of the Ancient Instruments" at the Astronomical Observatory of Capodimonte. In the pyramid is the celestial globe of Roll-Reinhold (1589), and in the corner to the right are an equatorial telescope by Reichenbach and Utzscheider (1814) and a Zenith telescope by Wanschaff (1892) (photograph courtesy M. Casciello, 2005).

On 14 September 1814 the Herschel mirror and the books purchased by Garganiof arrived in Naples in three boxes, but the Count of Mosbourg advised the Customs Office of the arrival of just two boxes. This mistake caused further delays and Zuccari eventually wrote to Zurlo asking him to inform the Customs Director, Graziano Ferrier, of the crates' existence so that they could be processed.

At about the same time Baron von Zach came to Naples to deliver and install the Reichenbach instruments (Piazzi, 1821), and he noted that a large Herschel mirror was among the astronomical instruments available at the Observatory of San Gaudioso:

> We found this observatory active when we arrived in Naples ... It was not badly equipped ... There was ... a large Herschel mirror for a telescope of twenty feet, it was not mounted, and it was acquired from the heirs after the death of Count de Hahn of Remplin, in the Duchy of Mecklenburg, etc ... (von Zach, 1819: 535-536).

The delay in finishing the new observatory at Capodimonte and the changed scientific interests of the successors of Zuccari, who were devoted more to positional astronomy, kept the mirror of the largest Herschel telescope ever installed in mainland Europe in its crate, even though it had arrived in Naples by the end of the summer of 1814. In September 1814 Zuccari wrote that

> … three packages [had arrived] at the big Customs House of Naples from Vienna, [and] they contain the mirrors of the big telescope of Herschel bought in Kemplin for the Royal Observatory together with many books. (Zuccari, 1814b).

Ten years later, Brioschi (1824-1826: 81) called the Herschel telescope useless, but "It is desirable if it could be set working, by constructing all the useful frameworks and devices, and [finding] also an appropriate place to store and use it." .

In 1835, there was still hope to install the large telescope "… polished by the famous Herschel and not yet put in place, but it will happen soon due to the generous and provident care of the sovereign." (Taddei, 1835: 63). Yet this did not eventuate, and the large Herschel mirror never was used to observe the night sky from Naples.

Today the Herschel mirror (Figure 8) is one of the most ancient instruments in the historical collection at the *Museo degli Strumenti Astronomici* (see Figure 9) at the Capodimonte Observatory (see Rigutti, 1992), along with the Roll-Reinhold globe (1589), the Chlasner clock (1567) and the equatorial sector of Sisson (first half of the eighteenth century), as well as instruments like the equatorial telescope and the 1814 meridian circle of Reichenbach-Utzschneider that over a 200-year period were used to make observations and discoveries by the astronomers of Naples.

5 NOTES

1. Herschel also had the "… happy idea to dispense with the small plane mirror in the 20-ft. telescope, and this resulted in a significant increase in the penetrating power ... He has not yet shown the magnification he can reach manufacturing his met-

al mirrors." (Notizie letterarie, 1810).

2. With the exception of this quote, which is taken from Spaight (2004), all other translations into English of French, German and Italian sources quoted in this paper are by the author.
3. Notizie letterarie (1810; my English translation) contains the following evaluation of Amici: "He will be able to improve his metallic mirrors, up to a point where he will not leave us envious of those of the most famous foreign opticians."
4. Bode (1798: 109) wrote: "Mr. Cassella, the royal astronomer in Naples, informed me that on 5 September 1793 he observed the beginning of the Solar eclipse at $11^h\ 7^m\ 31.7^s$ t. t. and the end at $2^h\ 22^m\ 38.1^s$." Data relating to the observations of the beginning and the end of the solar eclipse of 4/5 September 1793 made in Naples by Cassella and Giovanni Vivenzio are given in the table of observations made by Father Piazzi (1795) in determining the latitude difference between the Royal Palace in Naples and the Observatory in Palermo.
5. According to Bode (1808: 244-245),

> The royal astronomer Mr Cassello observed the occultation of Jupiter by the Moon on 23 September 1795 at the Royal Museum in Naples. He observed it using a 3½ feet Dollond telescope. The sky was clear.
>
> The first contact between the edge of and the Moon $6^h\ 49^m\ 34.9^s$ true time with 1 or 2^s uncertainty
> Full entrance of at $6^h\ 51^m\ 49.9^s$ exact
> Begin of exit of at $8^h\ 3^m\ 18.4^s$
> Total exit of at $8^h\ 5^m\ 26.4^s$

6. In December 1790 Italy acquired its second Herschel telescope when Giuseppe Piazzi received "… a reflector Telescope at least 6 feet focal length …" from Herschel (Foderà-Serio and Chinnici, 1997: 20). Piazzi had met Herschel when he visited France and England between 1787 and 1789. The telescope had an aperture of 16 cm and was acquired for the observatory in the S. Ninfa Tower at the Norman Palace in Palermo. It was made of mahogany and was equipped with a finder scope, seven eyepieces and two micrometers (Foderà-Serio and Chinnici, 1997).
7. According to Koch (1797: 249):

> In mid-July that year … von Hahn was in Berlin. He took his Arnold chronometer, whose motion and daily average deviation were verified and established same days before his departure from Remplin with his 5-ft. Ramsden meridian circle ...

8. Zollner (1797: L.23) wrote (my italics):

> So we saw ... the variable stars in the head of Medusa with the seven feet [telescope] of Herschel. Mister von Hahn has two mirrors for these instruments: one by Herschel and another by Schrader of Kiel. *There is no significant difference between the two*.

9. These were described by Piazzi (1821: 5) as

> ... a transit instrument of three and a half feet focal length, a repeating circle of 3 and a half feet focal length, a repeating circle of twelve inches, a multiplying theodolite of 8 inches and other small instruments ...

6 REFERENCES

The following abbreviations are used:

ASNa = Archives of the State of Naples
HAAOB = Historical Archives of the Astronomical Observatory of Brera
HAAOC = Historical Archives of the Astronomical Observatory of Capodimonte

Ajello, G., 1845. *Napoli e il Luoghi Celebri delle sue Vicinanze. Volume II*. Napoli, Gaetano Nobile.

Amodeo, F., 1924. *Vita Matematica Napoletana*. Napoli, F. Giannini e Figli.

Bode, J.E., 1792. Ueber den ingegenwärtigen 1792sten Jahr erschienenen Kometen. *Astronomisches Jahrbuch oder Ephemeriden für das Jahr 1795*, 184-187.

Bode, J.E., 1797. *Astronomisches Jahrbuch oder Ephemeriden für das Jahr 1800*, 244-245.

Bode, J.E., 1798. Noch verschiedene astronomische Beobachtungen und Nachrichten. *Astronomisches Jahrbuch oder Ephemeriden für das Jahr 1801*, 240-248.

Bode, J.E., 1801. *Uranografia*. Berlino, apud Autorem.

Bode, J.E., 1808. *Astronomisches Jahrbuch oder Ephemeriden für das Jahr 1811*, 264-266.

Bode, J.E., 1813. Letter to Zurlo, dated 9 February. SANa, *Ministero dell'Interno. Inv. II*, 2313:2.7-10.

Brioschi, C., 1824-1826. *Comentarj Astronomici della Specola Reale di Napoli. Volume 1(1)*. Napoli, Pietà de' Turchini.

Carcani, N.M., 1753. Solaris defectus. *Memorie per Servire all'istoria Letteraria*, 2(4), 77-78.

Carcani, N.M., 1761. Passaggio di Venere sotto il Sole, osservato in Napoli nel Real Collegio delle Scuole Pie, la mattina de' 6 Giugno 1761, Novelle Letterarie pubblicate in Firenze, 1761, col. 696-702, 714-720.

Cassella, G., 1788. *Dei Principali Movimenti e Fenomeni de' Corpi Celesti*. Napoli.

Cassella, G., 1790. *Efemeridi Astronomiche per l'anno Comune 1791 Calcolate al Meridiano di Napoli per Comodo e Vantaggio degli Studiosi dell'astronomia e della Navigazione*. Napoli.

Cassella, G., 1795. Beobachtungen der Bedeckung einiger Fixsterne von Mond, und astronomische Nachrichten, von Herrn Joseph Casella, Astronom des Königs von Sicilien, in Neapel angestellt. *Astronomisches Jahrbuch oder Ephemeriden für das Jahr 1798*, 109-110.

Cassella, G., 1796. Aus einem Schreiben des Herrn Cassella, Königl. Astronomen in Neapel. *Astronomisches Jahrbuch oder Ephemeriden für das Jahr 1799*, 244.

Cassella, G., 1799a. Einige astronomische Beobachtungen, zu Neapel angestellt. *Astronomisches Jahrbuch oder Ephemeriden für das Jahr 1802*, 202-203.

Cassella, G., 1799b. Occultazioni di stelle per la Luna osservate a Napoli. *Memorie di Matematica e Fisica della Società Italiana*, 8, 758.

Cassella, G., and Cagnoli, A., 1804. Lettera sull'Ecclisse del dì 11 Febbrajo. *Memorie di Matematica e Fisica della Società Italiana*, 9, 620-622.

Chiminello, V., 1804. Calcolo del passaggio di Mercurio pel disco del sole nel giorno 8-9 novembre 1802 secondo le osservazioni di Padova e di Napoli. *Memorie di Matematica e Fisica della Società Italiana*, 9, 182-192.

Crowe, M., 2011. The surprising history of claims for life on the Sun. *Journal of Astronomical History and Heritage*, 14, 169-179.

Foderà-Serio, G., and Chinnici, I., 1997. *L'osservatorio Astronomico di Palermo*. Palermo, Flaccovio.

Fürst, D., and Hamel, J., 1999. Graf Hahn, F. von auf Remplin. *Journal für Astronomie*, 3, 79-81.

Gazzetta Universale, 15(21), 161-168 (1788).

Gillespie, R., 2011. *The Great Melbourne Telescope*. Melbourne, Museum Victoria.

Hahn, F. von, 1792. Gedanken über die Sonne und ihrem Lichte. *Astronomisches Jahrbuch oder Ephemeriden für das Jahr 1795*, 226-232.

Hahn, F. von, 1795. Gedanken über die Ursachen der Lichtabwechselungen veränderlicher Sterne. *Astronomisches Jahrbuch oder Ephemeriden für das Jahr 1798*, 224-228.

Hahn, F. von, 1796. Gedanken über den Nebelfleck im Orion. *Astronomisches Jahrbuch oder Ephemeriden für das Jahr 1799*, 235-238.

Hahn, F. von, 1799. Ueber den planetarischen Nebelfleck bei μ Wasserschlange. *Astronomisches Jahrbuch oder Ephemeriden für das Jahr 1802*, 231-233.

Herschel, F.W., 1780a. Astronomical observations on the periodical star in Collo Ceti. *Philosophical Transactions of the Royal Society*, 70, 338-344.

Herschel, F.W., 1780b. Astronomical observations relating to the mountains of the Moon. *Philosophical Transactions of the Royal Society*, 70, 507-526.

Herschel, F.W., 1781. Account of a comet. *Philosophical Transactions of the Royal Society*, 71, 492-501.

Herschel, F.W., 1795. Description of a forty-feet reflecting telescope. *Philosophical Transactions of the Royal Society*, 85, 347-409.

Herschel, F.W., 1798. Ueber die eigentlichen Nebelsterne. *Astronomisches Jahrbuch oder Ephemeriden für das Jahr 1801*, 128.

Herschel, J.F.W., 1861. *The Telescope*. Edinburgh, Adam & Charles Black.

Holden, E.S., 1881. *Sir William Herschel: His Life and Works*. New York, Charles Scribner's Sons.

Hoskin, M., 2011. *Discoverers of the Universe: William and Caroline Herschel*. Princeston, Princeston University Press.

Koch, J.A., 1797. Aus einem Schreiben des Hrn. Dr. Koch aus Danzig. Vom 8. Aug. 1797. *Astronomisches Jahrbuch oder Ephemeriden für das Jahr 1800*, 249.

Lalande, J.-J.L. de, 1769. *Voyage d'un Français en Italie, Fait dans les Années 1765 et 1766. Volume 4*. Venice and Paris, Veuve Desaint.

Lalande, J.-J.L. de, 1783. *Ephémérides des Mouvemens Célestes*. *Volume 8*. Paris, la Veuve Hérissant.

Magalhaens, J.H. de, 1785. Ueber v.d. Herren Pigott und Goodricke entdeckten veränderlichen Sterne; astronomische Beobachtungen zu York von Herrn Pigott angestellt, und etwas von Hrn Herschels Manier zu beobachten. *Astronomisches Jahrbuch oder Ephemeriden für das Jahr 1788*, 161-164.

Mastrilli, M., 1813a. Letter to Zurlo, dated 1 March. ASNa, *Ministero dell'Interno. Inv. II*, 718:4.67.

Mastrilli, M., 1813b. Letter to Zurlo, dated 23 June. ASNa, *Ministero dell'Interno. Inv. II*, 718:4.83.

Mastrilli, M., 1814a. Letter to Zurlo, dated 31 May. ASNa, *Ministero dell'Interno. Inv. II*, 718:4.98.

Mastrilli, M., 1814b. Letter to Zurlo, dated 18 June. ASNa, *Ministero dell'Interno. Inv. II*, 718:4.99.

Mastrilli, M., 1814c. Letter to Zurlo, dated 5 August. ASNa, *Ministero dell'Interno. Inv. II*, 718:4.100.

Mininni, C.G., 1914. *Pietro Napoli Signorelli*. Città di Castello, Lapi.

Mullaney, J., 2007. *The Herschel Objects and How to Observe Them*. Berlin, Springer.

Napoli-Signorelli, P., 1788. Tentativi e lavori. In *Atti della Reale Accademia delle scienze e belle-lettere di Napoli dalla fondazione sino all'anno 1787*. Napoli, Donato Campo. Pp. 76-80.

Notizie letterarie e scoperte. *Giornale Bibliografico Universale*, 7, 284-288 (1810).

Occultatio τ Scorpii. *Saggi Scientifici e Litterarj dell'Accademia di Padova*, 2, 310 (1789).

Orloff, G.W., 1821. *Mémoires Historiques, Politiques et Littéraires sur le Royaume de Naple*s. *Volume 5*. Naples, Chasseriau.

Piazzi, G., 1795. Beobachtete Sonnenfinsternisse und Bedeckungen der Fixsterne vom Mond, zu Palermo. *Astronomisches Jahrbuch oder Ephemeriden für das Jahr 1798*, 104-107.

Piazzi, G., 1821. *Ragguaglio del Reale Osservatorio di Napoli Eretto sulla Collina di Capodimonte*. Napoli, Francese.

Rapporto a Sua Eccellenza Il Signor Ministro dell'Interno per il Locale di San Gaudioso destinato alla Specola, 1807a, dated 28 February. ASNa, *Ministero dell'Interno. Inv. II*, 2080:1.

Rapporto al Re per la invenzione della somma accordata, 1812, dated 3 June. ASNa, *Ministero dell'Interno. Inv. II*, 718:42.

Rapporto del Ministro dell'Interno al Sig. Duca di Cassano per la conversione del Belvedere di S. Gaudioso in Osservatorio Astronomico, 1807b, dated 31 January. ASNa, *Ministero dell'Interno. Inv. II*, 2080:1.

Rigutti, M. (ed.), 1992. *La Collina di Urania. Il Museo Storico dell'Osservatorio Astronomico di Capodimonte*. Napoli, de Rosa.

Santini, G., 1828. *Teorica degli Stromenti Ottici Destinati ad Estendere i Confini della Visione Naturale. Volume I*. Padova, Seminario.

Schröter, J.H., 1785. New observations in further proof of the mountainous inequalities, rotation, atmosphere, and twilight, of the planet Venus. *The Philosophical Transactions of the Royal Society*, 85, 117-176.

Schröter, J.H., 1796. *Aphroditographische Fragmente, zur genauern Kenntniss des Planeten Venus*. Helmstedt, C.G. Fleckeisen.

Sheehan, W., and Baum, R., 1995. Observation and inference: Johann Hieronymous Schroeter, 1745-1816. *Journal of the British Astronomical Association*, 105, 171-175.

Spaight, J.T., 2004. For the good of astronomy: the manufacture, sale, and distant use of William Herschel's telescopes. *Journal for the History of Astronomy*, 34, 45-69.

Taddei, E., 1835. Del Reale Osservatorio di Napoli. *Annali Civili del Regno delle Due Sicilie*, 8 (maggio giugno luglio e agosto), 61-72.

Toaldo, G., 1788. I miei viaggetti. *Library of the Episcopal Seminary of Padua*, Cod. 799, volume II: 98.

Troyli, P., 1752. *Istoria Generale del Reame di Napoli. Volume 4(2)*. Napoli.

von Zach, F.X., 1819. *Correspondance Astronomique Géographique, Hydrographique et Statistique. Volume 2*. A Gênes, A. Ponthenier.

Zöllner, J.F., 1797. *Reise durch Pommern nach der Insel Rügen und einem Theile des Herzogthums Mecklenburg, im Jahre 1795*. Berlin, Maurer.

Zuccari, F., 1812a. Letter to Oriani, dated 12 March. HAAOB, *Corrispondenza scientifica*, 101.

Zuccari, F., 1812b. Letter to Oriani, dated 14 March. HAAOB, *Corrispondenza scientifica*, 101.

Zuccari, F., 1812c. Letter to Zurlo, dated 10 May. ASNa, *Ministero dell'Interno. Inv. II*, 718:4.39.

Zuccari, F., 1812d. Letter to Zurlo, dated 26 October. ASNa, *Ministero dell'Interno. Inv. II*, 718:4.55.

Zuccari, F., 1813. Letter to Zurlo, dated 21 May. ASNa, *Ministero dell'Interno. Inv. II*, 718:4.76.

Zuccari, F., 1814a. Letter to Zurlo, dated 8 March. ASNa, *Ministero dell'Interno. Inv. II*, 718:4.92.

Zuccari, F., 1814b. Letter to Zurlo, dated 14 September. HAAOC, *Attività scientifica. Strumenti*, 1:6.

Zurlo, G., 1813. Letter to Zuccari, dated 3 January. ASNa, *Ministero dell'Interno. Inv. II*, 718:4.61.

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