Solar and Stellar Physics Through Eclipses
ASP Conference Series, Vol. 370, 2007
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Total Solar Eclipses in Europe: from Romania to France

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Abstract. The paper intends to present a history of the solar eclipses observed in common by the two countries. This has been possible due to the long cooperation between the two countries, which lasts for at least three centuries. The most important results were obtained during the total solar eclipses of 1893, observed in Senegal, and of 11 August 1999.

1. Why Romania and France?

Romania and France are situated at a relatively great distance from one another in Europe: the longitude difference between the capitals of the two countries - Paris and Bucharest - is of approximately 24°; namely a distance sufficiently great to observe an eclipse at two different moments and to draw important conclusions concerning the solar corona.

We have tried to identify the total solar eclipses that could be observed in both countries, especially those that could be seen in common. As the documents are rare, especially the records in Romania, we dwelt on some that were mentioned in both countries, beginning with the 17th century, when astronomy got the status of science, after Galilei had directed a refractor to the sky for the first time in 1609. It was the century when the astronomical observatory of Paris was set up in France, while in Wallachia, the southern region of present-day Romania was ruled by one of its most enlightened princes, Constantin Brancoveanu (1688-1714), who gave an unprecendented impetus to the culture of his country.

2. Eclipses Observed in the Two Countries in the 17th-19th Centuries

What can be said about the development of astronomy in France and Romania at the end of the 17th century and the beginning of the 18th one?

On 21 June 1667, the day of the summer solstice, the mathematicians of the French Academy traced on the ground the place where the present Observatory of Paris was to be built, as well as the meridian and the other directions necessary for the construction. Director of the Observatory was nominated Jean-Dominique Cassini (1625-1712).

In the same epoch Prince Brancoveanu sent the young people he needed for the education of his sons to the most important cultural centers in Europe. One of them was Hrisant Notaras. He worked for a short time with Cassini and

published in Paris, in 1716, *Introductio ad geographiam et sphaeram* in Greek. One of its chapters is dedicated to the eclipses.

Let us stop at the two eclipses observed in the two countries in the 17th century: the first one, a total eclipse, on 12 August 1654, the second one - a hybrid - on 22 September 1699.

Table 1 lists the data for the eclipses seen from Romania and France, taken from *Six Millennium Catalog of Solar Eclipse Paths*.[1]

Table 1. Solar eclipses seen from Romania and France

Date	UT Maximum	Type	Saros	Gamma	Mag.	Lat. (°)	Long. (°)	Sun's Alt. (°)	Path Width (km)	Center Dur.
12 Aug 1654	10:17	T	120	0.496	1.028	41.7N	42.5E	60	110	02^m16^s
23 Sep 1699	10:16	H	139	0.700	1.010	41.8N	40.7E	45	46	00^m49^s
12 May 1706	09:35	T	133	0.598	1.059	51.5N	15.3E	53	242	04^m06^s
25 Jul 1748	11:27	A	122	0.518	0.946	48.7N	24.6E	59	231	05^m12^s
01 Apr 1764	10:17	A	135	0.729	0.932	44.2N	2.5W	43	360	06^m20^s
08 Jul 1842	07:06	T	124	0.473	1.054	50.1N	83.6E	62	204	04^m05^s
09 Oct 1847	09:00	A	141	0.577	0.929	27.7N	52.8E	55	323	08^m35^s
16 Apr 1893	14:36	T	127	0.176	1.056	1.3N	34.6W	80	186	04^m47^s
30 Aug 1905	13:07	T	143	0.571	1.048	42.5N	4.3W	55	192	03^m46^s
15 Feb 1961	08:19	T	120	0.883	1.036	47.4N	40.0E	28	258	02^m45^s
11 Aug 1999	11:03	T	145	0.506	1.029	45.1N	24.3E	59	112	02^m23^s

An eclipse which was observed at the time of Notaras in both countries was that of 12 May 1706 (Table 1). As it can be seen, the eclipse was long enough to create a strong impression. Look what the chronicle is mentioning: *"And in the year 7213, May, the 5th, the sun darked, and no much time after it was a great plague that lasted the whole summer and the whole winter, and many people died."*

In France *"... an observation of La Hire in 1706 was quoted, which offered only a deviation of a minute and a half"*, Abbot Moreau recorded in his book two centuries later.

Two other eclipses of the 18th century could be observed in both countries, exceptionally long, but annular eclipses: 5^m15^s, 6^m20^s, respectively: that of 25 July 1748 (seen from Romania as partial) and that of 5 August 1766.

With the help of the scientists' forecasting work, public information replaced rumour. An annular eclipse having been announced in France in 1764, the Paris priests were invited to *"warn their people that the eclipses did not produce either sterility, or contagious diseases, or war, nor even disastrous accidents. These are the necessary sequences of the motion of the heavenly bodies, as natural as the rising or the setting of the Sun or the Moon"*.

For the 19th century we mention the total eclipse of 8 July 1842 and the annular one of 9 October 1847.

3. The First Common Romanian-French Expedition

A total solar eclipse took place on 4/16 April 1893, one of the longest ones of the century, of over 4 minutes. It was visible from several regions of the globe,

[1] `http://sunearth.gsfc.nasa.gov/eclipse/SEcat/SEcatalog.html`

from Chile, Brazil and up to Senegal. It also occasioned one of the minutest expeditions prepared so far.

Bureau des Longitudes, with the help of Observatoire de Paris, sent to the French colony Senegal two special missions to observe the eclipse from the point of view of both position astronomy and solar physics. In the same places there was also a particular mission, that of the Count Aymar de la Baume Pluvinel. Nicolae Coculescu (1866-1952), who has to become the first director of the Astronomical Observatory in Bucharest, observed this eclipse in Senegal, at Foundiougne, together with the French astronomical mission led by Henri Deslandres (1853-1948). A second French mission was led by Guillaume Bigourdan (1851-1932), on the coast of the Ocean, at Joal, near the delta of the Saloum river. At Foundiougne was also the English team of T.E. Thorpe. Other scientific missions went to Brazil, Peru and Chile. On that occasion Deslandres observed for the first time the rotation of the corona. He managed to superpose the spectra of two equatorial regions showing thus that the corona rotates with almost the same speed as the Sun.

As the Annual Report of Paris Observatory for 1893 mentions, the first mission left Paris on 30 November 1892. It was made up of G. Bigourdan and his assistant, J. Fayet.

During their sojourn in Senegal, they made determinations of longitudes and latitudes, meteorological observations, determinations of the relative intensity of gravitation, and, naturally, eclipse observations. Although the sky was not exceptional (the humid atmosphere of the shore at Joal made the observations difficult), the results were nevertheless quite good, according to the Report of the Academy of Sciences in Paris.

The second mission, led by Henri Deslandres, went aboard the steamer *La Plata*, of the Maritime Post Deliveries, in Bordeaux, on 5 March 1893, to arrive after seven days in Dakar, Senegal. After a stay of five days in Dakar and St. Louis, they embarked the warship *Brandon* in order to reach Foundiougne, a village of only 170 inhabitants, situated on the left bank of the river Saloum. The team was made up of three people, namely: Deslandres, as the chief, and two young assistants from Observatoire de Paris (G. Millochau of 26 years old, and S. Mittau of only 19 years old).

This was the mission which was joined by the Romanian astronomer Nicolae Coculescu, who was at that time attached to Observatoire de Paris. He was sent to observe the eclipse as a result of the interventions of the admiral E. A. Mouchez, the former director of Observatoire de Paris, and of Spiru Haret, the Minister of Public Instruction of Romania. Coculescu was accepted by Bureau des Longitudes in Paris to join the French mission at Foundiougne, namely in a zone situated farther from the coast. He had a programme and his own observation instruments. He had four weeks of training, which allowed him to adapt but also to suffer from an outright heatwave (ranging from 46 °C in the shadow to 65-70 °C in the sunlight), under a sky made almost opaque by the sands carried by the desert winds. The best observations were made between 6:00 and 10:30 a.m., and between 2:30 and 6:00 p.m. Coculescu had an equatorial of 16 cm, the same which had been used by André during the expedition in the New Caledonia in order to observe the passage of Venus over the solar disk, in December 1882. To this instrument he had attached a Henry telescope, which had a much larger searching field. Everything was set up at

a reasonable distance, to the west from the French group. His mission was to establish the moments of the eclipse contacts and to determine in this way the exact duration of the eclipse phases.

This is what Deslandres wrote about the Romanian astronomer's contribution: "*Mr. Coculescu, who was the only one who had a large instrument, suitable for visual observation, wished to take charge of the contacts observation and the announcement of the totality beginning. He had by his side two chronometers of mean and sidereal time, borrowed from the Marine's Warehouse and a loaded rifle, held by a seaman, who was supposed to shoot a fire immediately after the second contact*".

And further: *"The first contact, observed by Mr. Coculescu, occurred at 2h 21m 21s, mean time of Foundioum... Several minutes before the totality, a quite strong wind arose and brought about small dust clouds, so that the instruments and the objectives had to be cleaned rapidly. When the solar disk was reduced to a thin sickle, namely several seconds before totality, Mr. Coculescu, observing the programme established, shouted: Attention! And believing that totality had begun, fired the first rifle shot, which was followed, almost a second later, by the gunshot of Mr. Millochau. Only then the photographic cameras were started. Throughout the duration of the phenomenon, the observers keeping to their posts, a relative silence was maintained*". The last moment of totality was signaled by the Romanian astronomer four minutes and eleven seconds later, at $05^h03^m36^s$. The time was given in Paris time, which was with $01^h15^m20^s$ in advance with respect to the observers' place.

His impressions were overwhelming: *"The satisfaction felt by the observer in these moments is unbounded. More than ever he is filled with admiration for the most exact of the sciences and for the geniuses who created it!"*.

The expedition did not end without mishaps: the ship on which they should have embarked changed its destination because of a rebellion of the natives. In order to get aboard another ship, which was coming from Brazil and was supposed to take them to France they left on 9/21 April, at 9 p.m., on a simple sailing boat led by four niggers. They managed to arrive safely the following day at 7 a.m. in order to continue their voyage on the agitated water of the ocean. After two more days they were finally at Dakar, to arrive at Marseilles only on 9 May. This was how the first expedition of a Romanian astronomer to observe a solar eclipse ended.

His results were presented both in Bucharest and at the Academy of Sciences of Paris, at the latter one's meeting of 29 May 1893.

Nicolae Coculescu will observe another total solar eclipse in Burgos, at 29-30 August 1905.

The totality band began in Canada, crossed the Atlantic ocean, Spain, the Balears, the Mediterranean, a part of Algeria, Tunisia and ended in Arabia, on the shore of the Oman Sea. A rather unfavourable sky in the location region of allowed nevertheless the observation of the eclipse for almost one minute out of the 3^m46^s.

The same eclipse was observed by another Romanian, Nicolae Donici (1874-1956?), also in Spain, at Alcala de Chisvert, a small Spanish place nearby the Mediterranean shore. He led one of the two expeditions sent by the Royal Academy of Sciences of St. Petersburg. The French observers were Janssen, Deslandres, d'Azambuja. Charles Fabry, a professor of physics at the Faculty

of Sciences and astrophysicist, observed this eclipse, too. This eminent optician and photometrist was equipped to measure the intensity of the solar corona brightness. He managed to demonstrate thus that the general diffused light is more important than the light emitted by the solar corona. He measured the total light emitted by the corona and found it equal to 75% of that of the Full Moon.

4. The Eclipse of Wednesday, 15 February 1961

It was visible from Europe, Africa, Asia. It was total in France, Italy, Yugoslavia, Romania, Ukraine, Russia.

By comparison with the eclipse of 1999, it did not benefit by far by the same mediatization. Among the 1342 pages of *"Chronique du 20e siècle"* from Larousse, which sum up the most important events until 1986, 14 pages are dedicated to 1961. There is no mention however, about this eclipse.

Because the eclipse of 15 February 1961 was the only total solar eclipse which was seen as such in Romania after that of 20 November 1816, it has a special importance in spite of all ruthless clouds which did not allow us to see it. In Bucharest it lasted for 2^m10^s.

Nevertheless, it is also worth mentioning that: the air temperature dropped by 2 °C, the atmospheric pressure increased slightly after the maximum phase, and the wind intensified a little. What varied most of all was naturally the light intensity. Anyway, even if it had been completely clear, this eclipse would take place in the morning (9^h 50^m) and the Sun's height above the horizon would than be only 27° $03'$, so the impression would have made could not have been similar to the one of 11 August 1999, when the Sun's height was 59°.

5. The Total Solar Eclipse of 11 August 1999

There came the last eclipse of the 20th century, namely that of 11 August 1999.

Once again the astronomers were right: in spite of all the gloomy anticipations of Paco Rabanne, the famous Madame Tessier, not to mention those of Nostradamus, the coverage of the Sun began exactly at the moment announced and lasted precisely as much as the calculations foresaw, evidently without any consequences for the population, except for the scientific implications of the observation of such an important phenomenon.

The eclipse lasted for 2^m 23^s, a maximum which was reached on Romania's territory, in the zone of the town Ramnicu Valcea, and the Astronomical Observatory in Bucharest was situated exactly on the central line of the totality band. Although it was full summer, or maybe exactly because of that, the weather was extremely capricious.

The eclipse began in the northern part of the Atlantic, where it was registered by a team of the European Space Agency ESA. In England it could not be seen because of some ruthless clouds. In Noyton there were approximately 4000 amateur astronomers and another 10,000 viewers. In Paris, although the eclipse could be seen only as a partial one, the interest in it was great. The people went out on the streets and the Observatory was practically besieged by curious people. In Strasbourg it rained in the morning, but the sky cleared up during

the eclipse, so that over 5000 spectators attended the great cosmic "show" in the Petite France square.

The French organized throughout the entire week which preceded the eclipse, press conferences, from among which two in duplex with Romania. In Stuttgart it rained all day, so that the eclipse could be seen only on TV. Not the same thing happened in Munchen where the sky was perfectly clear.

Here we are in Romania.

In Timisoara the weather was terrible: there were clouds almost all the time, but even in these conditions, our colleagues from the Observatory of Timisoara obtained several photos and video images.

In the mountains a critical situation: a group of French and Japanese astronomers chose Parang Mountains to see the eclipse: rain! Their colleague, Prof. Kitamura said that he was too old to climb anymore and stayed in Targu Jiu: A perfect sky!

At Ramnicu-Valcea, dozens of astronomers had gathered, among whom even Prof. Jay Pasachoff, the president of the Working Group "Eclipses" of the International Astronomical Union. In the morning it poured and in the evening it was a terrible storm which knocked down a part of the instruments. What did it matter after all? Exactly during the eclipse it was a splendid clear sky. Nobody of those who chose the maximum place of the eclipse will ever forget neither the rain emotions nor the splendour of a unique phenomenon.

But let us continue our way along the totality band. The rest of the sky, namely to the east, was almost everywhere clear. Why "almost", because even in the capital there were places where the clouds impeded the observation of several stages of the eclipse, even the beginning of the total eclipse and right at the Astronomical Institute of the Romanian Academy, where there were the only professional instruments in the world situated right on the central line of the totality band.

No matter how many space missions will be launched (SOHO is only one of them), no technique, no matter how sophisticated will ever be able to accomplish what the Moon can do. It is not possible yet to simulate such a good coverage of the solar disk so that the Sun's corona can be seen so close to it.

As it is known, the preparations had begun here several years before. It is enough to mention the symposium of 1996 which constituted a world priority: it was for the first time in the history of eclipse observations that the greatest specialists of the world met before the phenomenon to establish the best observation methods and places. It was an international workshop organized under the aegis of NATO and organized within Romanian-French collaboration: "Theoretical and Observational Problems Related to Solar Eclipses".

It was followed in August 1999 by a NATO ASI "Advances in Solar Research at Eclipses from Ground and from Space" and the 24th International School for Young Astronomers, both organized through Romanian-French collaborations.

Wednesday, 11 August, the scientific programs at the Observatory in the Park Carol were prepared, the astronomers, Romanian and foreigners, were waiting impatiently for the first contact of the eclipse, namely the moment when the Moon's disk begins to cover that of the Sun.

Even if the clouds impeded us to see the beginning of the totality, we all felt the chill which came down (it was really necessary at the high temperature of the moment, both in the actual and figurative senses!) and we saw darkness

descending. Venus was already shining victoriously at 15° east of the Sun, while Sirius was seen at 52° to the south-west. The Czech colleagues situated on the northern platform of the Observatory's park photographed even the shadows left by the tree leaves during the eclipse; some splendid crescents.

However, the clouds dissipated rapidly and the eclipse showed itself in all its splendour. To everybody's amazement, the second ring of diamonds announced the end of the eclipse and the victorious return of the Sun. The astronomers felt relieved: their experiments, which seemed to be compromised at the appearance of the first clouds, had succeded; not so much as they would have wanted, but, still, they gave them hope to obtain some of the scientific results for which they had worked so much. Dozens of experiments were done under the conditions of a clear sky along the entire totality band, in Baragan or in Dobrogea, by professional and amateur astronomers from all meridians of the globe.

In Bucharest the next total eclipse will be visible as such only in 2236, while in Paris not sooner than 2081.

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