Chapter 17
The ups and downs (and ups again!) of astrophysics in Italy after Secchi

Simone Bianchi
INAF-Osservatorio Astrofisico di Arcetri
Largo E. Fermi, 5, 50125 Firenze, Italy
(sbianchi@arcetri.astro.it)

Abstract Astrophysics, the study of the constitution and physical state of celestial bodies derived from spectroscopic observations, had its pioneers in Italy with Angelo Secchi and other astronomers. Activity in the 1860s-80s was vigorous, with major achievements represented by Secchi's stellar classification, the monitoring of the solar activity by the *Società degli spettroscopisti italiani*, and the foundation of the first journal dedicated to the new science by Pietro Tacchini. A hiatus followed, caused by a lack of followers to carry on their work and a lack of financial support. A renewed interest emerged in the 1920s, thanks in particular to the influence of the American astrophysicist George Ellery Hale on Giorgio Abetti. Slowly, astrophysical studies grew in importance in Italian observatories and overtook Classical Astronomy in the 1950s-60s. This chapter provides a historical review of this process from the first Italian astrophysicists until modern times.

17.1 Introduction

The Italian astronomical community has always been aware of the role of Secchi and other national pioneers in the birth and development of Astrophysics. This is evident, for example, in a 1939 review of the achievements of Italian astronomers in the previous 100 years, written by the director of Rome Astronomical Observatory, Giuseppe Armellini (1887-1958). At a time when astronomical spectroscopy had become a minor topic in Italy, striving to regain its importance over decades in which most Italian astronomers had been devoted to Classical Astronomy and Geodesy, Armellini (a classical astronomer himself, with interests in theoretical Astrophysics; Masani 1998), could not but stress the Italian contribution to solar and stellar spectroscopy:

> Italian science ... *left a truly magnificent trail in solar astronomy* with the illustrious names of Secchi, Respighi and Riccò ... the start [of daily monitoring of solar prominences] *has to be credited exclusively to Italian astronomy* ... [Concerning stellar astrophysics] we can say, with full historical fairness, that our astronomy has the great pride of having been really at the forefront of this problem, and of having indeed laid the foundations of this chapter of the science of the heavens. In fact, Italy has the merit of having: 1) founded stellar spectroscopy, with Donati; 2) established the spectral types of the stars, with Secchi; 3) inaugurated the use of the best-suited instrument for stellar spectroscopy observations (the objective prism), with Respighi. ... It would be useless to add further considerations, since the facts are obvious. *In the 1860s, Italian scientists created stellar spectroscopy* [...] (Armellini 1939: 469,480,484; original Italian, author's translation).

Looking past the bombastic style, typical of texts written during the Italian fascist regime, one can feel in Armellini's words the urge to establish once again a foothold in a field that, after the initial burst of activity by Secchi and his colleagues, had largely developed elsewhere.

This chapter will follow the varying fortunes of astrophysics in Italy: from the work of the pioneers; to the decline of spectroscopic studies at the turn of the 19th century; through their resurgence around the 1920s, especially thanks to the exchange between George Ellery Hale (1868-1938) and Giorgio Abetti (1882-1982); until the definitive affirmation of astrophysics in modern times.

17.2 The Italian forerunners

The "founder of stellar spectroscopy" (at least according to Armellini 1939), was Giovan Battista Donati (1826-1873), assistant and, as of the end of 1859, director of Florence Observatory. By 1856 Donati thought of using a prism to observe the spectra of stars of different colors, in order to study their effects on scintillation and stellar position but also to compare their dark lines with those observed in the Sun (Galli et al. 2013). Using a single-prism spectroscope attached to a seventeenth-century burning lens, Donati observed the spectra of 15 stars and made a preliminary classification, noting that "the stellar striae have a certain relation to the star's colours. Thus the white stars seem to have a family likeness; and so the yellow, orange and red ones." (Donati 1863: 101).

Donati's article, dated August 1860, lacks any discussion of the physical origin of the "striae". In fact, the astronomer could not have been aware of the concurrent work by Kirchhoff on the identification of the sodium absorption lines in the solar spectrum. When the paper was finally printed (in Italian, French and English, between 1862 and 1863) it encountered wide attention and caused a rush of publications on stellar spectroscopy (Hearnshaw 2014). Among them, there is the 1863 paper by Secchi, the first of the series that eventually led to his classification of stellar spectra in five types (see Chapter 5). In turn, Secchi stimulated the interest of Lorenzo Respighi (1824-1889), director of the Campidoglio Observatory in Rome, in spectroscopic studies. As Armellini (1939) stated, Respighi was the first to use an *objective*

prism, a low-dispersion (small angle) prism in front of a telescope objective. Together with photography, the use of the objective prism proved to be essential in subsequent work on the classification of stellar spectra (for instance, the Henry Draper Catalogue), since it allowed one to analyze several stellar spectra in the telescope's view field. The objective prism was also used by Secchi almost at the same time as Respighi; a bitter dispute on the priority of this invention precluded any collaboration between the two astronomers and, as a consequence, affected collaborations with other fellow spectroscopists (Chinnici & Gasperini 2013).

Besides stars, the early Italian spectroscopists also turned their attention to aurorae, zodiacal light, comets, planets, and, obviously, to the Sun. Donati and Secchi had an interest in solar phenomena even before they made spectroscopic studies: both observed the 1860 solar eclipse from Spain and concluded that the reddish prominences seen at the border of the eclipsed disk were solar, rather than lunar or atmospheric phenomena. After the discovery by Lockyer and Janssen that prominences could be seen even without an eclipse by putting a spectroscope's slit tangential to the solar limb, in 1869 Respighi started the first series of systematic daily observations of the whole limb, the only ones available until 1871 (Armellini 1939).

The solar eclipse of December 22, 1870, whose totality path passed through Sicily, gave further opportunity for the community to grow. A program of observations was set up, including specific spectroscopic studies of the chromosphere, prominences, and corona (Olostro Cirella & Gargano, 2016). The organizing Committee met in September 1869 in Florence, where the attendees participated in the inauguration of the new astronomical Observatory on Arcetri hill (Fig. 17.1). An important role in the organization of the expedition to Sicily was played by Pietro Tacchini (1838-1905), an astronomer at Palermo Observatory. Tacchini had long been in contact by letter with Secchi, thanks to their common interest in observations of solar photospheric features, but he had not yet used a spectroscope by himself. On the day of the eclipse, he collaborated in the spectroscopic observations carried out by another young astronomer, Giuseppe Lorenzoni (1843-1914) from Padua Observatory, who learned how to use the spectroscope specifically for that event.

Fig. 17.1. The inauguration of the Arcetri Observatory on September 26, 1869. Among the participants are A. Secchi (number 4), G. B. Donati (n. 12) and G. Lorenzoni (n. 3). Photographic archive of the Arcetri Astrophysical Observatory, detail (see Bianchi et al. 2013 for the full picture and identification list).

In June 1871, Tacchini proposed to Lorenzoni and Secchi a program of joint spectroscopic observations of the solar limb, to determine the influence of the telescope, weather, and observer on drawings of prominences. The experiment was successful and Secchi suggested the collaboration be extended to other Italian observatories. The scientific program of a daily monitoring of prominences became the basis of the *Società degli Spettroscopisti Italiani*, established in October 1871. Soon after, Tacchini managed to obtain funding to publish the *Memorie della Società degli Spettroscopisti Italiani*, whose first issue appeared in January 1872 and which he edited until his death (Chinnici 2008).

17.3 The *Memorie* as the first astrophysical journal

The program of the *Società* was not as successful as Tacchini and Secchi had hoped because of a lack of participants and the rivalries between astronomers. Only the observatories of Collegio Romano and Palermo (later replaced by Catania) contributed to systematic solar limb drawings; Padua provided drawings only up to 1872, while Respighi never sent the series he had started in 1869. Nevertheless, all available observations were later combined and completed with the contribution of foreign observatories, constituting an invaluable dataset of solar activity over 40 years (Chinnici 2008).

By contrast, the success of the *Memorie* was immediate: Tacchini soon started to receive requests for copies from abroad, and in 1873 the journal was awarded a medal and certificate at the Universal Exhibition in Vienna. Later in 1893, the entire collection of the *Memorie* was on exhibit at the World Congress on Astronomy and Astro-Physics in Chicago. As expected from the objective of the *Società*, the major focus of the *Memorie* was on solar physics, though the journal

also contained articles on other branches of astronomical spectroscopy and, to a lesser extent, on spectroscopic studies unrelated to astronomy. The *Memorie* also accepted papers on non-spectroscopic astronomy and other topics traditionally studied in astronomical observatories, such as meteorology and geodesy. Despite these contributions, for several decades the journal kept its character as a publication mainly dedicated to spectroscopy. Though the main language of the *Memorie* was Italian, a sizeable fraction of papers (about 20%) were from foreign authors, among whom were several of the leading astrophysicists in Europe and America (Chinnici 2008). For these reasons, the *Memorie* can be considered the first international journal devoted to astrophysics (Meadows 1984).

Among the contributors of the *Memorie* was the American astrophysicist George Ellery Hale. In the US, astrophysics was having an enormous development thanks not only to the availability of private funding, but also due to the lack of an established tradition in classical astronomy (and its cultural burden). The rapid advance of Hale's academic career, fostered by his wide-ranging interests, mechanical skills, and entrepreneurial spirit, serve as an example of the possibilities offered to spectroscopists in America (for a biography, see Wright 1966). At the beginning of the 1890s, Hale invented and built the spectroheliograph, an instrument to photograph the Sun in monochromatic light, which he used from his own private observatory. Soon he secured funds for building the Yerkes Observatory of the University of Chicago, to which he was appointed director.

At the same time Hale worked to establish an international scientific journal of astrophysics. During a trip to Europe, Hale searched for support for this new publication among the astrophysicists he encountered. In spring 1894 he visited several Italian members of the *Società* and met Tacchini, who directed the Collegio Romano Observatory following Secchi's death. Hale returned to the US with a promise of cooperation from Tacchini and other prominent spectroscopists. "*The Astrophysical Journal - An international review of spectroscopy and astronomical physics*" started its publication in January 1895. The list of associated editors of the journal included five Americans and five Europeans, Tacchini being among them; eight out of ten were members of the *Società degli Spettroscopisti* (Chinnici 1997, 2008).

The legacy of the "*Società*" and its "*Memorie*" is evident in Hale's activity: "The volumes of the *Memorie* [...] stand in a case near my table and are used almost every day. I have good reasons to know how much I'm indebted to Tacchini, Secchi, Respighi, Lorenzoni and Riccò, not to mention the other members of the Society", he wrote to Tacchini in March 1896. In July 1897 he invited the Italian astronomer to give an informal talk at the incoming inauguration of the Yerkes Observatory, "as a representative of the Italian Society of Spectroscopists", then adding "it seems to us very desirable that the investigations be inaugurated, to some extent at least, under the Society's auspices". But Tacchini could not attend (Chinnici 1997). Hale was later elected as a foreign member of the *"Società",* in 1901.

17.4 The decline of the Italian spectroscopists

Under Tacchini's tireless activity, Italian astrophysics achieved several other successes. A high-altitude observatory was inaugurated on Mount Etna in 1880. This was followed by the foundation of the Catania Observatory, the first astrophysical observatory in Italy. The first permanent chair in astrophysics in the world was established at Catania University in 1890 (Chinnici 2008); it was given to Annibale Riccò (1844-1919), Director of Catania Observatory, who had been a collaborator and later a scientific heir of Tacchini.

Riccò contributed greatly to the monitoring of solar activity. During Hale's visit of 1894, the two of them attempted (in vain) to observe the solar corona outside of an eclipse by using a spectrograph from Mount Etna. Riccò installed the first of such instruments in Italy at Catania in 1908. He succeeded Tacchini as the director of the *Società* and in editing the *"Memorie"* (Abetti 1920).

Nevertheless, spectroscopic studies in Italy rapidly declined. The main reasons were probably the lack of financial means to obtain the newer instruments required by the progress of science and, more importantly, the lack of practitioners: Tacchini and Riccò did not create a school that continued their studies (Chinnici 2008). In 1909, a young Giorgio Abetti claimed Riccò to be "the sole astrophysicist in Italy" (Cristaldi & Mangano, 1997).

Beyond these reasons, Italian participation in two international enterprises may have worked against the development of astrophysics in that country.

The first was the *Carte du Ciel*, an international collaboration to produce a photographic atlas of the sky and its associated high-precision astrometric catalog. The involvement of European astronomy in this long and demanding program is credited for the decline of astrophysics in the whole continent, as compared to the US, where no observatory participated (Lankford 1984). Tacchini enrolled Catania Observatory into the collaboration (Chinnici 2009), probably hoping to obtain additional resources from the Government – it was the only Italian observatory participating in the project – but in fact diverting part of the resources of an astrophysical institute in favor of an activity that was related to classical astronomy.

The second collaboration was the International Latitude Service, a program born from an Italian proposal and intended to study the motion of the Earth's rotation axis. The Service started in 1899 and consisted of six astronomical stations which were required to make daily measurements of the zenithal distances between pairs of stars. The Italian station was installed at Carloforte, in Sardinia, and initially was manned through a turnover of personnel from universities and astronomical observatories (Calledda 2005). Because of a tradition of geodetic studies and the presence of this station in Italy, a considerable fraction of Italian astronomers in the first part of the 20th century devoted themselves to geodetical astronomy (Rosino 1986, Proverbio 1998).

The *Memorie* of this period (particularly, the second series, 1911-1919) reflected these trends, with a reduction of articles on spectroscopy, and an increase of those related to positional astronomy (Chinnici 2008).

17.5 Passing on the spectroscopists' baton: Giorgio Abetti meets George Hale

During his Italian journey in 1894, Hale visited the Arcetri Astronomical Observatory together with Tacchini and its recently appointed director Antonio Abetti (1846-1928). (Most likely, the visit took place on April 29; Tacchini 1894). Both Hale (Abetti 1960) and A. Abetti (1908) retained vivid memories of that meeting. As A. Abetti (1908) recalled, "On that occasion I mentioned my wish to establish astrophysical solar studies here [...] but I have been prevented by lack of means and of a proper staff". Despite these good intentions, Antonio had been trained in classical astronomy and mostly pursued observations of asteroids and comets. Moreover, the directorship of Arcetri Observatory had been left vacant for 20 years after Donati's death, and it had no modern spectroscopic instrument.

It has been said that during this visit in Arcetri, Hale met Giorgio Abetti, the twelve-year-old son of Antonio (Fracastoro 1983), though the event is not mentioned in Giorgio's recollections of his memories and correspondence with the "Maestro" Hale (Abetti 1960). However, Giorgio soon showed an interest in astronomy, helping his father with observations and seeking advice from his father's colleague, Lorenzoni, director of Padua Observatory, where Abetti senior had started his career.

Lorenzoni, after an initial interest in spectroscopy, mainly worked in geodesy and gravimetry. He frequently discussed Giorgio's future with Antonio Abetti, hoping he would pursue a career in more modern fields of astronomy. In 1901, at the start of Giorgio's academic studies, Antonio worried about his son's interest in Galileo and the history of astronomy (which continued for the rest of his life); he commented to Lorenzoni: "I dream of seeing him as an observer, experimenter, alive more than ever among the living in this dizzying race of electricity, photography, spectroscopy (a.t.)". In 1909, when Giorgio was already visiting the US, an aging Lorenzoni wrote not without a touch of melancholia: "Lucky is he who is given the power to acquire with relative ease a heap of practical knowledge, which will allow him to cultivate astrophysics, or better solar physics, with a success worthy of our best local traditions (a.t.)" (Bianchi & Gasperini 2017).

During his studies at Padua University, where he got a degree in physics in 1904, Giorgio Abetti "read with deep admiration and interest about the work Hale was doing in the field of solar physics" (Abetti 1960). In 1905 he wrote Hale to ask if there was any position opening in US observatories "to see the marvellous strides made by the astronomers in the States in Astrophysics". Hale replied that he was aware of none, particularly not at that moment at Mount Wilson in California, the new high-altitude observatory he had established a year earlier (Foderà Serio 2005).

Nevertheless, Abetti managed to achieve his "American dream". On an Italian grant, in July 1908 he arrived at Yerkes Observatory, where he observed solar prominences with a Rumford spectroheliograph, together with the assistant Philip Fox (1878-1944) (Fig. 17.2). These observations were presented in the first astrophysical paper by Abetti (Fox & Abetti 1908), which was published in the "*Memorie*". During his residence at Yerkes, Abetti studied the progress of astrophysics in the US (a couple of reviews of works by Hale were published that year in the "Memorie"). He was particularly impressed by the "Tower telescope" (Abetti called it "Solar Tower"; Abetti 1909), a vertical telescope of large focal length for solar spectroscopic studies, installed at Mount Wilson that year. Even before having seen it in operation, he conceived the idea of building one in Italy, possibly using the funds collected for Secchi Monument (Foderà Serio 2005; see also Chapter 16).

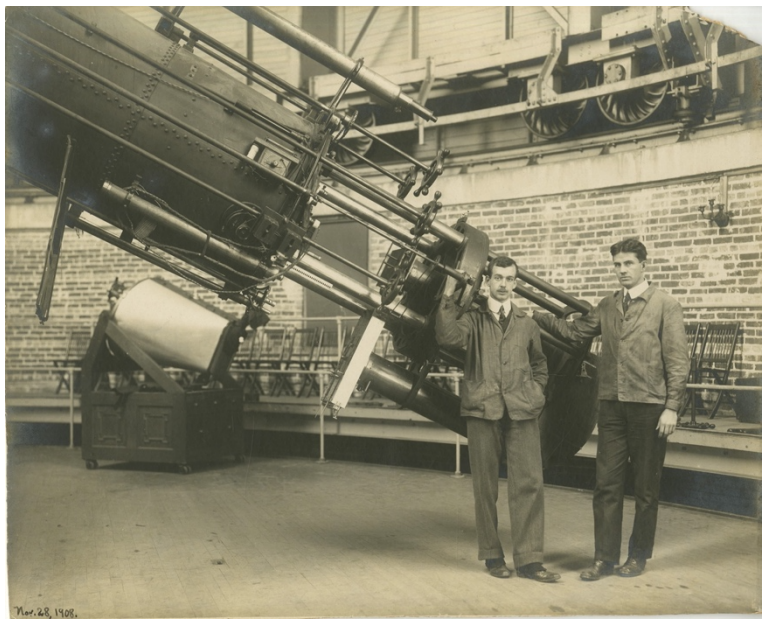

Fig. 17.2. G. Abetti (left) and P. Fox (right), pictured in front of the Rumford spectroheliograph attached to the 40 inches refractor (28/11/1908; courtesy of Northwestern University Archives).

Eager to visit Mount Wilson, Abetti wrote to Hale from Yerkes and, at the end of 1908, received an invitation to that Observatory (Foderà Serio 2005). For the young astronomer "nothing else was required to make him wing-footed. It seemed to him he was reaching Paradise, when immediately after [on January 11, 1909] he was able to accompany Hale" to the mountain (Abetti 1960). Abetti was first assigned to work at the 60-inch reflector, the largest telescope in operation in the world at that time, which had just seen first light. He also studied solar prominences, observed with the spectroheliograph of the Snow horizontal telescope; and monitored the activities at the 60-foot solar tower and the plans for the 150-foot tower (Abetti 1909).

The enthusiasm of the young astronomer working with state-of-the-art instrumentation must have been evident. Just a couple of weeks after Abetti's arrival, Hale wrote to Riccò: “We are enjoying a visit from Dr. Abetti, who seems to me one of the brightest and most promising of all the younger men now at work in astronomy. It is a pleasure to think that the splendid pioneer work of the Italian spectroscopists is to be carried forward by a man of such ability and training" (Hale 1909).

Abetti left Mount Wilson in May 1909. He passed some time in Pasadena at the physics laboratory and workshop of the Observatory; on his way back to Italy, he also visited other institutes, including the Harvard College Observatory, the place where stellar spectral classification was further developed after Secchi’s initial work (Abetti 1909).

Hale, who strongly believed in international cooperation, saw in Abetti's interest in solar towers the possibility of reviving a project for a solar observatory in Italy that he had discussed with Tacchini in 1894. However, plans for an Italian solar tower remained dormant for a while. Abetti took a position as assistant at the Collegio Romano Observatory, complaining that he had to "do much more astrometry than astrophysics" (Foderà Serio 2005).

17.6 The resurgence of Astrophysics at Arcetri

New hope for the development of astrophysics in Italy arose when an Institute of Physics was proposed, to be built on Arcetri hill near the Observatory (Foderà Serio 2005). But the project had to be postponed because of the onset of the First World War. At least the war offered Abetti an opportunity to strengthen his links with the US astrophysical community and Hale: a lieutenant of the Italian Army, he was sent as a military attaché to the Italian Embassy in Washington. At that time, he met with astrophysicists in Chicago and went again to California (Gasperini et al. 2008).

Finally, a decision was made to build a solar tower in Arcetri. In 1919, the Faculty of Science of the Istituto di Studi Superiori (later University) of Florence suggested the transfer of Abetti to Arcetri, because “his studies and the experience acquired with Hale at Mount Wilson and Pasadena ensured that he could give valuable help to [his father] the Director of Arcetri Observatory for installing and using the tower telescope (a.t.)” (Fracastoro 1983: 89). Abetti moved to Arcetri in 1920 and, at the retirement of his father Antonio in 1921, was charged with the direction of the Observatory (later confirmed, in 1925). This new direction was ratified in 1921 when Arcetri became an *Astrophysical* Observatory.

The work on the tower (Fig. 17.3) proceeded slowly. This was in part due to the fact that Abetti completely relied on the technical advice of the far-distant Hale, who practically directed the construction by letter from California (Gasperini et al. 2004). In the meanwhile, the Observatory was being equipped with other instruments for astrophysical observations. A 30-cm reflector with a set of objective prisms was installed in 1921, allowing Abetti to continue his studies in stellar spectroscopy, which he had started at Collegio Romano Observatory with the same instrumentation used by Secchi. Also a direct vision prism began to be used to monitor solar prominences jointly with the Amici refractor, the main telescope of the Observatory (Fracastoro 1983). A year later, at the first meeting of the International Astronomical Union in Rome, Arcetri Observatory was selected to be the collection center for solar observations obtained from other observatories in the world, replacing Catania Observatory in this task. At the second IAU meeting in Cambridge in 1925, it was decided that Arcetri Observatory should publish the drawings of solar limbs “as it was done in the past in the *Memorie degli Spettroscopisti*” (Abetti 1926). Definitely, the *Spettroscopisti*’s baton had been passed on!

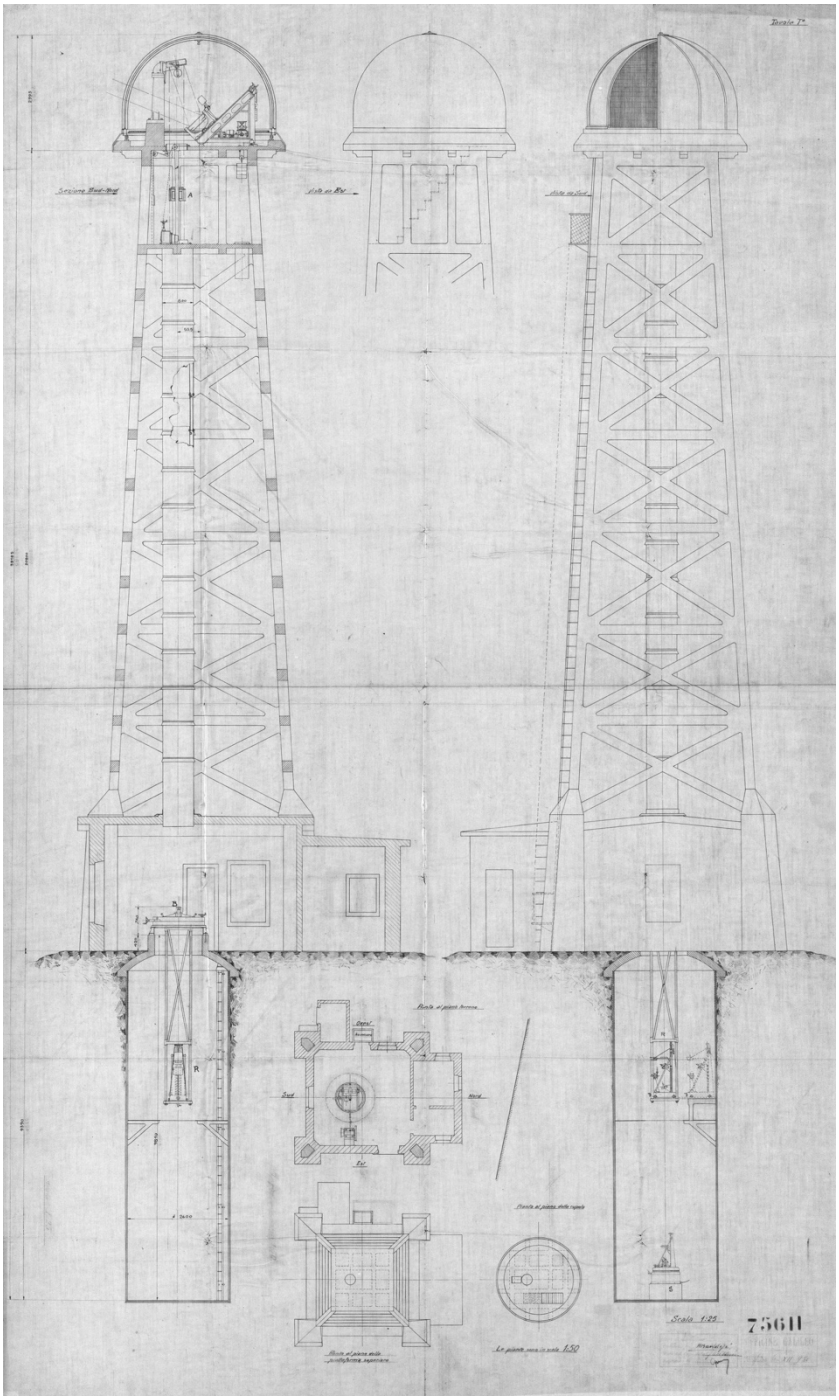

Fig. 17.3. Project of the Arcetri Solar Tower, 6/12/1920 (inverted blue-print; Historical Archive, INAF-Arcetri Astrophysical Observatory).

The building of the solar tower at Arcetri largely benefited from private patronage, one of the reasons for the growth of astrophysics in the US. The major contribution to the budget came from William Ellery Hale Foundation, administering the funds left by George's father. The second contribution was from the industrialist James William Ellsworth (1849-1925), an eccentric American living in Florence, who was interested in Galileo and his instruments preserved in Florence. In May 1923 (Fig. 17.4), Abetti arranged to have Galileo's spyglasses attached to the Amici telescope so that Ellsworth, Hale, and his friend Egyptologist James Henry Breasted (1865-1935) could use them to observe the sky. The further gift of an old watch from the Observatory finally convinced Ellsworth to finance the tower, whose work had been at an impasse due to the rising prices of post-war inflation (Abetti 1960, Gasperini et al. 2004). The solar tower was eventually inaugurated in 1925. Although it was already an aged instrument (essentially, a copy of the one built by Hale in 1908) and located in a place with poor atmospheric and meteorological conditions, the tower was essential to the development of solar physics studies in Italy (Righini 2003).

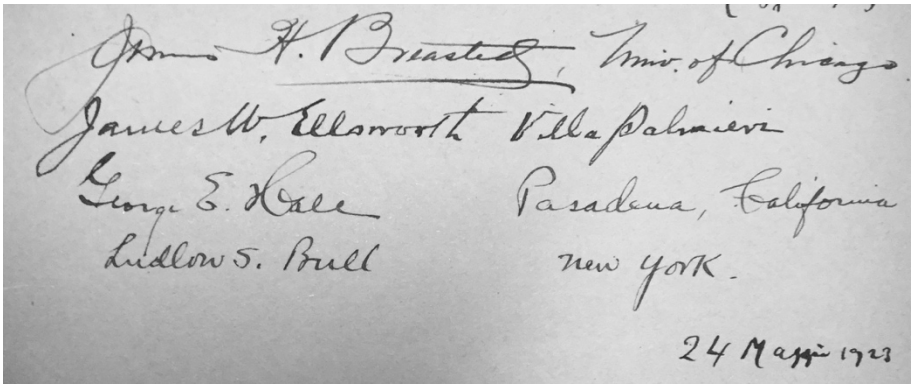

Fig. 17.4. Visitors' album of the Arcetri Observatory, recording the visit on 24/5/1923 of George Ellery Hale, James William Ellsworth and James Henry Breasted (Historical Archive, INAF-Arcetri Astrophysical Observatory).

A major achievement of Abetti's directorship (which lasted until 1952) was the formation of a school of astrophysicists. Limiting the list to the collaborators of Abetti who later became directors of Italian observatories, we can find: Guglielmo Righini (1908-1978), a solar physicist who succeeded Abetti as director of Arcetri; Attilio Colacevich (1906-1953) interested in stellar spectroscopy and optics; Mario Girolamo Fracastoro (1914-1994) and Margherita Hack (1922-2013), stellar spectroscopists; and Mario Rigutti (b. 1926) and Giovanni Godoli (1927-2006), solar physicists (Fracastoro 1983). As late as 1974, five of the nine directors of Italian observatories were from the school of Arcetri (Castellani 2005).

17.7 A renewed interest in Italy

At the beginning of 1920, the *Società degli Spettroscopisti Italiani* was transformed into *Società Astronomica Italiana*. As the new president Vincenzo Cerulli (1859-1927) wrote in the preface of the first volume of the *Memorie della Società Astronomica Italiana*, the renaming resulted from the "Società having once been just a gathering of spectroscopists only, but [now] having extended its activity to all branches of astronomy (a.t.)" (Cerulli 1920). Moreover, there was hope of getting new funding and eventually expanding the Society into public outreach, following the model of other societies abroad. The new *Memorie* was open "to sciences akin to astronomy, such as geodesy, celestial mechanics and radiation physics (a.t.)" but also to the history of astronomy (Cerulli 1920). The change, which transformed what initially was an international journal into an Italian bulletin, does not seem to have met with hostility from the astrophysicists; Hale himself approved it and "was glad to read of the organization of the new Astronomical Society on the solid foundation provided by the *Spettroscopisti*, which played such an important part also in the firm establishment of the science of astrophysics" (Abetti 1960). After the initial few volumes (published erratically), mainly dedicated to critical reviews and theoretical studies, the *Memorie* was opened to observational papers; and beginning with volume 4 (1927-1929) it started to include spectroscopic works, mainly from Arcetri.

Soon another astrophysics center opened: Brera Observatory, directed by Emilio Bianchi (1875-1941). Bianchi could be considered one of renovators of Italian Astronomy, though his role has been overshadowed by Abetti's, probably because of his uncritical support of fascism and the lack of a direct visible contribution to astrophysics (Braccesi 2006). Before becoming director at Brera in 1922, Bianchi had mainly worked in positional astronomy, first at Carloforte, then at the Collegio Romano. In 1926 he obtained a 102-cm Zeiss reflector equipped with a spectrograph for Merate Observatory, a new observational annex located far from the city of Milan where Brera Observatory is located.

Lacking personnel with any background in astrophysics, the instrumentation was first used for the determination of trigonometric and spectroscopic parallaxes, reflecting the Bianchi's interests in positional astronomy. The situation changed in 1934, when young Livio Gratton (1910-1991), fresh from studies abroad, arrived at Merate, and nova DQ Herculis exploded. Spectroscopic studies of this event (and of nova CP Lacertae in 1936) helped to establish an expertise in stellar spectroscopy and atmosphere models in Milan that attracted a new generation of physicists, and lasted until the departure of Gratton for Argentina in 1949 (Rosino 1986, Masani 1998, Braccesi 2005).

The astronomy practiced in other Italian observatories, however, was not as exciting as the latest discoveries in physics. A young, astrophysicist-to-be, Leonida Rosino (1915-1997) remembered a visit to Padua Observatory in 1933, where he was given a boring introduction to the use of the transit instrument. Later at University, he compared the "scientific excitement that animated the modern Institute of Physics [...] with the somewhat inactive atmosphere at the Observatory (a.t.)" (Rosino 1986:3). Most directors still believed that classical astronomy was a necessary knowledge for all astronomers: "Astronomers are formed at Carloforte", they used to say (Masani 1998). However, for astrophysicists like Fracastoro (1983:98-99), working at Carloforte was a sort of persecution: "Righini [...] was unexpectedly assigned to Carloforte (16/2/1937), according to a practice that dates from decades past and insists that astronomers from all observatories make an almost compulsory stay there [...] Everything seemed to be going well, when the lightning of Carloforte strikes the hill of Arcetri yet again. The designated victim this time is Colacevich (1/10/1939) (a.t.)".

17.8 Italian Astrophysics after WWII

An astronomical conference was held at Merate in September 1946 to reorganize Italian astronomy after the Second World War. That meeting, organized by Gratton in collaboration with the *Società Astronomica Italiana,* is generally considered the turning point of Italian astrophysics (Rosino 1986, Masani 1998). During the program, the hope arose of a change of attitude among Italian astronomers who up to then had not cared much to promote within the scientific faculties of universities, "the new currents of modern astrophysics, that nevertheless has among its pioneers Donati and Secchi (a.t.)" (Castellani 2005).

Soon after the meeting, the Italian National Research Council (CNR) agreed to finance the development of astrophysical research. In 1947 a center for solar physics was established at Arcetri and a joint one on stellar physics was set up at Merate and Asiago (an annex of Padua Observatory inaugurated in 1942). In 1951 they were merged into a single center for astrophysics. The choice of these three Observatories was dictated by the presence of skilled personnel and modern instrumentation (Masani 1998). Asiago Observatory was equipped with a 122-cm reflector, completed around 1950 with the arrival of a new spectroscope. A program on stellar spectroscopy was soon started by Righini. From 1953 the directorship of Asiago (and later of the joint Padua/Asiago sites) passed to Rosino, who extended the expertise of its astronomers to galactic and extragalactic astrophysics (Rosino 1986). Towards the end of the 1950s, other observatories started to benefit from the CNR support (Masani 1998).

At the turn of the decade, Italian Astrophysics expanded to include developments in radio astronomy and X- and γ-ray astronomy. At Arcetri, transformed by Righini into a purely solar observatory, the Sun was studied in the radio domain with dedicated radio telescopes, and in X-rays using data from the series of Solrad satellites (Fig. 17.5).

Other observatories tied to optical astronomy were not so interested in these new developments. Instead, the greatest interest came from physicists at Italian universities. In Bologna, Giampietro Puppi (1917-2006) promoted the development of radio astronomy, leading to the inauguration of the "Northern Cross" radio telescope of Medicina in 1964. Research in high-energy astronomy sprung up in several Institutes of Physics, including that of Milan University led by Giuseppe Occhialini (1907-1993). Cosmic-ray studies were also pursued, revitalizing a sector that had greatly suffered after the departure of Bruno Rossi (1905-1993), forced to leave Italy by the fascist racial laws.

A new generation of astrophysicists emerged around Gratton. In 1962 he had returned to Italy to become a professor at Rome University, and he created the CNR Center for Astrophysics at Frascati. The CNR further consolidated these activities at the end of the 1960s and the beginning of the 1970s, creating new laboratories (later Institutes) such as that of radio astronomy in Bologna and space astrophysics in Frascati, taking the lead in research in non-optical wavelength domains and space astronomy. Eventually, in 1999 all Observatories and CNR Astrophysics Institutes merged into the current National Institute of Astrophysics, INAF. (For a more extended account of the developments from the 1960 up to recent times, see Setti 2005.)

Fig. 17.5 The Arcetri Observatory seen from the Solar Tower in 1968. The image shows, from the right: the 10-m radiotelescope (installed in 1963); behind it, the 5-m radiotelescope (1962); next to the east (right) dome, the first Italian radiotelescope (1956); at the center, an antenna for satellite telemetry (Historical Archive, INAF-Arcetri Astrophysical Observatory).

In the 1960s, a couple of choices hampered the participation of Italian astronomers in projects of the international community, and which might have retarded the full development of astrophysics. The first was the proposal of a large reflector for a National Astronomical Observatory to be installed in Italy, which was never completed (Fig. 17.6; see also Chapter 16). Because of this project, Italy did not join the European Southern Observatory at its foundation in 1962, but only later, in 1983. A second snag might have been the refusal to merge the *Memorie* into the new European journal *Astronomy & Astrophysics (A&A)*, which started its publication in 1969. Nevertheless, thanks in part to *A&A*, Italian astronomers grew confident in their research, and the 1970s saw a rapid increase of their international publications both there and also in the American *Astrophysical Journal (ApJ)*. As astrophysicist Vittorio Castellani (1937-2006) recalled, "in the mid-1960s, American astronomy, as attested by ApJ, looked to us far and unreachable [but later] almost to our surprise, this feeling slowly transformed into the consciousness that even we, Italians, had something new to say and, not unfrequently, something important" (Castellani 2005: 402, a.t.).

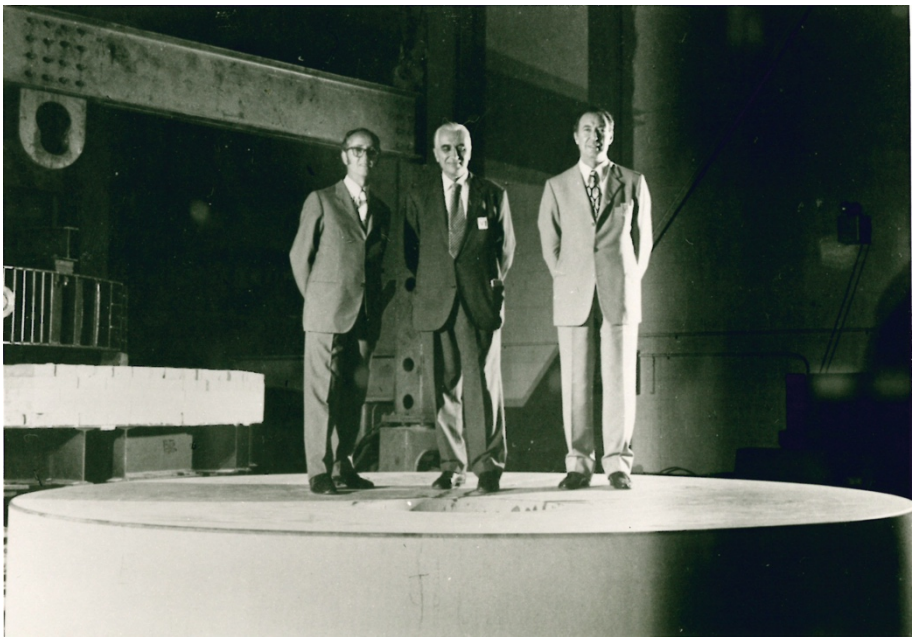

Fig. 17.6 G. Righini (center) standing on the blank of the mirror for the National Observatory. Corning Glass Works, Canton, NY, 31/8/1971 (Historical Archive, INAF-Arcetri Astrophysical Observatory). The blank was never polished into a mirror and remained in Florence until 2010, when it was sold to amateur astronomers.

The Merate meeting in 1946 marked a turning point for classical astronomy as well, leading to its decline (Proverbio 1998). Even though most funds were invested in astrophysical studies, research groups of classical astronomy still were present in many observatories until the end of the 1960s, and a few continued in the 1970s (the observational program at Carloforte stopped in 1979). In those years, the rift between the two communities was apparent, with astrophysicists referring to positional astronomy as "Round" Astronomy ("Astronomia rotonda"; Masani 1998, Rigutti 2017). A path of this division can be found in the draft of a proposal for a reorganization of the Italian Observatories, circulated in 1970. The authors (Hack, Rigutti and Godoli, all from the Arcetri school) asked for the suppression of the Brera, Torino and Teramo Observatories in order to create a center for astrometry in Sardinia, near Cagliari. The response of the director of Brera Observatory, Francesco Zagar (1900-1976), was indignant: "[The proposal] deals with issues of classical astronomy, of which the three proponents, astrophysicists by nature and culture, cannot have the minimal competence" (Zagar 1970; the draft itself is yet to be located, see also Mandrino & Bònoli 2015).

17.9 Concluding Remarks: Abetti's "History of Astrophysics"

As shown in this chapter, Secchi and the other pioneering spectroscopists were constantly mentioned in the works of Italian astrophysicists. Their names can be also be found in the earliest accounts of the development of astrophysics, such as Agnes Clerke's *A popular history of astronomy during the nineteenth century* (Clerke 1902), which cites Donati, Secchi, Respighi, Tacchini and Riccò. They are cited as well in modern historical reviews: Secchi, Respighi, Tacchini and Riccò are remembered in *Early Solar Physics* (Meadows 1970); Donati and Secchi in *The analysis of starlight* (Hearnshaw 2014). More difficult is to track the impact of Italian astrophysics in the 20th century. According to Righini (2003), in the first half of the 20th century only Italian solar physicists gave any significant contribution to astrophysics. In fact, in Hearnshaw's account (2014) the work of Italian observatories in the field of stellar spectroscopy only appears in the 1960s.

One can evaluate the impact of the early Italian astrophysicists by looking at Abetti's publications on the history of astronomy. Among his earliest ones is a life of Secchi which the author, as "a grateful and devout disciple (a.t.)", dedicated

to Hale (Abetti 1928). Another successful book was Abetti's *The History of Astronomy*, published in Italian, Spanish and English (Abetti 1952).

After publishing a second Italian edition of the book in 1962, the astronomer started to work on the draft of a *Storia dell'Astrofisica*, which Abetti intended to publish in collaboration with Hack. A typescript of 171 pages (about 65,000 words) was ready by the end of 1966. The text, divided into 16 chapters, spans from the first studies of the physical characteristics of celestial bodies by Galileo to the discovery of the first quasars at the beginning of the 1960s. The work of the pioneers in astronomical spectroscopy is described in Chapter 4, with a note on the early observations by Donati and an extended description of the activity of Secchi; brief references to Respighi and Riccò are made, while a paragraph is dedicated to Tacchini's role in the establishment of the *Società degli Spettroscopisti Italiani* and to the *Memorie*, stating its primacy as the first periodical dedicated to astrophysics. But the lack of direct disciples of those pioneers is evident in the lack of Italian names in the following chapters, except for a very brief reference to Abetti's work and his pupil's, Righini.

The original typescript, preserved in the Arcetri Historical Archive, was never published, though a 90-year old Abetti had an abridged version produced in 1973. In this final text, reduced to about one sixth of its original length, only references to Donati and Secchi survived (Abetti 1973).

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