



Publication Year	2022
Acceptance in OA @INAF	2024-03-18T14:52:53Z
Title	Theodor Bredikhin and the Italian Spectroscopic Society
Authors	CHINNICI, Ileana
Handle	http://hdl.handle.net/20.500.12386/34977
Journal	INASAN Science Reports
Number	7

Федор Бредихин и Общество итальянских спектроскопистов

Чинничи И.

Национальный институт астрофизики, Палермская астрономическая обсерватория, Палермо, Италия

В октябре 1871 г. несколько итальянских астрономов основали первое научное «Общество итальянских спектроскопистов», занимавшееся применением спектроскопии в области астрономии. Они договаривались о совместном ведении программы спектроскопических наблюдений лимба Солнца, чтобы отслеживать солнечную активность, сравнивать результаты, находить связи между фотосферными и хромосферными характеристиками и изучать взаимодействие Солнца и Земли. Позже от этой программы, в основном, отказались, а общество распространило свои интересы на популяризацию спектроскопических исследований. «Записки общества» сегодня считаются первым астрофизическим журналом: на его страницах мы находим сборники статей по астрономической спектроскопии всех пионеров астрофизики. «Записки» стали международным журналом, который в значительной степени поспособствовал преодолению того сопротивления, с которым астрофизические исследования встречались в традиционном астрономическом сообществе. Ф.А. Бредихин был членом «Общества спектроскопистов», что подтверждает его признание как одного из первых астрофизиков, а его исследования считались новаторскими в международном контексте. Он состоял в переписке с президентом общества Пьетро Таккини и опубликовал некоторые из своих работ в «Записках». В этой статье мы рассмотрим его публикации и в целом взаимоотношения Ф.А. Бредихина с «Обществом спектроскопистов».

Поступила в редакцию 01.08.2021 г. Принята в печать 01.10.2021 г.

Keywords: ранняя солнечная физика, история астрономии

Theodor Bredikhin and the Italian Spectroscopic Society

Chinnici I.

INAF-Osservatorio Astronomico di Palermo, Palermo, Italy

In October 1871, some Italian astronomers established the first scientific society explicitly devoted to the application of spectroscopy in the astronomical field. They agreed on sharing a programme of spectroscopic observations of the solar limb, in order to monitor solar activity, compare their results, find connections between the photospheric and chromospheric features and study Sun-Earth interaction. The programme was later mostly abandoned, but the interests of the Society were extended to the circulation of the spectroscopic studies. The Memoirs of the Society are today considered the first astrophysical journal: in its pages, we find collections of articles on astronomical spectroscopy by all pioneers of astrophysics. They became an international journal that greatly contributed to overcome the resistance that the astrophysical research met in the traditional astronomical community. Bredikhin was a member of this Society. This means that he was recognized as an early astrophysicist and his studies were considered innovative in an international context. He was in correspondence with its President, Pietro Tacchini, and published some of his works in the Memorie. In this paper, we shall examine these aspects and, in general, Bredikhin's relationship with the Society.

Received 01.08.2022. Accepted 01.10.2022.

Keywords: early solar physics, history of astronomy

DOI: 10.51194/INASAN.2022.7.2.012

1. Introduction

The phenomenon of the light dispersion through a glass prism was well-known in the 17th century and especially studied by Isaac Newton (1643–1727), who called “spectrum” the colors produced by dispersed light. More than two hundred years later, in 1802, physicist William Wollaston (1766–1828), for the first time observed a few dark lines in the solar spectrum, but did not pay attention to this phenomenon, which he simply interpreted as lines of separation of the different spectrum colors¹.

Who first accurately studied the spectral lines was optician Joseph von Fraunhofer (1787–1826). In 1817 he described the lines observed in the solar spectrum and named the most visible ones with alphabetic letters. He understood that the dark lines were an intrinsic feature of sunlight but, of course, he lacked a theoretical apparatus for explaining and interpreting them. This was provided, about forty years later, by Gustav Kirchhoff (1824–1887) and his collaborators, who formulated the radiation laws; it became clear that the dark lines were absorption lines revealing the presence of specific chemical elements in the solar atmosphere. Maps of the solar spectrum were produced in laboratory by Kirchhoff himself and perfected by other scientists².

For the first time, there was an instrument available for knowing the physical nature and the chemical composition of the celestial bodies: the spectroscope. Until then, astronomy was restricted to determining positions and orbits, and no additional knowledge was possible on stars, planets, comets and so on. The introduction of

¹On early spectroscopic observations, see [1].

²On early maps of the solar spectrum, see [2].

spectroscopy and photography in the astronomical field led to the development of a new astronomy, so-called astrophysics³.

In the decade 1860–1870, astronomical spectroscopy provided important scientific results, including spectral classification of stars, nebulae composition, cometary spectra, and many discoveries regarding solar physics⁴.

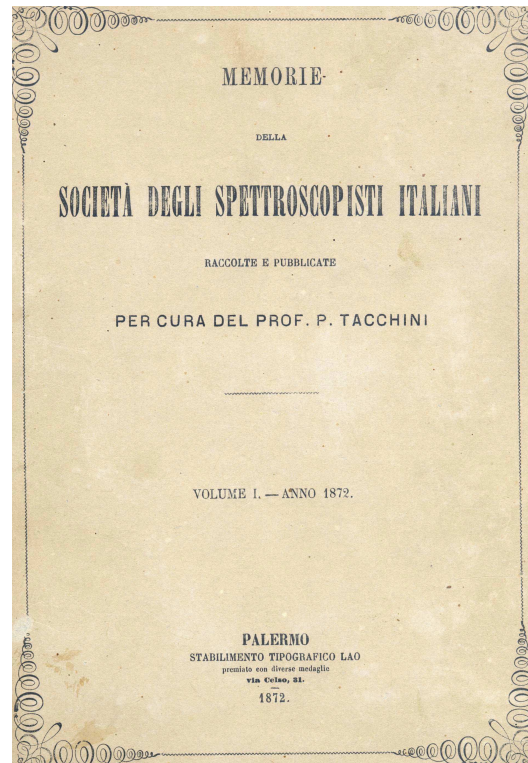


Figure 1: Cover page of the first volume of the *Memorie* (1872); courtesy of INAF-Palermo Astronomical Observatory Library, Historical Section.

2. The Italian Spectroscopic Society

In Italy, some astronomers decided to share a programme of solar spectroscopic observations for monitoring the sun, trying to find correlations between photospheric (sunspots, faculae) and chromospheric features (prominences). The idea was first proposed by Jesuit father Angelo Secchi (1818–1878)⁵, a pioneer of astrophysics, who worked in Rome at the Collegio Romano Observatory. He started a collaboration with his colleague astronomer Pietro Tacchini (1838–1905)⁶, who worked at the Palermo Observatory. Both astronomers possessed almost identical Merz equatorial telescopes and, in summer 1871, carried out simultaneous spectroscopic observations of solar prominences and compared their results.

Secchi proposed to Tacchini to invite other Italian astronomers to join them in this kind of observations. Giuseppe Lorenzoni (1843–1914) from Padua was soon involved in this research programme: his Merz refractor was smaller than those in Rome and Palermo, so that comparisons could be also made with instruments having different sizes.

In October 1871 they established the Italian Spectroscopic Society, together with other colleagues from Rome, and Naples Observatories, namely Lorenzo Respighi (1824–1889) and Arminio Nobile (1838–1897)⁷.

Its scientific programme included: monitoring (and drawing) of solar prominences; morphology of prominences, sunspots, etc.; spectroscopic studies about their chemical composition; correlation of solar activity with polar aurorae and geomagnetic perturbations.

³On the origins of astrophysics, see “The New Astronomy” by A. J. Meadows in [3].

⁴On the development of solar physics, see [4, 5].

⁵On Secchi’s life and scientific activity, see [6].

⁶On Pietro Tacchini and his studies, see [7].

⁷For different reasons, however, Respighi and Nobile never started an effective collaboration with the other members; on the establishment of Society, see [8].

Tacchini, President of the Society, was also Editor of the *Memorie della Società degli Spettroscopisti Italiani* (fig. 1), published from 1872, which are today considered the first astrophysical journal. In the incipit of the first volume we read:

*The spectroscope is undoubtedly the only instrument capable to extend our scientific knowledge with new discoveries about the physical constitution of the Sun.*⁸

This statement is a sort of manifesto of the Society and clearly shows its original aim: to improve the knowledge about the Sun through a programme of spectroscopic observations. The *Memorie* soon became an appreciated international journal, awarded at the Universal Exhibition held in Vienna in 1873.

The Society drew the attention of other spectroscopists abroad, who started a correspondence, especially with its President, Tacchini. He played an important international role in gathering those scientists who shared the same interests, creating an appropriate community for exchanging the results of their spectroscopic observations and providing a journal — the *Memorie* — for the circulation of their works.

3. Bredikhin and the Italian Spectroscopists

Theodor Bredikhin (1831–1904), in Russia, was one of the first foreign members of the Society and one of the most active. In Rome, there are 11 letters by Bredikhin to Tacchini which are preserved in the archives of the ex-Collegio Romano Observatory [10] (now a research institution for climatology, see below) and 7 letters in the archives of the Rome Astronomical Observatory [11], p. 93, 189, 228. A few letters contain drawings or scientific manuscripts annexed. Moreover, an undated letter (but datable 1876) from Bredikhin to Secchi is preserved in the archives of the Gregorian University in Rome [12]. Most of the letters by Bredikhin are in Italian, a language that he knew well. The correspondence was certainly wider but other letters, which are mentioned in these letters or in some publications, seem to have been definitely lost. Below is the list of Bredikhin's letters kept in Roman archives (APUG = Archivio della Pontificia Università Gregoriana; CREA-CMA = Consiglio per la ricerca in agricoltura e l'analisi dell'economia agraria — Unità di ricerca per la climatologia e la meteorologia applicate all'agricoltura; INAF-OAR = Istituto Nazionale di Astrofisica — Osservatorio Astronomico di Roma, located in Monte Porzio Catone, near Rome; + ms = manuscript annexed; + d = with drawings).

Recipient	Place	Date	Archive
To Tacchini	Moscow	1873, Sept. 6	CREA-CMA
To Tacchini	–	1873, Nov. 11	CREA-CMA
To Tacchini	–	1873, Dec. 12	INAF-OAR
To Tacchini	–	1874, Jan. 18	INAF-OAR
To Tacchini	–	1874, Feb. 7	INAF-OAR
To Tacchini	–	1874, Jul. 14 + d	CREA-CMA
To Tacchini	–	1874, Jul. 21 + d	INAF-OAR
To Tacchini	–	1876, Feb. 14	INAF-OAR
To Tacchini	–	1876, Mar. 14	CREA-CMA
To Secchi	–	[1876], Sept. 29	APUG
To Tacchini	–	1879, Oct. 25	CREA-CMA
To Tacchini	–	1881, Dec. 30 + ms	INAF-OAR
To Tacchini	–	1883, Mar. 14	CREA-CMA
To Tacchini	–	1883, Apr. 15	INAF-OAR
To Tacchini	Kineshma	1883, Jul. 26	CREA-CMA
To Tacchini	–	1883, Aug. 3	CREA-CMA
To Tacchini	Moscow	1883, Dec. 24 + ms	CREA-CMA
To Tacchini	Pogost	1884, Jul. 29	CREA-CMA
To Tacchini	St. Petersburg	1897, May 8	CREA-CMA

The letters by Tacchini and Secchi to Bredikhin (if any has survived) are presently missing and should be searched in Russian archives; anyway, the content of their letters can be deduced by Bredikhin's replies. In addition to the letters, there are 17 publications (two are letters to Tacchini) by Bredikhin in the *Memorie* of the Society [13]; they are mostly in French and generally deal with solar spectroscopic observations or comets, his favourite topic. These publications often contained comments by Tacchini and comparisons with the observations carried out in Italy. Below is the list of Bredikhin's publications in the *Memorie* (titles in original languages, English translation in brackets):

⁸*Lo spettroscopio è senza dubbio il solo istrumento capace di arricchire la scienza di nuove scoperte sulla fisica costituzione del nostro sole* [9].

Vol. II	1873	“Osservazioni spettroscopiche del Sole fatte nell’estate 1872”
–	–	(Solar spectroscopic observations made in summer 1872)
Vol. III	1874	“Osservazioni spettroscopiche del Sole fatte nell’estate ed autunno del 1873”
–	–	(Solar spectroscopic observations made in summer and autumn 1873)
Vol. III	1874	“Spettro della Cometa Coggia (lettera)” (Spectrum of Comet Coggia [letter])
Vol. III, App.	1874	“Fenomeni osservati nella Cometa Coggia (lettera)”
–	–	(Phenomena observed in Comet Coggia [letter])
Vol. IV	1875	“Osservazioni spettroscopiche del Sole fatte nel 1874 alla Specola di Mosca”
–	–	(Solar spectroscopic observations made in 1874 at Moscow Observatory)
Vol. IV	1875	“Spectre des nebuleuses” (Spectra of nebulae)
Vol. V	1876	“Osservazioni spettroscopiche del Sole fatte nel 1875 alla Specola di Mosca”
–	–	(Solar spectroscopic observations made in 1875 at Moscow Observatory)
Vol. V, App.	1876	“Sur la queue normale de la Comète 1862 II” (On the normal tail of Comet 1862 II)
Vol. X	1881	“Sur la comète de 1825 IV” (On comet 1825 IV)
Vol. X	1881	“Sur la queue des comètes <i>b</i> et <i>c</i> 1881” (On the tails of comets <i>b</i> et <i>c</i> 1881)
Vol. XII	1883	“Sur la grande comète de 1882” (On the great comet of 1882)
Vol. XII	1883	“Recherches sur la grande comète de 1882, II” (Studies on the great comet of 1882, II)
Vol. XII	1883	“Note sur la queue du I type de la comète 1882, II” (Note on the type-I tail of comet 1882, II)
Vol. XII	1883	“Les ondes cosmiques dans la comète 1882, II” (On the cosmic waves in comet 1882, II)
Vol. XII	1883	“Sur quelques anomalies apparentes dans la structure des queues cométaires”
–	–	(On some apparent anomalies in the structure of cometary tails)
Vol. XIII	1884	“Les syndynames et les synchrones de la comète Pons-Brooks (1883–1884) (avec une planche)”
–	–	(Syndynames et synchrones of comet Pons-Brooks (1883–1884) (with a plate))
Vol. XXXI	1902	“Sur le rôle de Jupiter dans la formation des radiants composés”
–	–	(On the role of Jupiter in the formation of composite radiants)

All papers are interesting and show that Bredikhin was up-to-date with the astrophysical questions that were debated in those years, as well as with instruments and publications, and actively contributed to the international discussion on these topics.

4. Bredikhin’s solar studies and the correspondence with Tacchini

Bredikhin was basically a volunteer member of the Society, from its establishment. He started his solar spectroscopic observations in summer 1872, in a property at Kineshma, near the Volga river. At that time, he was working at the astronomical observatory of the University of Moscow (fig. 2), and became director of this observatory one year later, in 1873. He published his first results in the Bulletin of the Imperial Society of Naturalists of Moscow, which he was member of. Bredikhin described the instruments he used (fig. 3) — namely a Merz⁹ equatorial telescope and a direct vision spectroscope, also by Merz — and explained the method he adopted. It consisted in observing solar prominences, measuring their position and height with a micrometer, and drawing them (fig. 4); to draft sunspots and mark their positions; in the evening, to check the appearance of polar aurorae. The Russian astronomer hence explicitly stated to have adopted the same programme of the Italian Spectroscopic Society:

*From what I have just said, you see that, as far as my instrumentation allows, I’ve tried to follow the rules of the programme adopted by the Italian Spectroscopic Society.*¹⁰

Bredikhin probably sent his observations to Secchi and Tacchini; the Jesuit was happy that the Russian astronomer confirmed his results on sunspots activity and solar prominences. Bredikhin too, in fact, considered that sunspots had two phases — quiet and active (the latter showing metallic eruptions) and proposed a classification of the solar prominences into two classes (hydrogenic — also containing helium — and metallic, depending on their chemical composition)¹¹. Secchi wrote to Tacchini:

*I have received a writing by a certain Bredikhin from Moscow [...] he confirms our ideas and I see that there is advancement.*¹²

For his part, Tacchini compared their drawings of solar prominences with those made by Bredikhin in the very same days of 1872 and decided to publish an excerpt of Bredikhin’s work in the *Memorie*:

*I have read the paper by Bredikhin, I have compared his drawings with ours and they fit very well: I will publish an excerpt in the Memorie.*¹³

⁹On Merz, see note 21, [14].

¹⁰*On voit d’après tout ce que je viens de dire, que je tâchais, en tant qu’il m’était permis par mes moyens instrumentaux, d’avoir pour norme le programme adopté par la Société des Spectroscopistes italiens* [15], p. 64.

¹¹Secchi’s (and Tacchini’s) classification of solar prominences was based on their morphology; of course, Bredikhin could not observe the prominences’ details, as Tacchini and Secchi did, as his telescope was smaller than theirs — he hence used a spectral classification, which was however in agreement with their results. On Secchi’s solar theories, see [18].

¹²*Ho ricevuto uno scritto di certo Bredichin di Mosca in cui esso comprova le nostre idee e vedo che si fa progresso.* (Secchi to Tacchini, 14 June 1873, in [19], p. 300).

¹³*Ho letto l’articolo di Bredichin, ho confrontato le figure colle nostre e vanno molto bene: ne metterò un estratto nelle Memorie.* (Tacchini to Secchi, 21 June 1873, in [19], p. 301).



Figure 2: The Observatory of Moscow University (from [16], plate facing p. III); source: Google Books).

Tacchini published Bredikhin's observations in the second volume of the *Memorie*, together with some interesting comments. Particularly, the comparison of Bredikhin's drawings of solar prominences with his own drawings as well as with those of Secchi and Lorenzoni (fig. 5) showed that the shape of the same prominences was perfectly comparable, especially in the observations by Bredikhin and Lorenzoni, who used instruments of similar sizes. Tacchini praised the work of the "diligent and dutiful" Russian astronomer and concluded that the general shape of each prominence was confirmed by this comparison. In September 1873, Tacchini wrote to Bredikhin an encouraging letter that the Russian astronomer enjoyed very much. In fact, he replied:

*I am very grateful for your kindest letter [...]: these words of appreciation — that from Italy, so loved by me, reached me here, where few scientists are interested in the new and important branch of physical astronomy — really make me happy.*¹⁴

This statement by Bredikhin confirms that, in Russia, astronomers who practiced spectral analysis met the same disinterest as almost everywhere. In general, traditional astronomers were skeptical about spectroscopic observations and kept the distance from them.

One of the main opponents to astronomical spectroscopy was Otto Wilhelm von Struve (1819–1905), influential director of Pulkovo Observatory, who still stated in 1886:

*As yet, astrophysical investigations are far from the standard of scientific accuracy possessed by classical astronomy [...] God forbid that astronomy should be carried away by fascination with novelty and diverge from [its] essential basis, which has been sanctified for centuries...*¹⁵

This kind of prejudice against astrophysics was quite widespread throughout Europe but, actually, it was soon overcome with the creation of new establishments. In the decade 1870–1880, astrophysical observatories — apart from astronomical observatories — were built in Meudon (France), Potsdam (Germany), South Kensington

¹⁴ *La Sua gentilissima del 3 sett[embre] mi riuscì molto grata: una parola d'approvazione, — che d'Italia, tanto amata da me, pervenne qui, ove pochissimi s'interessano del nuovo ed importante ramo d'astronomia fisica, — mi rende proprio felice.* (Bredikhin to Tacchini, 6 Sept. 1873; CREA-CMA Archives, Rome.)

¹⁵ Struve, 1886, quoted in Meadows (note 3, [3]), p. 61.

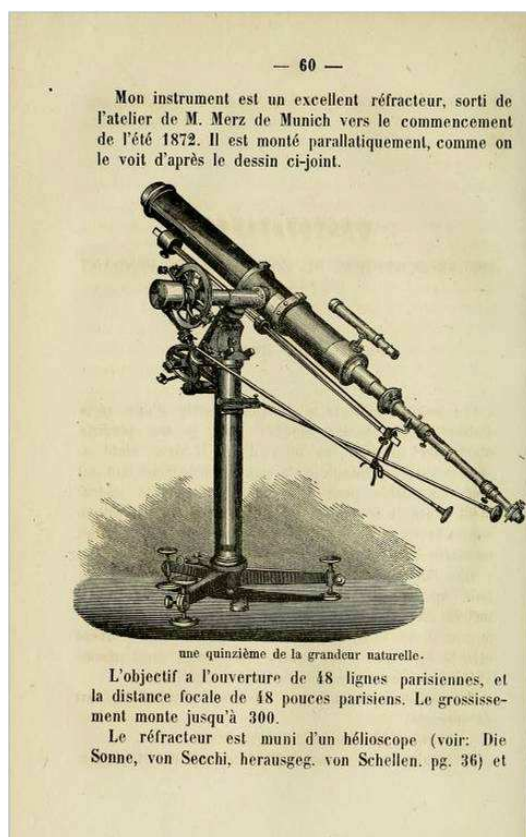


Figure 3: Page illustrating the instruments used by Bredikhin for his solar spectroscopic observations: a refractor telescope combined with a direct vision spectroscope, both made by Merz in Germany (from [17], p. 60).

(England), Catania (Italy). Inexorably, astrophysics was recognized as a new scientific discipline, apart from astronomy¹⁶.

Tacchini probably invited the Russian astronomer to continue to send his solar spectroscopic observations for publication in the *Memorie*, as Bredikhin wrote him:

*I feel honoured from your kind invitation to send you my notes, I cannot be proud enough of it and I consider myself obliged to be, in my Eastern astronomical station, a servant of Your honorable society.*¹⁷

Bredikhin intended to play an active role in the society and offered his collaboration; he wrote to Tacchini:

*If you like to assign me any task, for instance, carrying out any simultaneous observation or other — all will be exactly done.*¹⁸

In spirit of collaboration, Bredikhin sent reports on his solar spectroscopic observations from 1872 to 1875, and wide excerpts were published in the *Memorie*. The complete series of observations was published in the *Annals of the Observatory of Moscow* (fig. 6), whose publication was started by Bredikhin in 1874, once he became director of the University Observatory. He was by then in a condition to freely decide his work programme and to include solar studies.

In the same year 1874 the astronomical community was waiting for an important and infrequent phenomenon, the transit of Venus above the Sun. The observations of this phenomenon were crucial to obtain accurate determinations of the solar parallax and required to be made from many astronomical stations, as much as possible

¹⁶It is emblematic what French astronomer Hervé Faye (1814–1902) wrote in 1874 about the creation of a new observatory for astrophysical studies:... *this new branch of the old astronomy has a completely anew distinctive character. Here, Geometry and Mechanics are replaced by Physics and Chemistry. [...] This new branch has taken root and is developing very quickly. For us, old-fashioned astronomers, it is very difficult to recognize, for its ideas, its methods, its goals, and even the spirit which reigns, are very different from ours. [...] It is the case of applying an important law [...] that of division of work. [...] The two sciences [physical astronomy and classical astronomy] will develop in parallel, without getting in each other's way, but using different aptitudes.* (Faye, 1874, quoted in Chinnici (note 5, [6]), p. 4); on this topic, see also note 3.

¹⁷*Il Suo gentile invito d'inviarle le mie note mi fa onore, di cui non posso abbastanza vantarmi e mi reputo obbligato d'essere sul mio posto astronomico tanto orientale un servitore fido della Vostra società onoratissima.* (Bredikhin to Tacchini, 6 Sept. 1873; CREA-CMA Archives, Rome.)

¹⁸*Se ella crederà opportuno di darmi qualche carica, per esempio di fare qualche osservazione simultanea, od altro, — tutto sarà eseguito esattamente.* (Bredikhin to Tacchini, *ibid.*)

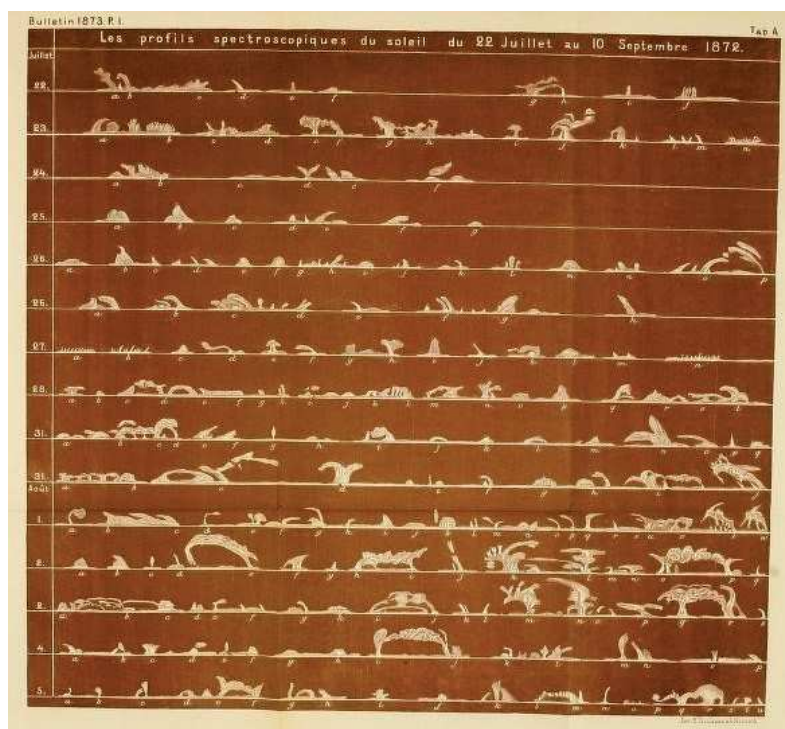


Figure 4: Drawings of solar prominences observed by Bredikhin in 1872 (from [17], pl. A).

distant among them. All the most advanced nations of that time organized official scientific expeditions. Bredikhin was involved in one of the Russian expeditions and, in December 1873, wrote to Tacchini inviting him (or other Italian spectroscopists) to join an expedition to Egypt, which was planned by the Moscow Society of Amateurs of Natural Sciences. They also offered a grant of 1,000 roubles, on the only condition to have the exclusive about the first communication of the observations. Tacchini, however, declined the generous invitation, explaining that he was organizing an Italian expedition for making spectroscopic observations of the transit¹⁹ — an initiative that Bredikhin appreciated:

*I am very glad [to learn] that the Italian expedition has been organized, at last. It is well understandable that you are obliged to decline [our invitation].*²⁰

In July 1874, he wrote to Tacchini that he too intended to make spectroscopic observations of the phenomenon. It is unclear if he changed his mind at Tacchini's suggestion. Anyway, bad weather prevented the observation of the phenomenon almost everywhere.

In the meantime, Bredikhin had tried to extend his spectroscopic observations — until then being basically solar observations — to other celestial objects. In January 1874, he announced to have attempted to observe star spectra, without success:

*I have tried to observe the spectra of the fixed stars with our large refractor (10.5 English inches), but unsuccessfully until now; I have already complained about it to my friend Merz.*²¹

He did not explain the reasons of his failure, but probably abandoned this kind of studies, due to this disappointment. This aspect would deserve further investigations.

In July of the same year, Bredikhin communicated to Tacchini his successful spectroscopic observations of the comet Coggia, and sent a drawing of the comet. One week later, he described a phenomenon that he interpreted as a detachment of matter from the nucleus of the comet, and sent another drawing. Tacchini published both letters in the *Memorie* (see list in section 3, here) as requested by Bredikhin, together with a reproduction of the second drawing. As usual, the complete series of drawings was instead published by Bredikhin in the *Annals of the Observatory of Moscow* (fig. 7).

¹⁹On the Italian expedition for the transit of Venus, see [22].

²⁰*Sono contentissimo, che la spedizione italiana si è finalmente organizzata. Si capisce benone, che voi siete obbligato di darci la risposta negativa.* (Bredikhin to Tacchini, 18 Jan 1874, INAF-OAR)

²¹*Provai d'osservare i spettri delle stelle fisse col nostro gran rifrattore (10.5 poll[ici] Ing[lesi]), ma questo non mi riesce finora; ne feci già un rimprovero al mio amico Merz.* (Bredikhin to Tacchini, 18 Jan 1874, INAF-OAR.) Sigmund Merz (1824–1908) was a well-known maker of optical instruments (especially refractors and spectroscopes) in Munich; see “The Merz Company: A Global Player of 19th century” by G. Wolfschmidt and J. Kost in [14], pp. 19–38.

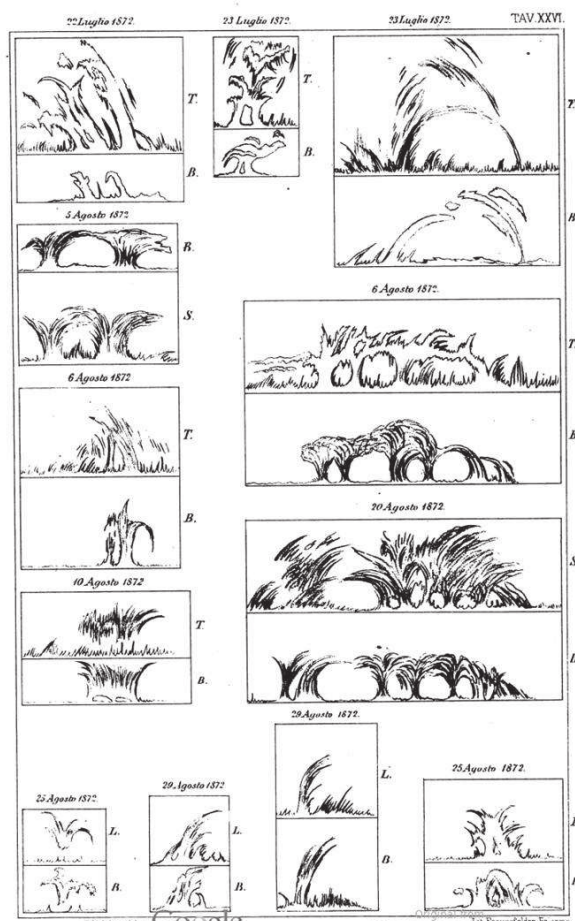


Figure 5: Plate showing the comparison of solar prominences observed in 1872 by Bredikhin and the Italian spectroscopists; the drawings marked with “B”, “T”, “S”, and “L” are respectively made by Bredikhin, Tacchini, Secchi and Lorenzoni (from [20], pl. XXVI; courtesy of INAF-Palermo Astronomical Observatory Library, Historical Section).

In the years, Bredikhin and Tacchini established a friendly relationship, with expressions of mutual cordiality. They exchanged their photographic portraits²² and Tacchini described Bredikhin as “a dear person” in a letter to Secchi²³. It is still unclear if they ever met in person, but it is highly possible that this happened on the occasion of Bredikhin’s visit to Italy, announced in a letter to Tacchini dated 1884²⁴.

6. From solar observations to cometary studies

In 1873 Tacchini had suggested to Bredikhin to use the same scale of the Italian Spectroscopic Society for making his drawings of the solar limb, in order to render easier their comparison. However, for Bredikhin, copying his drawings in another scale would have implied a more time-consuming work and, in spite of his sincere desire to collaborate with the Society, he could not continue this demanding work, because of his many duties: “I have been very busy during all last months of the past year. Moreover, I am not only the director of the observatory, but also professor, dean of the mathematics faculty and so on”²⁵ he wrote to Tacchini, apologizing for the delay in sending the drawings.

Actually, after 1875, there is no mention of Bredikhin’s solar observations in the *Memorie*, though they were continued at least in the following two years [24, 25]. In the meantime, Bredikhin considered that statistical studies on sunspots and other solar features were facilitated by replacing visual observations with photographs. He

²²See Bredikhin to Tacchini, 18 Jan 1874, INAF-OAR.

²³See Tacchini to Secchi, 28 Mar 1876, in [19], p. 413.

²⁴See Bredikhin to Tacchini, 29 July 1884, CREA-CMA.

²⁵... [sono stato] affaccendato tutti gli ultimi mesi dell’anno scorso. Debbo aggiungere ancora, ch’io non sono solamente il direttore della specola, ma professore, decano della facoltà matematica e via discorrendo. (Bredikhin to Tacchini, 14 Feb 1876, INAF-OAR.)

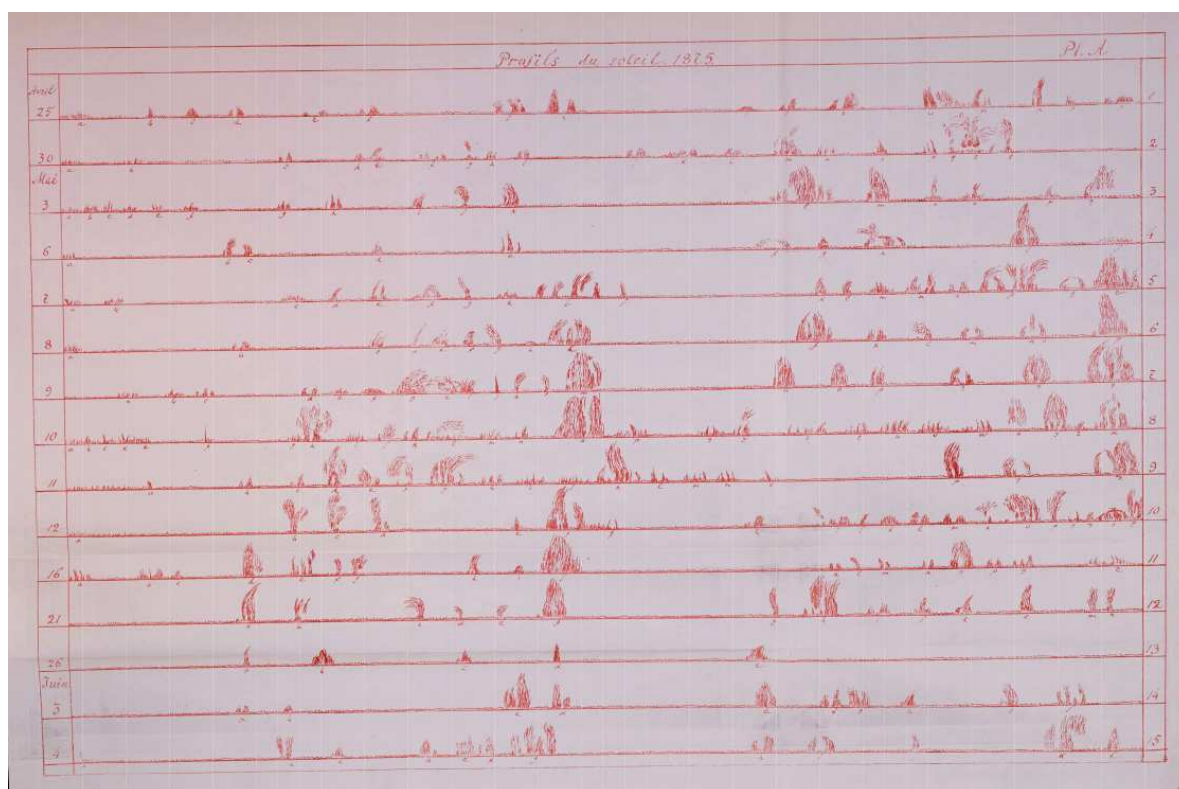


Figure 6: Drawings of solar limb observed by Bredikhin in 1875 (from [21], pl. A; source: Google Books).

therefore wanted a programme of photoheliographic observations, which was entrusted in 1876 to Witold Ceraski (1849–1925) [26] and then continued by Aristarkh Belopolsky (1854–1934)²⁶.

Tacchini was not the only member of the Society who was in correspondence with Bredikhin. Father Secchi was too, even if to a lesser extent. In the archives of the Gregorian University, there is a letter by Bredikhin to Secchi, in which the Russian astronomer mentions to have received a letter from Secchi. The content of the letter probably regarded Secchi's cometary studies, as we may infer from what he wrote:

*I regret that my memoir on the tail of comet 1862 II is now in press and I cannot enrich it with your beautiful observations [...] Your drawings and measurements of the [comet's] jets are extremely important and appropriate to shed light on the motions of the matter ejected from the nucleus. Next winter I intend to make special investigations on this subject, whose results will form a huge supplement to my memoir. Since I intend to make calculations, little by little, on all comet tails, I beg you to send me your valuable observations which are printed in Italian...*²⁷

The letter is datable 1876, because Bredikhin mentions the visit of Emperor of Brazil, Pedro II (1825–1891), to his Observatory, which took place in that year. By then, Bredikhin's investigations mainly regarded cometary studies. Secchi was an expert observer of comets²⁸, and Bredikhin was of course interested in his works.

At present, no other letter by Bredikhin to Secchi has been found; their correspondence was probably sporadic and obviously interrupted by the death of the Jesuit astronomer in February 1878. However, it is remarkable that Secchi mentions Bredikhin's solar observations in his famous book [18] (vol. 2, pp. 128 and 158), one of the most important treatises of solar physics of that time.

²⁶See [27]. Both Ceraski and Belopolsky also published papers in the *Memorie* of the Italian Spectroscopic Society; they can be considered pioneers of astronomical photography in Russia.

²⁷*Mi rincresce che la mia memoria sulla coda della cometa del 1862 II adesso si trova già sotto torchi e ch'io non posso per conseguenza adornarla colle vostre bellissime osservazioni. [...] I vostri disegni e misure dei zampilli sono altamente importanti e propri a darci lume sui movimenti della materia emessa dal nucleo. Questo inverno io mi propongo di farne uno studio particolare, i cui risultati formeranno un supplemento assai grave alla mia memoria. Avendo io l'intenzione di sottomettere al calcolo poco a poco tutte le code delle comete, [...] mi rivolgo a voi colla preghiera d'inviarmi le vostre preziose osservazioni, che sono stampate in italiano ...* (Bredikhin to Secchi, 29 Sept (1876), APUG).

²⁸See [6], pp. 67–69; 164–165.

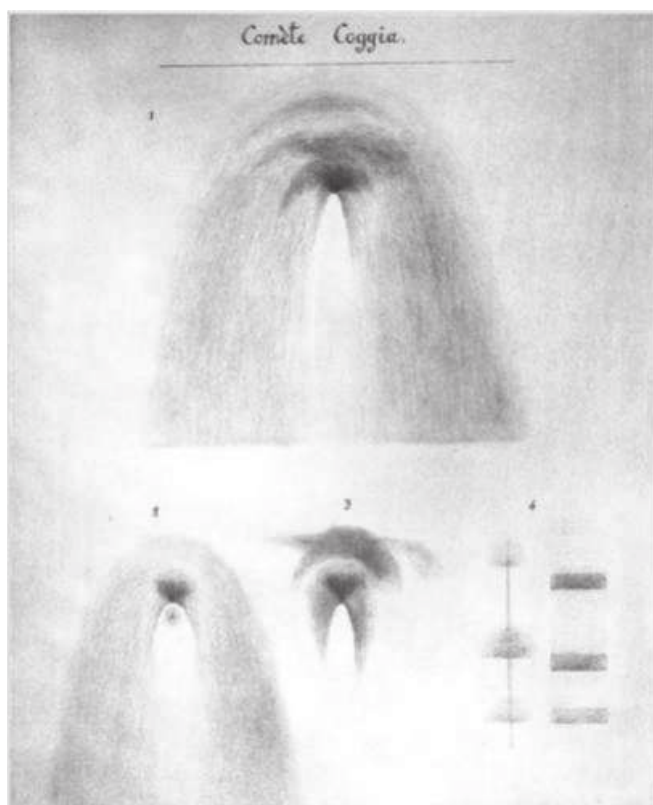


Figure 7: Visual and spectroscopic observations of comet Coggia by Bredikhin in 1874 (from [23], pp. 80–93, plate unnumbered; source: Google Books).

7. Final issues

After the death of Secchi, the scientific programme of the society was definitely compromised and solar observations were slowly abandoned. Tacchini left Palermo for Rome, to replace Secchi as director of the Collegio Romano Observatory in 1879, and his duties as Director prevented him to carry out regular solar observations, as in the original intentions of the Society.

From 1880 on, Bredikhin only sent articles on comets, that had become his main research topic, and they were published in the *Memorie* (see list in section 3, here)²⁹. After his move to Pulkovo Observatory in St. Petersburg, in about 1892, he still was in correspondence with Tacchini (fig. 8), even if less frequently.

In 1890, an official list of members of the Italian Spectroscopic Society was published for the first time, and we find the name of Bredikhin, together with those of the main astrophysicists of his time. He was member of the Society until his death: the last publication by Bredikhin in the *Memorie*, dated 1902, regarded meteor showers.

Tacchini died in 1905, one year after Bredikhin, quite deceived from the trend of the Italian astronomy, which was coming back to traditional astronomical studies, basically abandoning spectroscopic research. The golden age of the Italian Spectroscopic Society was slowly fading away³⁰.

At the beginning of the 20th century, Italy (and Europe) had definitely lost their leadership in the astrophysical research, which developed fast in the United States, thanks also to many private investments.

8. Concluding remarks

Theodor Bredikhin was among the protagonists of the rise of astrophysics in Europe and contributed to build a network of open-minded astronomers who understood the importance of using spectroscopic means to enlarge the horizons of the astronomical research.

His connection with the Italian Spectroscopic Society encouraged him to carry out spectroscopic observations and allowed him to have international exchanges in this field, in spite of the general disinterest or, even more, opposition, from a large part of the traditional astronomical community.

²⁹As a whole, in the years 1874–1888, more than forty articles on cometary spectra were published by many authors (Bredikhin was one of them) in the *Memorie*: the journal of the Society, therefore, largely contributed to the development and circulation of cometary theories.

³⁰As a consequence of this inner crisis and the post-war effort of restarting anew, in 1920, the Society decided to renew itself and to change his name into Italian Astronomical Society, a name that still preserves today.

St. Petersbourg,
1897, 8 mai.

Monsieur et cher Collègue,

Je vous prie beaucoup
d'avoir l'obligeance de me
plus expédier à Moscou
les *Memorie della Societa...*
que vous aviez eu l'ama-
bilité de m'envoyer toujours,
mais de les adresser ainsi:
Russia, Odessa.

Parco Alessandro, Osservatorio
All'Academico Th. Bredichin.

Veuillez agréer, cher
Collègue, l'expression
de ma parfaite consi-
dération.

T. Bredichin

Figure 8: Letter by Bredichin to Tacchini, dated 1897; courtesy of CREA-CMA (source: project TROMOS-INGV).

For his early spectroscopic studies, Bredikhin can be rightfully considered the founder of Russian astrophysics; his scientific heritage was taken over by Bernhard Hasselberg (1848–1922), in St. Petersburg, and Belopolski (previously mentioned), in Moscow.

Definitely, he can be numbered among those far-sighted astronomers that, with other members of the Italian Spectroscopic Society, paved the way to modern astrophysical research.

References

1. J. B. Hearnshaw, *The Analysis of Starlight: Two Centuries of Astronomical Spectroscopy* (2014).
2. K. Henschel, *Mapping the Spectrum: Techniques of Visual Representation in Research and Teaching* (2002), URL <https://books.google.ru/books?id=WceRw3sr-rQC>.
3. O. Gingerich, ed., *The General History of Astronomy*, volume 4 (1984).
4. A. J. Meadows, *Early solar physics* (1970).
5. K. Hufbauer, *Exploring the sun: solar science since Galileo* (1991).
6. I. Chinnici, *Decoding the Stars: A Biography of Angelo Secchi, Jesuit and Scientist*, Jesuit studies (2019), URL <https://books.google.ru/books?id=A6jbugEACAAJ>.
7. I. Chinnici, *Memorie della Societa Astronomica Italiana Supplementi*, **9**, 28, 2006.
8. I. Chinnici, *Annals of Science*, **65**, 393, 2008.
9. P. Tacchini, *Memorie della Societa Astronomica Italiana Supplementi*, **I**, 1, 1872.
10. I. Chinnici, *Quaderni P.R.I.ST.EM.*, **7**, 22, 1994.
11. M. Grossi, S. Trani, and F. Perrotta, *L'Osservatorio Astronomico di Roma — Inventario* (2016).
12. I. Chinnici and W. Gramatowski, *Nuncius*, **16**, 571, 2001.
13. A. Riccò, ed., *Memorie della Societa degli Spettroscopisti Italiani. Indice Generale 1872-1911* (1912).
14. I. Chinnici, *Merz Telescopes; A global heritage worth preserving* (2017).
15. T. Bredikhin, *Bulletin de la Société Impériale des naturalistes de Moscou*, **46**, 59, 1873, URL www.biodiversitylibrary.org.
16. in *Imprimerie de l'Université Impériale*, **I** (1874), URL <https://books.google.ru/books?id=yC42AQAIAAJ>.
17. in *Moscou, Societe imperiale des naturalistes de Moscou, 1829-1917*, **46** (1873), URL <https://www.biodiversitylibrary.org/item/107118>, <https://www.biodiversitylibrary.org/bibliography/4951>.
18. A. Secchi, *Le Soleil*, volume I–II (1875–1877).
19. I. Chinnici and A. Gasperini, *Alle origini dell'astrofisica italiana: il carteggio Secchi-Tacchini 1861–1877* (2013).
20. T. Bredikhin, *Memorie della Società degli Spettroscopisti Italiani*, **II**, 1873.

21. T. Bredikhin, *Annales de l'Observatoire de Moscou*, **II-2**, 1, 1875.
22. L. Pigatto and V. Zanini, *Journal of Astronomical History and Heritage*, **4**, 43, 2001.
23. T. Bredikhin, *Annales de l'Observatoire de Moscou*, **II-1**, 80, 1875.
24. T. Bredikhin, *Annales de l'Observatoire de Moscou*, **III-1**, 110, 1877, URL <https://books.google.ru/books?id=yC42AQAIAAJ>.
25. T. Bredikhin, *Annales de l'Observatoire de Moscou*, **IV-2**, 89, 1878, URL <https://books.google.ru/books?id=PS82AQAIAAJ>.
26. W. Ceraski, *Annales de l'Observatoire de Moscou*, **II-2**, 51, 1876.
27. A. Belopolsky, *Annales de l'Observatoire de Moscou*, **IV-2**, 102, 1878.