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WILHELM TEMPEL AND HIS 10.8-cm STEINHEIL TELESCOPE

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Abstract: The German astronomer Ernst Wilhelm Leberecht Tempel (1821–1889) owed most of his successes to a 10.8-cm Steinheil refractor, which he bought in 1858. A lithographer, without an academic foundation, but with a strong passion for astronomy, Tempel had sharp eyesight and a talent for drawing, and he discovered with his telescope many celestial objects, including asteroids, comets (most notably, 9 P/Tempel 1) and the Merope Nebula in the Pleiades. Tempel carried his telescope with him throughout his moves in France and Italy. The telescope is now conserved in Florence, at the Arcetri Astrophysical Observatory, where Tempel was astronomer from 1875 until the end of his life. Using unpublished material from the Arcetri Historical Archive, as well as documents from other archives and published material, we trace the history of the telescope and its use during and after Tempel's life, and describe its recent rediscovery and status.

Keywords: Wilhelm Tempel, nineteenth-century astronomy, instrumentation, Steinheil, Arcetri

1 A LITHOGRAPHER WITH AN INTEREST IN ASTRONOMY

Ernst Wilhelm Leberecht Tempel was born on 4 December 1821 in Niedercunnersdorf, which at that time was in the Kingdom of Saxony. The son of farmers, he received a basic education in the village school. His teacher, Johan Kiesewalter, passed to the boy his passion for science and astronomy: local lore states they observed the sky with the naked eye from the church bell tower, where the young Tempel earned some money as a bell ringer. Kiesewalter also taught Tempel drawing, and apprenticed him to a lithographer in the nearby town of Meissen (Clausnitzer, 1989; Eichhorn, 1963). After this experience, Tempel started to wander through Europe. He worked for three years as a lithographer in Copenhagen (Tempel, 1884a), then after returning to Germany for a while he moved to Italy. In 1852 we find him in Venice, where he converted to the Catholic faith (Mutti, 1852).

During these years, he offered his drawing skills to several scientific institutes, but he was not considered for a permanent job because of his lack of an academic title (Clausnitzer, 1989; Eichhorn, 1963). However, he visited a number of astronomical observatories: probably the old observatory of Copenhagen (Clausnitzer, 1989); surely those of Marseille and Bologna. At the last two observatories, Tempel was probably employed in the making (and copying) of star charts. Among the Tempel documents stored in the Historical Archive of the Arcetri Astrophysical Observatory,[1] there is a lithographic copy of an equinoctial chart, compiled by J. Laurent (Valz, 1857a) in March 1857 under the direction of Benjamin Valz, Director of the Marseille Observatory, and engraved by Tempel. Several lithographic copies of Bishop's *Ecliptical Atlas* (Howard-Duff, 1985) are stored in the Library of the Arcetri Observatory, a few of which are annotated by Tempel, and one in particular has the note: "autogra. emprimer sur papier Bologna."

2 THE 10.8-cm (4-in) STEINHEIL TELESCOPE

In 1856, while in Marseille, Tempel (1856) wrote to the workshop of scientific instruments at the Bavarian Academy of Science in Munich, to which Carl August Steinheil had just been appointed by King Maximilian II (Brachner, 1987; Steinheil, 1856), and asked for information on the cost of refracting telescopes of 8.1-cm to 9.5-cm aperture (3–3.5 inches; the workshop used French inches: 1 inch = 2.707 cm). However, Valz advised against the purchase, and instead offered Tempel the use of the instruments at the Marseille Observatory. About a year later, Tempel was in Bologna. On behalf of Lorenzo Respighi, Director of the local observatory, he wrote again to Steinheil, asking for a 13.6 to 16.2-cm refractor for the institute (Tempel, 1858a; Steinheil, 1858a). Respighi indeed bought a 16.2-cm Steinheil telescope of 260-cm focal length (Poppi et al., 2008), and he was very satisfied with its quality (Tempel, 1858b).

In 1858 Tempel moved back to Venice, and wrote again to Steinheil about buying a telescope for himself. The purchase was defined in a series of letters in summer and autumn of 1858. Tempel chose to buy item n. 7 in the 1857 price list (Steinheil, 1857), comprising a 10.8-cm (4-in) refractor of 1.62-m focal length (5 feet), with a wooden tube and without an equatorial mount. According to the price list, the telescope was equipped with a 2.7-cm finder (24.4-cm focal length), a set of five astronomical eyepieces providing magnifications of 60, 80, 120, 180 and 240, and a 60× terrestrial eyepiece. Tempel also bought a solar filter, a 300× eyepiece, and two more wide-field eyepieces with 24× and 40× that were not in the price list. Later, he bought other eyepieces and filters, to substitute for broken ones. The telescope was identified by its production number, engraved in the brass ring holding the objective: it was N. 216 (Steinheil, 1858b).

The telescope was in Venice in December 1858, but Tempel could not use it because the wooden alt-azimuth mounting that he had ordered from a local craftsman was not yet ready (Tempel, 1858c). The telescope and its mounting can be seen in Figure 1 (left), the only photograph of Tempel next to his instrument. More technical details on the mounting can be inferred from a drawing (Figure 1, right) in one of Tempel's notebooks stored in the Arcetri Archive (which perhaps documents the project to build the mounting). A long fork rotated in azimuth on a cylindrical base, provided with three adjustable feet for

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horizontal positioning. A pivot for the movement in altitude was located on the fork and connected to the telescope tube by a band. A wing nut on the pivot probably kept the telescope steady in altitude. On the upper part of the fork, a ring could be closed to keep the telescope tube vertical when not in use. Surely, this mount was not easy to use: the Venetian doctor, Antonio Berti (1861), wondered how Tempel could at the same time follow the movement of the celestial sphere and make drawings (see Clausnitzer, 1989).

The telescope and its accessories cost Tempel 400 South German florins. Tempel bought it with his own savings (Berti, 1861; Schiaparelli, 1889b), perhaps from money obtained by selling some lithography tools (Clerke, 1893) or with the help of his wife (Baldelli, 1881), the Venetian Marianna Gambin (or Gambini; see Iliazd, 1964). The burden of the purchase was surely high, as the price of the telescope was close to the annual salary of an assistant at the nearby University of Padua (equivalent to about 490 South German florins; Tucci, 1960). Later Tempel thought of selling the instrument, possibly when he was experiencing economic difficulties. In February 1865 Valz wrote to him saying that "… it is a too cruel necessity that you have to get rid of the telescope." (Iliazd, 1964; our translation). In the spring of the same year, Tempel told his cousin, Gottlieb Hummel, that he had in his pocket an advertisement for the telescope, but did not have the heart to post it in a newspaper because it would harm both him and his wife (Eichhorn, 1961). Such an advertisement can be found inside one of Tempel's notebooks in the Arcetri Archive. It describes, in French, an "… excellent telescope … [from the] famous Steinheil workshop in Munich, of 48 lines [12 lines = 1 inch] aperture …" (our translation), complete with the eyepieces that we have described. The advertisement has no date, but it reports that Tempel made "… from 1859 13 astronomical discoveries." (ibid.). According to *Decouvertes Astronomiques*, Tempel considered the asteroid (81) Terpsichore his thirteenth discovery, which he made on 30 September 1864, while the fourteenth (Comet 55P/Tempel-Tuttle) was on 19 December 1865 (see Table 1). The advertisement says that the telescope is to be sold "… because of my impending departure." (our translation). This probably refers to the (vain) hope Tempel had in 1865 of being called to the Leipzig Observatory, where he had a sponsor in the High Appeal Court Magistrate and amateur astronomer, Friedrich Carl Gustav Stieber (Eichhorn, 1961). However, the telescope was not sold.

A refractor of that aperture could have been attractive not only to an amateur, but also to a professional observatory. Already in March 1859, before Tempel made any discoveries, Valz offered him a position at the Marseille Observatory, promising a dome and an equatorial mount for his telescope. However, when Tempel worked at the Observatory, from March 1860 to December 1861, a dome was not available, and he continued using his telescope—with the altazimuth mount—from the terrace of the building (Clausnitzer, 1989). Tempel found two instruments similar to his in aperture and focal length in the other two observator-

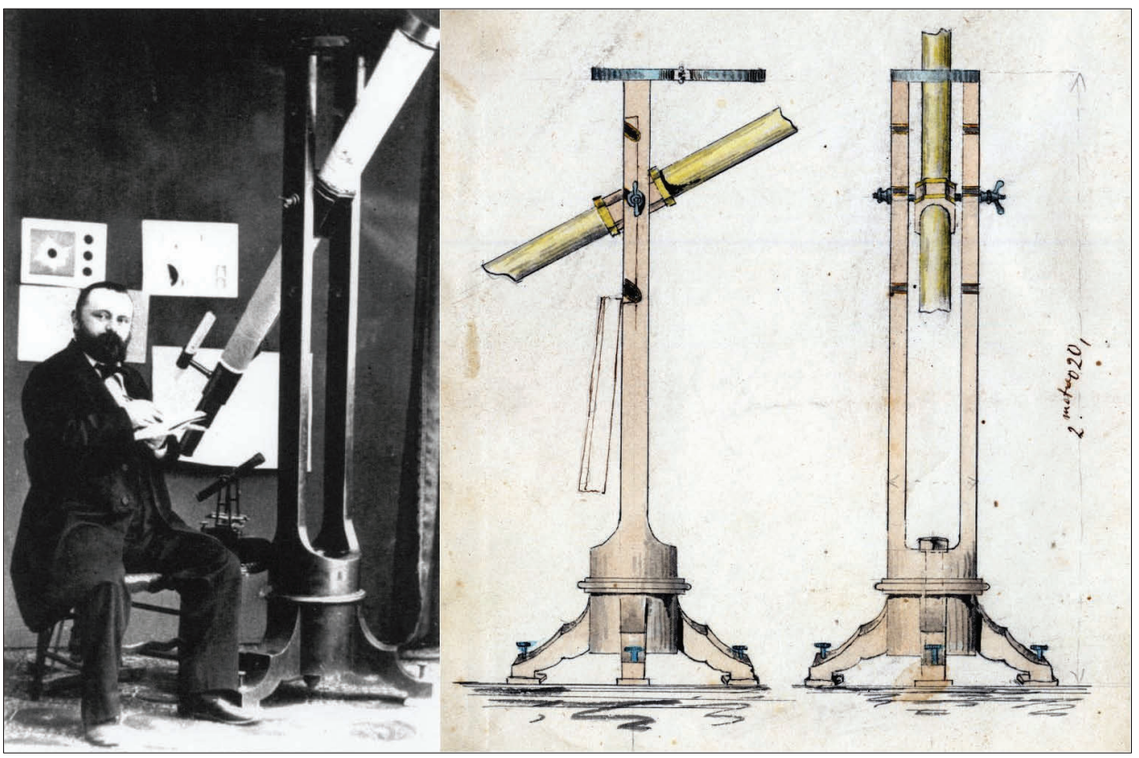

Figure 1: The left panel shows Tempel in Marseille next to his telescope, in 1868 (Clausnitzer, 1989). On the wall in the background we can recognise, to the left, the drawing of the totality phase of the solar eclipse of 18 July 1860, which was published as a lithograph in Donati (1866) and, to the right, the lithograph of the Moon presented here in Figure 6. In the right-hand panel is a drawing of the altazimuth mounting from one of Tempel's notebooks in the Arcetri Archive (series: *Wilhelm Tempel*). The height of the mounting is given as 2.02 m.

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ies where he later worked, Brera and Arcetri. In Brera, there was a late eighteenth century Sisson equatorial sector equipped with an 1855 Plössl objective, the only equatorial instrument available in the Observatory until 1874, when the 22-cm Merz telescope was finally installed (Tucci and Valota, 1983). An equatorially-mounted Fraunhofer refractor, originally from the old Observatory of Florence (the *Specola*), was installed in a side dome of the newly-built Arcetri Observatory, that hosted as its main instrument the 28-cm equatorial refractor Amici I (so called by Tempel in 1875 to distinguish it from a smaller Amici telescope), which at the time was the largest telescope of this type in Italy (Schiaparelli, 1875). Therefore, at both Observatories 4-inch refractors were considered minor, even obsolete, instruments, to be replaced or already replaced with more powerful telescopes. However, Tempel used both.

3 ASTRONOMICAL OBSERVATIONS FROM VENICE AND MARSEILLE (1859-1870)

By the beginning of 1859, the new telescope mounting was ready and Tempel started observations in Venice. As recorded in the *Decouvertes Astronomiques*, he observed from the *escalier Lombard,* the winding staircase of the Palace Contarini del Bovolo (Berti, 1861; Iliazd, 1964). Observations fascinated him, so much so that he was distracted from his daily work. In the same year he wrote his cousin, Hummel, that it was too tiring to work in the daytime and also at night, since he often observed from seven in the evening to four in the morning, in the cold and damp. Thus, he asked his cousin if he knew of a benefactor able to finance him in Marseille, so that he could widen his astronomical knowledge without the need to work as a lithographer (Eichhorn, 1961). It is not clear why Tempel was worried about having to work as a lithographer in Marseille, since he had already been offered a position at the Observatory by Valz. Perhaps he wanted to cover a delay in his appointment due to some problems that are alluded to in his correspondence with Valz (Iliazd, 1964). Or maybe he was worried that his employment at the Observatory had to do more with lithography than astronomical observations, since it appears that he was employed as a 'drawing astronomer' (Berti, 1861; Iliazd 1964). While he was in Marseille, Tempel's zeal for night observations also was considerable. In November 1860, the well-known Italian astronomer Giovanni Battista Donati congratulated Tempel on the discovery of a new comet, but reminded him that he also had to work during the day, since he promised to produce lithographs of the total solar eclipse of the previous July (Donati, 1860b). A few months after the retirement of Valz, Tempel left the Marseille Observatory because of problems with the new Director, Charles Simon, and resumed working as a lithographer (see Table 2, where Tempel's career in astronomy is summarised). However, he only worked four hours during the day, thus procuring for his wife and himself a meager income (Clausnitzer, 1989). Instead, he passed long nights successfully observing the sky from the garden, the balcony, and even the windows of his houses (see Table 1).

Tempel's interests were as wide as those of any passionate amateur astronomer, and he observed all the objects that were within the reach of his instrument. However, he must have devoted most of his observing time to the search for comets and asteroids, whose discovery could bring him fame and the possibility of employment in a professional observatory (as eventually happened—see Section 4 below). In this respect, the published lists of his discoveries (Tempel, *Decouvertes Astronomiques*; Flammarion, 1874; as reproduced here in Table 1) could be seen as a sort of curriculum vitae that he could present to the scientific community. Together with the quality of his Steinheil telescope, the large number of Tempel's discoveries can be explained by his commitment to observing and by the clear skies over Marseille, which he praised several times (e.g. see Tempel, 1863; 1864b). Surely, most of his success must have been due to his 'sharp eye' (Schiaparelli, 1889b) and his ability to detect faint details, possibly a result of his experience in observing and drawing since youth.

3.1 Comets

On 2 April 1859 Tempel was in Venice when he discovered his first comet, C/1859 G1, the only one detected that year. Lacking an equatorial mounting, he derived an approximate position using Harding's Atlas (Trettenero, 1859). This atlas (Harding, 1856) was owned personally by Tempel, and is now in the Arcetri Library. In it, Tempel marked the position of the 1859 comet from the day of the discovery (Figure 2) and of many other comets and nebulae that were observed later, right up till the end of his life.

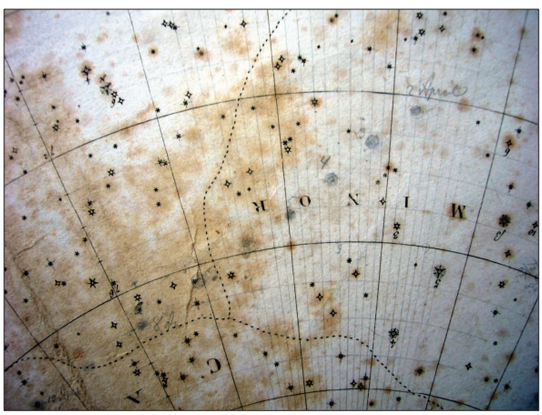

Figure 2: The path of Comet C/1859 G1 in Ursa Minor, from the day of its discovery, 2 April 1859. Tempel marked the positions in pencil on plate 27 in his personal copy of the Harding Atlas, which can be found in the Library of the Arcetri Observatory. The atlas is included in a list of Tempel's books left at Arcetri after his death, written during the reorganization of the Library in 1894 (Historical Archive of the University of Florence, Florence; Sovrintendenza, year: 1894, file: 83 bis).

In Marseille, Tempel discovered seven more comets: C/1860 U1, C/1863 V1 (Figure 3); C/1864 N1, the first comet with an observed spectrum (Donati, 1864); 55P/1865 Y1 Tempel-Tuttle (Figure 3), which was soon associated with the November Leonid meteor shower (Schiaparelli, 1867); 9P/1867 G1 Tempel 1 (Figure 3), which in 2005 was visited by the NASA mission Deep Impact (A'Hearn et al, 2005) and will be targeted by STARDUST/NexT in 2011 (Veverka et al., 2008); C/1869 T1; and 11P/1869 W1 Tempel-Swift-LINEAR.

Tempel also discovered independently other comets (see Table 1), but never as the first observer. Among

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Table 1: Tempel's astronomical discoveries made with the 4-in Steinheil telescope (adapted from Tempel, 1868a and Flammarion, 1874).

No.	Name	Alternative Name	Type of Object	Discovery Date	Observing Location
1	C/1859 G1	1859	comet	2 April 1859	Venice, Escalier Lombard
2	NGC 1435	Pleiades Nebula	reflection nebula	19 October 1859	Venice, Escalier Lombard
3	C/1860 U1	1860 IV	comet	24 October 1860	Marseille Observatory terrace
4	(64) Angelina		asteroid	4 March 1861	Marseille Observatory terrace
5	(65) Cybele	Maximiliana	asteroid	8 March 1861	Marseille Observatory terrace
6	C/1862 N1	1862 II	comet	2 July 1861	Marseille, home garden
7	(74) Galatea		asteroid	29 August 1862	Marseille, home window
8	C/1863 G2	1863 III	comet	17 April 1863	Marseille, home garden
9	(79) Eurynome		asteroid	6 October 1863	Marseille, home window
10	C/1863 T1	1863 VI	comet	14 October 1863	Marseille, home balcony
11	C/1863 V1	1863 IV	comet	5 November 1863	Marseille, home garden
12	C/1864 N1	1864 II	comet	5 July 1864	Marseille, home garden
13	(81) Terpsichore		asteroid	30 September 1864	Marseille, home window
14	55P/1865 Y1	1866 I	comet	19 December 1865	Marseille, home balcony
15	38P/1867 B1	1867 I	comet	28 January 1867	Marseille, home balcony
16	9P/1867 G1	1867 II	comet	3 April 1867	Marseille, home window
17	(97) Klotho		asteroid	17 February 1868	Marseille, home window
18	7P/1869 G1 (?)	1869I, 1869a	comet	29 June & 12 August 1869	Marseille, home balcony
19	C/1869 T1	1869 II, 1869b	comet	12 October 1869	Marseille, home garden
20	11P/1869 W1	1869 III, 1869c	comet	27 November 1869	Marseille, home balcony
21	C/1870 K1	1870 I, 1870a	comet	30 May 1870	Marseille, home balcony
22	C/1871 L1	1871 II, 1871b	comet	14 June 1871	Milan, Brera Observatory
23	C/1871 V1	1871 IV, 1871e	comet	3 November 1871	Milan, Brera Observatory
24	10P/1873 N1	1873 II, 1873b	comet	4 July 1873	Milan, Brera Observatory
Other discoveries not included in the references above					
25	NGC 1398		galaxy	9 October 1861	Marseille
26	NGC 1360		planetary nebula	9 October 1861	Marseille
27	X/1871 Y1		comet	29 December 1871	Milan
28	C/1874 G1	1874 II, 1874b	comet	19 April 1874	Milan

Notes:

A progressive number is given in Tempel (1868a), up to number 17 (second edition of the sheet; Iliazd, 1964). Numbers are omitted in Flammarion (1874), although the list order is the same. In this table, numbers in bold refer to objects for which Tempel was the first observer.

Objects 6 and 7 were discovered from Tempel's address at rue Pythagore 10, those from 8 to 21 from rue Pythagore 26.

Supposedly, objects 22, 23, 24 and 28 were discovered with the Steinheil (see discussion in Section 4).

For comets, designations and discovery dates are taken from Kronk (2003), to which we refer for the bibliography. No reference is found for the observations of object 18. Flammarion (1874) reports the year 1868 but we believe it should be 1869: in the note for the object, it is said that it was discovered by Winnecke on 9 April, and that Tempel found it independently, before and after perihelion. We thus believe it was 7P/1869 G1, whose perihelion was on 30 June.

For other objects, references are provided in the text.

Table 2: Tempel's career in astronomy

Period	Location	Occupation
early 1859 – March 1860	Venice	Amateur astronomer, lithographer
March 1860 – December 1861	Marseille	Drawing Astronomer at the Marseille Observatory
January 1862 – early 1871	Marseille	Amateur astronomer, lithographer
early 1871 – early 1875	Milan	Assistant at the Brera Observatory
early 1875 – 16 March 1889	Florence	Helper, then Assistant, at the Arcetri Observatory

these is C/1870 K1, which was found by Tempel only fifteen minutes after Winnecke had made the initial discovery (Littrow, 1870).

For the comets he discovered in 1869, Tempel received the first two prizes of the Imperial Academy of Sciences in Vienna. He was given a gold medal for the first comet, and its monetary value (20 Austrian ducats) for the second (Preisertheilungen …, 1870). Tempel (1884c) believed that the reason for his success as a comet hunter was the good quality of his telescope, and in the large 2° field of the 24× eyepiece (Tempel, 1866). Schiaparelli (1889b) alluded to this excellent eyepiece when he listed the comet discoveries in Tempel's obituary.

3.2 Asteroids

In Valz's obituary which Tempel (1867a) wrote, he lists among the achievements of the former Director of the Marseille Observatory the idea of simplifying the discovery of asteroids by the use of the ecliptic and equatorial charts produced by Chacornac (1856-1863) and Laurent (Valz, 1857a; 1857b), respectively. Thus, it is not by chance, while in Marseille, that Tempel engaged in the search for these bodies. In a note dated 16 July 1860 (Arcetri Archive, Series: *Wilhelm Tempel*), he wrote, in Italian, that he was angry with Chacornac because so many stars were missing on his ecliptical charts, which made the search for a new asteroid, the 59th, very difficult. He added that he was

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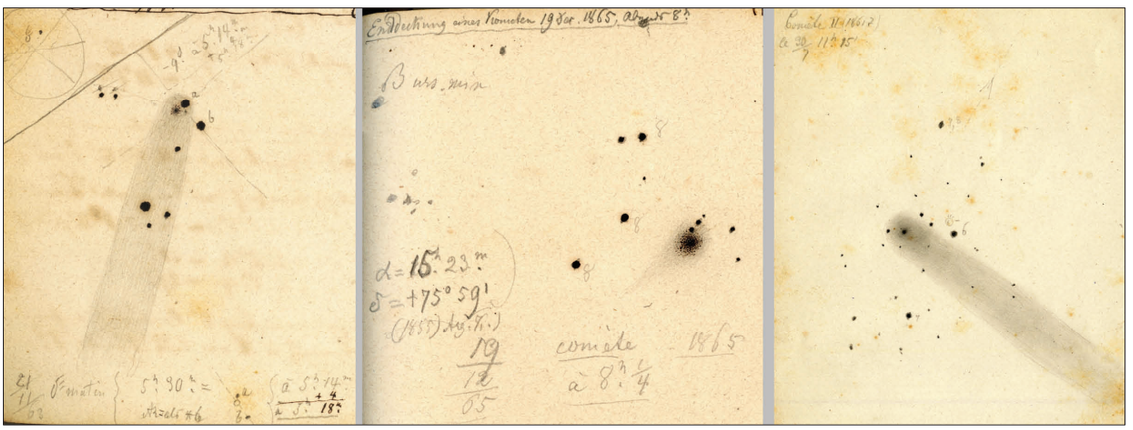

Figure 3: Drawings of comets discovered by Tempel, from his personal notebooks in the Arcetri Archive (Series: *Wilhelm Tempel*). Left: Comet C/1863 V1 on 21 November 1862. Center: Comet 55P/Tempel-Tuttle on the day of its discovery, 19 December 1865. Right: Comet 9P/Tempel 1, observed on 30 July 1867.

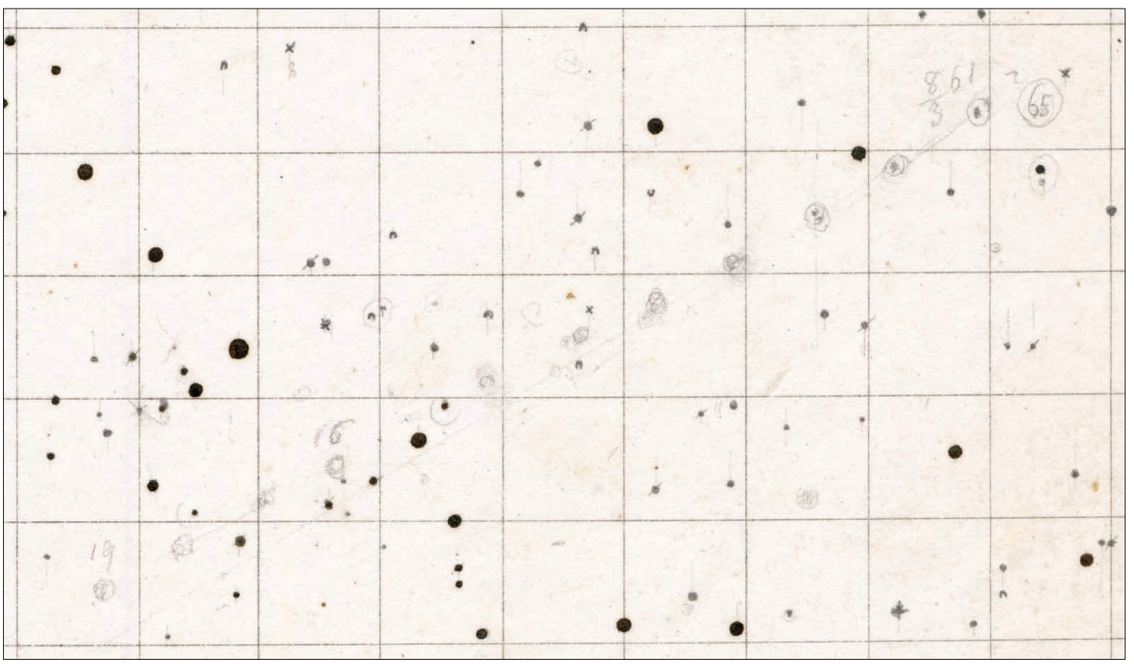

Figure 4: The path of (65) Cybele (Maximiliana) from the day of its discovery, 8 March 1861. The path is marked on what looks to be a copy of Laurent's equinoctial chart, in the Arcetri Archive (Series: *Wilhelm Tempel*). The Arcetri Archive also has a chart with the path of (64) Angelina, similar to the copy in the Preußischer Kulturbesitz of Berlin, which has been published by Clausnitzer (1989). The star close to the second position of the asteroid is HD 106189, next to the grid intersection at RA 12h 6m and Dec 1° (1855). The grid spacings are 1m in RA and 15′ in Dec. North is at the bottom.

"… so disgusted that he had lost the will to search for new planets." (our translation). Ironically, asteroid (59) Elpis was found by Chacornac later that year (see Discovery of Minor Planet 59, 1860). However, Tempel did not abandon his own search, and on 4 March 1861 he found asteroid 64 (Tempel, 1861b), called Angelina by Valz (Peters, 1861). A few days later, on 8 March, Tempel (1861c) discovered asteroid 65 (Figure 4) and asked Steinheil to name it. Steinheil chose the name Maximiliana, in honor of the Bavarian King (Name des Planeten (65), 1861). As in the case of the naming of Victoria (Gould, 1850), the choice of a political rather than a classical name for asteroid 65 gave way to a (mostly German) campaign against it. At the end of 1861, this asteroid was renamed Cybele (Iliazd, 1964).[2] For both of these asteroid discoveries, Tempel was awarded the 1861 Lalande Prize by the French Academy of Science (*Comptes Rendus*, 1861).

After leaving the Marseille Observatory Tempel discovered three more asteroids while observing from the windows of his houses: Galatea in 1862 (Tempel, 1862), Terpsichore in 1864 (Tempel, 1865) and Klotho in 1868 (Tempel, 1868b). The 40× eyepiece was used in the search for asteroids (Tempel, 1884c). Later, Tempel (1885) claimed to have stopped hunting for asteroids because his telescope was too good for that purpose: it showed many more stars than those on the charts at his disposal (see also Tempel, 1863; 1883a), making it difficult to mark them and search for newer, ever fainter, minor planets.

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3.3 Nebulae

Another famous discovery by Tempel was the Pleiades Nebula, which was made from Venice on 19 October 1859. Tempel (1861a; 1874; 1885) recounted the discovery on various occasions in the literature. He observed the Pleiades in March 1859 and made a sketch, which was later reproduced as a lithograph (Figure 5). After about six months, he observed the star cluster again and, comparing his drawing with the sky, he noted there was nebulosity around the star Merope. At first he thought it was a comet, but on the following evening the nebula's position was unchanged. The discovery was only announced to the scientific community in 1861, when Tempel showed the nebula to Valz and others (Tempel, 1861a). A drawing of the nebula was published much later (Tempel, 1874). In the years following the publication of the discovery in *Astronomische Nachrichten*, many astronomers tried to observe the nebula. Many did not succeed, and others thought it was a variable nebula (see d'Arrest, 1863; Steinicke, 2009; Tempel, 1875). In 1880, Tempel pointed out the reason for these unsuccessful observations: it is more important to have a wide-field eyepiece than a telescope of large aperture.

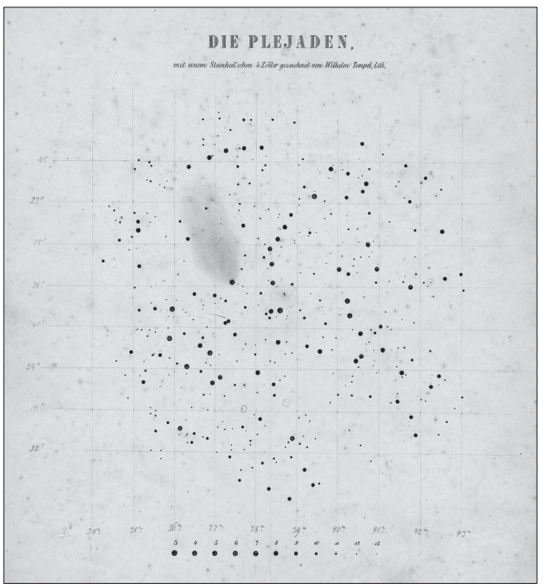

Figure 5: Lithograph of the stars in the Pleiades, from the Arcetri Archive (Series: *Wilhelm Tempel*). The Merope Nebula (and the coordinate grid) has been drawn by hand. The Archive has several versions of this diagram, some without the nebula. A diagram with the nebula drawing and dated *März 1859* is bound in a personal copy of Über Nebelflecken (Tempel, 1885) which was once in the Arcetri Library but is now housed in the Library of the Institute and Museum of the History of Science in Florence. A complete lithograph including the nebula was published later (Tempel, 1874). Tempel's last drawing of the field was done at Arcetri using the Amici I telescope in 1880. In all of these diagrams the field of view is about two degrees, which is that of the Steinheil telescope with the 24× eyepiece (Tempel, 1866). North is at the bottom.

Tempel also observed the Orion Nebula, a drawing of which was published in *Astronomische Nachrichten* (Peters, 1862). The editor of the journal, Christian Peters, praised Tempel for his skills in observing and drawing. He also described the telescope used by Tempel: a 4-inch refractor, with low magnification from 24× to 40×, i.e., the configuration used in the search for comets and asteroids. During his surveys, Tempel must have come across many nebulous objects. For example, one was seen in the stellar field where he found (74) Galathea (Tempel, 1862). Two other nebulae were discovered in Marseille in 1861, and registered on a small star chart that he used during his search for new comets (Tempel, 1882); they were the planetary nebula NGC 1360, first seen by Swift, and the galaxy NGC 1398 (Steinicke, 2009).

In reply to Chacornac's (1863) announcement of the discovery of a variable nebula, Tempel (1863) wrote a letter to the magazine *Les Mondes* in which he expressed doubt about the variability. Believing that nebulae were unresolved star clusters (Tempel was against the idea that some of them were gaseous; Dreyer, 1887), he argued that it was rather improbable to have them all variable at the same time. Instead, he claimed that the supposed variability was the result of changeable atmospheric conditions: for example, his detection of the Pleiades Nebula was due to the exceptional transparency of the sky on the night of the discovery. Then, he suggested a test to verify his claims: one should draw on a copy of the Berlin Academy star chart (Akademische Sternkarten, 1859) the nebulae of the Virgo cluster listed in John Herschel's General catalogue, as observed with a 4-inch telescope, such as his own one. If the map was then compared to those of other astronomers (he referred to d'Arrest and a map in Mädler, 1841), one could get some idea of the different appearance of the same field observed under different circumstances. As we can perceive from the text, Tempel actually made the test: in the Arcetri Archive (series: *Wilhelm Tempel*) there are two maps of the Virgo Cluster, one drawn from observations of d'Arrest, another based upon Tempel's own observations. The latter is much richer in nebulous objects, confirming the good transparency of the sky over Marseille, and most likely showing the self-esteem Tempel had of his ability as observer! In *Les Mondes*, Tempel also resolved to verify the variability of Chacornac's nebula and to give a report on his observations. On a copy of Herschel's General Catalogue,[3] Tempel wrote that he had indeed shown Valz that the object was only a false image. However, they did not publish a note on it, and the nebula ended up classified as variable in the Catalogue. Nevertheless, Tempel sent a comment to John Dreyer, who reported it in the notes of the New General Catalogue (Dreyer, 1888). Indeed, the object, NGC 1988, is just a star (Steinicke, 2009).

A trace of Tempel's first observations of nebulae can be found in his later work, *Observations and Drawings of Some Nebulae*, a collection of twenty-two plates made at the Arcetri Observatory in about 1879. The collection, which is still unpublished, is held in the Arcetri Library. From this work, we know that Tempel used his Steinheil telescope to observe the Andromeda Galaxy (M31) and Omega (M17), Lagoon (M8; Tempel, 1877), Flame (NGC 2024) and Helix (NGC 7293) Nebulae.

3.4 The Moon

The Earth's satellite was one of the first objects to which Tempel directed his observing and drawing skills. In the Arcetri Archive there are several of his drawings of craters and other lunar formations, most of which were made in Venice between July and October

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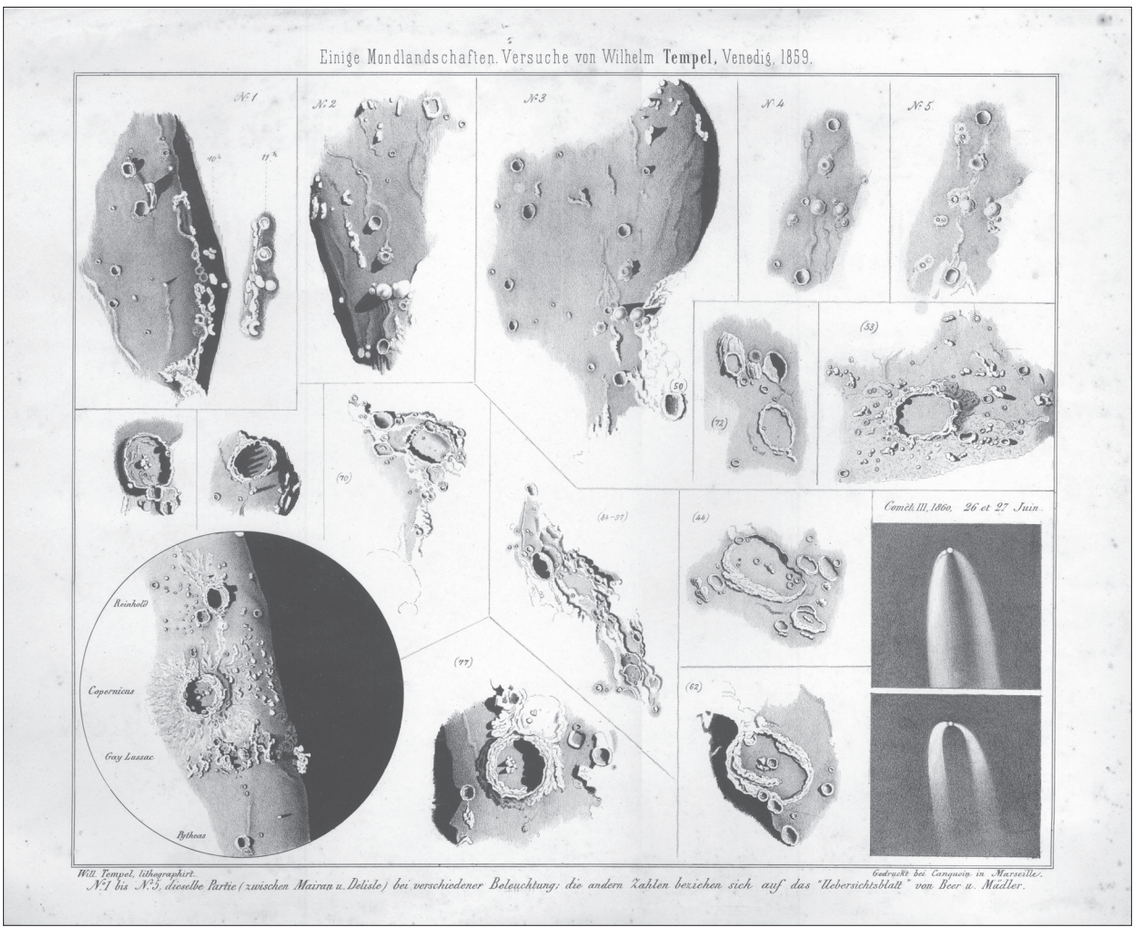

Figure 6: Unpublished lithograph with observations of the Moon, made in Venice in 1859, from the Arcetri Archive (Series: *Wilhelm Tempel*). At the top, the sequence numbered from 1 to 5 shows an area between craters Mairan and Delisle, and in particular the region around Mairan A and Gruithuisen, under different illuminations of the Moon (Tempel 1867b). Around the circular insert are shown, clockwise, the craters Gassendi, Archimedes, Mersenius, Sirsalis and Damoiseau, and Theophilus. The circular insert shows the region around Copernicus, identical to a smaller lithograph published by Clausnitzer (1989: 28); it has a diameter of about 4', probably the field of view of the Steinheil telescope's 120× eyepiece. Under panels n. 4 and 5 the craters Cook and Monge, and Plato are shown (from the left). Beside the comet drawings are the craters Cleomedes (top) and Posidonius (bottom). The Archive has the original drawings for some of the regions shown in the litograph, dating from July to October 1859. In all of Tempel's lunar drawings south is at the top. The two drawings of Comet C/1860 M1 were later published (see Tempel, 1874).

1859. Some of them were included in a lithograph made in Marseille probably in the second half of 1860 (Figure 6). Later, Tempel (1867b; 1867c) published some remarks on the appearance of the Moon's surface, following the news of the disappearance of the crater Linné (Schmidt, 1867).[4] Tempel confirmed the disappearance of the crater, and observed in its place a round white spot, similar to those observed elsewhere on the Moon. He suggested that these spots may be "… of interest for chemically warm activity." (our translation). One of these 'small bubbles' is drawn between craters Diophantus and Delisle (top-left in panel N.3 of Figure 6). In reality, the spot corresponds to a high-albedo area centered on the small craters Samir and Louise, and its appearance (together with that of Linné) may have been due to a lack of resolution and poor seeing.

However, Tempel (1867b) warned about the difficulty of identifying real changes on the Moon's surface, both because lunar atlases were incomplete and because of the differing appearance of the same area in the course of a lunation. In support of this, he described five drawings that he had made of the region between the craters Mairan and Delisle that changed so much from night to night that they looked to have been drawn by different observers, or represented different areas of the Moon's surface (most certainly these are the five numbered panels on the top of Figure 6).

Tempel also suggested that astronomers should look for possible signs of 'luminous activity' on the Earth-lit part of the Moon, not directly illuminated by the Sun. In this way he had been able to observe a light which was "… star-like, diffused, in color reddish-yellow …" (our translation) coming from the crater Aristarchus (Figure 7) during two events in 1866 and 1867. Tempel can thus be counted among the observers of the controversial Transient Lunar Phenomena (TLP), which have been reportedly seen on numerous occasions in the Aristarchus region (Crotts, 2008).

For his lunar observations, Tempel used larger magnifications, from 120× (Tempel, 1867b) to 300× (Tempel, 1867c). By contrast, he used 24× to observe the

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Moon during the total eclipse of 1 June 1863. He made a realistic color drawing of this event in his notebook (Arcetri Archive, series: *Wilhelm Tempel*), and later published a lithograph of it (Tempel, 1874).

3.5 Other Observations

In July 1860, Tempel joined an Italian scientific expedition to observe a total solar eclipse, organized by Giovanni Battista Donati and Francesco Carlini, Directors of the Florence and Milan Observatories, respectively

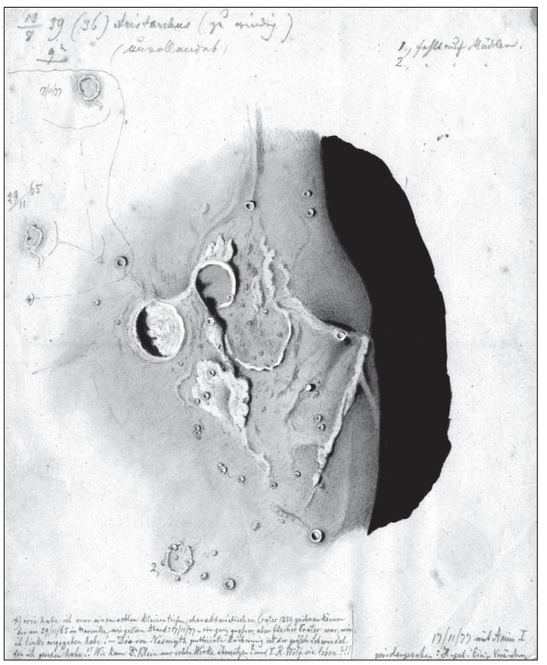

Figure 7: The lunar craters Aristarchus and Herodotus, observed on 16 August 1859 (Arcetri Archive, Series: *Wilhelm Tempel*). The floor of Aristarchus is colored in red, probably to describe the later observations of a TLP (Tempel, 1867b). The small crater to the top left (Aristarchus F) was drawn on two other occasions, on 29 November 1865 from Marseille, and on 17 November 1877 from Arcetri with the Amici I telescope. Tempel noted that this crater appeared larger and shallower in the two later drawings. The rest of the note reports criticisms on a drawing of the same region by Nasmyth, which Tempel considered to be the biggest fake he had ever seen. The same criticisms were written by Tempel on the Aristarchus and Herodotus plate in a copy of the German translation of the work by Nasmyth and Carpenter (1876). This book, once at the Arcetri Library, is now housed in the Library of the Institute and Museum of the History of Science in Florence. As a matter of fact, the plates in Nasmyth and Carpenter's book do not show drawings, but rather photographs of models of the lunar surface (Astronomical Register, 1874).

(Donati, 1866b). The expedition embarked from Marseille for Spain, the final destination being Torreblanca, a town on the Balearic Sea north of Valencia. On the day of the eclipse, 18 July, Tempel was given the task of following it with his telescope and of giving an overall description of the phenomenon, while the other astronomers determined the times of the event, measured the positions of sunspots and prominences, and took photographs. Once back in Marseille, Tempel made two lithographs for Donati (1866b): one showing the appearance of the solar disk before and after the eclipse, based upon the photographs and on sunspot drawings that he made (Donati, 1860a); the other, of the appearance of the corona during totality, again based upon his own drawings. Eddy (1974) compared the drawings made by Tempel with those of other astronomers who observed this eclipse, and claimed that a prominence in Tempel's drawing is a coronal mass ejection, a rare phenomenon to observe during an eclipse, and that the German astronomer produced a more realistic description than that given by the more experienced and well-known P. Angelo Secchi, who observed the event at the same time from a nearby location.

In the summer of 1863, Tempel went on a trip to Germany, where he visited his birthplace, gave a public lecture in Ebersbach and spent time at the Leipzig Observatory (Clausnitzer, 1989), where he probably sought employment. He also had the objective of his telescope cleaned by Steinheil in Munich, which corrected some shape imperfections (Tempel, 1864b).

Back in Marseille, Tempel tested his telescope and was very satisfied with the result: he managed to resolve double stars as close as 1.5″, even objects such as β Orionis which he had not been able to resolve prior to the cleaning. After these tests, he went on to observe Sirius. The companion, Sirius B, had been discovered by Clark in 1862 and observed many times with large telescopes in America and Europe (Holberg and Wesemael, 2007). In Paris, Goldschmidt (1863) claimed to have observed six stars around Sirius, some closer to the main star than Sirius B (the separation at the time was about 10″; Wesemael and Racine, 2008). Tempel, observing with a slightly larger telescope than Goldschmidt and from a place with better atmospheric conditions, was indeed able to see point sources with the lower magnifications (24 and 40×). However, these were fainter at 60× and disappeared with magnifications larger than 80×. Since this was at odds with his experience on the Pleiades, where fainter stars were more readily visible with larger magnifications, Tempel (1864b) concluded that the companions seen by Goldschmidt were only false images. Later, Tempel (1872b; 1874) returned to the topic of the visibility of fainter stars next to bright ones and also observed Sirius from Arcetri (Tempel, 1875-1877; 1878a).

Finally, Tempel (1874) used his Steinheil telescope to observe Jupiter and Saturn. He was particularly interested in the satellites' configuration, but did not neglect to give a realistic representation of their appearance in the telescope (e.g. see Figure 8). Later, he was committed to planetary observations and made numerous drawing using the Amici I at Arcetri; these were never published, and are now held in the Arcetri Archive (series: *Wilhelm Tempel*).

4 THE TELESCOPE AT BRERA AND ARCETRI (1871-1889)

Because of the Franco-Prussian War, at the beginning of 1871 Tempel, being German, was expelled from France. He moved to Milan, and was employed as an Assistant at the Brera Observatory, which at the time was directed by Schiaparelli; thus he again became a professional astronomer (Clausnitzer, 1989). While at Brera, Tempel discovered three more comets: C/1871 L1, C/1871 V1 and the periodic 10P/1873 N1 Tempel 2. Tempel's skills were well suited to the research interests of his employer, Schiaparelli, which related to the study of cometary orbits and tails, and the associ-

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ation with meteors. Schiaparelli took advantage of Tempel's drawing and engraving ability, which allowed the Italian astronomer to publish an overdue work on the shape and direction of cometary tails which had been delayed for more than ten years because of the "… difficulty of finding a way to reproduce exactly and faithfully the numerous drawings …" that he had made of comet 109P/1862 O1 Swift-Tuttle (Schiaparelli, 1873: 3; our translation). In this period, Tempel (1874) also had the opportunity to publish some of his own earlier, unknown, drawings.

While at the Brera Observatory, Tempel could use a micrometer and an equatorially-mounted telescope, the Sisson equatorial sector with the Plössl objective (which he called the Plössl telescope). With these instruments, he made accurate positional measurements that were included in his publications. However, Tempel believed that his Steinheil refractor was of better quality than the Plössl telescope, although both had the same aperture and focal length (Schiaparelli, 1871): "… the difference in visibility of nebulae and faint comets was sometimes incomprehensible … [while in the Plössl] often there was no trace of nebulae and comets, that were seen so well in the Steinheil." (Tempel, 1875: 67; our translation). In the publications of this period (most of which were translated into Italian and included in Tempel, 1874), Tempel wrote several times that he had used the Steinheil to observe comets too faint for the Plössl. Thus, it is very likely that he used the Steinheil telescope for the comet discoveries (even though the 'discovery telescope' is never mentioned). We can guess this for C/1871 L1, which was discovered when he was drawing nebulae (Tempel, 1871), and perhaps also C/1871 V1, which was found next to the open cluster (he said *nebula*) M26 (Tempel, 1872a). In one case there is no doubt: on 29 December 1871 he reported a comet (X/1871 Y1, which was never seen again—Kronk, 2003) with his instruments without an equatorial mounting (Tempel, 1872b). Furthermore, using the Steinheil refractor and the 24× eyepiece he made three plates describing the changing appearance of Coggia's Comet, C/1874 H1, along its path (Tempel, 1874).

Because of health problems and the cold Milan winters, at the beginning of 1875 Tempel moved to the Astronomical Observatory of Arcetri in Florence (Schiaparelli, 1889b),[5] where, sponsored by Schiaparelli, he was first employed as *aiuto* (helper), then Assistant Astronomer. Tempel arrived in Arcetri after the death of the founder Director, Giovanni Battista Donati in 1873, and of the *aiuto*, Domenico Cipolletti, in 1874. He was the only astronomer in service at Arcetri till the end of his life, since the astronomy chair at the Institute of Superior Studies[6]—upon which the Observatory depended—remained vacant till 1894. Being alone, and with only the tasks of preserving and maintaining the instrumentation (Parlatore, 1876), he was free to use the telescopes at will. The principal instrument in Arcetri was the 28-cm refractor, Amici I, which Tempel (1877) immediately used to observe nebulae. This became his principal activity at Arcetri. Besides drawing the plates of *Observations and Drawings of some Nebulae* (Tempel, 1879), for which he received from the Lincei Academy the Royal Prize of H.M. King Umberto I for Astronomy (A*tti della R. Accademia dei Lincei*, 1881), he discovered many new objects (about 150 entries of Dreyer's [1888] *New General Catalogue*; Steinicke, 2009) and published a more extended work on the topic, Über Nebelflecken (Tempel, 1885). From Florence he discovered yet another comet, C/1877 T1, while moving the Amici I telescope from Mars to some nebulae he had discovered earlier (Tempel, 1878b). For this and the comet discoveries in Milan, he received four other prizes from the Imperial Academy of Sciences in Vienna (Weiss 1878). As final recognition for his comet discoveries, he received the Valz Prize in 1881 (Clausnitzer, 1989).

Although only sporadically, he kept using his Steinheil telescope to observe comets (Tempel, 1878c; 1883b). Since the Amici I could not be used for targets located <20º above the horizon (Tempel, 1877), he also used the Fraunhofer equatorial telescope for positional measurements. It is interesting to note that Donati, who was a pioneer of spectroscopy, equipped the Fraunhofer refractor with a spectroscope (Cipolletti, 1872), but Tempel does not seem to have used it, and indeed he did not trust spectroscopic studies (Tempel, 1885). It should be noted, however, that following Donati's death even Schiaparelli (1875), with a supporting letter from Struve, stated he preferred classical astronomy over the yet uncertain role of astrophysics.

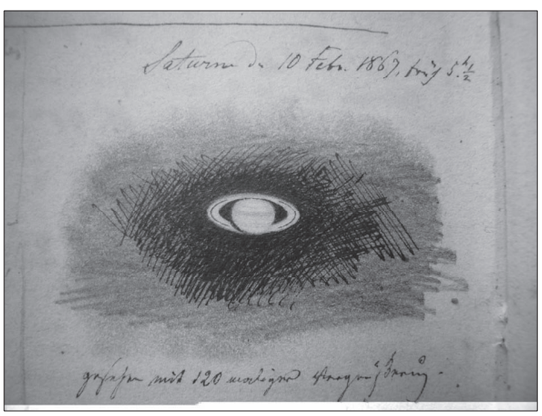

Figure 8: A drawing of Saturn made on 10 February 1867, using the 120× eyepiece. From one of Tempel's notebooks (Arcetri Archive, Series: *Wilhelm Tempel*). South is at the top.

As for the Fraunhofer telescope, it was identical to Tempel's Steinheil refractor in aperture and focal length but, like the Plössl in Brera, was not as good for the observations of comets and nebulae (Tempel, 1884d; 1885). In his declining years, Tempel (1884b; our translation) wrote to A. Steinheil about his superb telescope:

> Shouldn't you remember, the excellent work of your father – my beautiful four inch! – had a big part in my astronomical successes. I must always remember with respect and gratitude the firm: C.A. Steinheil.

A last note on the total number of discoveries made with the Steinheil refractor: Tempel told Geltrude Walker Baldelli (1881), a visitor to the Observatory, that he made 26 discoveries with his telescope, while in a letter to A. Steinheil he wrote that he found 5 asteroids with the 40× eyepiece, and made another 21 discoveries with the 24× – again 26 discoveries (Tempel, 1884c). In his list of discoveries either as first observer or independent discoverer (see Table 1) Tempel named 24 objects. To these, we can add the galaxy NGC 1398, the planetary nebula NGC 1360, and the

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comets X/1871 Y1 (never seen again) and C/1874 G1, the priority of which belongs to Winnecke (Tempel, 1874). We thus have a total of 28 discoveries, though there are some inconsistencies: 6 asteroids, rather than 5, are listed, including (79) Eurynome, which was found by Watson (Tempel, 1864a); three objects are not included in the 1874 list, though they had been discovered before the publication date; for a comet, probably 7P/1869 G1, two discovery dates are given because Tempel claimed to have found it before and after perihelion, independently while lacking any news or ephemerides. Unfortunately, these inconsistencies, together with the discrepancy between the current count and his later claims, do not help us in clarifying whether the comet discoveries from Milan (objects 22, 23, 24 and 28 in Table 1) were made with the Steinheil telescope. But, if this is true, Tempel used this telescope to discover a total of 11 comets (excluding X/1871 Y1), 5 asteroids, the Pleiades Nebula and the galaxy NGC1398.

5 THE TELESCOPE AFTER TEMPEL'S DEATH (1889-PRESENT)

In the last years of his life Tempel was ill and had to abandon observing (Dreyer, 1890; Schiaparelli, 1889b), but partly also because of the terrible conditions of the Observatory building, which had experienced rain-proofing problems since the early years of its existence (Baldelli, 1881; Schiaparelli, 1875). In December 1887, the Amici I was dismantled and sheltered to avoid damage from a possible collapse of the rotten wooden dome. In March 1888 the roof of the east wing of the Observatory, where Tempel lived with his wife, collapsed and they had to move to a nearby villa (Tempel, 1888). Despite illness, which often confined him to bed, we can imagine that Tempel still found time to use his telescope, for after his death (on 16 March 1889) his widow told a visitor to the Observatory that "… Tempel worked to the last … the poor sufferer observed, ill as he was, from the top of his house with a small telescope." (Sawerthal, 1889: 349).

Marianna Gambini,[7] who shared with Tempel a meager and frugal life, found herself in a state of poverty upon the death of her husband. Furthermore, she could not receive any pension from the Government, as Tempel had not worked in Italy long enough to be entitled to it (Sovrintendente, 1890). To help her, an international subscription was opened (Roberts; 1889), while Schiaparelli acted for her to open a licensed salt and tobacco shop (Hagen, 1912). In addition, Gautier (1889) reported that Tempel's widow "… hopes to realize something from the books, letters, and instruments which he possessed – among other things from the telescope with which he worked so heroically." Through the interest of the Institute of Superior Studies, the Italian Ministry of Public Education agreed to help the widow by rewarding her for the extraordinary work of her husband[8] if she "… handed over to the Observatory all of the drawings of nebulae and other celestial objects made by her husband at the Observatory." (Sovrintendente, 1890; our translation). The Steinheil telescope was added to these negotiations, and Marianna Gambini initially asked for 2000 Italian lire, "… an amount already asked by my deceased husband." (Gambini-Tempel, 1890a; our translation) in a previous negotiation (of which we could find no other trace). After talking to Pietro Tacchini, Director of the Observatory at the Collegio Romano in Rome, she settled for 1500 lire for the telescope, and 3000 lire for the nebula plates (Gambini-Tempel, 1890b). Tacchini wanted the telescope for the Museum of the Collegio Romano, but the purchase was made only in favor of the Institute of Florence (Targioni Tozzetti, 1890). The Minister delayed making the payment for the telescope until April 1891 (Ministro dell'Istruzione Pubblica, 1891), while negotiations for the plates lasted even longer, as some of them were missing and it was necessary to reassemble the collection (Ministro dell'Istruzione Pubblica, 1893).

Although the intended destination of the telescope and of the plates was the Arcetri Observatory, after the purchase they were added to the collections of the Museum of Ancient Instruments at the Florence Institute of Superior Studies (and the collections later became the core of the current Institute and Museum of the History of Science in Florence; see Miniati, 1991). In the inventory of the Museum, item 1266 is a "Steinheil telescope built in wood and brass, of length 1.6m with objective, eyepieces and other accessories, mounted on a wooden foot of height 2.06m." (*Inventario*, 1872-; our translation). The description is fully compatible with the appearance of the telescope and mounting as depicted in Figure 1, showing that the telescope had not been altered up to that date. The value of the instrument is given as 1500 lire (i.e. the payment given to Tempel's widow). In March 1895, the new Director of the Observatory, Antonio Abetti, asked for the plates and the telescope to be transferred to Arcetri. He held that

> Tempel's telescope, which provided him in many details because of his exceptional eyesight, has to come back to Arcetri, where it could still be used to view the sky in those areas explored and drawn by the very skillful astronomer and artist. (Abetti, 1895b; our translation).

In exchange for it, Abetti would give to the Museum "… some old instruments that are renowned here, but are useless, since they have been dismantled or are unsuitable for current astronomical research …" (Abetti, 1895a; our translation).[9] The Director of the Museum, A. Roiti (1895; our translation), looked favorably upon the transfer of the telescope "… if there is somebody who really uses it …", but not of the plates, because they could be damaged. Abetti insisted on the necessity of having the plates, to compare them with other drawings and notes by Tempel already at the Observatory. The aim was to publish the plates, and the name of a young astronomer, Bortolo Viaro, was suggested for the task (Abetti, 1895c). Also the telescope was necessary, since it was needed "… to make a check of the sky …" (our translation) and verify the conditions under which Tempel observed. Abetti (1895b) probably did not refer here to the plates, all of which were taken with the Amici I telescope, but rather to the other drawings made by Tempel. The transfer of the telescope (and Viaro's appointment) were authorized in the summer of the same year by the Superintendent of the Institute of Superior Studies (Nobili, 1895). However, in subsequent years Viaro was employed for astronomical observations (Abetti, 1923), and the plates, which were eventually transferred to the Arcetri Observatory Library (Abetti, 1921), were never published.

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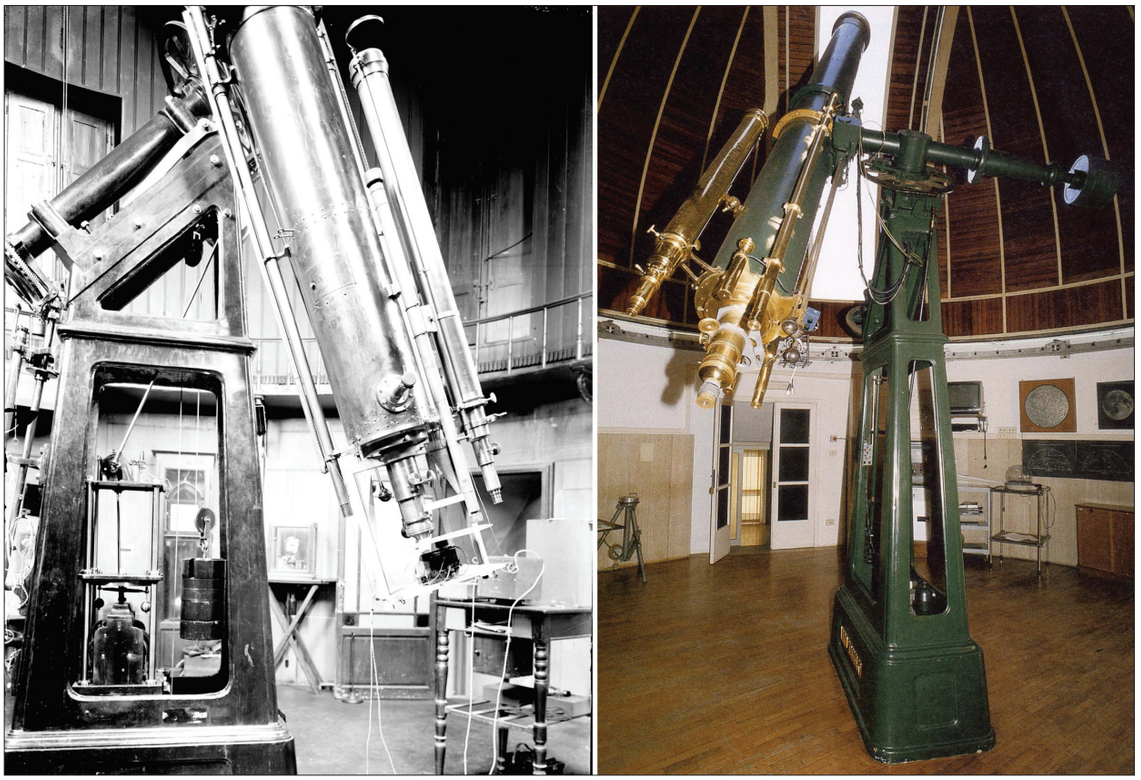

Figure 9: Tempel's telescope, used as a guide scope on the Amici telescope. In the left panel, a photograph taken in 1933 in the old central dome of the Arcetri Observatory, Tempel's telescope is the longer instrument to the right of the Amici tube. The smaller, thinner, tube next to Tempel's telescope and to its left is one of Galileo's original telescopes. The whole apparatus was used to convert lunar light, as observed through Galileo's telescope, into a radio signal to light the Chicago *Century of Progress International Exposition* during an homage to Guglielmo Marconi (Colacevich, 1933). The right-hand panel shows a modern view inside the Amici Pavilion. In this photograph, Tempel's telescope is the brass tube to the left of the Amici telescope.

Tempel's telescope, which was again in Arcetri at the end of 1895 (Cerulli, 1895), was only sporadically used. When the equatorial mounting of the Fraunhofer telescope was restored, Abetti (1901; our translation) foresaw a use also for the "… historic Steinheil telescope of 109 mm, which was property and glory of Tempel ...", but instead, the telescope was put in a room at the Observatory where old instruments were stored (Abetti, 1909). We found only one trace of its use during this period, when "… a telescope called the Tempel …" was used with a wide field eyepiece (probably the 24×) to observe Comet Gale, C/1912 R1 (Abetti, 1913; our translation).

At the beginning of the 1920s, Giorgio Abetti succeeded his father, Antonio, as Director of the Arcetri Observatory. He had the "… renowned telescope of Tempel …" mounted as a finder on the Amici equatorial telescope,[10] so that it could be used as a "… guide [scope] during photographic exposures and to observe the Sun." (Abetti, 1922; our translation). From this time, photographs of the telescope are available (e.g. see Figure 9). At an unknown date between late 1895 and early 1922, the instrument was modified, and it now has a cylindrical brass tube in place of the original wooden one shown in Figure 1. It is possible that this brass tube originally belonged to the Fraunhofer telescope, which was almost identical to the Steinheil and was the only instrument of that size at the Observatory. The Fraunhofer refractor originally had a mahogany tube, as documented in price lists (e.g. see Verzeichnifs ..., 1822) and in the catalogue of instruments at the old observatory of Florence, where the Fraunhofer telescope came from (Catalogo, 1839-1854). Its tube could have been changed during the two main modifications that the telescope underwent. The first involved the making of an equatorial mounting by the workshop Officina Galileo in Florence, to prepare the telescope for a scientific expedition to Sicily in 1870 in order to observe a total solar eclipse (Chinnici, 2008; Cipolletti, 1872). The second upgrade of the mounting, which we have already mentioned, was carried out in the workshop of the Observatory of Padua by the mechanics Giuseppe Cavignato and Sante Mioni (Abetti, 1901). The Fraunhofer telescope is mentioned for the last time in the 1906 inventory of the Arcetri Observatory (Abetti, 1909), and its dome was dismantled in 1924 (Abetti, 1925), a couple of years after Tempel's telescope was mounted as a guide scope on the Amici refractor. It should be stressed, however, that the identification of the tube in Figure 9 as that of the Fraunhofer telescope is not certain, as no supporting documentation could be found in the Arcetri Archive. However, the engraving on the brass ring holding the objective leaves no doubt about its identification, as it reports the original production number of Tempel's telescope: "Steinheil in München N. 216" (Figure 10). The altazimuth mounting that Tempel had made for the telescope in Venice is lost, along with the wooden tube.

With the passing of the years, memory of the presence of Tempel's telescope at the Arcetri Observatory was almost lost, and it was only at the beginning

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of 2008 that the instrument was 'rediscovered', after we read some of the old publications of the Observatory. In the summer of 2008 the telescope was detached from the Amici refractor and restoration began. Once the restoration is completed, the telescope will be displayed to the public in the Amici Pavilion, together with information panels. Thus, we will finally pay homage not just to an instrument that is of some importance in the history of astronomy, but also to its owner, "… ensuring for his memory a fame that will last as long as mankind continues to honor the study of astronomy." (Schiaparelli, 1889a: 472; our translation).

Figure 10: The objective of Tempel's telescope. The engraving on the brass ring holding the objective states: "Steinheil in München N. 216". The production number is on the right side of the ring (a close-up is shown on the top right).

6 NOTES

1. The Historical Archive of the Arcetri Astrophysical Observatory contains the scientific and private documents of several astronomers, most notably Giovanni Battista Donati, Wilhelm Tempel, Antonio and Giorgio Abetti, Guglielmo Righini, Pietro Tacchini and Giuseppe Lorenzoni (Capetta and Gasperini, 2008). Tempel's documents and books were probably left in the Observatory at the time of his death or were later bought from his widow, Marianna Gambini (see Section 5, above). In a probable attempt to sell her husband's correspondence, in 1895 the widow made a detailed inventory that still existed in the 1960s (Iliazd, 1964), but is now missing. The remainder of Tempel's documents were finally sold in 1907 by Marianna Gambini to the Preußischer Kulturbesitz, for 250 marks. Only three out of a total of six boxes are now available, the others having been lost during World War II (staff at the Preußischer Kulturbesitz, private communication, 2009).
2. During the twentieth century, events surrounding the naming of Maximiliana and the disagreement between Tempel and some of the academic community inspired the German painter, Max Ernst, and the Georgian poet and editor, Iliazd (Ilia Zdanevich). A biography of Tempel's life was published by Iliazd (1964) together with the illustrated book *Maximiliana ou l'Exercice Illégal de l'Astronomie: L'Art de Voir de Guillaume Tempel* (Ernst, 1964). In 1966, Max Ernst and the German film director, Peter Schamoni, produced the short film *Die widerrechtliche Ausübung der Astronomie - Ein Film über Ernst Wilhelm Leberecht Tempel *1821 +1889*, and another book was subsequently published (Schamoni, 1974).
3. In Tempel's obituary, John Dreyer (1890: 182) wrote:

   > In the beginning of 1887, when he found himself unable to observe, Tempel began to arrange and put in order his scattered notes and sketches, many of which had as yet only been jotted down on various maps, and intended to enter them all in a copy of Herschel's General Catalogue, interleaved with two white leaves between each two pages, but we are not aware whether he succeeded in completing this task.

   A copy of the General Catalogue (Herschel, 1864) with those characteristics still exists in the Arcetri Library. Several drawings and notes by Tempel, dating from the end of 1876 to 1885, are written on the white pages. A copy of the Supplement by Dreyer (1878), which is bound in with this volume, is also annotated. The Supplement includes many objects discovered by Tempel while he was at the Arcetri Observatory (see Steinicke, 2009).
4. Schmidt's 1867 paper resulted in a long series of observations by many different astronomers. Nowadays, the event is not considered to have been real (Moore, 1977).
5. In 1921 this became the Arcetri Astrophysical Observatory (see Abetti, 1922).
6. In 1924 this became the University of Studies of Florence (see Lotti, 1986).
7. Countess Baldelli (1881) described Marianna Gambini as "… if not scientific herself, certainly a benefactor of astronomy."
8. It should be noted that Tempel was knighted by the Italian Crown in 1883 for his contribution to Italian astronomy (see Clausnitzer, 1989).
9. Among the items on Abetti's list (1895a) that were "… renowned here, but are useless …" is part of the apparatus used by Donati for his pioneering observations of the spectra of stars (Donati, 1866a) and for the first observation of a cometary spectrum, that of C/1864 N1 (Donati 1864), one of the comets discovered by Tempel. This apparatus is now on display at the Institute and Museum of the History of Science in Florence.
10. The current Amici telescope at the Arcetri Astrophysical Observatory and the Amici I used by Tempel only have in common a cast-iron pedestal. The equatorial mounting, lacking graduated setting circles and a clock-drive mechanism, was upgraded in 1894, and the original wooden tube was replaced by a metal one (Abetti, 1896). A 36-cm Zeiss objective was then substituted for the 28-cm Amici I objective (Abetti, 1926). The original tube of the Amici I is conserved at the Institute and Museum of the History of Science in Florence, while the Amici I objective is at Arcetri (Righini, 1969).

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