# A SHORT HISTORY OF TWO NINETEENTH CENTURY GERMAN INSTRUMENTS AT THE BOLOGNA OBSERVATORY: THE 16-CM STEINHEIL REFRACTOR AND THE ERTEL & SOHN MERIDIAN CIRCLE

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**Abstract:** Recent work to restore and set up the materials exhibited at the Museo della Specola of the University of Bologna provided an opportunity to review the history of two important German instruments from the mid-nineteenth century, an Ertel & Sohn meridian circle and a Steinheil refractor. Purchased by the Directors of the Bologna Observatory to revitalise local astronomical research, which had gradually declined over the years, both instruments have intriguing histories because, despite the fact that they were essentially underused, they also contributed to two important research projects. Lorenzo Respighi used one of them—the Ertel & Sohn meridian circle—for an experiment in physical optics related to the debate on whether light was undulatory or corpuscular, and it was essentially a forerunner of 'water-filled telescopes'. The other, a Steinheil refractor to which a Tauber spectroscope was attached, was the largest and most important instrument used by the Italian expedition to India, organised by Pietro Tacchini to observe the transit of Venus across the Sun in 1874.

**Keywords:** Instrumentation, observatories, Italian astronomy, nineteenth-century astronomy

## 1 THE BOLOGNA OBSERVATORY

At the beginning of the eighteenth century Luigi Ferdinando Marsili—a Bolognese count, a man-at-arms, a versatile scientist with a broad range of interests and a skilled organiser—gave the city a large collection of instruments, naturalistic collections and books that had been housed in his *palazzo* until then and were used by Bologna's most prominent scholars.[1] One of the provisos of Marsili's donation, which was made official on 11 January 1712, was that (Fantuzzi, 1770: 229):

> … a place would be found for them that was big enough and suitable enough to house them; a chemical laboratory would be set up; there would be enough rooms for a sizeable library; an observatory tower would be put up; stipends put aside for the professors; funds provided for the purchase of books, and machines for physics experiments …

The Istituto delle Scienze di Bologna was thus established and in 1714 it was merged with the Accademia delle Scienze, which in turn had developed from the existing Accademia degli Inquieti, founded in 1690-1691 by the young astronomer Eustachio Manfredi and a group of friends (Baldini, 2007; Bònoli, 2007b; Bònoli and Piliarvu, 2001: 176; Tabarroni, 1981). Manfredi, who had already coordinated the astronomical activities of the observatory set up at Marsili's *palazzo*, was appointed to oversee work on the large new observatory slated to be built on top of the Palazzo Poggi, which the Bologna Senate had purchased to house the Istituto delle Scienze. It took many years to complete the observatory, due also to financial reasons. Consequently, Manfredi was unable to commence his observations there until 1726.

Bologna's astronomical school, which took up the seventeenth-century legacy of both the University of Bologna, with astronomers such as Giovanni Domenico Cassini and Geminiano Montanari, and the Jesuit college, with Giovanni Battista Riccioli and Francesco Maria Grimaldi, enjoyed a prestigious reputation throughout Europe in the eighteenth century. It played a leading role in astronomical research, thanks to the work of Manfredi and his successor, Eustachio Zanotti, both of whom became Fellows of the Royal Society of London in 1728 and 1740, respectively.[2]

During the nineteenth century, however, the school encountered a number of setbacks and the observatory was gradually sidelined from Italy's scientific scene, due above all to political circumstances. These problems, which commenced with Napoleon's campaigns and continued with the Restoration ushered in by the Congress of Vienna, culminated with the difficult unification of the Kingdom of Italy (Bònoli and Poppi, 2001 and 2006; Bònoli et al., 2005; Poppi and Bònoli, 2002). It was during this period that Bologna ceased to be the prestigious main university of the Papal States.

In the meantime, following Napoleon's reforms the Istituto delle Scienze and the annexed observatory became part of the University of Bologna. During the nineteenth century more than ten astronomers succeeded each other at the helm of the observatory itself and as holders of the Chair of Astronomy; moreover, this professorship remained vacant for nearly twenty years. Among these astronomers, at least two can be credited with augmenting the observatory's instrumentation, in an attempt—which turned out to be futile—to inject new life into Bologna's listless astronomical studies.

Consequently, two important German-made instruments were brought to the Bologna Observatory and despite the fact that their use was quite limited, they ultimately proved to be significant.

The historical site of the Bologna Observatory still exists. Until just a few years ago it housed the Department of Astronomy of the University of Bologna and the Bologna Astronomical Observatory of the National Institute of Astrophysics. Today it is the home of the Museo della Specola of the University (Figure 1), and the instruments employed by Bologna astronomers over the course of three centuries are exhibited in the very same rooms in which they were originally used (Baiada et al., 1995).

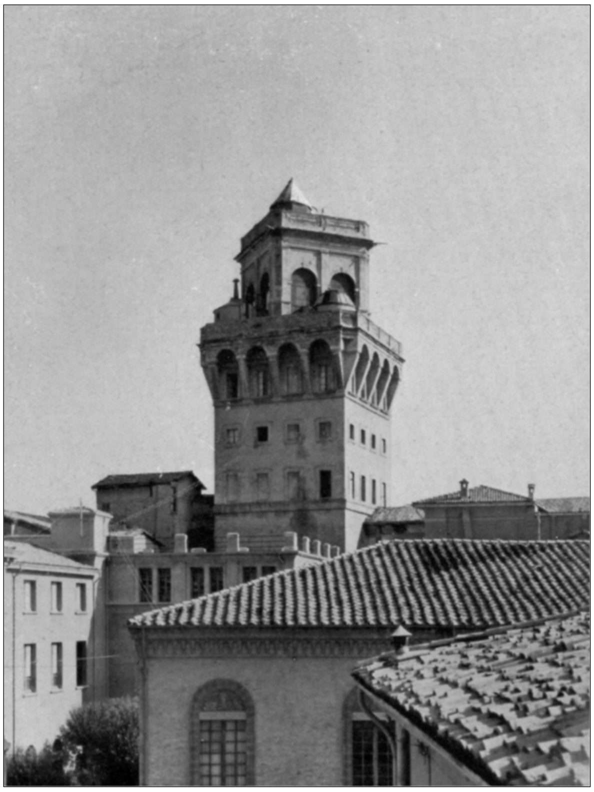

Figure 1: This photograph from the early 1950s shows the Observatory tower, which rises over the rooftops of the main campus of the University of Bologna. The dome visible in the foreground on the terrace of the second-to-last floor of the tower (which has since been replaced by a lift) housed the Steinheil telescope. The dome to the left of the terrace, on the same floor, is the one that was built in 1850 to hold the Ertel & Sohn meridian circle and was restored in the late 1900s (courtesy: Archive of the Department of Astronomy, University of Bologna).

## 2 IGNAZIO CALANDRELLI, LORENZO RESPIGHI AND THE ERTEL & SOHN'S MERIDIAN CIRCLE

Ignazio Calandrelli (1792–1866), who was born in Rome and was the nephew of the better-known Giuseppe Calandrelli, Director of the Observatory of the Collegio Romano, was appointed to teach mathematics while he was still a student (Bònoli and Piliarvu, 2001: 211). After graduating with a degree in philosophy and theology, he was ordained a priest and in 1845 was invited to Bologna to head the Observatory; he was also appointed to the Chair of Mathematics and Optics at the University of Bologna, but remained there for only a short time. Following the uprisings for independence in 1848, Pope Pius IX summoned him to Rome to head the Capitoline Observatory. During his short stay in Bologna he attempted to modernise the Observatory's array of instruments, most of which dated back to the late eighteenth century, and obtained funds from the Pontifical Government to purchase a meridian circle from the German company Ertel & Sohn.

In 1806 Traugott Lebrecht Ertel (1777/8–1858) entered the workshop of Reichenbach, Liebherr and Utzschneider as an employee. After changing fortunes and divisions of the workshop, in August 1815 Reichenbach made Ertel his business partner. Ertel rapidly became his successor and the faithful continuer of his construction technique. Together they signed many instruments with the name Reichenbach und Ertel. After Reichenbach withdrew in 1820, however, Ertel continued on his own until he was joined by his son Georg (1813–1863), with whom he established Ertel & Sohn, which would stay in business as Ertel-Werke until 1984 (Brachner, 1987a; Preyss, 1962). Ertel also built meridian circles for the Christiania, Glasgow and Warsaw Observatories and, in Italy, for the Roman observatories of the Capitol and the Collegio Romano (the latter was subsequently moved to the Astrophysics Observatory of Catania in 1885), and for the Istituto Idrografico della Marina in Genoa (later moved to the Brera-Milan Observatory in 1924). The meridian circle that Calandrelli ordered from him in 1846 was thus unquestionably on a par with the instruments used by the era's most important observatories for astrometric measurements. Calandrelli decided to set up a special area for it (Figure 2), building an oval room next to the large upper room in the Observatory tower that had been built for observations using the large telescopes with a long focal length typical of the seventeenth and eighteenth centuries (see the original project in Parmeggiani, 1848). Four granite pillars were embedded in the floor to support the telescope axis, and rails were mounted in order to hold the wrought-iron trolley used to reverse the telescope. This operation was essential for estimating certain measurement errors through observations conducted before and after the inversion. The focal length was 5 feet (153.4 cm), it had a 4" (10.2 cm) objective lens and the diameter of the divided circle was 30" (76 cm). The instrument had two micrometers and four celestial eyepieces, as well as a water level with a leaf-spring support in order to check the horizontality of the axis. The words Ertel & Sohn, München are engraved on one of the arms of the divided circle.

As reported in Bologna chronicles of the era (Bottrigari, 1960: 244), one of the Ertels went to Bologna in 1851 to oversee the set-up of the instrument built by the father-and-son team:

> The famous artist, Mr Ertel of Munich, has been in Bologna for some time: he is currently installing his large meridian circle at the observatory of our University, in those rooms that were expressly built based on the plans and under the supervision of our architect Filippo Antolini.

He was assisted by Calandrelli, who had returned from Rome specifically to check the operation of the meridian circle he had ordered. While he was there, he drew up his *Uso del Circolo Meridiano*, with instructions on how to fine-tune and use it (Calandrelli, 1851).

Despite the fact that this type of instrument requires the utmost stability, its installation on one side of the tower, at a height of about 37 m from the ground, made it difficult to use and somewhat inaccurate. As a matter of fact a meridian circle on the top of a tower was not state-of-the-art at that time. Moreover, the fact that instruments of this kind were inadequately built, hard to use and less accurate than expected is demonstrated by the fact that the hundreds of observations made with a similar Ertel & Sohn meridian of the same size, installed in 1844 at the Washington Observatory (now the U.S. Naval Observatory), went unpublished for reasons that the Director, M.F. Maury (1846: 3), explained to the Secretary of the Navy, Hon. George Bancroft:

> I have been induced to suspect the existence, in the Meridian Circle, of error as to figure, divisions, unequal flexure, or some other imperfection not clearly ascertained. Owing to this circumstance … I have concluded not to publish the observations (several hundreds) made with it, until I shall have satisfied myself with regard to it.

In any event, the Bologna instrument essentially went unused—although it is unclear if this is attributable to inaccuracy, inadequate placement, the transfer of the man who had ordered it, the fact that other local astronomers were not interested in using it or the lack of appropriate observation programmes—until Lorenzo Respighi (1824–1889) found an entirely new application for it several years later (Bònoli, 2007c; Bònoli and Piliarvu, 2001: 214). Respighi was one of the most important Italian astronomers of the mid-nineteenth century and, along with Pietro Tacchini, Angelo Secchi and Giuseppe Lorenzoni, he founded the Italian Society of Spectroscopists and *Memorie della Società degli Spettroscopisti Italiani*, respectively the world's first astrophysics society and journal (Chinnici, 1999; 2007). Appointed full Professor of Astronomy and Optics at the University of Bologna in 1851 and then Director of the Observatory the following year, he filled the position that had been vacant for several years after Calandrelli's transfer to Rome. Due to political reasons, however, he too was sent to Rome to head the Capitol Observatory, succeeding Calandrelli there as well. Following the end of pontifical rule in Bologna and the establishment of the Kingdom of Italy, he was suspended from his Professorship for several years and left the city for avowed "… reasons of conscience …" in 1865.[3]

Despite adverse political conditions, during the short time that he worked at the Bologna Observatory Respighi was never deterred from his research activity. It was during this period, using the Ertel & Sohn meridian circle as a zenith instrument and a basin of mercury for reflected observation, that he compiled a catalogue of the declinations of more than 2,000 stars (Respighi, 1864):

> I was able to take advantage of this flaw in our meridian circle, i.e. the fact that it is set at a great height from the ground, to create a sort of zenith telescope from the meridian telescope.

Nevertheless, the most interesting use of the telescope came with Respighi's work in the early 1860s for a singular and delicate experiment in physical optics (Gualandi, 2004). The astronomer focused the telescope through a hole drilled in the floor to observe a clear cavity filled with water, set on the level 8 m below. Under the container of water, he placed a piece of glass with impurities that formed little air bubbles; the glass was illuminated by a light source beneath it. Respighi wondered if the bubbles would show small systemic shifts as if they were zenith stars. His experiment involved observing the possible presence of small ellipses travelled over the course of a day that—based on an idea posited during the previous century by the Jesuit scientist Ruggiero Boscovich (1785: 248-314)—could be explained as apparent 'diurnal aberration' (i.e. generated by the combination of the velocity of light and that of the Earth's rotation).

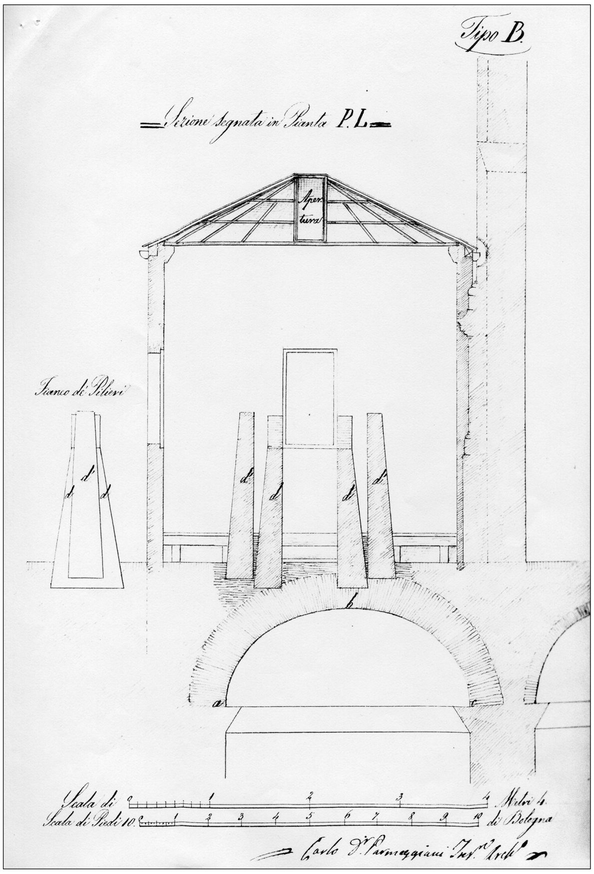


Figure 2: Section of the project for the oval room designed to house the Ertel & Sohn meridian circle (after Parmeggiani, 1848). Note the anchorage of the pillars supporting the instrument (courtesy: Archive of the Department of Astronomy, University of Bologna).

The experiment originally involved a variant to the annual observation cycles to record the apparent stellar trajectories subject to the effect of 'annual aberration'. The ellipse of the annual aberration of starlight is formed by an apparent path, described over the course of a year, which is derived from the combination of the velocity of light and the velocity of the Earth's revolution around the Sun (Gualandi and Bònoli, 2008). According to Boscovich, the size of the ellipses could theoretically be altered by refraction introducing a new medium in the path of light rays. With respect to what would have been expected in observations without a basin of water, the experiment should have demonstrated if the velocity of light travelling first through water and then through air generated wider or narrower ellipses. Boscovich's idea was to build a water-filled telescope through which it would be possible to discover the extent to which the new medium of refraction affected the size of the ellipses and thus the path of the light rays through the new medium.

Examined in this manner, the small trajectories of the bubbles would theoretically indicate how the passage from one refracting medium (water) to another (air) affected light rays, an effect that would then be summed with the Earth's rotation. Through his observations using the 'modified' Ertel & Sohn meridian circle, Respighi discovered that the apparent motion predicted by this theory did not occur, and he attributed its absence to the action of the surrounding ether, numerically expressed by the 'Fresnel coefficient'. As important as these details may be, an in-depth discussion would digress from the topic of this paper.

Figure 3: What remains today of the Ertel & Sohn meridian circle, repositioned in its original dome. One of the pillars is visible in the background (courtesy: Museo della Specola, University of Bologna).

Respighi's contribution has now been forgotten, yet it makes him a forerunner of the work envisaging the installation and use of water-filled telescopes, which had been theorised since the eighteenth century but were impossible to build due to the level of precision required by such measurements (see Pedersen, 2000). In effect, the idea that Respighi had borrowed from Boscovich went back to 1785.

In the intentions of those who devised and built them, these instruments were supposed to confirm the corpuscular theory of light by showing the variation in the velocity of light as it passed through two different propagation media. According to nineteenth-century physicists, however, the construction of water-filled telescopes would bear out the exact opposite: it would prove the wave theory of light. The experimental datum that was expected to prove one theory or the other was the measurement of a decrease (according to the Newtonian corpuscular theory) or increase (as instead predicted by Huygens's wave theory) of the velocity of light passing from one refractive medium to another less dense medium. Water-filled telescopes would later become rather successful, above all following George Airy's famous experiment of 1871 (Airy, 1872; Satterthwaite, 2003).

With the observations conducted in Bologna, Respighi attempted to contribute to the debate between two Northern European astronomers—Martin Hoek (1834–1873) and Wilhelm Klinkerfues (1827–1884), Observatories—regarding confirmation of the wave theory of light, which he was convinced would be demonstrated by measurements made using the meridian circle. With his zenith observations, Respighi thought he had measured variations in the constant of aberration while also providing experimental proof of the Earth's rotation. The Ertel & Sohn meridian circle thus enjoyed what would effectively turn out to be its only 'moment of glory', and it would never again be put to any significant use.

After gathering dust for decades, in the mid-twentieth century the instrument and its support pillars were dismantled. A large hole was then made in the floor of the small oval room that had housed it in order to permit observations using the tessellated telescope installed two floors below it in the tower. This was a highly original project devised by Guido Horn d'Arturo (1879–1967), Director of the Astronomical Observatory of the University of Bologna at the time (Abetti, 1981; Bònoli, 2003, 2007a), to create a large-diameter light collector using a mosaic of specially aligned smaller mirrors, thereby avoiding the technical difficulties and high costs involved in creating a single large mirror (Bònoli and Zuccoli, 1999). As a result, this telescope is rightly considered the predecessor of modern multi-mirror telescopes (Jacchia, 1978). Horn first developed the project in 1932 with a prototype that had a diameter of 1 m. In 1952 he completed his definitive instrument, which had a total diameter of 1.8 m and was composed of 61 hexagonal segments; it had a focal length of 10.4 m. Consequently, the floor that once held the Ertel & Sohn meridian circle served as the focal plane with the plate-holding chassis of the tessellated telescope, which Horn used to expose tens of thousands of plates of the zenithal sky of Bologna.[4]

When the upper part of the Turret Room of the Museo della Specola was renovated in the late twentieth century, the floor was also restored and the Ertel & Sohn instrument was reinstalled there (Figure 3). However, many of the large mechanical and optical parts of the meridian circle have disappeared, making functional restoration impossible. Furthermore, the floor—in which a hole had been bored and then closed up again—is now too fragile to hold the original pillars.

## 3 LORENZO RESPIGHI, PIETRO TACCHINI AND THE STEINHEIL REFRACTOR

As we have noted, in 1851 Lorenzo Respighi (Figure 4) replaced Calandrelli at the helm of the Bologna

Observatory and he immediately showed greater dynamism than his predecessors, boasting interests that ranged from astronomy to physics and optics. The new Director's pressing desire to turn the Observatory around is evident in a letter dated 1857 and addressed to the Directors of the most important Italian observatories. In it, Respighi declared that he was "… burdened by the obligation to improve the conditions of this establishment, which unfavourable circumstances have rendered completely idle and forgotten for many years." Thus, he sought their assistance in order to create a national astronomical research network (Respighi, 1857a). That same year he submitted a request to Pope Pius IX to upgrade the instruments at the Bologna Observatory (Respighi, 1857b), asking for a contribution in order to purchase "… the most essential astronomical instrument, and that is an equatorial telescope in keeping with the current needs of science …", a refractor that had been ordered the previous year from the Bavarian optician Carl August Steinheil (1801–1870).

This was a particularly lively historical period for physics and astronomy, and Italy's leading figures in these fields attempted to carve out a place for themselves in the heated scientific debates of these years. This was not only the era of the birth of astrophysics, but also of the development of Maxwell's equations of electromagnetism and the triumph of Stokes's and Fresnel's wave theory of light.

By the eighteenth century, Italian optics had lost the leading role that—along with Holland—it had enjoyed in Europe in the previous centuries. Consequently, Italy was forced to depend on other countries (England and then Germany) that could produce lead glass (flint glass) to correct chromatic aberration.[5] Consequently, it had become routine to import precision optical devices.

Towards the 1850s Bavaria had established an important tradition in the construction of optical instruments. Carl August Steinheil was one of the standard-bearers of this tradition and he became enormously successful during this period. In a detailed profile, Alto Brachner (1987b) defined the Physics Professor, who devoted his career to making instruments, as the "… mental successor of Fraunhofer." A pupil of Friedrich Bessel, Steinheil was fully a part of the nineteenth-century German astronomical tradition, working with eminent figures such as the chemists Justus Liebig and Robert Bunsen, and the physicist Gustav Kirchhoff. In 1855 King Maximilian II decided to rely on Steinheil to uphold the tradition of the school of Bavarian opticians and summoned him to Munich from Vienna, where the scientist was working on telegraph networks.

It was Steinheil's workshop that Respighi contacted in 1856 in order to expand the instrumentation at the Bologna Observatory, which—as already noted—was experiencing one of the nadirs of its history. The telescope he ordered was built in the spring of 1858 and was already in use by the summer, as indicated by the fact that Ernst W. Tempel, who planned to purchase one for Venice, requested information about its operation (Steinheil, 1858; Tempel, 1858). It was a refractor with a German equatorial mount and an achromatic lens with a diameter of 16.24 cm, composed of "… one crown bi-convex lens and one flint convex-concave lens …" (the brass ring holding the lens reads "Steinheil in München n.° 1026"), and with a focal length of 260 cm (Baiada et al., 1995: 142). It had seven 'celestial' eyepieces, a helioscope and a finder with an aperture of 4.5 cm. It was installed in a dome on one of the side terraces of the tower. Fraunhofer and Steinheil had delivered larger lenses prior to this, so at the time this 16-cm telescope was only of moderate size, yet it ranked fourth of all Italian refractors after the 28.3-cm and 23.8-cm Amici refractors, built in 1841 and 1854, at the Florence Observatory, and the 17.5-cm Fraunhofer & Reichenbach refractor which was installed at the Capodimonte Observatory in Naples in 1815.

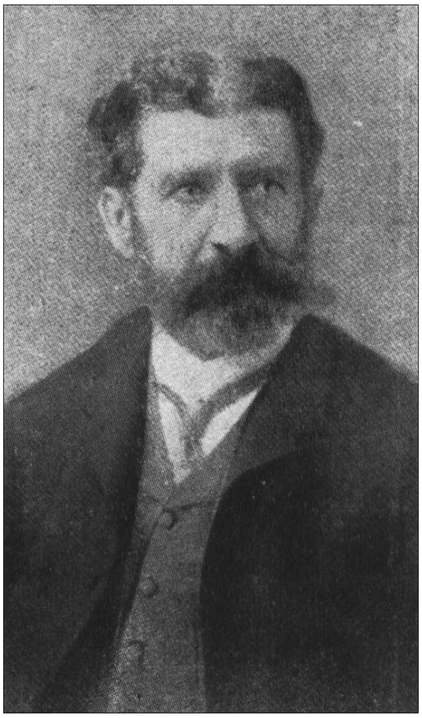

Figure 4: Lorenzo Respighi (1824–1889) (courtesy: Archive of the Department of Astronomy, University of Bologna).

However, the political situation changed rapidly and, with the plebiscite of March 1860, Bologna rid itself of pontifical rule, joining the new Kingdom of Italy less than a year later. As we have seen, Respighi was busy using the meridian circle to catalogue the stars, and was working on his experiments in physical optics, so the new refractor went virtually unused.

After Respighi was transferred to Rome in 1865, the post of Observatory Director was vacant for approximately twelve years and was finally assigned to Antonio Saporetti (1821–1900), a controversial figure who held it until the end of the century but was clearly incapable of valorising the institution he represented (Bònoli and Piliarvu, 2001: 213; Poppi and Bònoli, 2002). According to Giovanni V. Schiaparelli (1900):

> The contrast between [Saporetti] and Respighi could not have been sharper, nor could it have been any clearer that the value of a scientific institution depends first and foremost on the knowledge and character of the people called upon to direct it.

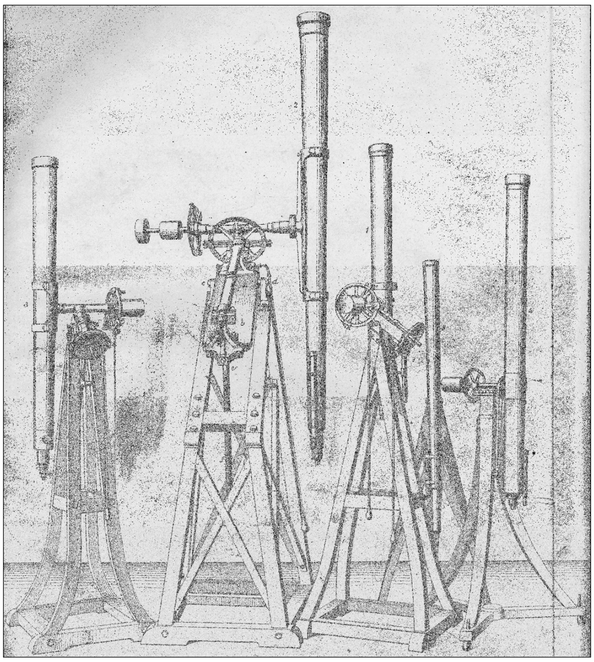

Figure 5: The telescopes used for the 1874 India expedition, portrayed with the field mounts made by the workshop of the Padua Astronomical Observatory (after Tacchini, 1875a). From left to right: the Turin Fraunhofer equatorial, the Bologna Steinheil telescope, the Padua Starke equatorial, the Palermo Dollond telescope and the Padua Starke altazimuth telescope.

The Steinheil instrument was thus destined to become obsolescent very quickly, due above all to the progress that England and the United States had made in the construction of optical systems for large refractors. In 1851 the British instrument maker William Simms produced a type of flint glass for a 33-cm achromatic lens and began to work on a 40-cm one, whereas the American company of Clark & Sons made the 76-cm Pulkovo refractor in 1885. In 1874, however, Pietro Tacchini (1838–1905), who was at the Palermo Astronomical Observatory, asked if he could use the Steinheil telescope for an important scientific expedition (Tacchini, 1875a). Tacchini was one of the most versatile Italian astronomers of the era, not only from a scientific viewpoint but also a 'political' one, due to his connections at the Ministry of Public Instructions as well as his ability to organise and coordinate Italian astronomical research. As we have already noted, Tacchini, Secchi, Lorenzoni and Respighi founded the Italian Society of Spectroscopists and the journal *Memorie* in 1871 (Chinnici, 1999 and 2007; Lugli, 2001).

Figure 6: The dome that housed the Steinheil refractor at the Italian station in Muddapur, India. Pietro Tacchini is on the left, by the Tauber spectroscope from Palermo, which was adapted to the telescope (private archive).

The goal of the expedition to Muddapur (India) was to observe the most eagerly awaited astronomical event of the era, the transit of Venus across the Sun on 9 December 1874. This event, which had not occurred since 1769, was fundamental for calculating the Sun's exact parallax, thereby allowing scientists to deduce the dimensions of an Astronomical Unit and thus the correct scale of distances within the Solar System (Chinnici, 2003; Pigatto and Zanini, 2001). The Kingdom of Italy had been united only a few years earlier following the Italian army's entry into Rome in 1870 and the end of the millenary Papal States. Consequently, participating in an astronomical event that had mobilised hundreds of astronomers around the world for coordinated observations offered Italian astronomy—whose reputation Tacchini was attempting to restore—a chance to gain great international visibility.

In 1874 Tacchini sent a report to the Ministry of Public Instruction, hoping to reorganise the eleven Italian observatories on which the Government was wasting limited funding, personnel and instruments (Tacchini, 1875b). Moreover, in his report Tacchini suggested downgrading the Bologna Observatory to a simple meteorological observatory (along with those of Modena and Parma), but his proposal was never fully implemented, as the Bologna Observatory was merged with the local university and thus became the University Astronomical Observatory (Bònoli and Poppi, 2001; Poppi et al. 2005). Nevertheless, Tacchini was chiefly interested in the Observatory's main instrument—the Steinheil refractor—for an extremely delicate task, with which he planned to supplement the observations made using four other instruments that he was taking on the expedition to India. In other words, he wanted to determine the contacts of the transit of Venus using an original method that called for observing the solar limb using a spectrograph adapted to the telescope's focal plane. As Secchi wrote in Part One of the publication presenting the results of the observations (Tacchini, 1875a):

> Among the various methods proposed for this observation, there is also the one referred to as spectroscopic, which seems capable of yielding extraordinary precision, eliminating most of the inevitable problems of direct observation. This method is completely new and in 1874 it was used for the first time for such observations.

Once the Bologna instrument was obtained, the workshop at the Padua Observatory prepared it for the expedition, along with four other instruments from the observatories of Palermo, Padua and Turin, by creating special field mounts that were easy to transport and suitable for the latitude of the observation site (Figure 5). The Tauber spectroscope from the Palermo Observatory was mounted on the Steinheil, the largest instrument used by the expedition (Figure 6), and Tacchini personally handled the observations with this instrument.

At the end of the expedition, described in a publication the following year (Tacchini, 1875a) and recently presented in detail in this journal by Pigatto and Zanini (2001), Tacchini tried to keep the instrument for his own institution, not only because of its quality but also because he knew it was not being used at Bologna. Moreover, he continued to hope that his project for reorganising the astronomical observatories would be implemented, thereby closing the one in Bologna and redistributing its instruments. However, Saporetti (Figure 7), who had just filled the long-vacant position at the helm of the Bologna Observatory, promptly asked Tacchini to return the Steinheil telescope. Following several requests, the instrument was reluctantly returned in December 1876, arriving in Bologna "… greatly improved …" (Saporetti (1877) by the work that had been done at the workshop of the Padua Observatory.

The story of this telescope and the dispute surrounding it did not end here, however, and the correspondence preserved at the Department of Astronomy of the University of Bologna shows that the University Chancellor and the Minister for Public Instruction became involved in it. Just a year later, Tacchini undiplomatically asked if the telescope had ever been used and, if so, what the results had been (Tacchini, 1878); there is no trace of Saporetti's reply, if indeed he replied at all.

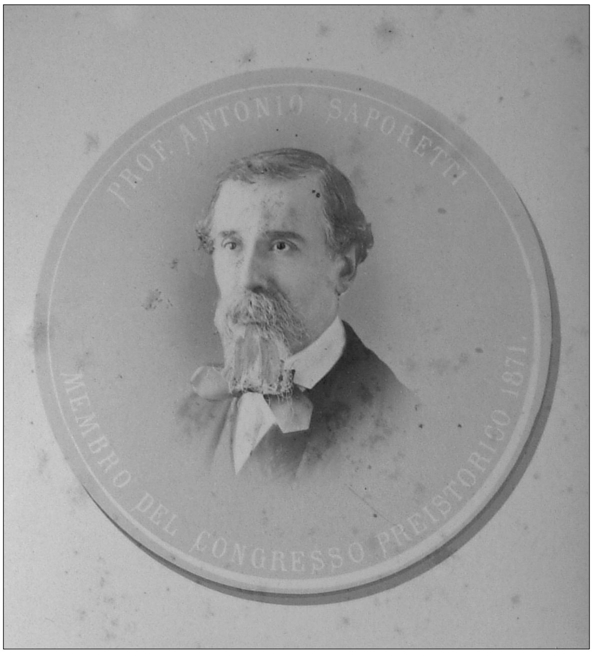


Figure 7: Antonio Saporetti (1821–1900) (courtesy: Archive of the Department of Astronomy, University of Bologna).

Tacchini then requested the Steinheil telescope again for an expedition for the spectroscopic observation of the corona during the solar eclipse of 6 May 1883, which was visible from the Pacific Ocean and was especially important because its totality lasted 5 minutes. Unfortunately, the Italian expedition was never organised, due to the lack of funding from the Ministry of Public Instruction. Tacchini himself only managed to participate as a guest of the French mission, which was coordinated by Jules C. Janssen, and he went to Caroline Island, in what is now Kiribati.

This time, however, Saporetti was forced to answer, due also to the fact that Tacchini asked the Ministry to step in. Nevertheless, his negative response clearly mirrors the resentment he had harboured towards Tacchini's old project to downgrade the Bologna Observatory (Saporetti, 1883a and 1883b):

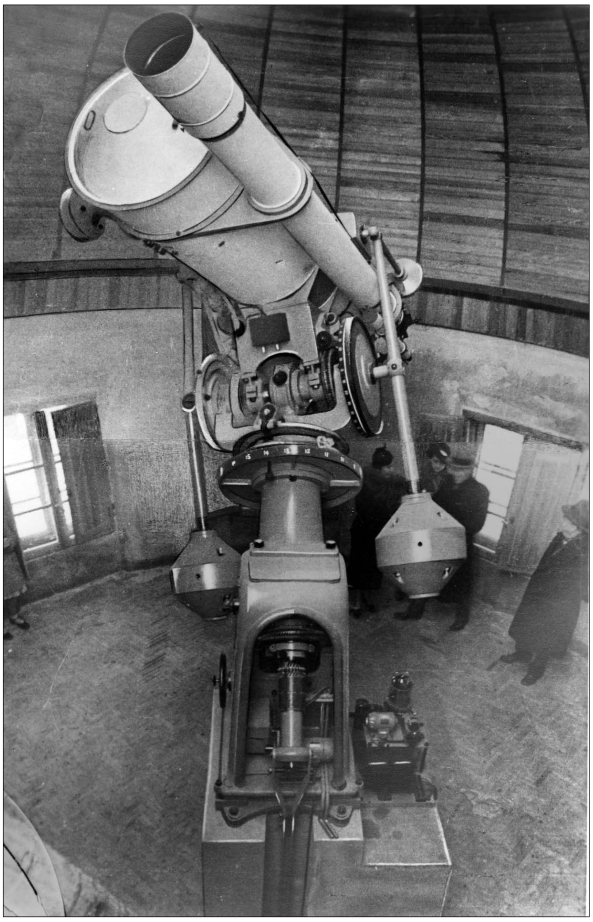

Figure 8: The 60-cm Zeiss reflecting telescope, photographed in the dome at Loiano a few days after it was inaugurated in 1936. In the foreground, the long tube of the guiding telescope on which the 16-cm achromatic lens from the Steinheil telescope was used for about 30 years. On the right, Guido Horn d'Arturo (courtesy: Archive of the Department of Astronomy, University of Bologna).

> … as soon as I heard that you wanted our instrument (a few months ago) and I officially informed the person so requesting it on your behalf that, on my part, I had no problem with it, I spoke to our illustrious professor, Rector Magni … and others from the University and was told that it could not be loaned under any circumstances. Furthermore, courses in the theory and practice of Astronomy have already commenced this year and the university students at the Chair of Astronomy come here to conduct these observations and learn about the main astronomical instruments, namely the Steinheil Equatorial and the Ertel Great Meridian Circle ... I regret that you plan to contact His Excellency the Minister or may already have done so, but he will be convinced that, as mistreated, derelict, neglected and abandoned as this observatory may be, he will nevertheless not wish for the death that may be in the minds of many, perhaps by turning it into a simple meteorological [observatory] as you have proposed.

We have no knowledge of any further use of the telescope since then. Moreover, we do not know if it was repositioned in the dome of the Observatory tower, on its original equatorial mount or on the field mount that Tacchini had made for the mission. It was not until much later—in 1936—that the top-quality lens was reused as a guiding telescope objective lens for the 60-cm Zeiss reflector (Figure 8) at the newly-built Loiano Observing Station of the Astronomical Observatory of the University of Bologna, situated on

Mount Orzale about 40 km from Bologna, at an altitude of approximately 800 m above sea level. It would remain here until the 1960s, when the guiding telescope was replaced. What remained of the old Steinheil refractor—the objective lens and the wooden tube with an iron mount—ended up hanging on a wall in a room at the Observatory, whereas a box with several eyepieces was tucked away in a drawer in the mechanical workshop. The dome of the tower where it had originally been housed was demolished during this period to make room for a lift.

Figure 9: The Steinheil telescope following restoration work, on the wooden mount that was made by ARASS (Association for the Restoration of Ancient Scientific Instruments) of Milan, which also made the hour and declination circles. In the background, the large desk that was used by Guido Horn d'Arturo, to whom the room in which the telescope is exhibited is dedicated (courtesy: Museo della Specola, University of Bologna).

The problem of restoring an instrument of unquestionable historical value arose several years ago when the decision was made to set up a new room at the Museo della Specola. The room was named after Guido Horn d'Arturo, who was the Director of the University Observatory and Professor of Astronomy for more than thirty years (with a hiatus due to racial persecution, as he was Jewish) and promoted the renaissance of Bologna's astronomical research in the twentieth century. This room, which now houses the prototype of the tessellated telescope designed by Horn and the 60-cm Zeiss mirror, also proved to be the ideal location for the Steinheil telescope (Figure 9), which was once again placed near the instrument (the Zeiss mirror) with which it shared the final phases of its scientific 'career'.

However, there was no trace of its original mount. Consequently, a wooden mount, like the field mount that had held the telescope during the expedition, was created for it. The mount was reconstructed based on photographs and drawings that Tacchini had published concerning the Indian expedition and on period photographs from the Padua Observatory, which were kindly provided by Luisa Pigatto. The mount was built on a smaller scale so that the telescope could be set up in the museum room. The work, whose goal was to restore the instrument to its 1874 conditions but without erasing the signs of history and time, was conducted by ARASS (Association for the Restoration of Ancient Scientific Instruments) of Milan, with the supervision of the staff from the Museo della Specola in Bologna (Poppi et al., 2003). In addition to the mount, ARASS also made the hour and declination circles of the instrument, based on available drawings and photographs. For the 2004 transit of Venus, the Steinheil telescope—which had been used to observe the same astronomical event from India one hundred and thirty years earlier—was exhibited in its new setting in the Museo della Specola of the University of Bologna.

## 4 NOTES

1 For biographical notes on Count Marsili (or Marsigli) see Stoye (1994).

2 For a reconstruction of the activities of the Observatory of the Istituto delle Scienze of Bologna see Baiada et al. (1995: 13-80) and references cited therein. For a history of the teaching of astronomy at the University of Bologna and a biographical overview see Bònoli and Piliarvu (2001). For an overview of the city's scientific milieu in the seventeenth century, in which the University, the Jesuit College and private academies operated, see Cavazza (1990) and Borgato (2002). Information on astronomy in Bologna during this period can also be found in Heilbron (2001).

3 The reasons that Respighi left Bologna are cited in the transposition of one of his autographic works, dated 1 December 1864, by a certain Mr. Bianchi who, "… on behalf of the Ministry …", wrote to Respighi from Turin on 11 January 1865, in *Fondo Respighi*, Archive of the Astronomical Observatory, Rome (Scatola I). See also Horn d'Arturo (1963).

4 For a complete bibliography of the works of Horn d'Arturo, see the website of the Archive of the Department of Astronomy, Bologna: *Fondo Horn d'Arturo*, M. Zuccoli (ed.), at www.bo.astro.it/~biblio/Archives/Galleria/hornbib.html.

5 The reasons that led to the decline of Italy's great glassmaking and instrumental tradition represent a topic that has never fully been clarified (but see Bònoli, 2002; Brenni, 1985; and Proverbio, 2000).

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