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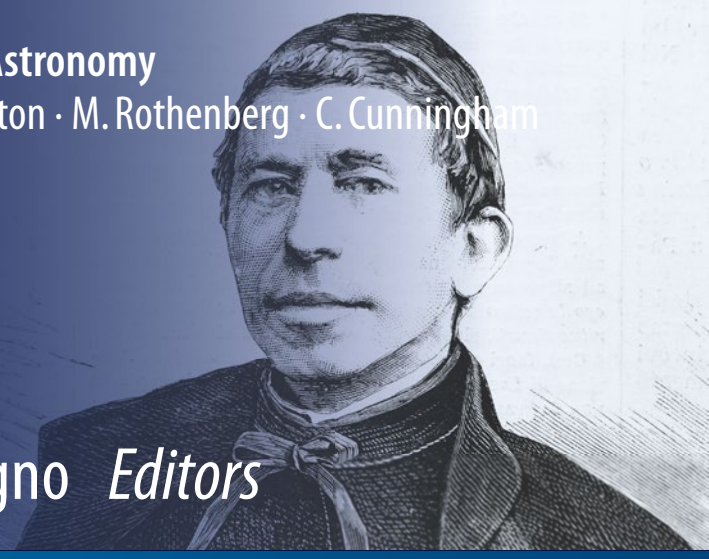

Ileana Chinnici
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Angelo Secchi and Nineteenth Century Science

The Multidisciplinary Contributions of a Pioneer and Innovator

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Chapter 3
Between Science and Religion: Angelo Secchi and his Time

Giuseppe Tanzella-Nitti

3.1 Introduction

The idea of a Jesuit priest working as a professional astronomer was not unusual in the epoch of Angelo Secchi. There are a number of theological, historical, and intellectual reasons underlying Christianity's interest in science, endorsed by a huge literature, especially concerning historical issues or centered on outstanding scientific figures, believers, and scientists (see, for instance, Lindberg and Numbers 1986; Brooke 1991; Brooke and Cantor 1998; Grant 2006).

From a practical point of view, the Christian community was interested in the study of the celestial motions and the calendar because of need for the exact determination of the date of Easter, which depends on the lunar phases and the position of the Spring equinox. But Sacred Scripture also conveys the idea that nature—the starry sky in particular—is the result of the Word of God, so that the beauty and order of creatures are able to declare the glory and attributes of their Creator. It was in dialogue with the philosophers of the first centuries of the Christian era that the Fathers of the Church were persuaded of the consonance between the Logos of which those philosophers of nature spoke, and the one and unique God revealed in Jesus Christ. In this way, the observation of the sky was kept free from idolatry and recognized as a path that leads to knowledge of God. The Greek apologists—Basil of Cesarea, Augustine of Hippo, and Leo the Great, to mention a few—were quite explicit in this respect.

Beginning in the ninth century, astronomy, arithmetic, and geometry, together with music, were the four disciplines of the *Quadrivium*, a part of the required

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studies for pupils of those schools associated with Catholic cathedrals. Coupled with the three disciplines representing the *Trivium*, (grammar, rhetoric, and logic) they gave rise to the Faculty of Liberal Arts, which were prerequisites of studies of the three major Faculties hosted in the universities of the Middle Ages, namely, law, medicine, and theology. Within the intellectual climate of the twelfth and thirteenth century universities, for the first time an interdisciplinary dialogue took place between the discourse on God (theology) and the discourse on man, society, and cosmos.

The observation of the sky easily entered into the philosophical reflection on human religious experience, and the observation of nature in general soon became part of natural theology: a discourse on God starting from nature, not from the Scriptures. The natural sciences were practiced in many religious schools and communities of the Renaissance and of the modern age, especially botany, astronomy, meteorology, alchemy, and crystallography, and later biology, chemistry, and geology. At the beginning of the nineteenth century, the official curriculum taught in Catholic seminaries obliged future priests to be examined, among other disciplines, in mathematics, astronomy, physics, and chemistry.

That a Catholic priest could be assigned to direct an astronomical observatory of national importance was, for all these reasons, a widely accepted occurrence. On the other hand, the interest of Christianity for scientific research extended beyond the boundary of Catholic Church, as witnessed by many Protestants, ministries, and laymen involved in the sciences. In Italy, a close relationship between astronomy and the Catholic Church was well in place in the epoch of Secchi, as can be seen by the many astronomical observatories supported by religious orders and individual priest-scientists (Ministero della Pubblica Istruzione 1956).

These scholars of the starry sky operated, of course, not only in the limited extent of the Pontifical States—which in the epoch of Secchi included a small area within central Italy—but also across the Italian territory at large, from Lombardy to Sicily. Almost all Italian astronomical observatories established from the end of the eighteenth century onward had a religious member or a priest as its founder. They often developed from small observatories built on the roofs of seminaries and religious schools for educational purposes.

The funding for instruments and research was covered by individual benefactors or by the scholarly community. In some cases, as occurred in the first university observatory in Bologna, both Popes Clemens XI (1700–1721) and Innocent XIII (1721–1724) provided the resources necessary to build the Observatory Tower and supplied the instruments as that territory was part of the Pontifical States. The Jesuits of the Brera College founded the first astronomical observatory in Milan, directed by Luigi La Grange (1711–1783) and then by Ruggiero Boscovich (1711–1787); when the Jesuit order was suppressed, a member of the Barnabite order, Barnaba Oriani (1752–1832), made the continuation of scientific studies possible. Theatin Giuseppe Piazzi (1746–1826), and priests Giuseppe Cassella (1755–1808), and Giuseppe Toaldo (1719–1797) established the astronomical observatories in Palermo, Naples, and Padua, respectively.

Although there were some minority currents in Catholicism that viewed scientific culture with distrust, especially because of the tension between some scientific circles and the Church that arose from the historical consequences of the Galileo affair, the positive contribution of the Catholic Church to the practice and promotion of astronomy in Italy is undoubted. On a smaller scale, something similar happened in other European countries and even further, as witnessed by the heritage of Matteo Ricci (1552–1610) in China.

The connection between science and the Catholic Church, implicitly reinforced by the fact that even a large fraction of nonclergy scientists in the seventeenth and eighteenth centuries were believers, becomes highly significant given the number of priest-scientists active throughout the entire nineteenth century, only declining in the twentieth century. Among Angelo Secchi's contemporaries we find a number of priests working in sciences other than astronomy: Gregorio Mendel (1822–1884), Antonio Stoppani (1824–1891), Francesco Faà di Bruno (1825–1888), and Giuseppe Mercalli (1850–1914) are just a few worth recalling here. We know that Secchi read the works of the Italian geologist Stoppani, both his strictly scientific ones and his essays on Bible and science, explicitly mentioning him and using his thought as a source of inspiration (Secchi 1879: 1, 80, 95). We also possess correspondence between Secchi and Faà di Bruno concerning projects to popularize astronomy and concerning how priests and scientists ought to behave before political authorities with respect to the autonomy of the Church (Palazzini 1980).

3.2 The Historical and Cultural Context

Consider two major circumstances within the historical and cultural context in which Angelo Secchi lived and worked. The first is the new situation that Secchi and his Jesuit confreres experienced in Rome after 1870. They had all been citizens of the former Pontifical State, which was formally dissolved after the Piedmont troops entered the Pope's city and declared Rome to be the capital of the Kingdom of Italy. The second circumstance was the tension between some conservative Catholic circles and other Catholic scholars, like Secchi, who developed innovative syntheses among Biblical exegesis, theology, and science. Threatened by the events that had led the papacy to oppose a number of modern European trends, more than a few Catholics were inclined to look at all cultural novelties, science included, with a sense of suspicion.

Both circumstances affected the way the relationship between science and religion was understood in Europe for many decades. The political contrasts between the Pontifical States and other European countries were seen as paralleling a contrast between the contents of Catholic faith and the knowledge brought about by the new political and cultural order. It is precisely in these years that in Italy the so-called Galileo affair took on a new life, through the publishing of critical essays and the building of monuments implicitly denouncing the Church's role. Meanwhile, the suspicions of conservative Catholics hampered the development of a theology

able to embrace the results of the natural sciences. As a consequence, this impeded the use of scientific knowledge as a positive source of dogmatic progress.

In the nineteenth century, Italian Catholics had different views about the "questione romana," that is, the acknowledgement of Rome as the capital of the new Kingdom of Italy. A large number of them, especially in Northern Italy, looked with favor at the loss of papal political sovereignty over various geographical regions (Rome included) which formed the Papal States, and affirmed that the Pope should exert a spiritual authority only. Others preferred that a special political status was acknowledged to the city of Rome. Yet other Catholics considered the attitude of the Italian government against the Pontifical States as a sort of battle of the forces of evil against the truth of faith, and thus a major danger for the future of the papacy in Europe. Nevertheless, many Catholics (lay faithful and priests) collaborated with the establishment of the Reign of Piedmont, aimed at unifying all Italian territory under the same King.

In this respect, it is illustrative that King Vittorio Emanuele II asked parish priests to help teach the unified metric system, which was newly established in his realm, replacing all the different regional units of measuring land, weights, and liquids. Each Sunday after the celebration of the Holy Mass, the parish priest left the Missal and came back from the sacristy bringing a textbook issued by the Ministry of Agriculture to give a lesson to the people present in the church on the new measuring system.

However, the situation was a bit different in Rome because of the proximity of the Pope, who was both the spiritual guide and the "town mayor" for the people living in the city.

Within the Pontifical States the papacy had promoted the development of culture and arts. At the beginning of the fourteenth century, a *Studium Urbis* was established in Rome by Pope Boniface VIII. During the pontificate of Alexander VII, in 1660, the *Studium* moved into the prestigious building of St. Ivo, in Corso Rinascimento, beginning its activities as the University "La Sapienza" (from the biblical motto *Initium Sapientiae timor Domini*, carved on the entrance door). Scientific studies were encouraged, especially those of medicine, anatomy, and surgery.

Astronomy also began to develop in Rome, albeit with instruments that were less advanced than those existing in other Italian sites. When Angelo Secchi took over the direction of the astronomical observatory of the Roman College in 1850, at least two other observatories already existed in the Pope's city (see Maffeo 1991; Chinnici 2018; Buonanno 2008). One was located in the Tower of the Winds in the Vatican Gardens, established in 1576 by Pope Gregory XIII, whose meridian line was used to demonstrate the reform of the Gregorian calendar in 1582 . At this time it was no longer in use, but it would become the future site of the Specola Vaticana in 1891. The other one was the university observatory built on a roof of the Campidoglio (City Hall), equipped with a 13 cm Merz refractor which Pope Pius IX provided in 1853. The Roman College Observatory—which Angelo Secchi moved from the Calandrelli Tower, adjacent to the College, to the roof of St Ignatius

Church—included a 22-cm Merz equatorial refractor, a 16-cm Cauchoix refractor, and an Ertel Meridian Circle.

3.3 Secchi's Chair of Astronomy at the University "La Sapienza"

By 1870, when the Piedmont troops conquered Rome, Angelo Secchi was a prominent scientist, well known in Italy and abroad especially for his studies on spectral classification of stars and solar physics, but also for his research in the field of meteorology. His fame was known to government administrators and bureaucrats of the new Italian government, even to the point that the Jesuit astronomer was one of the first scholars explicitly and personally contacted by government officers.

This gave rise to the events related to the chair of physical astronomy at the University of Rome "La Sapienza," a position which the Kingdom of Italy soon offered to Secchi and which he eventually had to refuse. Being a key episode in Secchi's life as a scientist and a faithful Catholic, this subject deserves to be examined in depth. A detailed report, from which we quote Secchi's correspondence and diary, was published many years ago by Castellani (1944). A more recent account is offered by Ileana Chinnici (see Chinnici 2012: 51–54, 2019).

On the evening of September 20, 1870, just after the Piedmont troops gained access to the Pope's city, a letter from Giovanni Cantoni (1818–1897), General Secretary of the Ministry of Education of the Kingdom of Italy, was delivered by hand to Secchi. The message expressed the government officer's wish for Secchi to remain at the Observatory of the Roman College, reassuring him that the Italian government would provide for his needs and would pay him a professor's salary.

The building of the Roman College was at that time the site of a prestigious high school, run by the Jesuits and attended by many Roman schoolboys. Due to the seriousness of the situation, Secchi did not give a definite answer. However, he expressed his willingness to remain in Rome, even though this city was now the capital of the new unified Kingdom of Italy, in order to continue his scientific research activity and teach as professor in the Jesuit school. From his diary we know that Secchi had invested a significant part of his personal patrimony, a sum of about 9000 *scudi* (today equivalent to about €250,000), into the equipment of the Observatory (APUG 1870: II, 29).

Three days later, on September 23, the mathematician Francesco Brioschi (1824–1897), senator of the Kingdom of Italy, visited the Observatory and handed Secchi a letter from the Italian Minister of Finance, Quintino Sella (1827–1884). Sella too, like Brioschi, was a man of science who had later become a politician, and someone who knew Secchi's scientific reputation. The minister proposed that Secchi become part of the teaching staff at the University "La Sapienza," which had just ceased to be under the Pope's authority and had passed to the Italian government.

Quintino Sella wrote to Secchi (cited by Castellani 1944: 41):

> You occupy a too eminent place in the scientific world, and science occupies too important a place in the civil world, not to deal with what is happening. Brioschi [who delivered the letter *brevi manu*] will be able to explain to you verbally, better than in writing, the intentions of the government. These intentions, with the exception of the question of the temporal power of the papacy, are very favorable to the clergy.

It is remarkable that Angelo Secchi was at the top of the list of Roman intellectuals whom the Kingdom of Italy immediately wanted to contact. This demonstrated the fame that the scientist, at the age of 52, enjoyed at a national level.

In a written reply, Secchi did not mention directly the university teaching that had been proposed to him but instead expressed concern about the dissolution of the teaching staff of the Roman College and about the future of the school run by the Jesuits. In fact, from September 20, some Piedmont military troops had settled in Roman College, reducing the number of rooms available to the religious community. In addition, as he noted in his diary, Secchi wanted to make it clear to the new governors that he had the right to remain in the rooms of the Observatory; the astronomer considered these rooms his own home, having spent much of his personal patrimony for the construction of the new Observatory location and in the purchasing of the new instruments (Castellani 1944: 42–43).

We know that, thanks to the help of many Italian astronomers who were good friends of Secchi, particularly Pietro Tacchini (1838–1905) from Palermo, a provisional solution was later reached: in 1873, when the buildings of the Roman College were definitively expropriated by the Italian Government, Secchi was able to maintain his quarters at the Observatory and obtained independent access for himself and his collaborators through a separate entrance.

The governmental reorganization of the Italian Astronomical Observatories enacted by the Bonghi decree in 1876 granted a special status to the Observatory of the Roman College. However, until his death Secchi had to face the major problem of financing his astronomical research. In fact, the Holy See was no longer willing to invest in a scientific institution for fear of losing it at any time, as had already occurred for many other institutes and buildings in Rome, while the Italian government did not support the Observatory because it was not a part of its scientific or academic system.

Returning to the events of 1870, during the month of October, the Italian government asked Secchi several times to accept the university teaching position at "La Sapienza," (Fig. 3.1) with a chair that would be associated with the directorship of the Roman College Observatory.

The Jesuit astronomer replied by asking for some guarantees. First, he did not intend to make an oath of fidelity to the new Kingdom of Italy, because he feared that it would have had consequences for his condition as a religious faithful to the Pope and, in addition, he did not approve of many of the aspects of the new government's activities in Rome. Second, he asked to be free to follow his duties toward the Society of Jesus and the Pope. Third, he asked to be free to choose his collaborators for the scientific studies carried out at the Observatory. Cantoni reassured Secchi by writing to him on October 18 (Castellani 1944: 43):

Fig. 3.1 Courtyard of the *Palazzo della Sapienza*, where the University of Rome was located until 1935. (From: Wikipedia)

> On behalf of the Minister, I renew my confirmation that you will not have to take any oath and that you will be treated as the other astronomy professors and directors of top ranked observatories on the Italian territory… Please write to me, directly and in all confidence, everything that seems useful to you for your studies, in order to unify as soon as possible the Jesuits' expectations and those of the government. We are much more favorable and conciliatory than you might think.

As we can notice, the tone of the letter is heartfelt: Cantoni wants to do everything to gain Secchi's affirmative answer.

On November 2, 1870, during a personal interview, Senator Brioschi renewed his invitation to Secchi: "Go and answer me in writing if you want to give lessons to 'La Sapienza' on your beautiful discoveries" were Brioschi's words recorded in Secchi's diary. We know from this same diary that, during this interview, the Jesuit priest verbally accepted the appointment as Professor of Astronomy at the university, indicating also that the title of the chair would be "Physical Astronomy." This was quite a significant title, for it was precisely through spectroscopy and solar physics in those years that Secchi had introduced the application of physics and chemistry to astronomy and thus laid the foundations of modern astrophysics.

Brioschi promised Secchi that the Jesuits could direct a private and free school in the Roman College, just as the Italian government had allowed the Scolopians to do in Florence. As Secchi records again in his diary, Brioschi would not specify any details about the new legal arrangement for the Jesuit school, notwithstanding the fact that the Jesuit astronomer repeatedly insisted on having more information (APUG 1870: II, 32–35) (Fig. 3.1).

In those days, Secchi was arranging a trip to Sicily as an invited member of the Italian expedition to observe the December 22 solar total eclipse. After consulting his religious superiors once again, on November 4 (1 day before leaving for Palermo), Secchi accepted the appointment, writing a short note to Brioschi. In that same written note, he refines the chair's title specifying "Physical Astronomy and Meteorology," since a general chair of "Astronomy" already existed at the university. Angelo Secchi's formal nomination was published in the *Gazzetta Ufficiale* of the Italian government on November 13, 1870, less than 2 months after the Jesuit scientist was first proposed for this position.

However, in those same hours something unexpected happened. A letter dated November 3, sent by Brioschi to the Rector of the Roman College, reveals the reasons why the senator did not want to give Secchi any details in his previous interview on how the Jesuits would maintain their freedom of teaching. Brioschi now officially informed the Jesuits that the freedom of teaching in the Roman College would be guaranteed only for theological disciplines taught to clerics and members of the former Pontifical State. Otherwise, the Italian state would not recognize the degrees obtained by Italian students in all other curricula at this school. In short, the degrees conferred by the Roman College would no longer have been of any value for admittance to schools of higher education and universities in the Kingdom of Italy nor would their degrees have been valid for employment in the Italian State.

When the Rector of the Roman College received this letter, Secchi was already on his way to Naples, en route to Palermo. A few days later, his Jesuit confreres in Rome informed Secchi by letter about the recent government decisions, that degrees from Jesuit and Catholic schools in Rome would not be acknowledged and that their freedom of teaching was to be significantly restricted.

On November 16, while the Jesuit astronomer was in Sicily, the question of his appointment to the Chair of Physical Astronomy at the University "La Sapienza" was commented on during a meeting between Pope Pius IX and the Jesuit General Superior Fr. Peter Beckx (1795–1887). Pius IX expressed strong reservations about

this nomination, as numerous controversies still existed between the papacy and the Kingdom of Italy.

Soon after his interview with the Pope, the Jesuit Father General immediately wrote to Secchi in Sicily. Beckx did not ask Secchi to give up his chair but to obtain more clarification from the Italian government about the ways in which his loyalty to the Pope and the Society of Jesus would be respected as a professor in a state university. Secchi replied to Beckx that he would ask the Italian government for further guarantees, including that the Jesuit community of the Roman College would be respected in its own buildings. At the same time, with great humility, Secchi affirmed that if his Jesuit superiors were to ask him to renounce the chair, he would do so. Moreover, if he could no longer direct the Observatory as a consequence of that, he was ready to leave Rome to be assigned to another role.

It is easy to imagine the inner feelings and suffering of Angelo Secchi, after more than 20 years of scientific activity at the Observatory and many internationally recognized achievements. As a Jesuit he wanted to obey his superiors, and not oppose the Pope's will.

In the following days, two important events took place that had a crucial influence on Secchi's final decision.

The first concerned the dismissal of the Jesuit schools, decreed in Rome by the Italian government: the official motivation was so that the members of this religious order would not warn the families of their pupils about the loss of the legal value of their school degrees. Only a month later, on December 3, the new government inaugurated a new high school in those same buildings, entitled to Ennio Quirino Visconti (a school still active today), entrusting it to lay teachers.

The second episode concerned the speech *Science and Freedom* delivered by the jurist Emidio Pacifici-Mazzoni (1834–1880) on November 20, 1870 at the University "La Sapienza" for the opening the new academic year. Various professors who were faculty members, thanks to their previous papal nomination, judged that speech as an indirect attack on the Pope, as the Catholic Church was accused of having maintained an obscurantist attitude toward science. The Jesuit Fr. Johann Bollig (1821–1895), distinguished Professor of Oriental Languages, directly informed Secchi about the contents of this speech (Castellani 1944: 174) in a letter written on November 21.

In light of these events, Angelo Secchi drafted a letter addressed to Senator Brioschi from Palermo, dated November 25, formally renouncing the appointment of Professor of the Chair of Physical Astronomy. As Secchi himself asked, the letter was first read privately by the General Superior Fr. Beckx and then shown to Pope Pius IX, on November 29. Soon after, the letter was sealed and delivered to Francesco Brioschi.

In this letter, the Jesuit astronomer wrote (Castellani 1944: 175):

> However, I must inform you that when I accepted this prestigious position, before the official decree [of appointment] was published, the circumstances were very different from the present ones. The favorable disposition that V. S. [Your Lordship] assured me towards our schools of the Roman College was such that it induced me to accept, and my superiors not to oppose, hoping that a mutual agreement could be beneficial to our youth. Now things

> have changed a lot: the events that took place in Rome, both at the College and at the University, and the general course of affairs, require me to be more cautious. I therefore ask V.S. to accept my resignation from the above-mentioned prominent position.

Answering Secchi on December 5, from Rome, Brioschi expressed his displeasure and astonishment, hoping that the Jesuit astronomer would change his mind and withdraw his resignation. After receiving the letter from Brioschi, Secchi sent a new longer and more detailed letter, dated December 1870, from Augusta, where he was testing instruments for the eclipse observation. In this letter, both significant for its clarity and the free expression of his conscience, the astronomer blames the Italian government for the anti-Catholic criticism promoted in Rome, for the injustices suffered by the Jesuits and other religious orders, and for the ambiguous conduct that, in his opinion, the authorities of the new Italian government had toward him. Here are some passages from this second letter, reported, like the previous ones, from the archive material published by Castellani (1944: 177–179):

> The contents of the opening speech at the University were such that they could not be tolerated by all ears. How could one applaud an inauguration that insulted the religion of the country? … How could I become part of this University especially after the dissolution of the colleges, which in a certain way degraded me after 18 years that I was part of it? The hope that Rome would be respected and governed by particular laws compatible with the majesty of the Pontiff, has now vanished, and I retire into my nothingness. I am always ready to serve my country wherever my gratitude and feelings were not compromised, but I cannot take part in its favors.

A few years later, in 1876, priest and scientist Francesco Faà di Bruno had to undergo similar circumstances. Aware of Secchi's renunciation of the chair and having to decide whether or not to continue his career as a professor at the University of Turin, Faà di Bruno wrote to the Jesuit astronomer for advice. Secchi exhorted Faà di Bruno to continue his academic work at the university, explaining to him that the present situation in Turin was different from the one that he had faced years earlier in Rome:

> You are already an old member of the University—Secchi writes on October 22, 1876—and you do not join it in a time of [political] crisis. Thank God that, even if there are people who have a too liberal mentality, the University of Turin has not perpetrated those scandals that the University of Rome instead had done. Here in Rome it was not decent for a Catholic and a priest to stay at the University: so it happened for me and for this reason I resigned. (Palazzini 1980: 23)

Angelo Secchi continued to be Director of the Observatory of the Roman College until his death on February 26, 1878. His expected successor in the direction, the Jesuit Fr. Gaspare Stanislao Ferrari, was not appointed by the Italian government; instead, in 1879, the rooms of the Observatory, like the entire building of the Roman College, were confiscated by the Kingdom of Italy. Pietro Tacchini was called upon to establish the Central Bureau of Meteorology there, and he took over Secchi's observatory (which also had valuable meteorological instruments) in order to continue its astronomical activities. Tacchini also held the Chair of Astronomy and Physics at the University "La Sapienza" that Secchi had renounced.

In 1891, by the *motu proprio Ut mysticam*, Pope Leo XIII officially established a new Vatican Observatory located in the Tower of the Winds in the Vatican Gardens, where the Barnabite Fr. Francesco Denza (1834–1894) installed various instruments (Chinnici 2018). Today the Vatican Observatory headquarters is at Albano Laziale, after being at Castel Gandolfo.

3.4 The Intellectual Context of Nineteenth Century for Science and Religion

Like other priest-scientists who worked during the eighteenth and nineteenth centuries, Angelo Secchi did not work out a systematic relationship between science and faith. However, his epistemological and philosophical views can be deduced from the considerations he presented in the last pages of some of his works, in particular in the concluding chapters of *L'unità delle forze fisiche, Saggio di filosofia naturale* (1864) and of the book *Le stelle, Saggio di astronomia siderale* (1877). The appendix of the posthumously published edition of *Lezioni di Fisica terrestre* (1879) contains the texts of two popular lectures presented in 1876 and 1877 at the Accademia Tiberina, which deal with some interdisciplinary issues. References to the Christian faith are present in other unpublished talks and, above all, in his letters. Due to the fragmented nature of the material available, a complete reconstruction of his thinking on the subject has so far been difficult. However, the existing material is sufficient to have an idea of his thought.

It is helpful to associate Secchi with two other important contemporary Italian priest-scientists, Antonio Stoppani and Francesco Faà di Bruno. Secchi shared with the geologist Stoppani the conviction that a better knowledge of scientific thought would benefit the education of the clergy and that a better approach to relevant biblical or dogmatic issues would be possible only through knowing in depth what science says and how it says it. Like the mathematician Faà di Bruno, Secchi too had a vision of science as a service. They both saw science as a way for promoting humanity, and they thought that scientific popularization should be provided to all social classes. All three authors agreed that scientific research should not be seen as an obstacle to faith but rather as an adventure of knowledge, capable of fostering a deeper understanding of theology and better biblical exegesis.

This same perspective had been adopted centuries earlier by Thomas Aquinas, in the spirit of Medieval universities, as shown by his belief, presented in *Summa contra gentiles,* that a better knowledge of nature leads to a less imperfect knowledge of God (Book II, nos. 2–4). Between the eighteenth and nineteenth centuries, however, the idea that science could play a positive role in theological research remained in the shadows. As a result of the hesitations shown in the transition from the geocentric to the heliocentric system, some clergymen mistakenly viewed the rapid progress of science in contrast to the philosophical-religious framework prevailing in their epoch.

Like Stoppani and Faà di Bruno, Angelo Secchi is part of the tradition of a Catholic Church that promoted science. For much of the nineteenth century this still represented the majority viewpoint, due to the widespread work in school and university education that several religious orders, Jesuits and Barnabites in particular, had undertaken over time. As mentioned above, at that time the involvement of the Catholic Church in astronomy was quite evident, but it was also significantly involved in the fields of mathematics, physics, meteorology, botany, and biology.

It should not be forgotten that at the time of Angelo Secchi the debate between scientific thought and Catholic theology was certainly being influenced by positions that were on opposite political sides: on one side, the temporal power of papacy and, on the other, a good part of Italian and European intellectual culture. This contrast, whose primary characteristic was the opposition of views on the mission of the Catholic Church and its relationship with the secular power of the papacy in Rome, was carried through into an opposition between a religious and a scientific worldview. The contrast was read ultimately in terms of a conflict between faith and reason, something that should have been dealt with within a more appropriate epistemological framework and deeper than what the political circumstances of a specific country could dictate.

In Italy, for instance, the nineteenth century reading of the Galileo affair saw it as a radical opposition between him and the ecclesiastical authorities. This interpretation was a way in which the Freemason ruling class of the new Kingdom of Italy could strengthen its status after regaining its capital in Rome via the fall of the Pontifical States. Political reasons also conditioned the academic life of some Catholics in France and Italy, as is shown by some of the vicissitudes experienced by Pierre Duhem and Francesco Faà di Bruno.

On a philosophical level, the years in which Angelo Secchi lived and worked were characterized by currents of thought that were critical toward Christianity. The greatest of these currents was undoubtedly the progressive rise of materialism in Germany and (also partly) in France. In the second half of the eighteenth century, the widely read *Système de la nature* (1770) by Paul Heinrich Dietrich von Holbach had stated that everything that did not belong to phenomena studied by science should be considered pure imagination. In the same years, in his work *De la Nature* (1761), Jean-Baptiste Robinet expressed the idea of a progressive evolution of nature as a succession of increasingly complex and sophisticated mechanisms, having at the top the human being whose psychic faculties and individual freedom were only the mere result of physico-mechanical processes alone.

The idea of a "naturalistic materialism" was thus well established. Its main components were, on the one hand, the historicism coming from Hegelian philosophy and, on the other hand, the anticipation of a philosophical evolutionism. The latter proposed a wholly materialistic reading of the place occupied by the human being within the animal world, denying any transcendent causality in the origin of man, something well beyond Charles Darwin's (1809–1882) intentions. Naturalistic materialism had a strong anti-spiritualist perspective, seeking support specifically in the results of science. It is difficult to establish whether it was a truly majority

current in European scientific circles, but its representatives undoubtedly enjoyed considerable popularity.

It is not surprising, therefore, that the criticism of materialism was passionate and widespread when Secchi discussed the subject of faith and science, forming the backdrop to almost all of his reflections. With regard to materialism and its interpretations, it is worth mentioning the peculiar reading that Fredrich Engels (1820–1895) gave of Secchi's work *L'unità delle forze fisiche* (1864, second edition 1874). Engels believed that Secchi's vision demonstrated the plausibility of the idea of an eternal and self-sufficient nature, the basis of nature's dialectical materialism. It is true that starting from the equivalence between mechanical energy and caloric energy, and observing the close correspondence between chemistry and light radiation, Secchi had affirmed the reducibility of radiation and electricity to motion. Likewise, in Secchi's opinion, the atomic structure of matter, based on attractive and repulsive interactions, showed that every form of energy could be reduced to motion. He writes in the Preface of his first edition (Secchi 1864: 9):

> The great discovery that currently concerns all men of science, and illustrates our time, is the mechanical theory of heat, for which this agent is reduced to a simple mode of movement. The purpose of this work is to present the basis of this theory and to extend its applications to imponderable forces [light and magnetism] and to all other physical forces.

Secchi's program of proposing a unified theory of motion that included all physical forces is seen by Engels as a theoretical framework able to justify that the energies of matter are, by themselves, forces capable of sustaining the physical cosmos and determining its evolution in time. In Engels' *Dialectic of Nature* Angelo Secchi earns 11 different citations; among scientists, only Darwin, Newton, and von Helmholtz are cited more often. Engels quotes Secchi more frequently than Galileo.

The German philosopher mistakenly believed that he could attribute to Secchi the idea of the indestructibility of motion and matter, thus affirming the eternal dialectical cycle of nature. The epistemological correctness with which Secchi does not mix the transcendent First Cause with the secondary causes, and does not invoke any mechanical interventions by God Creator to allow the universe to function, is taken instead by Engels as a confirmation of the irrelevance of the hypothesis of "God" and, therefore, a proof of his nonexistence. Engels joked about this (Engels 1967: 214–215):

> God is nowhere treated worse than in the pages of scientists who believe in him... Father Secchi bows Him [the Creator] out of the solar system altogether, with all canonical honours it is true, but nonetheless categorically for all that, and he only allows Him a creative act as regards the primordial nebula.

Actually, Secchi is very clear on this point: reducing the whole structure and energy of the cosmos down to motion does not mean that matter is sufficient, by itself, to understand the physical universe. When matter is separated from intelligence and intentionality, from a principle of creation, then it remains insufficient in itself. The reference to a Creator, which Engels considers only a useless appendix, is instead for Secchi something substantial, the ultimate reason for the understanding of the cosmos, and the origin of all things.

Secchi's reflections are part of that tradition of natural theology that developed mainly in the eighteenth century but without succumbing to the temptations of concordism and Physico-theology. Secchi's path is that of a spontaneous philosophy. From the observation of nature one can deduce the existence of the Creator: as the cause that has drawn all things from nothing, giving them being, but also as Intelligence responsible for the existence and coordination of the laws of nature. If it is true that in the universe everything depends on matter and motion, it is also true that matter and motion do not have the ultimate cause for their being and behaving in themselves. Secchi affirms that God's creative act is continuous and transcendent. It is not limited to calling things into existence; creation and conservation in being are the same act. The causality of God the Creator transcends the level of natural causes, but makes those causes possible, just as an artist transcends the level of mechanical causes that give rise to his work, a work, however, also present in his mind (Secchi 1874: vol. 2, 369–380).

We know that Secchi's scientific vision, based on a physics that was progressively understanding the structure and forces of matter, caused incomprehension amongst those ecclesiastics who were not familiar with science. Secchi was charged with atheism for his use of the atomic theory of elements (Chinnici 2019: 262-267). A pamphlet authored by some traditionalist Catholics asked the Fathers of Vatican Council I to close the Observatory of the Roman College, because they thought it was a place dangerously prone to atheism (Altamore and Lay 2012: 291).

From 1870 onwards, this incomprehension became more acute. Secchi was challenged from opposite fronts: on the one hand, some Roman clergymen considered Secchi a sort of betrayer, a collaborator with the Italian government, and a supporter of modernism; on the other, anticlerical representatives of the scientific environment categorized him as a "retrograde priest." Moreover, some politicians praised Secchi as a free thinker, as Giovanni Bovio (1837–1903) did, who in a public speech to the Chamber in January 1877 presented Secchi as an example of autonomy from religious authority.

The Jesuit astronomer had to clarify his position. Writing a clear letter to the *Osservatore Romano's* director, he reaffirmed his fidelity to the Church (Viganò 1979: 451). In his reply to Bovio, we read:

> While some see in my writings incredulity and atheism, others see exalted, instead, a theology that falsifies physics to support the Bible... Some complain of not finding in my writings the discoveries they were waiting for; others do not find there the physics of Thomas Aquinas. To the latter complainants I will only say that physics certainly has progressed since Aquinas, and that if St. Thomas lived in our time he would not have adopted the physics he adopted at his time, but would have taken the one now in use in the schools of our time... However, notwithstanding its progress, science has not succeeded in denying God; those who hoped that science would come to affirm this that have not achieved such a result, nor will their successors ever achieve it (APUG 1877: 23, I, 5).

From Secchi's letters we know that he also confided to Giovanni Virginio Schiaparelli, a Catholic scientist and director of the Brera Observatory, some of the misunderstandings he was experiencing (Buffoni et al. 1991) (Fig. 3.2).

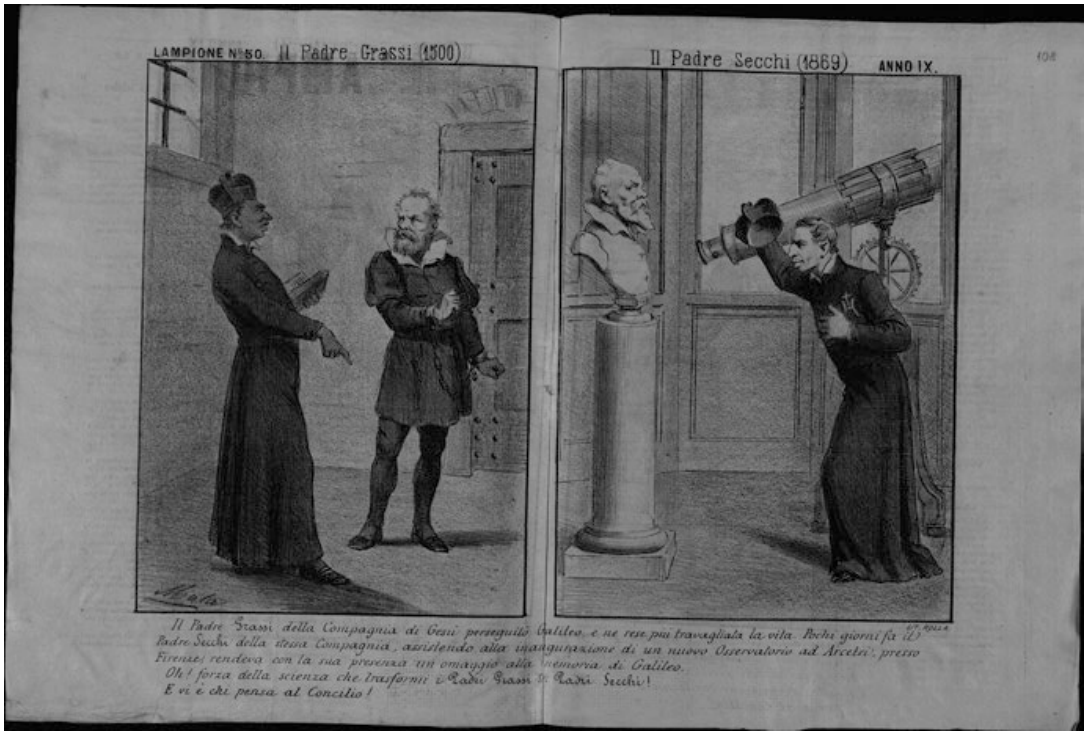

Fig. 3.2 Satirical vignette comparing Secchi, Grassi and Galileo: "Father Grassi from the Society of Jesus persecuted Galileo and rendered much troubled his life. A few days ago, Father Secchi from the same Society, by attending the inauguration of a new observatory at Arcetri, near Florence, with his presence rendered a tribute to the memory of Galileo. Oh, what a force in science which transforms Father Grassi into Father Secchi! And there are those who think about the Council!. (From: *Il Lampione,* 1869, no. 50; courtesy of Biblioteca di Storia Moderna e Contemporanea, Rome)

3.5 Secchi's Views on Christian Faith and Scientific Research

During the years in which Secchi directed the Observatory of the Roman College, a lively debate was emerging in Europe about the evolutionary vision of life and the origin of the human being, following the works published by Charles Darwin. Secchi does not tackle explicitly the issue of the origin of man, but he offers a view on the confrontation between creation and evolution. As in other issues, he underlines the insufficiency of matter to explain the phenomenology of living beings, especially that of human thought and freedom. It is not because of an anthropomorphic projection that we place thought and intelligence at the origin of all things, he says; we do so because, thanks to our experimental knowledge, we are aware of matter and its properties and we recognize they are inadequate to provide a complete and exhaustive explanation of reality and of its ultimate causes (Secchi 1879: 202).

> The idea of subsequent transformations, taken with due moderation, is not irreconcilable with reason, nor with religion. In fact, if one does not want everything to be caused by the brute innate forces of matter, but admits that these forces derive from a First Cause who

> created matter, and endowed matter with the power to produce certain effects, there is no difficulty in believing that, as long as no new force intervenes, certain organisms can develop in one way rather than another, and thus give rise to different beings. But when you pass from a series of living beings to another series of living beings which contains a new principle, then things change. From the vegetable, without sensitivity, the animal which possesses sensations cannot be produced: we need here a new power that cannot come from self-organization, nor from matter alone. And much more must be said when one passes from the brute animal to the human being who thinks, reflects and has a conscience. A new principle must then be associated with the physical forces of matter to achieve these results. (Secchi 1879: 199)
>
> The observation of matter, and above all of the phenomenon of the human being, leads the Jesuit astronomer to conclude that at the origin and in the foundation of the world there is an immaterial Principle with which he associates the name of God (cf. Secchi 1874: vol. 2, 363–364).

Writing a few years after the publication of Darwin's *The Origin of Species* (1859), Secchi argued that such a Creator Principle could embrace from eternity with a single glance the succession of biological forms and their development from the simplest to the most complex ones, ensuring that the laws of physics were in harmony with what life would need. He proposes the image of a parametric function in which the same mathematical form, here compared to the Creator's sight, is able over time to gradually give rise to different forms of life through a variation of the parameters, thus producing different effects, but all foreseen by that mathematical function. Secchi says that recognizing that all morphologies and their development are contained in, and intended by, the same creative intelligence—the mathematical function that transcends the order of nature, according to the proposed image—should reassure those who fear that Darwinian ideas would have negative consequences on faith (Secchi 1874: vol. 2, 359–360).

Meanwhile, the progress of geology that had dated the Earth's formation and the origin of life far back in time had led to criticism of the content of Sacred Scripture on two fronts. The first was that natural history now argued for a much longer timeframe than that which a naïve and literal reading of the biblical texts on creation would have imagined. The second concerned the origin of animal species and the origin of the human being, themes on which biblical teaching was hastily placed in conflict with the Darwinian theory of biological evolution. Secchi did not hesitate to defend the truth of Scripture. However, avoiding its literal reading, he tried to frame its teachings within the results of the sciences, without embarking on an approximate theology.

In those same years, a number of apologetic writings were authored by certain religious people who were committed to countering the danger of atheism, which they believed were inherent in the new scientific theories. While praising the good intentions of these authors, Secchi also indicated the scientific errors they made. According to the Jesuit astronomer, the starting point for this discussion should not be questions of principle, which are inevitably subjective, but on experimental data.

Here we find an approach very similar to that followed by Antonio Stoppani, who among his "maxims for the Catholic apologist" had placed in first place "fighting

science with science." With this motto, Stoppani meant that when some assertions arise within a scientific context that seem to contradict truths of faith, then, first of all, one must confirm whether there are scientific reasons capable of clarifying or denying those same assertions. It is not by turning to Scripture or theology that the meaning and scope of scientific statements should be clarified but, logically, in turning to science itself. Similarly, when the scientific results are clear and confirmed, the sacred Scriptures must be read accordingly (Stoppani 1884: 117–150).

A text from *Le stelle, Saggio di astronomia siderale*, reflects the same approach followed by Antonio Stoppani. In the face of the discovery of the great dimensions of the cosmos, which were becoming progressively more accessible by telescopic observations, Secchi argued that the vastness of space should not be denied on the basis of some superficial understanding of the Bible:

> The greatness of creation is one of those ideas that frightens the small human mind. When it was first announced that, once the barriers of space, imagined as a material sphere, had been broken, and the stars recognized as so many suns, the mind was astonished by the vastness of the universe, by the enormous quantity of celestial bodies of which it was now made up. The human mind almost tried to escape these consequences, hiding behind misinterpreted sacred words! Don't be surprised by the long history of the past times, because the broadening of the horizons of time today also renews what once amazed us with the vastness of space. It is hard to believe the myriad of centuries that must have crossed our globe to complete the geological formations that we touch with our hands. If we are convinced that the work of the Creator is commensurable only to Him, then one thing [space] will help us to understand the other [time]. It is a greatness that we will always be unable to understand entirely, the immensity of space and duration that we observe, and even more in the absolute infinity and eternity. (Secchi 1877: 288)

As evidence of Secchi's open-mindedness to cosmological issues, we should also mention his position regarding the possibility of life in the cosmos. As known, contemporary interdisciplinary literature on extraterrestrial life is very broad (see, for instance, Impey et al. 2012; Thaphagan 2015; Peters 2018). Although susceptible to different religious and philosophical views, in the Modern epoch, extraterrestrial life had been set in highly critical terms for the Christian faith by Thomas Paine in his influential work *The Age of Reason* (1794). Between the late eighteenth and early nineteenth centuries, theology had not developed specific positions in this regard. Astronomers who were also believers, William Herschel (1738–1822) for instance, endorsed the hypothesis that life was widespread in the universe. Secchi touched on the subject soberly but in a sufficiently clear manner, probably influencing Schiaparelli, also a Catholic, who a few years later would write a popular essay on the subject (Schiaparelli 1988). Francesco Denza, a Barnabite and eventually director of the Vatican Observatory, shared the same position. Secchi writes in his book (Fig. 3.3) *Lezioni elementari di fisica terrestre*:

> Creation, which the astronomer contemplates, is not a simple mass of luminous matter: it is a prodigious organism in which, where the burning of matter ceases, life begins. Although life is not observable with our telescopes, from the analogy of our globe we can argue its general existence in other celestial bodies. The atmospheric constitution of the other planets, which in some ways is similar to ours, and the structure and composition of the stars similar to that of our sun, persuade us that these bodies are in a stage similar to those present

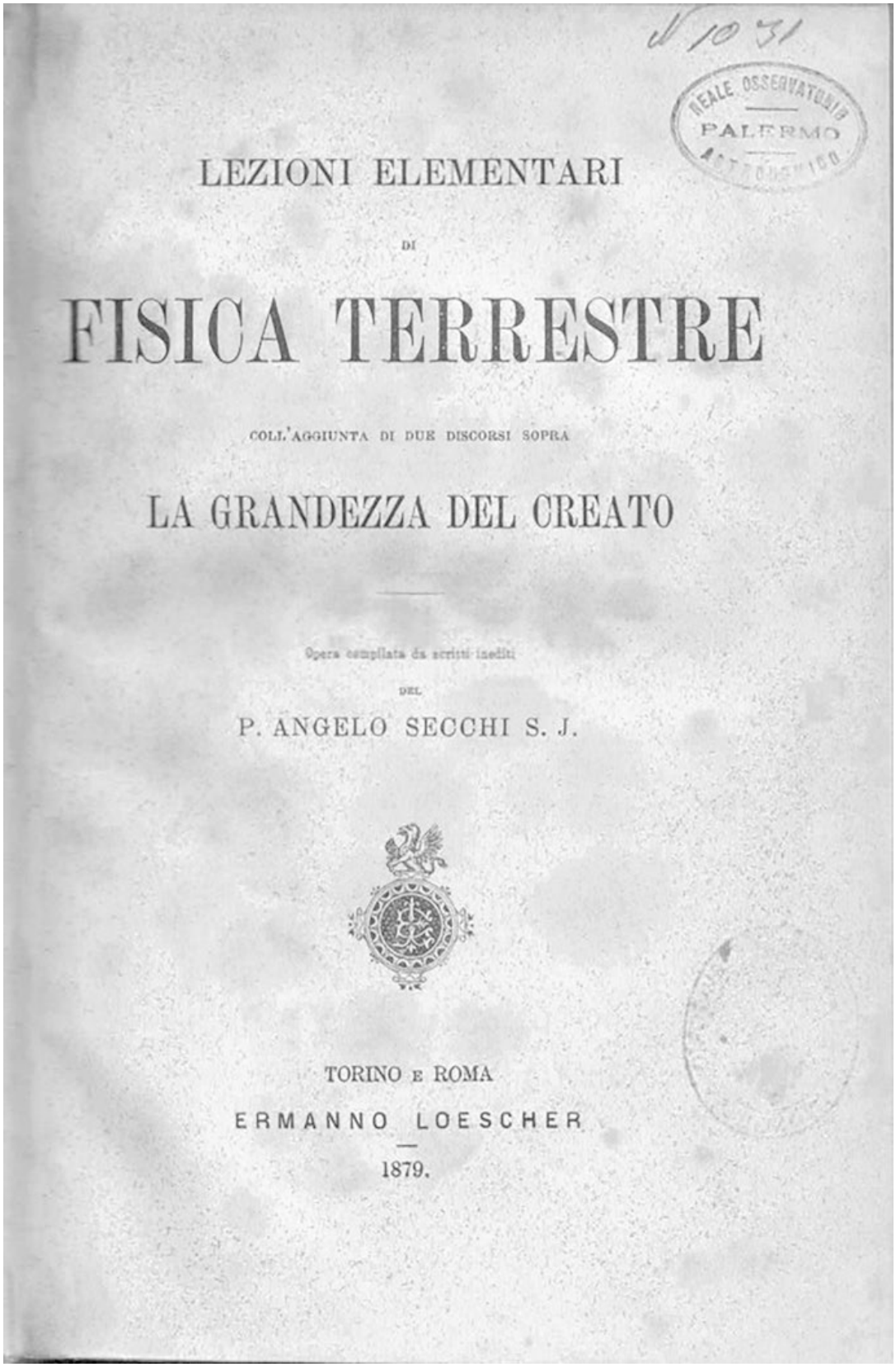

Fig. 3.3 Title page of Secchi's treatise *Lezioni di Fisica Terrestre.* (Courtesy of INAF-OAPa)

> in our solar system, or are in one of the periods already crossed by it, or to be crossed in the future. From the immense variety of creatures that were on our planet, and now are present on it, we can argue the diversity of life forms that may exist in other planets. If on the Earth the air, water and land are populated by so many varieties of living beings, which changed over time with the changing circumstances of both climate and matter, how many more forms of life can be found in many other systems. And all this, bearing in mind that in various stellar systems the planets are illuminated not by one, but by more than one sun, and the climatic variations are really extreme, both due to the eccentricity of their orbits, and the different intensities of the star radiations…. (Secchi 1879: 214–215)

It is interesting to note that the Jesuit astronomer does not hesitate to hypothesize on the possibility of forms of life also very different from what chemistry and terrestrial biology would suggest, proposing ideas that seem to anticipate some visions of contemporary exobiology :

> It is true that life on our planet cannot exist except within very limited temperature ranges; however, who can know if these are limits only for our organisms? However, even with these limits, if life could not exist in the luminous [stellar] bodies, in the global project of creation these stars would always have the great task of supplying energy, regulating the course of the smaller bodies, through the attraction of their masses, and providing light and heat... Life permeates the universe, and intelligence must be associated with life; just as we have many beings inferior to us, then, in other conditions, many other living beings can exist and have much greater capacities than ours. Between the weak light of the divine ray that shines in that fragile compound that we are, thanks to which we are able to know so many wonders, and the wisdom of the Author of all things, there is an infinite distance. This distance could be covered by the infinite degrees of His creatures. Our mathematical theorems, fruit of arduous studies, could be just simple intuitions for creatures far superior to us. (Secchi 1879: 215–216)

3.6 Concluding Remarks: The Religious and Humanistic Dimension of Science

For Secchi, scientific work leads to humility and contemplation. As a believer, he often associates scientific activity with prayer. Here we find a perspective similar to Robert Boyle (1627–1691), as it emerges, for example, from the pages of his *The Christian Virtuoso* (1690). For both Boyle and Secchi, the wonder that science arouses is destined to grow with time. In the book presenting the results of his spectroscopic studies, Secchi writes: “We are not yet at the end of the wonders: we will be at the end only when we cease to study” (Secchi 1877: 312). Faith and science, affirms the Jesuit astronomer on the occasion of the inauguration of the new Observatory of the Roman College, “are rays of the same Sun directed to illuminate our blind and weak minds towards the way of Truth. Without this high purpose, such studies would be a mere curiosity, and would often cause only unrewarded pains and labors. Thinking how magnificent it is to manifest the Creator’s works to others is a stimulus that spurs even when all other enthusiasm is lacking; this raises the mind above the materiality of numbers, and transforms the labors of science into a sublime and divine work” (Secchi 1856: 157; in Maffeo 2012: 40).

Finally, science and faith were closely related in the scientific popularization that Secchi promoted, especially in Rome. Secchi did not hesitate to use the church of St. Ignatius in Rome to repeat the famous Foucault experiment in 1851 (see Chinnici 2019). He went so far as to suggest, with Faà di Bruno in Turin, the use of churches as classrooms for scientific lectures and even as astronomical observatories, for example, to show the general public images of the Moon or projections of the solar disk through a system of mirrors.

Francesco Faà di Bruno tried to involve Secchi in a series of lectures to be held in the Church of Santa Maria del Suffragio in Turin. He wrote to Secchi on December 31, 1873: "Where V. S. Rev. [Yours Reverend Lordship] has nothing against it, I would prefer physical astronomy classes on the sun or the moon, the stars, etc.; I would like to combine them with brilliant experiments, aimed at surprising people there. One could, for example, project stellar spectra and talking about the composition of the stars; one could project the moon in front of the audience... Through the [bell-tower] dome, which has 16 windows, and with some parallactic apparatus, it could be possible with 45° mirrors to bring down the image of the moon on a visible screen before the public" (Palazzini 1980: 12).

This is a small window into the popularization of science in the nineteenth century, little known today, but one that could serve as an example for us even now. For them, knowledge was seen as a right of everyone. Astronomical studies have always been nourished by this enthusiasm—an enthusiasm that, with the passing of the centuries, must never be lost.

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