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# Italian Contributions to Planetary Astronomy

## From the Discovery of Ceres to Pluto's Orbit

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# Chapter 3
# Planetary and Cometary Astronomy at the Collegio Romano

**Aldo Altamore and Francesco Poppi**

**Abstract** Jesuit astronomers working at the Collegio Romano Observatory have made many contributions in the field of planetary astronomy: De Vico and Dumouchel studied Halley's comet, while Secchi was a pioneer in cometary spectroscopy, studying the surface of the Moon, Saturn's shape, and Mars' surface; he discovered a comet in 1853, and in 1869 he was the first to observe the spectrum of Uranus.

## Introduction

The Collegio Romano can be considered one of the places where modern science was born. Since its foundation,[1] astronomical observations have been carried out there, first with the naked eye and later with optical instruments.

The first telescopic planetary observations date back to 1611, when Cardinal Roberto Bellarmino (1542–1621) asked his Jesuit confreres to verify Galileo's observations. Under the supervision of Christopher Clavius (1538–1612), they built a Galilean telescope and confirmed the conclusions of the Pisan scientist.

However, the establishment of a true observatory at the College dates back to the year 1787, when Abbot Giuseppe Calandrelli (1749–1827) built a tower in the south-east corner of the roof of the palace to house astronomical instrumentation (Fig. 3.1).

[1] The Collegio Romano was established by Ignatius of Loyola (1491–1556) a few years after the foundation of the Society of Jesus for the purpose of training young people from elementary school to university. At the order of Pope Gregorio XIII, between 1582 and 1584 a large building was erected to host the sessions; after the fall of Rome in 1870, it was expropriated by the Italian State. Its cultural tradition was later passed on to the Università Gregoriana (Monaco, 2000; Maffeo, 2012).

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The tower still exists today and is even now used for meteorological observations with the instrumentation placed on its top. Inside the tower there is a sundial, and in the same room there are two marble commemorative plaques: one concerns the construction of the tower in 1787, the other one the visit of Pope Pius VII together with the King of Sardinia, Vittorio Emanuele I, on the occasion of the solar eclipse of 11 February 1804 (Buffoni et al., 2001).

Calandrelli was called to the chair of mathematics in 1773, when Pope Clemens XIV ordered the suppression of the Society of Jesus and entrusted the College to the secular clergy.

After the reconstitution of the Society of Jesus in 1824, the directorship of the astronomical observatory was held first by Etienne Dumouchel (1773–1840), who was director until 1838, and then by Francesco De Vico (1805–1848) from 1839 to 1848.

Dumouchel strove to equip the Observatory with new instruments; in particular, thanks to the financial support of the General Superior of the Society of Jesus Luigi Fortis (1749–1829), in 1825 he purchased a Cauchoix achromatic refractor telescope of excellent construction (Fig. 3.2).

This instrument had a long operational life. After Secchi became director in 1850, it was installed on a new equatorial mount and moved to the new Observatory of the Collegio Romano, built by Secchi above the church of St. Ignatius. It was later used


**Fig. 3.1** A gravure of the Collegio Romano with the Calandrelli Tower (G. Calandrelli and A. Conti, *Opuscoli astronomici*, 1803)

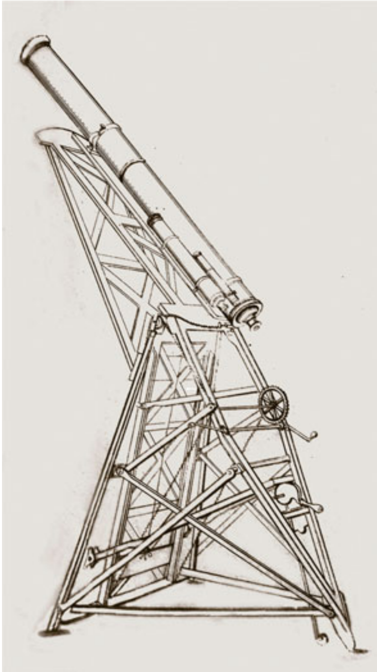

**Fig. 3.2** The Cauchoix telescope with the old altazimuth mounting (De Vico, 1840c)

by Pietro Tacchini (1838–1905) and Giuseppe Armellini (1887–1958) until it was finally moved to the Monte Mario Observatory, where it was still used for both scientific and educational purposes until the end of the 1980s.

In 1851, under the direction of Angelo Secchi (1818–1878), the Observatory was completely renewed (Secchi, 1856a). Only the meteorological instruments remained at the Calandrelli Tower, while the astronomical instruments, especially those dedicated to astrophysics studies, were located in the new rooms and installed above the sturdy pillars that had been designed to support a large dome that was never built.

After Secchi's death, the Observatory passed to the Italian State and was annexed to the newly established Ufficio Centrale di Meteorologia, directed by Pietro Tacchini. Astronomical observations continued until the early 1900s under the guidance of Tacchini himself and Elia Millosevich (1848–1919).

Finally, in 1923 the Observatory of the Collegio Romano was merged with the Observatory of the Campidoglio under the direction of Giuseppe Armellini and became the founding nucleus of the Astronomical Observatory of Rome, whose headquarters were located in the ancient Villa Mellini in Monte Mario in 1938.

## Planetary Observations in Italy Before the Nineteenth Century

After the observations made at the time of Galileo, the Jesuits continued to study the Solar System, not only at the Collegio Romano.

The Jesuit Giovanni Battista Riccioli (1598–1671), who lived in Bologna, produced a detailed map of the visible part of the Moon and created the nomenclature of craters and seas that is still used today. He was also among the first astronomers to deepen the study of the libration of the Moon, manifested by an oscillation of the visible lunar disk. This means that the visible surface of our satellite during the year is greater than half of its total surface even if the Moon turns the same face to the Earth. These studies were carried out with the contribution of another Jesuit, Francesco Grimaldi (1618–1663), who is also famous for the discovery of light diffraction (Fig. 3.3).

In addition, Riccioli observed and described the five planets known at the time (Mercury, Venus, Mars, Jupiter and Saturn) and noted the variations in the shape and position of Jupiter's bands.

Francesco Bianchini (1662–1729), maker of the famous meridian line in Santa Maria degli Angeli church in Rome, made systematic observations of Venus. He determined its rotation period to be 24 days, which is very far from the real value (Bianchini, 1728). Indeed, due to the dense atmosphere that covers the planet's surface, the period of rotation of Venus remained an enigma until the twentieth century, when it was possible to perform radar observations in frequencies where the planet's atmosphere is transparent.

Bianchini drew a map of the planet and constructed a globe of Venus, which is now kept at the Museo della Specola in Bologna. His observations were conducted from various places in Rome and from Albano using telescopes made by Giuseppe Campani (1635–1715) with a focal length of more than 10 m. Campani had his optics laboratory in the centre of Rome, not far from the Collegio Romano, and made planetary observations by himself, in particular of Saturn, drawing the unequivocal shape of the rings (Campani, 1664).

Eustachio Divini (1610–1685) is the other famous instrument maker operating in Rome in the seventeenth century. His telescopes were provided with wooden tubes whose focal length could exceed 15 m; with them he observed the Moon, Jupiter and Saturn and those of their satellites that were known at the time (Divini, 1660).

The Jesuit Gille François de Cottignies (1630–1689) observed the atmosphere of Jupiter, as well as the great comets of 1664, 1665 and 1668. Assisted by Brother Salvatore Serra, de Cottignies observed Mars from 27 to 30 March 1666 with a telescope by Divini of "25 palms"[2] and with a second telescope of "45 palms". By measuring the changes in the position of some formations on the Martian surface,

[2] 25 palms of focal length correspond to approximately 5.6 m. It is probably one of the long focal length telescopes currently on display at the Astronomical and Copernican Museum of the INAF-Astronomical Observatory in Rome.

**Fig. 3.3** Drawing of the Moon by Giovanni Battista Riccioli and Francesco Grimaldi (Riccioli, 1665)

they hypothesized a rotation period around the axis of the planet of approximately 13 h (Cassini, 1666), which is very far from the true rate.[3]

Giuseppe Maria Asclepi (1706–1776) observed the 1761 transit of Venus across the Solar disk from the Collegio Romano. He also measured the diameters of Venus and Mars, and conducted observations of Mercury and the comet of 1769 (Asclepi, 1761, 1765, 1767, 1770).

Finally, it is worth mentioning that Ruggero Giuseppe Boscovich (1711–1787) SJ observed the transit of Mercury in 1737 in Rome. He laid the foundations of geodesy through the first measurement of the geodetic base along the Appia Antica. His work was interrupted because of the Napoleonic occupation and subsequently resumed by

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[3] "*Anno 1666 die 30 Martii hor. 2 n.s. typus Martis cum insignibus maculis Romae visis primum a DD. fratribus Salvatore ed Francisco de Serris tubo Eustachii Divini palmorum 25., ac subinde 60. a die 24. Martii ad 30., qua die in aedibus Ill.mi D. Caesarii Giorii hora praedicta, et ipsomet Illmo D. describente tub. pal. 45. apparuit, ut hic exprimitur, inverso modo nigriore inter alias existente macula orientali, pro situs observata variatione ejusdem planetae circa primum axem revoluzionis periodum indicatura, horis nempe circiter 13*" (books.google.it/books?id = qmZPeL_r9i4C at the Biblioteca Casanatense).

Secchi in 1854–55, as reported in a plaque placed along the ancient street near Capo di Bove (Aebischer, 2012).

## Comets' Observations at the Collegio Romano Observatory

Giuseppe Calandrelli and his assistant Andrea Conti (1777–1840) described the observations of planets and other celestial bodies in the eight volumes of *Opuscoli astronomici* of the Collegio Romano published from 1803 to 1824. They calculated the orbits of planets and comets and provided detailed tables of the parallax of the Moon. Later, in 1816 they were joined by Canon Giacomo Ricchebach (1776–1841). A few decades later, Angelo Secchi declared that the scientific value of the work of these astronomers far exceeded the poverty of the instruments they had used at the Collegio Romano.

In the *Opuscoli astronomici* of the year 1808, Calandrelli reported the observations of the comet of September 1807. In the same issue Andrea Conti published the orbital elements of the comet (Calandrelli, 1808; Conti, 1808).[4] Similarly, the 1813 issue reports the observations and orbital elements of the great comet that appeared in 1811 (Calandrelli, 1813; Conti, 1813). This comet was visible to the naked eye for approximately 250 days and was mentioned by Lev Tolstoj in *War and Peace*.

Etienne Dumouchel observed the return of Halley's comet with the Cauchoix refractor on 5 August 1835, and he immediately reported it in the periodical *Astronomische Nachrichte* (Dumouchel, 1835). The credit for this discovery is attributed to his young assistant Francesco De Vico (1836), who calculated the comet's orbit on the basis of previous apparitions and identified its expected position, thus allowing its discovery long before other astronomers noticed it (Secchi, 1851b).

De Vico continued to carry out cometary observations at the Collegio Romano Observatory during his directorate. We just mention the comet of July 1839, which was discovered during the collection of data concerning the constitution of nebulae: as written in the *Memorie del Collegio Romano* published on 31 January 1840, the observations were made with the Cauchoix telescope with the assistants Luca Boccabianca (1810–1875) SJ and Benedetto Sestini (1816–1890) SJ (De Vico, 1840a). In total, De Vico was given priority in the discovery of seven comets observed at the Collegio Romano in the years from 1839 to 1847, and for his discoveries he was awarded by the King of Denmark.

Questions about the physical structure of the Solar System became increasingly interesting during the nineteenth century, and they drove the attention of astronomers to comets because cometary orbits were used to determine the masses of the planets with no satellites and to understand the composition of the comets themselves.

Angelo Secchi, who succeeded De Vico in the direction of the Observatory, reported in the *Astronomische Nachrichte* on 25 August 1852 the observation of

[4] This comet was also observed in Palermo by Niccolò Cacciatore (1770–1841) (Cacciatore, 1808; Chinnici, 2015).

the return of Comet Biela, which split into two parts during the previous passage of 1846 (Chinnici, 2019; Secchi, 1852b, 1856e).

In the same issue of the German periodical, Secchi communicated data on the asteroid Melpomene observed at the Collegio Romano (Secchi, 1852a), which had been discovered just over a month earlier by the English astronomer John Russell Hind (1823–1895). In 1853 Secchi himself discovered a new comet (Chinnici, 2019; Secchi, 1856f).

Secchi mentions observations of numerous other comets between the years 1856 and 1862 (Secchi, 1856h, 1863a) and then again in 1874, carried out together with his assistant Enrico Cappelletti (1831–1899) SJ. Cappelletti was a good draftsman, and his contribution was of great importance for sketching the drawings of comets and other celestial objects (we will see later in particular those of Mars) that Secchi observed.

Extensive studies were made for the Comet of 1861, in particular on its nucleus, to show that the tail jets increased as the distance from the Sun decreased (Fig. 3.4). Secchi was also interested in cometary spectra, starting from 1866, when he observed

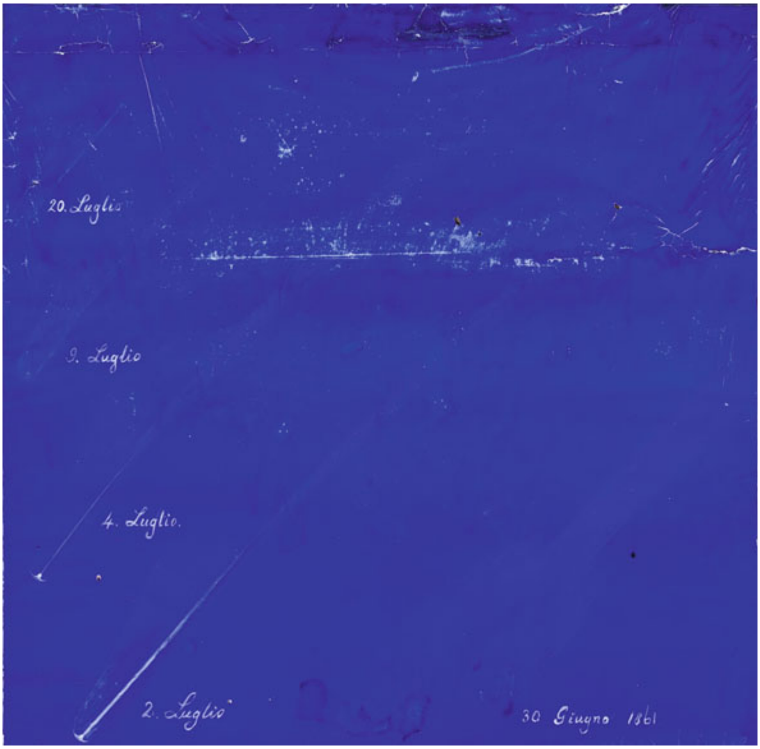


**Fig. 3.4** Comet observed at the Collegio Romano Observatory in 1861 (INAF-Osservatorio Astronomico di Roma, Historical Archive)

the spectrum of Comet Tempel and found that the chemical composition of the comets was different from that of nebulae (Secchi, 1874a).

The greatest development on the subject came with Schiaparelli's discovery of the correlation between comets and shooting stars, to which Secchi gave space on several occasions in the *Bullettino* he edited (Schiaparelli, 1866). In Secchi's words, "these meteors moved accordingly with the orbits of comets, so one of two consequences was inevitable, either that comets were clusters of shooting stars, or that comets were large shooting stars that were tied to the orbits of these bodies" (Secchi, 1877).[5]

Finally, we recall the contribution of Elia Millosevich, who, unlike his predecessors, was more devoted to celestial mechanics than to astrophysics, turning his attention to calculating the orbits of comets and asteroids (Cerulli, 1919). He discovered the asteroids Josephina and Unitas in 1891, and in 1899 he was among the first to calculate the highly eccentric orbit of the asteroid Eros with very high accuracy, showing that the trajectory covered by this asteroid periodically brings it close to Earth. This work, in particular the prediction of the proximity of Eros to the Earth on the occasion of the asteroid's opposition in 1900, was of great use for a more precise determination of the Solar parallax and, consequently, of the astronomical unit.

## Planetary Observations During the Directorates of Giuseppe Calandrelli and Francesco De Vico

From the *Opuscoli astronomici* edited by Giuseppe Calandrelli, we know that Andrea Conti, a friend and pupil of Calandrelli, observed the transit of Mercury on 8 November 1802 from the tower built by Calandrelli himself on the roof of the College (Conti, 1803). Conti wrote that the observations of the phenomenon were disturbed by the frequent passage of clouds. However, he did not lose heart and completed the mathematical study of the phenomenon. In his analysis he also used observational data provided by Giuseppe Cassella (1755–1808), director and founder of the Astronomical Observatory of Naples at the ancient monastery of San Gaudioso in Caponapoli; by the Viennese astronomer Franz de Paula Triesnecker (1745–1817); and by the French Joseph Jérôme Lefrançois de Lalande (1732–1807), who sent him the data taken by Joseph Thulis (1768–1810), director of the Observatory of Marseille.

Observations of Uranus and Jupiter on the occasion of their oppositions of 1819 are reported in the *Opuscoli astronomici* of the year 1822 (Conti, 1822). Conti wrote that the measurements of the position of Uranus were made with the transit instrument and the mural quadrant, and with the transit instrument and the Reichenbach multiplier circle for Jupiter. He used the positions of the fixed stars from Piazzi's catalogue, published in 1814, as reference points. From them, Conti calculated the times of the

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[5] "…queste meteore andavano di conseguenza con le orbite delle comete, onde era inevitabile una delle due conseguenze, o che le comete erano ammassi di stelle cadenti, o che le comete erano stelle cadenti maggiori che camminano di conserva con le catene di questi corpuscoli" (Secchi, 1877).

oppositions of the two planets and proposed new tables of Uranus, with correction of the old tables by Barnaba Oriani (1752–1832) and Jean Battiste Delambre (1749–1822).

Conti was assisted by Ignazio Calandrelli (1792–1866) in calculating the elements of Uranus' orbit. Ignazio was nephew of Giuseppe Calandrelli and director of the Astronomical Observatory of the Campidoglio after 1848. Ignazio Calandrelli renovated this observatory, obtaining funds from Pio IX for improving the instrumentation, which was increased with an Ertel meridian circle and an equatorial refracting Merz telescope.

Back at the Collegio Romano, in the *Opuscoli* of 1824, we also find tables to calculate the annual parallaxes of Jupiter and Saturn by Conti (Conti, 1824a). In addition, he calculated new tables of Mercury (Conti, 1824b) starting from the data of the planet's transit over the solar disk, which was observed in November 1822 in Parramatta (New Wales, Australia) by Georg Friedrich Wilhelm Rümker (1832–1900).

We have already mentioned Francesco De Vico in the section dedicated to comets, in particular for his precise calculation of the ephemeris of Halley's comet, which made it possible to observe the return of the comet at the Collegio Romano in 1835 before any other observers.

His skill was not limited to calculation; he was also a keen observer. In 1838 De Vico was able to observe the satellites of Saturn, Mimas and Enceladus with the Cauchoix telescope. From a series of very accurate observations, he calculated the period of revolution of both and the ephemeris of Mimas (De Vico, 1838b). Due to the proximity of these satellites to the planet, only the discoverer William Herschel (1738–1822) had seen them before De Vico did, and that only on a few occasions.

De Vico attempted to study the divisions of Saturn's rings; to facilitate these observations he introduced a small opaque metal sheet into the focus of the eyepiece to hide the planet, whose brightness interfered with seeing the objects closest to it (De Vico 1838a, 1840b, 1842a, 1843a). He tried to measure the supposed eccentricity of the rings with respect to the position of Saturn and to verify the rotation time of the rings themselves, in both cases without success (Fig. 3.5).

De Vico and his assistants Clemente Palomba (1819–1891) and Benedetto Sestini conducted numerous observations of Venus with the aim of calculating the rotation period of the planet. However, he was misled by the presence of a dense atmosphere on Venus, which was unknown at the time and did not allow us to observe its surface. In the *Memorie del Collegio Romano* we find a detailed description of the attempts to see the spots on the surface of Venus and to follow their movements as long as possible, even in broad daylight.

Using the Cauchoix telescope with a string micrometer applied on it, he concluded that a full revolution of Venus on its axis occurred in between 23 and 24 h (De Vico, 1840c, 1842b, 1843b). De Vico also wrote that he could not believe that Bianchini had made such a gross mistake by declaring a rotation of 24 days. Today we know that both were wrong; in fact, the rotation period of Venus is very slow, equal to approximately 243 Earth days, and retrograde.

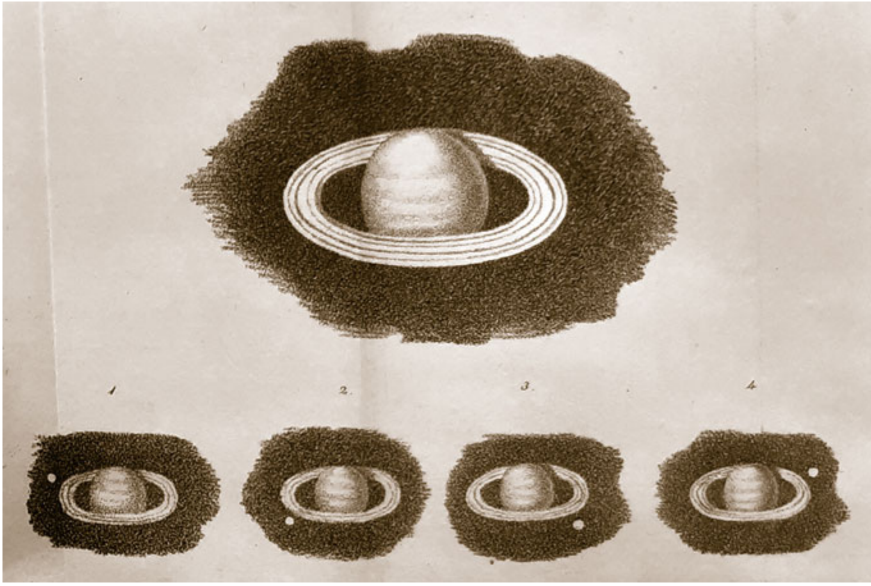

**Fig. 3.5** Saturn and its first satellite observed by Francesco De Vico (De Vico, 1840b)

## Planetary Observations During the Directorate of Angelo Secchi

When Secchi took over the directorate of the Observatory of the Collegio Romano, he found himself having to work with instruments located in a tall tower that lacked the necessary stability for accurate observations. As previously mentioned, he started the construction of a new observatory located on the pillars of the church of St. Ignatius and commissioned new instrumentation, including the Merz equatorial refractor. The first improvement he made concerned the Cauchoix telescope, which was equipped with a new equatorial mount, making it more suitable for observations of comets and minor planets. Among others, Secchi studied asteroid Massalia (Secchi, 1852c), discovered in September 1852 by Annibale de Gasparis (1819–1892) at the Astronomical Observatory of Capodimonte, and at the same time by the French astronomer Jean Chacornac (1823–1873), who first communicated the discovery, and Polimnia (Secchi, 1856g).

It is well known that Secchi was more interested in the study of the physical nature of celestial bodies rather than in their motions, and this is evident in the planetary observations he conducted. From the beginning, his studies included spectroscopic observations of the planets, and these became more extensive from the end of the 1860s (McKim Sheehan, 2021).

## The Moon Photographs

The eclectic nature of Secchi's interests led him to experiment with all kinds of new techniques in astronomical observations, including photography. In fact, together with the pharmacist and photographer Francesco Barelli, in 1858 he created the first photographic atlas of the Moon (Secchi, 1858a, 1858b). Using the wet collodion technique, they obtained eight different detailed images of the satellite during the crescent phases. Moreover, Secchi made an extremely detailed drawing of Crater Copernicus, the result of a study that lasted more than two years starting in 1855 (Secchi, 1856d). Secchi also photographed the planets Jupiter and Saturn: "in the first [Jupiter] the bands, in the second [Saturn] the ring with its shadow were very clear"[6] (Secchi, 1858c, 1859b).

His photographs of the Moon have survived to our time, but not those of the planets. Secchi tells us that the latter were overexposed. From the exposure times he deduced that the absolute brightness of Jupiter exceeded that of Saturn, which far exceeded that of the Moon, and referring to the latter he ironically noted that his conclusion "may seem strange to those who hear so much praise of [the Moon's] silvery splendor" (Fig. 3.6).[7]

## Mercury

Secchi mentions numerous observations of Mercury. He noticed spots and structures on its surface, but he did not systematically study it, probably due to the difficulty of observing the planet as it is always immersed in twilight (Secchi, 1863b).

## Venus

With Benedetto Sestini, Secchi observed Venus several times, both on the occasion of its transit in front of the solar disk and during inferior conjunctions. In particular, during the inferior conjunction of 1857, Secchi was convinced that the planet had a dense atmosphere. He also mentioned the presence of possible surface structures, which he believed to be solid. Today we know that in reality the very opaque atmosphere prevents observation of the surface of Venus. At that time one issue was therefore to determine the exact period of rotation of the planet, which remained unanswered until the 1960s, when radar observations in radio wavelengths were able to penetrate the dense atmosphere.

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6 *"…nel primo si ebbero nettissime le fasce, nel secondo l'anello fino colla sua ombra"* (Secchi, 1859c).

7 *"…conclusione che potrà parere strana a chi tanto sente decantare l'argenteo suo splendore"* (Secchi, 1859c).

**Fig. 3.6** Photograph of the Moon on the 6th day taken by Angelo Secchi and Francesco Barelli (Secchi, 1858a)

Secchi himself realized that some of the features he observed changed their shape and that consequently they could not be associated with the surface of the planet but with its atmosphere. From the observations of the spectral lines, Secchi noticed a certain similarity between the atmospheres of Venus, Mars and the Earth (Secchi, 1874b).

## *Mars*

Mars was the planet most continuously observed by Secchi (Secchi, 1856i, 1858c, 1859c, 1863d). In 1859 Secchi published 18 detailed drawings of the red planet and two representations of the view of its lower and upper poles (Secchi, 1859a). This was the result of observations carried out from June to August of the previous year, at the time of the opposition of the planet, drawn with great accuracy by the hand of Cappelletti. The result was noteworthy, most likely thanks to the favourable conditions given by the planet's position in the sky and by the excellent quality of the Merz telescope with a 24-cm aperture and 4.35-m focal length.

Several years later, in 1877, Secchi described his work on Mars, writing that "the most important discovery is that of two permanent blue channels between the two great red equatorial continents, which was confirmed by subsequent observations since the planet has been reobserved in recent years almost under the same aspect".[8] (Secchi, 1877). Regarding the polar caps, he went on saying that "their extreme variability was proved; which leads us to believe them to be clusters of clouds rather than snow or ice".[9] He concluded by saying that "many of these latter drawings are unpublished",[10] as if to demonstrate an awareness of the value and uniqueness of his work, or perhaps a certain humility in not considering the result of his observations sufficiently confirmed by other studies (Fig. 3.7).

We also know from Secchi's words that a few of these drawings were sent to Francois Terby (1846–1911), who was also interested in studying the planet. From these drawings and his writings it is possible to note that Secchi observed and documented some Martian sandstorms (McKim, 1999).

A significant landmark in the study of this planet in the years to come was the use by Secchi of the word "*canali*", which should be translated as "channels", to indicate the regular structures that seemed to be present on the surface of the planet. This usage anticipated and perhaps generated the great attention towards the red planet that would be unleashed just over a decade, when the word "*canali*" was taken up by Giovanni Virginio Schiaparelli (1835–1910), who began observing Mars at the Brera Observatory starting in 1877.

It is worth remembering the great mutual esteem between the two scientists (Maffeo, 2011), which is well attested by the note written by Schiaparelli in the register of observations of 26 February 1878, the day of the death of Angelo Secchi (Fig. 3.8).

Concerning spectroscopic observations, Secchi observed few absorption bands in Mars, and from this he deduced that the Martian atmosphere should be thinner than the atmospheres of the other planets and in particular of the outer giant planets and that its chemical composition is rather similar to that of the Earth's atmosphere.

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[8] *"…la scoperta più importante è quella di due canali azzurri permanenti tra i due grandi continenti equatoriali di color rosso, che è stata confermata dalle osservazioni posteriori essendosi il pianeta riosservato negli ultimi anni quasi sotto lo stesso aspetto"* (Secchi, 1877).

[9] *"…si provò la loro estrema variabilità; il che fa credere piuttosto ammassi di nubi che di nevi o ghiacci"* (Secchi, 1877).

[10] *"…molte di queste figure ultime sono inedite"* (Secchi, 1877).

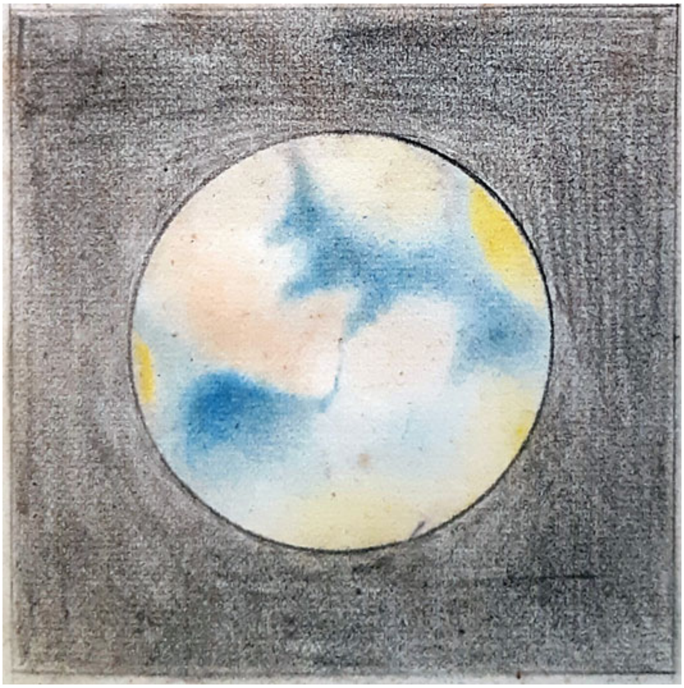

**Fig. 3.7** Drawing of Mars in colours by Angelo Secchi and Enrico Cappelletti (*Osservazioni all'Equatoriale dal 23 giugno 1858 al 24 febbraio 1859,* INAF-Osservatorio Astronomico di Roma, Historical Archive, Folder 43, no. 158)

## *Jupiter*

Secchi made a large number of drawings of Jupiter and noticed that the planet's appearance rapidly changed. He was convinced that phenomena similar to our storms occurred in its atmosphere (Fig. 3.9). The Jesuit also studied the satellites of Jupiter and, in particular, their rotation inferred from the observation of spots on their surfaces (Secchi, 1855, 1856c, 1863e, 1874c).

Regarding spectroscopic observations (Secchi, 1864), Secchi observed some peculiar absorption lines that only in the twentieth century have been explained to be due to the high-pressure condition of the gas. In addition, the existence of lines of water vapour was highlighted, as their presence was first denied and then confirmed by other astronomers. However, in light of modern knowledge, it is now understood that these bands are due to the Earth's atmosphere.

In general, the outer planets showed very different spectra from that of the Earth's atmosphere, which led Secchi to believe that the atmospheres of the gas giants were in a primordial stage and composed of unknown gases.

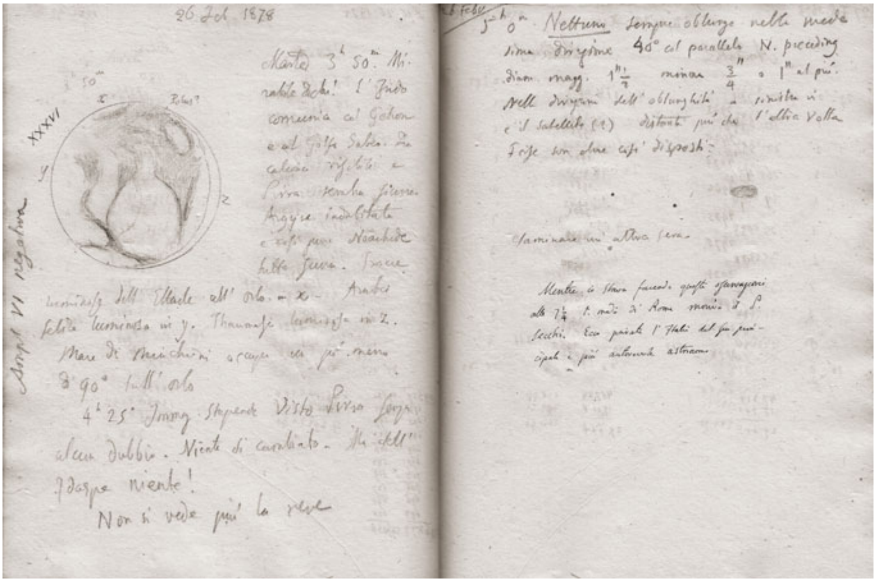

**Fig. 3.8** Pages of register of the observations made by Giovanni Virginio Schiaparelli on 26 February 1878 with the annotation of the death of Angelo Secchi (INAF-Osservatorio Astronomico di Brera, Historical Archive, Fondo "G. V. Schiaparelli", cart. 491, fasc. 1)

## *Saturn*

Saturn was the first planet to be observed by Secchi, as early as 1850 (Secchi, 1851a), initially with the Cauchoix telescope at the old observatory (the Calandrelli Tower) and later in the new observatory with the Merz telescope.

He conducted detailed observations of the structure of the rings, revealing their irregularities and confirming the previous observations made by De Vico and other astronomers (Secchi, 1856b, 1856k). In particular, he observed the very thin third ring, in addition to the first two rings already known from the times of Cassini and Campani. Moreover, he was able to see two subtle divisions of the outermost ring. One of these divisions was discovered in Berlin by Johann Franz Encke (1791–1865). From these observations Secchi was convinced that the divisions must be real empty spaces that separate the rings (Secchi, 1856k).

Secchi's hypotheses were confirmed by Étienne Léopold Trouvelot (1827–1895), who repeated the same observations with large American refractors in the observatories in Cambridge and Washington.

This research continued until 1862, at which time the position of the planet was no longer favourable to observations, and perhaps by then Secchi's interests were directed elsewhere (Secchi, 1863c).

**FIG. 3.9.** Drawing of Jupiter dated 23 January 1859 (*Osservazioni all'Equatoriale dal 23 giugno 1858 al 24 febbraio 1859,* INAF-Osservatorio Astronomico di Roma, Historical Archive, busta 43, n. 158)

## *Uranus and Neptune*

The two outer planets were observed several times without any spots or structures on their surface. In 1869 Secchi was the first to observe the spectrum of Uranus, which was very bright and characterized by the presence of two dark bands (Secchi, 1869). The first was located in the green region of the visible spectrum and the second in the violet. The spectrum of the planet also showed a wide empty interval in the yellow region and a weak emission in the red region. Secchi noted differences with respect to the spectra of Jupiter and Saturn, and also with respect to the spectrum of the Sun, from which he deduced that the peculiarities of the spectrum of Uranus, compared to the reflected light of the Sun, had to be introduced by the planet's atmosphere (Grassi, 2021) (Fig. 3.10).

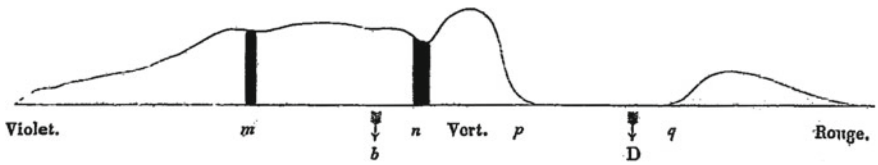


**Fig. 3.10** The spectrum of Uranus, as observed by Angelo Secchi (Secchi, 1869)

## Conclusion

As we have seen, the study of planetary astronomy has been a regular part of the work at the Collegio Romano since its foundation, and this has been conducted by Jesuit astronomers and other scholars over the centuries.

These activities continued until the beginning of the twentieth century. In fact, planetary observations were carried out by Pietro Tacchini and Elia Millosevich, who took over the Observatory from the Jesuits after the unification of Italy.

In 1880 they used the 24-cm aperture Merz refracting telescope to observe Uranus and the minor planets Juno, Ceres, Hebe, Diana and Nemausa (Tacchini, 1880). Later, further observations were made with the new 39-cm aperture Steinheil-Cavignato refractor, which was installed to replace the Merz telescope (Millosevich, 1904).

After that time, the study of the planets continued at the Astronomical Observatory of Rome in Monte Mario under the direction of Giuseppe Armellini. His main field of study was celestial mechanics, and therefore his planetary research was of a theoretical nature (Armellini, 1922). In particular, he conducted in-depth studies on the motion of Uranus and the perturbations of Triton, the largest satellite of Neptune, which made him suspect the existence of other satellites. This intuition was later verified in 1948 when a fifth satellite of Uranus (Miranda) was discovered and again in 1949 with the discovery of a second satellite of Neptune (Nereid), both by Gerard Kuiper (1905–1973).

Armellini also studied the perturbations of the orbit of Hungaria, an asteroid of the main belt discovered in 1898 by the German astronomer Max Wolf (1863–1932).

Lines of research concerning the planets are still active today in the two INAF institutes of the Roman area. At the Astronomical Observatory of Rome, located in Monte Porzio Catone, this activity is focused on the study of the minor bodies of the Solar System, based on the analysis of data collected by telescopes both on the ground and orbiting in space. Since its foundation, the Institute of Astrophysics and Space Planetology, in Frascati, has been the seat of advanced planetary research, both observational and theoretical, which is still ongoing through participation in important space missions.

Planetary astronomy is also carried out at the Vatican Observatory, concerning both the observation of planets and the laboratory study of meteoritic materials.

The long tradition of planetary research that we have described in this work, together with the astronomical observations that have been conducted since classical antiquity and the founding of stellar astrophysics in the nineteenth century, make Rome a unique place in the history of astronomy. For this reason, it would be worthwhile to further enhance the places and testimonies of this history through dissemination among students, young people in general, and the general public. This could happen through the frequent organization of events, encouraging public access to places of astronomical interest in the city and the development of museum structures dedicated to science.

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## References

Aebischer, T. (2012). Le misure geodetiche. *Angelo Secchi. L'avventura scientifica del Collegio Romano*, editors Altamore A. and Maffeo S., Foligno, pp. 227–239.
Asclepi, G. M. (1761). *De Veneris per solem transitu exercitatio astronomica habita in collegio Romano soc. Jesu a patribus ejusdem societatis anno 1761*, Rome.
Asclepi, G. M. (1765). *De objectivi micrometri usu in planetarum diametris metiendis. Exercitatio optico-astronomica habita in Collegio Romano a Patribus Societatis Jesu*, Rome.
Asclepi, G. M. (1767). *De nova et facili methodo elevandi Mercurium in tubis ad altitudinem consuetam maiorem*, Rome.
Asclepi, G. M. (1770). *De cometarum motu exercitatio astronomica habita in collegio Romano patribus Societatis Jesu.Prid.Non.Septem*, Rome.
Armellini, G. (1922). Sopra le distanze dei pianeti dal Sole. *Astronomische Nachrichten, 215*, 263–264.
Bianchini, F. (1728). *Hesperi et phosphori nova phaenomena, sive Observationes circa planetam Veneris*, Rome.
Buffoni, L., Mangianti, C., & Mangianti, F. (2001). L'astronomia nella documentazione marmorea a Roma e Milano. *Atti del XXI Congresso Nazionale di Storia della Fisica e dell'Astronomia*, Cosenza.
Cacciatore, N. (1808). *Della cometa apparsa in settembre del 1807 osservazioni e risultati di Niccolò Cacciatore assistente della Specola*, Palermo.
Calandrelli, G. (1808). *Osservazioni e riflessioni sopra la Cometa del settembre anno 1807* (pp. 1–76). Opuscoli astronomici.
Calandrelli, G. (1813). *Osservazioni sopra la Cometa del 1811* (pp. 1–116). Opuscoli astronomici.
Campani, G. (1664). *Ragguaglio di due nuove osservazioni una celeste in ordine alla stella di Saturno; e terrestre l'altra in ordine a gl'istrumenti medesimi, co' quali s'e fatta l'una e l'altra osservazione*, Rome.
Cassini, G. D. (1666). *Martis circam asxem proprium revolubilis observationes Bononiae*, Bologna.
Cerulli, V. (1919). Elia Millosevich, *Memorie della Società degli Spettroscopisti Italiani*, series 2, vol. 8, pp. 99–103.
Chinnici, I. (2015). Nineteenth-century comets: Studies and observations in Sicily. *Journal for the History of Astronomy, 46*(2), 130–158.
Chinnici, I. (2019). *Decoding the stars: A biography of Angelo Secchi, Jesuit and Scientist*, Leiden-Boston.
Conti, A. (1803). Sul passaggio di Mercurio osservato il dì 8 novembre del 1802, *Opuscoli astronomici, e fisici*, Rome, pp. 74–103.
Conti, A. (1808). *Elementi dell'Orbita della Cometa che apparve nel settembre del 1807* (pp. 77–108). Opuscoli astronomici.

Conti, A. (1813). Elementi dell'Orbita parabolica, ed ellittica della Cometa che apparve nel anno 1811, *Opuscoli astronomici*, Rome, pp. 117–150.

Conti, A. (1822). *Osservazioni di Urano e di Giove presso le loro opposizioni fatte nel 1819—Tavole di Urano* (pp. 172–184). Opuscoli astronomici.

Conti, A. (1824a). *Tavole per calcolare la parallasse annua di Giove di Saturno* (pp. 23–47). Opuscoli astronomici.

Conti, A. (1824b). Passaggio di Mercurio sul disco solare osservato dal Sig. Rumker a Paramatta nel novembre del 1822, *Opuscoli astronomici*, Rome, pp. 48–60.

De Vico, F. (1836). *Nuova cometa di breve periodo ossia Memoria intorno alle perturbazioni cagionate dall'azione di Giove nell'orbita di una delle comete comparse il 1819.*

De Vico, F. (1838a). Anelli di Saturno*, Memoria intorno ad alcune osservazioni fatte alla Specola del Collegio Romano nel corrente anno 1838*, Rome, pp. 10–11.

De Vico, F. (1838b). Osservazioni del I e II satellite di Saturno*, Memoria intorno ad alcune osservazioni fatte alla Specola del Collegio Romano nel corrente anno 1838*, Rome, pp. 12–15.

De Vico, F. (1840a). Cometa del 14 luglio 1839*, Memoria intorno a parecchie osservazioni fatte nella Specola dell'Università Gregoriana in Collegio Romano dagli astronomi della Compagnia di Gesù l'anno 1839*, Rome, pp. 38–39.

De Vico, F. (1840b). Anelli di Saturno*, Memoria intorno a parecchie osservazioni fatte nella Specola dell'Università Gregoriana in Collegio Romano dagli astronomi della Compagnia di Gesù l'anno 1839*, Rome, pp. 40–41.

De Vico, F. (1840c). Rotazione di Venere sul proprio asse*, Memoria intorno a parecchie osservazioni fatte nella Specola dell'Università Gregoriana in Collegio Romano dagli astronomi della Compagnia di Gesù l'anno 1839*, Rome, pp. 42–64.

De Vico, F. (1842a). Anelli e satelliti di Saturno*, Memoria intorno a parecchie osservazioni fatte nella Specola dell'Università Gregoriana in Collegio Romano dagli astronomi della Compagnia di Gesù negli anni 1840–1841*, Rome, pp. 30–31.

De Vico, F. (1842b). Rotazione di Venere, *Memoria intorno a parecchie osservazioni fatte nella Specola dell'Università Gregoriana in Collegio Romano dagli astronomi della Compagnia di Gesù negli anni 1840–1841*, Rome, pp. 32–71.

De Vico, F. (1843a). Saturno, *Memoria intorno a parecchie osservazioni fatte nella Specola dell'Università Gregoriana in Collegio Romano dagli astronomi della Compagnia di Gesù l'anno 1842*, Rome, pp. 23–26.

De Vico, F. (1843b). Rotazione di Venere, *Memoria intorno a parecchie osservazioni fatte nella Specola dell'Università Gregoriana in Collegio Romano dagli astronomi della Compagnia di Gesù l'anno 1842*, Rome, pp. 29–47.

Divini, E. (1660). *Brevis annotatio in systema Saturnium*, Rome.

Dumouchel, E. (1835). Auszug aus einem Schreiben des Herrn Dumouchel. *Astronomische Nachrichten, N., 288*, 415.

Grassi, D. (2021). La spettroscopia planetaria: un'eredità di Padre Angelo Secchi. *Padre Angelo Secchi. La figura, le opere, l'astrofisica, a cura di Silvia Chicchi e Roberto Marcuccio*, Correggio (RE), pp. 241–254.

Maffeo, S. (2011). G.V. Schiaparelli and Fr. A. Secchi, S.J. *Memorie Della Società Astronomica Italiana, N., 82*, 259–267.

Maffeo, S. (2012). Il Collegio Romano e l'insegnamento delle scienze. *Angelo Secchi. L'avventura scientifica del Collegio Romano*, editors Altamore A. and Maffeo S., Foligno, pp. 15–41.

McKim, R. J. (1999). Telescopic Martian dust storms: A narrative and catalogue. *Memoirs of the British Astronomical Association*, vol. 44, pp.19–20.

McKim, R., & Sheehan, W. (2021). Planetary Observations by Angelo Secchi, *Angelo Secchi and the Nineteenth Century Science*, editors Chinnici I. and Consolmagno G., pp.105–121.

Millosevich, E. (1904). Osservazioni di pianeti e della cometa 1904 I. *Astronomische Nachrichten, 167*, 7–10.

Monaco, G. (2000). *L'astronomia a Roma.* Dalle origini al Novecento.

Riccioli, G. B. (1665). *Astronomiae reformatae*, Bologna.

Schiaparelli, G.V. (1866). Intorno al corso ed all'origine probabile delle stelle meteoriche, *Bullettino Meteorologico dell'Osservatorio del Collegio Romano*, vol. 5, n. 10, pp. 97–106.
Secchi, A. (1851a). Nuove apparenze dell'anello di Saturno. *Annali Di Scienze Matematiche e Fisiche, N., 2*, 39–44.
Secchi, A. (1851b). *Ragguaglio intorno alla vita e ai lavori del p. Francesco De Vico della Compagnia di Gesù.*
Secchi, A. (1852a). Beobachtungen der Melpomene auf der Sternwarte des Collegio Romano. *Astronomische Nachrichten, N., 822*, 88.
Secchi, A. (1852b). Entdeckung und Beobachtungen eines kleinen Cometen. *Astronomische Nachrichten, N., 822*, 90.
Secchi, A. (1852c). Osservazioni sul pianeta Massalia fatte all'Osservatorio del Collegio Romano all'Equatoriale Cauchoix. *Atti Dell'accademia Pontificia De' Nuovi Lincei, 5*, 314.
Secchi, A. (1855). Ricerche sopra il pianeta Giove, fatte coll'equatoriale de Merz all'Osservatorio del Collegio Romano durante l'anno 1850. *ll Nuovo Cimento, Giornale di Fisca, di Chimica, et delle loro Applicationi*, n. 2, p. 351.
Secchi, A. (1856a). Descrizione dell'Osservatorio. *Descrizione del Nuovo Osservatorio del Collegio Romano D. C. D. G. e Memoria sui lavori eseguiti dal 1852 a tutto aprile 1856,* pp. 9–24.
Secchi, A. (1856b). Osservazioni di Saturno e suoi anelli. *Descrizione del Nuovo Osservatorio del Collegio Romano D. C. D. G. e Memoria sui lavori eseguiti dal 1852 a tutto aprile 1856,* pp. 97–113.
Secchi, A. (1856c). Ricerche sopra il pianeta Giove. *Descrizione del Nuovo Osservatorio del Collegio Romano D. C. D. G. e Memoria sui lavori eseguiti dal 1852 a tutto aprile 1856,* pp. 114–117.
Secchi, A. (1856d). Selenografia. *Descrizione del Nuovo Osservatorio del Collegio Romano D. C. D. G. e Memoria sui lavori eseguiti dal 1852 a tutto aprile 1856,* pp. 134–135.
Secchi, A. (1856e). Cometa di Biela nella sua apparizione del 1852. *Descrizione del Nuovo Osservatorio del Collegio Romano D. C. D. G. e Memoria sui lavori eseguiti dal 1852 a tutto aprile 1856,* pp. 147–149.
Secchi, A. (1856f). Cometa del 6 marzo 1853 scoperta all'Osservatorio del Collegio Romano. *Descrizione del Nuovo Osservatorio del Collegio Romano D. C. D. G. e Memoria sui lavori eseguiti dal 1852 a tutto aprile 1856,* pp. 149–150.
Secchi, A. (1856g). Osservazioni del Pianeta Polimnia. *Descrizione del Nuovo Osservatorio del Collegio Romano D. C. D. G. e Memoria sui lavori eseguiti dal 1852 a tutto aprile 1856,* p. 150.
Secchi, A. (1856h). Osservazioni della Cometa Donati e Cometa di Bruhns. *Descrizione del Nuovo Osservatorio del Collegio Romano D. C. D. G. e Memoria sui lavori eseguiti dal 1852 a tutto aprile 1856,* p. 151.
Secchi, A. (1856k). Misure di Sturno e suoi anelli. *Descrizione del Nuovo Osservatorio del Collegio Romano D. C. D. G. e Memoria sui lavori eseguiti dal 1852 a tutto aprile 1856,* pp. 152–153.
Secchi, A. (1856i). Osservazioni di Marte. *Descrizione del Nuovo Osservatorio del Collegio Romano D. C. D. G. e Memoria sui lavori eseguiti dal 1852 a tutto aprile 1856,* pp. 154–156.
Secchi, A. (1858a). *Mappe fotografiche delle principali fasi lunari.*
Secchi, A. (1858b). Atlas photographique lunaire. *Comptes Rendus Hebdomadaires Des Séances De L'academie Des Sciences, 47*, 362–364.
Secchi, A. (1858c). Études sur la planète Mars. *Comptes Rendus Hebdomadaires Des Séances De L'academie Des Sciences, 47*, 364–366.
Secchi, A. (1859a). Osservazioni di Marte fatte durante l'opposizione del 1858. *Memorie Dell'osservatorio Del Collegio Romano, Nuova Serie, 1*(3), 17–24.
Secchi, A. (1859b). Fotografie lunari e degli altri corpi celesti. *Memorie Dell'osservatorio Del Collegio Romano, Nuova Serie, 1*(20), 158–160.
Secchi, A. (1859c). *Quadro fisico del Sistema Solare secondo le più recenti osservazioni.*
Secchi, A. (1863a). Alcune considerazioni su le tre ultime grandi comete. *Memorie Dell'osservatorio Del Collegio Romano, Nuova Serie, 2*(2), 18–32.

Secchi, A. (1863b). Passaggio del pianeta Mercurio avanti al Sole il giorno 12 novembre 1861 osservato alla Specola del Collegio Romano con aggiunta di altre osservazione diverse. *Memorie Dell'osservatorio Del Collegio Romano, Nuova Serie, 2*(9), 65–71.

Secchi, A. (1863c). Osservazioni di Saturno in occasione della disparizione dell'anello negli anni 1861 e 62. *Memorie Dell'osservatorio Del Collegio Romano, Nuova Serie, 2*(10), 73–76.

Secchi, A. (1863d). Osservazioni del pianeta Marte. *Memorie Dell'osservatorio Del Collegio Romano, Nuova Serie, 2*(10), 76–79.

Secchi, A. (1863e). Giove. *Memorie Dell'osservatorio Del Collegio Romano, Nuova Serie, 2*(10), 79.

Secchi, A. (1864). Observations of the spectrum of Jupiter. *The London, Edinburgh and Dublin Philosophical Magazine and Journal of Science, 28*, 486–488.

Secchi, A. (1869). Resultats fournis par l'analyse spectrale de la lumiere d'Uranus, de l'etoile R des Gemeaux, et des taches solaires. *Comptes Rendus Hebdomadaires Des Séances De L'academie Des Sciences, 68*, 761–765.

Secchi, A. (1874a). Sullo spettro della cometa Tempel. *Memorie Della Società Degli Spettroscopisti Italiani, 3*, 29–30.

Secchi, A. (1874b). Sugli spettri prismatici del pianeta Giove e degli altri pianeti. *Bullettino Meteorologico Dell'osservatorio Del Collegio Romano, 13*(11), 97–99.

Secchi, A. (1874c). Giove e satelliti. *Memorie Della Società Degli Spettroscopisti Italiani, III*, 39.

Secchi, A. (1877). *L'astronomia in Roma nel pontificato di Pio IX*, Rome (cap. III, pp.16–22).

Tacchini, P. (1880). Osservazioni di pianeti fatte all'Equatoriale di Merz dell'Osservatorio del Collegio Romano. *Astronomische Nachrichten, 97*, 187–190.