

AN "ITALIAN" OBSERVATORY IN INDIA : THE HISTORY OF THE CALCUTTA OBSERVATORY

ILEANA CHINNICI

An Italian Expedition to Bengal

In 1874, the astronomical community was waiting for an important event: the transit of Venus across the Sun. The importance of this event, as known then, followed from the fact that, the best method for measuring solar parallax was based on such observations.¹ The last transit had been observed in 1769² hence great interest of astronomers of 19th century in that important event.

All important European nations and the United States had planned to send scientific expeditions to set up stations all over the world, from where the transit could be observed. India was among one of them, together with Australia, New Zealand, Japan, China, the South Pole and some locations in Siberia and in the Pacific. Eleven stations were planned by British expeditions, six stations by the French astronomers, seven by the Americans and many others by the Germans and the Russians. In Italy, the dynamic astronomer and meteorologist, Pietro Tacchini (1838-1905),³ persuaded the Government to take part in such an important enterprise, in order to affirm the national scientific prestige. In those years immediately following the political unification of Italy,⁴ patriotic spirit was still present in the Italian scientific community. At that time, Tacchini was Adjoint Astronomer at the Observatory of Palermo.⁵ At first, he wrote an article in 1872 in a local paper and urged the Italian Government to plan an expedition for observing the transit. A few days later, the Director of Palermo's Observatory, Gaetano Cacciatore (1814-1889), sent to the Minister a proposal on the planning of an Italian scientific expedition for the observation of the transit of Venus.⁶ The plan was kept aside for more than a year, but the pressures exercised by Tacchini compelled the Minister at the end of 1873 to call him for collecting more information concerning the organization of a scientific expedition according to the availability of financial grant.

The grant was allocated with more delay than by other nations and it was so meagre that only one station could be constructed. Therefore, Tacchini "redesigned" the aim of the expedition. Rather than measuring solar parallax, for which many stations for observations were

required, Italian astronomers were to study the problem of determining the best method to observe the contact, spectroscopically⁷ or visually.⁸ So he wrote to the Minister:

“For this purpose, we need to execute concomitantly as well as in the same place, the observation of the transit of Venus, with the new spectroscopic method as well as with the usual method while having a place from which possibly all the four contacts could be observed.

From a first examination of the Proctor’s map, it can be immediately seen that a suitable place could be found in Southern India, where the geographic position of some English astronomical stations could be used to determine that of the chosen site for Italian observations.”⁹

With such an appropriate adjustment, Tacchini persuaded the Minister of the “possibility and convenience” to organize an Italian expedition and he was officially made in-charge of the expedition of January 5, 1874.

Though the time available was very short—the transit was to take place on December, 8/9 of the same year—Tacchini succeeded in organizing even the scientific part of the expedition in only fifteen days and on January 20, he presented to the Minister a detailed report. The members of the expedition were the famous spectroscopist,¹⁰ the Jesuit Angelo Secchi (1818-1878), director of the Observatory of the Collegio Romano; Alessandro Dorna (1825-1886) of the Observatory of Turin and Antonio Abetti (1846-1928) of the Observatory of Padua. The last two carried out the usual observations, while Tacchini and Secchi the spectroscopic ones.¹¹ Since they had to select themselves the site for observations and as every place in India was good enough for their scientific programme, Tacchini decided to write to the Consuls of Bombay, Calcutta and Madras as well as to the Director of Madras Observatory, Norman R. Pogson (1809-1891). The first positive answer came from F. Lamouroux, Consul of Calcutta. Tacchini then requested him to choose the best site for observations, either in the city or in its neighbourhood in accordance with the best probability of a clear sky. Lamouroux consulted the rector of St. Xavier’s College¹² in Calcutta and the Belgian Jesuit Eugène Lafont (1837-1908)¹³ who was professor of physics in the same College, meteorologist and good amateur spectroscopist. Lafont was invited to join the expedition. After making some enquiries, Lamouroux communicated to Tacchini in the beginning of October that the most suitable station seemed to be Madhupur (*Muddapur*).

During the following summer, Secchi had to leave the expedition for health reasons. The spectroscopic observations were therefore allotted to Abetti, while Dorna and Lafont carried out visual observations. A private amateur, Carlo Morso di Favarella of Palermo, joined the team at his own expenses.

The expedition faced a difficult and adventurous travel from Venice to Bombay. From there, they went by train to Allahabad and then to the selected station. Tacchini and his colleagues arrived in Madhupur by mid November, just in time for preparing the camp and for setting up the instruments. They selected a little hill near the house which the Consul had put at their disposal, and which was not far from the railway station, whose staff contributed to the daily chores.

Notwithstanding the expected climatic condition on the day of the transit, the observations were hindered by variable weather conditions and only the third and fourth contacts could be observed by both methods. The most important result was the evidence of the substantial difference between the contacts-times recorded visually by the simple telescope and those recorded by the spectroscope, the third and fourth contacts were indeed observed about two minutes before the ones observed telescopically. Another important result obtained by Tacchini was the existence of absorption bands in the observations of Venus. He correctly concluded that Venus had an atmosphere, the composition of which consisted of "...a great deal of vapours, analogous to the terrestrial ones".¹⁵

The Foundation of the Calcutta Observatory

After the observation of the transit of Venus, Tacchini stayed in India a little longer as he had been invited by the Royal Astronomical Society of London to join the planned English expedition for the observation of the next total eclipse of the Sun on April 6, 1875 visible from the Nicobar Isles in the Gulf of Bengal.

Tacchini had then the opportunity to carry out a long thought out project. In 1871 he had founded with Secchi, Giuseppe Lorenzoni, Lorenzo Respighi (1824-1889) and Arminio Nobile (1838-1897), the "Italian Spectroscopists' Society" (*Società degli Spettroscopisti Italiani*), the first scientific society specifically devoted to astronomical spectroscopy or "physical astronomy", later was the first term for astrophysics.¹⁶ The first aim of the Society was the execution of a programme of spectroscopic observations of any change in the solar limb, in order to examine and to study solar features in a continuous way.¹⁷ Actually, this was the pretext to organize the spectroscopic research in Italy and to create a body for scientific exchanges and collaboration

in this nascent field of astronomical science; having realized that the Italian could thus occupy a high position on the international scene.

Tacchini therefore exploited his long stay in India to realize a daring idea for promoting further the activity of the Society:

"During our stay in Muddapur (...) we experienced the most favourable climatic conditions to carry out a series of spectroscopic observations of solar limb in a season in which we are seldom successful in Palermo and in other Italian towns.

*We recall, then, the necessity already expressed in preceding years by me and by Secchi, of having in another country an observatory which could be used to, complement the series of our solar observations, as during the winter season they are suspended in our observatories, especially from November to March."*¹⁸

Tacchini compared climatic conditions in Calcutta and in Palermo and he found that the months of minimum rain fall in Palermo corresponded to those of maximum rain fall in Calcutta and vice-versa. Moreover, the best months to observe in Calcutta were also the cooler ones, with great advantage for the observers. And since the difference of latitude between Calcutta and Palermo was about five hours, the observations would never be simultaneous, even if the Sun was observed by both observatories in the morning of the same day. That provided a great advantage for compiling data of solar features. So Tacchini concluded: "...it is evident that the station at Calcutta has got all required advantages for a complementary Observatory."¹⁹

The next step was to find someone capable to carry out the project. The most suitable person seemed to be Father Lafont, the Rector of St. Xavier's College, whose collaboration Tacchini had the opportunity to take advantage of in Madhupur. Lafont was very popular in Calcutta. He had arrived in India in 1865 to teach experimental physics at St. Xavier's College and he had contributed to its reputation. Only two years after, he had earned the respect of Calcutta's society for his warning of an impending violent cyclone, which caused later only partial damage due to his forecast. As a result of his forecasting, he had succeeded in the same year in establishing a meteorological observatory at the College, with the contribution of the high and middle classes of the Calcutta's society.²⁰ In 1871 he was named Rector of the St. Xavier's College,²¹ where he promoted the scientific studies and got constructed a physical laboratory, the first in that region. He provided for the laboratory a good collection

of scientific instruments, which in turn were offered by many local authorities, maharajas and other friends in Calcutta.²² Moreover, he was an associate member of the Asiatic Society of Bengal and a great friend of Dr. Mahendra Lal Sircar, whom he had supported in founding the *Indian Association for the Cultivation of Science*. He became its vice-president and carried out a considerable work in the popularisation of science by giving weekly lectures.²³ Tacchini immediately realized that Lafont was the right man for his purpose. He persuaded him to build a spectroscopic observatory at the St. Xavier's College; Tacchini himself drew the plan of the new observatory, while Lafont opened a public subscription to collect the funds.²⁴ At the end of March 1875 Lafont had collected sufficient money to buy a good astronomical instrument and Tacchini ordered for him a 7-inch equatorial of Merz in Munich. The building of the Observatory was soon started and when Tacchini left Calcutta at the end of April it was so advanced that Lafont wrote to Tacchini in July 1875:

*"I am pleased to announce to you that our observatory is almost completed (...). Mr. Merz had already written to me and he is busy building a 7-inch Equatorial with parallactic mounting for 12,500 francs. It will not be finished before eighteen months. I am going to receive a 10-prism spectroscope of Browning as the Lockyer's one, and also a direct vision spectroscope which I will use with a small 3-inch telescope of Steinheil, while waiting for the installation of my grand instrument".*²⁵

At the same time, Tacchini announced to the scientific community, on the pages of the *Memorie della Società degli Spettroscopisti Italiani*,²⁶ the creation of a spectroscopic observatory in Calcutta:

"The eminent father Lafont, Diector of St. Xavier's College in Calcutta, after observing the chromosphere and the solar prominences with our instruments in Madhupur, and seeing the practical way to execute the spectroscopic observations of the Sun at our station, has accepted the proposal to build an Observatory in Calcutta in his College with the aim of carrying out there regular solar observations, which (...) could fill the inevitable gaps of our Observatories because of the too often overcast sky in (winter) months.(...) The station is almost complete and I myself ordered to Merz, for the new observatory, a 7-inch refractor which will be installed on the site in 1876. (I) mean that we do not have to wait long, the new Calcutta Obser-

vatory will be able to give the best results under the active direction of Lafont, to whom our colleagues will be very grateful for remedying, with his ability and commitment, a long complained snag."²⁷

Here is the description of the Observatory, as planned by Tacchini:

The refractor's room is circular, and it consists of 7-foot walls on which a 10-foot revolving dome is placed. This dome moves with the well-known system of small wheels with independent frame. The circular tower having the room has a diameter of 27 feet and is 53 feet high. At its centre, a strong pillar has been built to support the equatorial. All around the tower, there are stairs and other rooms meant for the observatory".²⁸

While waiting for the great refractor, Lafont procured other small instruments and he started practising spectroscopic observations. In autumn 1875, he wrote to Tacchini:

"...I have adapted a direct vision spectroscope to a little 3-inch telescope and very often I enjoy myself in looking for some prominences. This enables me to train my eyes gradually..."²⁹

And a month later:

"I am waiting for my instruments with impatience and while waiting for them I practise with my spectroscopes to familiarize with the different spectra, the gaseous and the metallic ones."³⁰

Tacchini did not neglect also to publish an account of the progress of the new observatory in the *Memorie*:

"...Lafont wrote to us from Calcutta (...) giving us the good news that he had obtained for his observatory, another 9-inch equatorial. The objective has been made by Steinheil and the parallactic mounting will be executed in England in a way close to perfection.³¹ In so doing the spectroscopic observations of Calcutta will be entirely comparable to those made by the refractors of Palermo and Rome".³²

In the same year, news about the establishment of the Observatory was published in *Nature*, in an article entitled 'Solar observations in India,' signed by the chemist Raphael Meldola (1849-1915)³³:

"Now that the subject of solar observation in India is likely to occupy the attention of the scientific public³⁴, (t)he following details of the Solar Observatory now in progress of construction at Calcutta may be of interest to readers of *NATURE*. The suggestion emanated in the first plan from the well-known Italian astronomer and spectroscopist, Prof. Tacchini, who was sent in India by the Italian Government as director of the Transit of Venus' Expedition. The idea thus put forth was at once taken up by Père Lafont, the Principal of St. Xavier's College. A subscription was opened to enable the work to be carried on and in a short time the collection had amounted to 10,000 rupees, to which Indian Government added 5,000 rupees. So warmly does the idea seem to have been taken up, that a theatrical benefit was given, at the suggestion of Col. Wyndham, in aid of the observatory fund. The observations proposed to be carried out are to supplement those made in Italy (...). A complete annual record of changes in the sun's chromosphere, & c., will thus be kept up. With regard to instruments, an equatorial of 7-inch aperture is now being constructed by Merz, but more funds are needed to complete the instrumental 'plant' of the Observatory. In course of time it is to be hoped that a transit instrument and a complete set of meteorological apparatus will be added.

The Italian Transit of Venus' Expedition has thus been the means of sowing seeds which, finding themselves in a soil most favourable for development, are calculated at no very distant period to bear fruit of the greatest value to science (...). It is only by systematic observations of this kind, carried on by public enterprise, that we can ever hope to detect cyclical changes in the sun's composition and constitution..."³⁵

At the same time, Tacchini started a correspondence with Col. James Waterhouse (1842-1922), secretary of the *Asiatic Society of Bengal* and amateur spectroscopist. His letters to Tacchini give evidence of the support given by the Society to the project. In 1875, after thanking Tacchini for sending the collection of the *Memorie* as gift for the Society, he added:

"...the Council (of the Asiatic Society) looks forward with great interest to the time when the Spectroscopic Observatory (...) set up under the directions of Revd. Father Lafont, will be sufficiently advanced to enable observations to be made

*and recorded, in this most important branch of Science and they will have great pleasure in communicating these observations to the Society of Italian Spectroscopists, as soon as publis(h)ed in the Society's Journal."*³⁶

And, a week later:

*"I do not know when we shall be in a position to give you any results of Fr. Lafont's observations but will do so when we receive them".*³⁷

Actually, at the end of 1876, Lafont was still waiting for his instruments:

*"...my equatorial is not mounted. This deprives me of the pleasure to begin my work.(...) I have prepared everything. The only missing thing is the parallactic support".*³⁸

Finally, in summer 1877, the refractor of Steinheil was ready and the Observatory well-equipped; Lafont wrote to Tacchini:

"Here are the instruments which I have at my disposal for the time being:

1. *An excellent telescope of 9-inch aperture, with the objective made by Steinheil in Munich.*
2. *The above-mentioned telescope is mounted on a strong parallactic machine with 13-inch divided circles and with a clock mechanism for the latitude of Calcutta, made by John Browning of London. This apparatus is perfectly constructed and supported by 3 (lower or levelling) screws of big size. It is installed in such a way that I can make it work by hand or by the clock mechanism.*
3. *A 6-prism reversing spectroscope, equipped with 3 oculars and a micrometric screw.*
4. *A very dispersive direct vision spectroscope.*
5. *An ocular spectroscope for the stars, without slit, with cylindric glasses, all by J. Browning.*
6. *An excellent astronomical clock and a watch-shaped recording chronometer, dividing the seconds in 5 parts.*

*I think that, with these instruments, a clear sky and some practice, next winter I should be able to send you my observations of the solar limb."*³⁹

Once the Merz was mounted, Lafont was ready to start his work:

"I am pleased to announce that the telescope of Merz is practically completed; in 2 or 3 days' time, if the sky is clear, I shall begin my work. This parallactic mounting is by far better than the English one, so I prefer to keep this telescope even if it is smaller and I have dismantled the 9-inch one, which I wish to sell for covering the remaining expenses for the Observatory".⁴⁰

Lafont sent the first results of his observations in 1878:

"...I send you some observations which the excellent weather conditions of the season had allowed to carry out. Do not publish them, for these are my first trials with the Eddison's electric pen, which, I think, will be very useful to me when publishing my observations about solar limb..."⁴¹

His observations were in good accord with those recorded in Palermo, to the great satisfaction of Tacchini:

"In this first essay sent by Lafont there are some solar limbs drawn in November 1877 and April 1878. The traits of the prominences and of the chromosphere were in good accordance to the drawings made in Palermo; from some of the observations about the solar limb drawn here on the same day, one could verify the shapes and the sizes of the same prominences, their slope and their height, so that by now it can be said that the drawings which we shall receive from Calcutta are entirely comparable with those made in Italy. (...) And for us, Italians, the Calcutta results are more than gratifying as that Observatory was built consequent to the Italian expedition to Bengal in 1874".⁴²

Unfortunately, the results of Calcutta's observations were never published as asked by Lafont, who was probably not yet completely sure of their accuracy. Moreover, in November 1878 probably stressed by the work, Lafont was seriously ill and was forced to go back to Europe for months. He wrote to Tacchini:

"...I think that misfortune is attached to my observatory. When I was going to begin the spectroscopic observations, I was struck by a malignant fever which led me almost to death and which weakened me so much that the Doctors thought it would be better for me to go back to Europe for a year. Thus the observatory at Calcutta reduced to inactivity for an unlimited period of time. I am sure you regret this as much as I."⁴³

Tacchini, in publishing the letter, added:

"Shortly after having received this letter, (...) in the beginning of January 1879, we were pleased to see in Palermo our colleague who, thought still lying due to illness, had already recovered enough so as to believe that he would soon go back to Calcutta".⁴⁴

Actually, the following year Lafont left again Europe for India, but no more news about the Observatory was published in the *Memorie*. Several reasons could be considered to explain this fact.

In 1878, Father Secchi died. The spectroscopic research in Italy lost a great scientist. The programme of the *Società degli Spettroscopisti Italiani* changed. There had already been some problems inside the Society about the sharing of the observations and, actually only Tacchini, Secchi and Lorenzoni really worked on the programme. After the death of Secchi, Tacchini was named the Director of the *Ufficio Centrale di Meteorologia*,⁴⁵ and he was replaced by Annibale Ricco' (1844-1919) as Adjoint Astronomer at the Observatory of Palermo. He was put in charge of many tasks in Rome so that he had less time to devote to the solar observations. He was then preoccupied only with the solar statistics, in order to find some correlations between the photospheric and chromospheric features. But while his international and political role became very important, his scientific work actually decreased both in quantity and in quality. Other problems arose in the scientific community, such as the spectroscopy at high altitude, and Tacchini was at that time very busy reorganizing the national meteorological and seismological network. So the contacts with Calcutta were probably lost and the project of collaboration ended without having ever really begun.

The Destiny of the Observatory

Father Lafont came back to India at the end of 1879 and he continued his activity at the Observatory. He left Calcutta again in 1900, for a year, to study the scientific section of the *Exposition Universelle* in Paris. It is likely that he had met there again Tacchini at that occasion, but it had no consequence for the observatory. In 1877, Lafont had been nominated as a Fellow of the University of Calcutta; he became member of the Senate of the University and he was often delegated as its representative in the Syndicate. In the beginning of 1904, he was elected as the President of the Faculty of Arts and in 1908 Lord Minto, Chancellor of the University of Calcutta, conferred upon him the honorary degree of Doctor of Science, in acknowledgement of his work to introducing scientific studies at the

University. He collected also many honorary decorations, such as the title of *Companion of Indian Empire*, which he received by the Empress Victoria at the request of Lord Lytton; in 1880 he received the Medal of the *Indian Star* and later the title of *Officier de l'Académie de France* at the request of Marquis Dufferin, formerly Viceroy of India and later British envoy at Paris, and finally that of *Chevalier de l'Ordre de Léopold*, given to him by the king of Belgium in 1898. He died in 1908 at the St. Joseph College in Darjeeling, where he had retired because of health problems.

In his obituary notice, published in *Nature*, it can be read:

"Father Lafont will long be remembered in Bengal for his distinguished scientific attainments and for the enthusiastic zeal with which he forested the study of practical science by every means in his power among the Indian and Eurasian students. He was, however, an educationist rather than an original thinker or original worker, but he did yeoman service for science in Bengal. (...) Lafont was a born popular scientific lecturer (...). He was always held in the greatest respect and esteem by all his fellow-workers, and was most popular with all Indian gentlemen. (...): his name will thus be long kept in mind as that of one of the pioneers of scientific education in Bengal, and his death is hence a great loss, especially at this time, when strenuous efforts are being made to put education in Bengal on a satisfactory basis".⁴⁸

The analysis and the judgement of his contemporaries is fully to be shared. Lafont's main contribution was effectively in the field of education rather than in science. Actually, he had left the responsibilities as Director of the Observatory since a long time before his death. After his first departure for Europe in 1878, the Observatory had been put shortly under the directorship of Fr. Desiderius Van Impe (1843-1878), a mathematician; in 1887, a third floor was added to the building of the College and the Observatory, with its massive dome, was transferred to the garden, in a most isolated and comfortable position. In about 1891, Fr. Alphonse De Penaranda (1834-1896), formerly Lafont's assistant and teacher of Mathematics and Astronomy at the College since the end of 1874, was named as Director of the Observatory. He observed some astronomical phenomena, such as a transit of Mercury and some eclipses. In 1902, the Observatory was put under the directorship of Fr. Constantin De Clippeleir (1843-1908), physician and astronomer, who was at first assisted by Fr. Julien Meunier (1862-1934) before the latter was named as Rector of the

St. Joseph's College in Darjeeling. In 1904 the Director of the Observatory was Fr. Edouard Francotte (1843-1923); in 1906 it was still reported as an astrophysical observatory:

*"The observatory of the St. Xavier's College in Calcutta is especially an observatory of astrophysics. It was founded in 1875 by the Rev. Fr. Lafont, Rector of the College, on the request of Mr. Tacchini (...) with the aim of collaborating in the work of Fr. Secchi and of other members of the Society 'degli Spettroscopisti Italiani'. The sky of Bengal, always very clear in winter months, had to be used for precious solar observations, (thus) completing the ones carried out in Europe. (...) The main instruments are as follows: a telescope of 22-cm aperture by Steinheil of Munich; a reversing spectroscope by Browning of London, equivalent to 16 prisms of 60°; a little 7.5-cm equatorial; a little transit instrument; finally a celostate with double mirror made by Gautier of Paris. Some interesting works could be carried out with these instruments; unfortunately, up till now, it has been impossible for the Superiors of the Bengal's mission to provide it with the necessary staff for constant observations."*⁴⁷

In this last assertion lies perhaps the reason for the decline or, better, of the failure to expand the Observatory. His only recorded scientific contribution was the observation of some eclipses of Sun: on June 17th, 1890, Frs. Vincent de Campigneulles (1847-1917) and de Penaranda observed an annular eclipse at Bhagalpur and in 1898 a little staff of nine Jesuits and ten assistants under the direction of Fr. De Clippeleir observed the total eclipse of January 22nd in Dumraon.⁴⁸ The next total eclipse of 1901, observed at Poday, was instead hindered by clouds and gave no results. No other news about the successive activities of the Observatory had been founded. It seems, that under the Direction of Fr. Francotte only meteorological observations were carried out there;⁴⁹ it was probably closed down in 1920's.⁵⁰

Remarks about the Development of Astrophysics in India in 19th Century

The idea of Tacchini to establish a solar observatory in India was really a brilliant intuition.⁵¹ If the project had succeeded, India should have got its first astrophysical observatory about twenty years before the establishment of the Kodaikanal solar observatory, which was built in 1895 and started functioning in 1900, thanks to Charles Michie Smith (1854-1922), Director of the Madras Observatory,

who tried to start the practice of 'New Astronomy' in India.⁵³ Calcutta Observatory seemed to be also the forerunner of the Takhtasingji Observatory which was founded in Poona in 1882 and which was directed by the Indian physicist Kavasji Dadabhai Naegamvala (1857-1938).⁵³ Actually, he visited the Observatory at Calcutta and in 1884 he was recommended by Fr. Lafont for visiting the most important observatories and laboratories in Europe, including, as it was natural, Tacchini's Observatory of the Collegio Romano. Naegamvala spent some time at South Kensington to practise astrophysics under the direction of Norman Lockyer (1836-1920), and when he returned to India, in about 1888, he equipped the Observatory with good spectroscopic instruments, with the support of the Royal Astronomer of Greenwich, William H. Christie (1845-1922), who wrote to him in 1897:

*"India seems to be peculiarly marked out for observations of the Sun, especially spectroscopic..."*⁵⁴

This is exactly the same remark which Tacchini had made about twenty years before. It is not surprising, then, that in 1893 Tacchini himself had supported the establishment of a spectroheliograph at the Naegamvala's Observatory.⁵⁵ The excellent equipment of Naegamvala, the best at that time in India, had been preceded only by the valuable set of instruments collected in Calcutta by Lafont in 1876 for his Observatory. Quite curiously, both the Observatories never used their excellent equipment to their fullest capacity. Apart from their excellent reports about the observations of the Solar eclipse of 1898, Takhtasingji Observatory as well as Calcutta Observatory seems to have done no other contributions to solar physics. Naegamvala was perhaps hindered in his scientific work by his simultaneous activity as a teacher at the University of Bombay and this was probably the same for Lafont and his successors at Calcutta at one time. Anyway, Calcutta's Observatory appears as a missed opportunity. It could have led to Indian astrophysics to develop quickly and to have very soon found a respectable place in the international arena of the new born science in which solar physics was developing at the same time in Europe with great success.

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NOTES AND REFERENCES

- 1 This method consists of comparing the contact-times recorded by several stations located at different points of the globe from where the transit can be observed. The importance of the measurement of the solar parallax as exactly as possible is due to its use for the calculation of Sun-Earth distance, which in turn is the Astronomical Unit (AU). This is the first step in the determination of cosmological scale of distance. Another methods used later, was that of the transit of some asteroids: we recall here the international work carried out at the occasion of the transit of Eros in 1909.
- 2 This phenomenon takes place alternately every 115 ± 8 and 8 years.
- 3 Tacchini can be really considered as the great organizer of scientific research in Italy in 19th century. He was born in Modena in 1838; after studying engineering, he went to the prestigious Observatory of Padua to specialize in astronomy. After two years, at the age of twenty-one, he came back to Modena to undertake the Directorship of the small local Observatory until 1863, when Giovanni V. Schiaparelli (1835-1910), the famous director of Milano's Observatory, offered him the charge of Adjoint Astronomer at the Palermo Observatory. In 1879 he succeeded the famous spectroscopist Father Angelo Secchi (1818-1878), as director of the Observatory of the Collegio Romano. He was the founder of the "Società degli Spettroscopisti Italiani" in 1871 and of the "Società Sismologica Italiana" in 1895, the author of the first reform of Italian Observatories, and the promoter of the creation of many astronomical, meteorological and seismological observatories. Tacchini was known by the international scientific community especially for his studies in solar physics; for which kind of research he received in 1888 the "Rumford Medal" of the Royal Astronomical Society of London and in 1892 the "Prix Janssen" of the Académie des Sciences of Paris.
- 4 In 1870 the Italian Government annexed Rome and its suburbs as the national territory, thus achieving a complete political unity—a process which had begun in 1861.
- 5 The Observatory of Palermo was founded in 1792 and it became famous in Europe for the work of Giuseppe Piazzi (1746-1826), who was its first Director and who discovered in 1801 the *first* asteroid *Ceres*, while working for the compilation of his important catalogue of stars. At that time, the observatory of Palermo was the most southern observatory in Europe.
- 6 It is easy to realize that Tacchini was probably the real author of the proposal. As a matter of fact, he was the direct interlocutor of the Minister.
- 7 After the publication of Kirchhoffs laws of radiation in 1859, a vast field of research was opened to the astronomers of 19th century. The introduction of the spectroscopy in astronomy led to the birth of astrophysics as an independent science. Nevertheless, in the beginning only a few astronomers realized that, in spite of some hostility from certain classic astronomers.
- 8 The idea of comparing spectroscopic and visual observations had been proposed, for the first time, by the French astronomer Hervé A. Faye (1814-1902), before 1870; the transit of 1874 should be then the first occasion for its application.

9 *"Per arrivare a ciò è necessario di potere eseguire contemporaneamente, cioè nelle stesse condizioni di sito, l'osservazione del passaggio di Venere, tanto col nuovo metodo spettroscopico, come col metodo ordinario, e scegliere possibilmente una località dalla quale osservar si possano tutti e quattro i contatti.*

Da un primo esame fatto sulla carta di Proctor si vede subito, che una posizione conveniente potrebbe trovarsi nelle Indie meridionali, ove qualche stazione astronomica inglese potrebbe anche servire di base per la determinazione della posizione geografica del sito scelto per le osservazioni da farsi dagli italiani," (see: Tacchini, p. 3-4).

- 10 Secchi had been a real pioneer in astronomical spectroscopy and he was an unquestioned authority in this field. His fame was especially due to his remarkable research in solar physics and to his spectral classification of the stars —one of the first in the history of astronomy.
- 11 Regarding the instruments, Tacchini obtained from the Observatory of Bologna a Steinheil refractor of 162 mm aperture and from the Observatory of Turin a Fraunhofer refractor; two Starke apertures of 117 mm and other secondary instruments from the Observatory of Padua which offered also a good mechanic, Cagnato. Then, Tacchini got constructed the building of the tool sheds and obtained other secondary instruments from the private collection of the marquis Montecuccoli in Modena.
- 12 St. Xavier's College was founded in 1860 by the first Belgian Jesuit mission in the ancient theatre Sans-Souci, which had been already the seat of St. John's College. In 1862 St. Xavier's College was affiliated to the Calcutta University. The College still exists.
- 13 Lafont was born in Mons in 1837 as son of an old officer. After his studies at the Sainte Barbe's College at Gand, he joined in December 1854 the Jesuits' order and during his novitiate he studied the philosophy of science at the Faculty of Namur. There he developed a special aptitude for physics, and after completing his studies, he devoted himself to teaching at the St. Barbe's College in Gand, later at the St. Sever's College in Liegi and finally at the St. Ignace's Institute in Anvers. In 1864, the Catholic mission of Bengal was entrusted to the Belgian Jesuits. Renouncing perhaps a promising career in Europe, Lafont sought for the assignment to the new mission. He became soon very popular in Calcutta for his work on popularization of science among the cultured classes of Calcutta's society.
- 14 Probably some controversies arose with the spectroscopist and astronomer, Giuseppe Lorenzoni (1834-1914), at the Padua's Observatory about the best method to observe the contact by the spectroscope.
- 15 *"...una grande quantità di vapori, analoghi a quelli dell'atmosfera terrestre,"* see: Tacchini, p. 111. The idea that Venus had a gaseous atmosphere had already been expressed by some astronomers, but it had never been observed spectroscopically.
- 16 In the summer of 1871, Tacchini proposed the first programme of simultaneous observations between the Observatories of Collegio Romano and Palermo. He was interested in studying solar prominences in order to classifying them; so he proposed to Secchi to carry out a series of observations of the solar limb on the same days, at the same hours, with the same instruments and to compare the results for verification. After that first positive experience, they recognized the usefulness of observing the Sun continuously and in a detailed way. They realized also that it was necessary to have a team work comprising main Italian Observatories. So, Tacchini founded the Society of Italian Spectroscopists in

- October 1871, with the advice of Secchi and by sharing the responsibilities with Giuseppe Lorenzoni (of the Observatory of Padua), Lorenzo Respighi (of the Observatory of Rome), Campidoglio and Arminio Nobile (of the Observatory of Naples-Capodimonte).
- 17 They decided to work in monthly shifts in order not to hinder other activities of any Observatory. In so doing they ingeniously solved a problem which troubled national Observatories abroad, i.e., the introduction of physical astronomy at the cost of classical astronomy and which was often criticized and contested.
 - 18 "*Durante la nostra dimora in Muddapur (...) notammo la condizione propizia di quel clima per potervi eseguire una serie di osservazioni spettroscopiche del bordo solare in una stagione, nella quale a Palermo ed in altre città italiane riescono soltanto di rado. Ci risovvenne allora della necessità espressa negli anni precedenti da me e dal Secchi di avere un osservatorio in altro paese, il quale potesse fornire il complemento alla serie di osservazioni solari che rimane interrotta nei nostri osservatori durante la stagione invernale, e più propriamente dal novembre al marzo,*" (see: Tacchini, p. 115).
 - 19 "*E' dunque evidente che la stazione di Calcutta possiede tutti i vantaggi desiderati per un osservatorio di complemento,*" (Ibid., p. 117).
 - 20 The observatory was equipped with some valuable instruments, such as a Secchi's meteorograph, which was acquired in 1870.
 - 21 Meanwhile, Lafont had been named vicar after his ordination in 1869 and then priest of the St. Thomas' parish—a charge that he held for more than twenty years, getting more popularity as an eminent preacher as time went by.
 - 22 At that time, the scientific studies were not much developed in Bengal and even the higher education was generally lacking in scientific contents. He started, for the first time, the teaching of experimental physics in the College and he was long considered a pioneer in the promotion of scientific studies at the University of Calcutta.
 - 23 The Association started work in 1876, but the friendship with M. L. Sirkhar dated back probably from 1869, when the project of founding an Association for popularizing science was announced. Later, the *Indian Association for the Cultivation of Science* developed into a renowned Research Center, where remarkable research and discoveries were carried out in the field of the spectroscopy.
 - 24 Lafont was well-known in both European and Hindu society of Calcutta and of Bengal. From the Press of these times it can be seen that of the three quarters of the high and middle classes of Bengal, Catholic, Protestant or Hindu, Father Lafont was considered the most popular representative, and even a symbol of Catholicism. He appealed to the traders of Calcutta and to other friends for donations. The Governor of Bengal gave 5,000 rupees. A special performance was given at the Opera's theatre of Calcutta for the proposed Observatory. In so doing he soon collected a remarkable amount of about Rs. 21,000, cf. Tacchini, p. 117; also *MBCJ* (1905) pp. 69-75; *ibid* (1908) pp. 263-270.
 - 25 "*...J'ai le plaisir de vous annoncer que notre Observatoire est presque fini (...) M. Merz m'a déjà écrit et il est occupé à construire un équatorial de 7 pouces avec machine parallatique pour 12500 francs. Cela ne sera pas terminé avant dix-huit mois. Je vais recevoir un spectroscopie de Browning à 10 prismes comme celui de Lockyer plus un spectroscopie à vision directe que je me propose d'employer avec un petit télescope de 3 pouces par Steinheil en attendant que mon grand instrument soit installé,*" (Lafont to Tacchini: Calcutta, July 19th, 1875—Archives of the *Ufficio Centrale di Ecologia Agraria*, Rome); see also Chinnici (b), p. 56.

- 26 The *Memorie* was a very renowned scientific review. At that point of time it was actually the only review entirely devoted to spectroscopy, twenty years before the publication of *The Astrophysical Journal*, whose founder George E. Hale (1868-1938) took inspiration from the *Memorie*. All most important works in astrophysics were regularly published in the *Memorie* and it was a great international success.
- 27 "L'illustre P. Lafont direttore del Collegio di S. Saverio in Calcutta, dopo di avere a Muddapur osservato coi nostri istrumenti le cromosfera e le protuberanze solari, e veduto il modo pratico col quale si eseguivano nella nostra stazione le osservazioni spettroscopiche del sole, accolse col massimo interessamento la proposta di erigere in Calcutta un osservatorio nel proprio collegio, allo scopo di eseguirvi regolarmente delle osservazioni sul sole, le quali (...) potessero servire a colmare le inevitabili lacune delle nostre specole a motivo del cielo troppo spesso coperto nei suddetti mesi (invernali) (...) Il locale è già quasi finito, ed io stesso ordinai al Merz pel nuovo osservatorio un refrattore di 7 pollici, che entro il 1876 potrà venir collocato al suo posto: così' che non passerà gran tempo, che il nuovo osservatorio di Calcutta potrà dare ottimi frutti sotto la solerte direzione del Lafont, al quale i nostri colleghi saranno oltremodo grati per avere egli colla sua abilità ed attività saputo rimediare ad una mancanza da tanto tempo sentita," (see: *Memorie Soc. Spetr. It.* (a), p. 136).
- 28 "La stanza del rifrattore è circolare, e si compone di una parte a muro alta 7 piedi, sulla quale poggia il cupolo girante che ha un'altezza di 10 piedi: detto cupolo muovesi col noto sistema delle rotelle a telaio indipendente. La torre circolare sulla quale sta la detta stanza ha 27 piedi di diametro ed è alta 53: al centro di essa fu costruito un robusto pilastro, destinato a sostenere l'equatoriale, a all'intorno vi è la scala ed altri locali addetti all'osservatorio," (see: Tacchini, p. 117).
- 29 "...j'ai cependant adapté un spectroscopie à vision directe à un petit télescope de 3 pouces et de temps en temps je m'amuse à chercher des protubérances: cela fait peu à peu l'éducation de mes yeux..." (Lafont to Tacchini: Calcutta, October 1st, 1875, Archives of Ufficio Centrale di Ecologia Agraria, Rome; see also Chinnici (b), p. 56).
- 30 "J'attends avec impatience mes instruments et en attendant je m'exerce avec mes spectroscopes pour me familiariser avec les différents spectres gazeux et métalliques." Lafont to Tacchini: Ibid, Calcutta, November 5, 1875.
- 31 At first, Lafont had thought to keep both the refractors (Merz and Steinheil), if possible, or to sell one of the two if he did not have sufficient money to pay for them.
- 32 "Il P. Lafont ci scrive da Calcutta (...) dandoci la bella notizia di avere egli ottenuto pel suo osservatorio un altro equatoriale di 9 pollici di apertura: l'obiettivo è di Steinheil, e la montatura parallattica sarà eseguita in Inghilterra nel modo il più perfetto possibile. In questo modo le osservazioni spettroscopiche di Calcutta saranno intieramente comparabili con quelle dei refrattori di Palermo e di Roma," (see: *Memorie* (b), p. 8).
- 33 Meldola was Frankland's and then Lockyer's assistant and Tacchini's good friend.
- 34 The subject of the foundation of a solar observatory in India was then very actual. In a circular of 1872 of the Royal Astronomical Society, William Huggins (1824-1910) had strongly supported "...the establishment of a new observatory on the Highlands of India, or in some other part (...) where the climate is favourable for the use of large instruments..." (R.A.S. circular, June 21, 1872; see Meadows, p. 97).

- 35 See: *Nature* (a), p. 400.
- 36 Waterhouse to Tacchini: Calcutta, December 2nd, 1875, *Archives of the Ufficio Centrale di Ecologia Agraria*, Rome. Tacchini established a regular correspondence with the *Asiatic Society* by sending them the publications and the *Memorie della Società degli Spettroscopisti Italiani* since 1875, see Chinnici (b), p. 93.
- 37 Waterhouse to Tacchini: Calcutta, Dec. 9th, 1875, *Ibid.*
- 38 "...mon Equatorial n'est pas encore monté. Ce qui me prive du plaisir de commencer mon travail. (...) J'ai tout préparé: il ne me manque que la pied parallatique." (Lafont to Tacchini: Calcutta, November 17th, 1876, *Archives of the U.C.E.A.*).
- 39 "Voici donc les appareils dont je dispose pour le moment:
- 1° Une excellente lunette de 9 pouces d'ouverture, objectif parfait par Steinheil de Munich
 - 2° la dite lunette est montée sur une forte machine parallatique à cercles divisés de 13 pouces et à mouvement d'horlogerie, faite pour la latitude de Calcutta par John Browning de Londres. Cette machine est parfaitement soignée et portée par 3 vis calantes de forte dimension. Elle est installée de façon que je puis la faire marcher à la main ou par le mouvement d'horlogerie.
 - 3° Un spectroscopie à reversion à 6 prismes, muni de 3 oculaires et d'une vis micro-métrique.
 - 4° Un spectroscopie à vision directe très dispersif.
 - 5° Un oculaire à spectroscopie pour les étoiles, sans fente, à lentille cylindrique tous par J. Browning.
 - 6° Un excellent horloge astronomique et un chronomètre enregistreur, forme de montre, divisant la seconde en 5 parties.
Je crois qu'avec ces instruments, du beau temps et de l'exercice je pourrai, l'hiver prochain, vous envoyer mes observations du bord du Soleil," (Lafont to Tacchini, from the original: Calcutta, June 12, 1877, published in *Memorie* (c), p. 76, with the wrong date of July 12th). In the same letter, Lafont wrote to Tacchini that he had decided to sell the equatorial of Merz to a native of Calcutta who wished to build a solar observatory too, "so that, perhaps, there will be soon here two observers rather than one" ("...il y aura peut être bientôt ici deux observateurs au lieu d'un seul", *Ibid.*). It is difficult to identify the personality whom Lafont spoke about; he could be the above-mentioned Dr. Mohendra L. Sirkar, founder of the *Indian Association for the Cultivation of Science*, but there are no clues available which can support such an hypothesis.
- 40 "Je vous annonce avec plaisir que le télescope de Merz de 7 pouces est à peu près monté, dans 2 ou 3 jour si le ciel pur je commencerai mon travail. Cette monture parallatique est beaucoup meilleure que l'anglaise c'est pourquoi je préfère garder ce télescope quoiqu'il soit plus petit et j'ai enlevé le 9 pouces que je désire vendre pour couvrir ce qui reste à payer pour l'Observatoire", (Lafont to Tacchini: Calcutta, September, 28th 1877, *Archives U.C.E.A.*, Rome).
- 41 "...je vous envoie (...) les quelques observations que l'état extraordinaire de la saison m'a permis de faire. Ne les publiez pas, car ce sont mes premiers essais avec la plume électrique d'Eddison, qui je crois me servira fort bien à publier mes bords du soleil, quand je le saurai mieux la manier, (Lafont to Tacchini: Calcutta, May, 28th 1878, published in *Memorie* (d), p. 82).
- 42 "In questo primo saggio inviatoci dal Lafont sono contenuti diversi bordi solari disegnati nel novembre del 1877. E per noi italiani i risultati di Calcutta tornano anche più graditi, in quantochè quell'Osservatorio venne costruito in seguito alla spedizione italiana nel Bengala al 1874", (see: *Memorie* (d), p. 82).

- 43 "...*Je crois que la fatalité s'attache à mon observatoire. Au moment où j'allais commencer les observations spectroscopiques, j'ai été atteint d'une fièvre maligne qui m'a mis à deux doigts de la mort et m'a tellement réduit que les Médecins m'ont ordonné de retourner en Europe pour un an. Voilà donc encore l'observatoire de Calcutta réduit à l'inaction pour un temps illimité. Je suis sûr que vous le regretterez autant que moi*", (Lafont to Tacchini: Calcutta, November 22, 1878, *Archives U.C.E.A.*).
- 44 "*Poco dopo ricevuta questa lettera, al principio cioè del gennaio, ebbero il piacere di vedere in Palermo il collega, il quale sebbene ancora abbattuto dal male, erasi già abbastanza ristabilito per far ritenere prossima la guarigione completa e non molto lontano il suo ritorno alla specola di Calcutta,*" (see: *Memorie* (e), p. 12).
- 45 After 1887, it became *Ufficio Centrale di Meteorologia e Geodinamica*.
- 46 See: *Nature* (b), p. 35. It must be remembered that scientific education in India was very defective. In 1875, Tennant wrote to Lockyer: "...in *High Indian circles men of Science are considered as loafing impostors who trade on the general ignorance at home*". (Tennant to Lockyer, July, 25. see: *Meadows*, p. 233). That was the situation still in 1908 as described by the Governor of Bombay, George Clarke: "*I am simply appalled at the science teaching in India. It is mostly contempt and it produces no results. I am trying to make changes; but the difficulties will be very great. This University (Bombay) is about 40 years out of date, and education generally in India is unsound in method and in character,*" (Clarke to Lockyer, June 11, 1908, *Ibid.*).
- 47 See: de Vregille, p. 142.
- 48 The results of the observation of the last eclipse were published in a report: "The total Solar Eclipse, 22 Jan. 1898," by Frs. de Campigneulle and Henri Josson (1886-1939). For the observations, they used photographic cameras of various focal lengths, a prismatic and a grating camera, 3 and 4 inches telescopes, a chronograph, and other secondary instruments, cf. de Vregille, pp. 142-143, and Prof. Udias, *private communication*, Feb. 13, 1995.
- 49 The most important work in this field is a fifty years report of meteorological observations which was compiled by Fr. Francotte from 1868 to 1918, Ansari (b), p. 41.
- 50 Probably the Observatory is presently meant only for teaching, see Ansari (b), p. 41.
- 51 During the years of the establishment of the Calcutta Observatory, Lockyer also tried to establish a solar Observatory in India without success.
- 52 In a report of 1892, he remarked that the well-known Madras Observatory, the most important observatory in India at that time, was not yet equipped for astrophysical researches: "... *astronomy had advanced so rapidly (...) that the instrumental equipment is again found very defective (...) for the 'new astronomy'—photography and spectroscopy—there is practically no provision*", (C. Michie Smith—*Report on the Working of the Observatory for 1891*, Govt. of Madras Public Dept. No. 403, 404-Public-June 14, 1892, see Ansari (a), p. 247).
- 53 For the history of Takhtasingji Observatory and for some biographical notes about Naegamvala, see Ansari (b), pp. 36-40.
- 54 Letter of Christie to Naegamvala: Greenwich, Aug. 6, 1897, *Herstmonceux Archives*, see Ansari (a), p. 256.
- 55 In 1893 Naegamvala wrote to Tacchini: "...*allow me to thank you for your kindness in accounting the resolution at the late Chicago Congress concerning the establishment of a spectro-heliograph at the Observatory*" (Naegamvala to Tacchini: Poona, October 27, 1893, *Archives of the Ufficio Centrale di Ecologia Agraria in*

Rome; see also Chinnici (b), p. 68. He described also his equipment:
 "The principal instruments are:

(1) a 40 cm Cassegrain Equatorial mounted by Sir Howard Grubb.

This is supplied with photographic apparatus and spectroscopes with grating and prisms of glass and spar. It has a 15 cm telescope, achromatic, attached to serve as a guide and also for studying the solar surface.

(2) there is also a horizontal telescope of 20 cm aperture, achromatic, with a siderostat of 25 cm diameter, specially reserved for S Stars spectroscopic work. To this account telescope I propose to attach the spectro-heliograph, but at present I have only a grating spectroscope 375 mm in aperture with all necessary movements for observations of prominences etc". (Ibid.). He added then: "I shall feel proud to receive advice from you regarding the special solar spectroscopic work that you would consider desirable for me to undertake with my present instruments (emphasis as in the text). I beg also to request that you will be good enough to supply the Observatory with a set of the Publications of the Society of Italian Spectroscopists, as the informations contained therein will be a valuable help for me". (Ibid.) All these assertions confirm clearly his intention to carry out spectroscopic works at the Poona Observatory.

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Fig 1: Portrait and autograph of Pietro Tacchini (1838-1905), founder of the "Società degli Spettroscopisti Italiani" and chief of the Italian expedition to India in 1874.



Fig. 2: The Italian scientific team in Madhupur. From left to right, sitting: Fr. E. Lafont, P. Tacchini, the Consul F. Lamouroux, A. Abetti, A. Dorna.

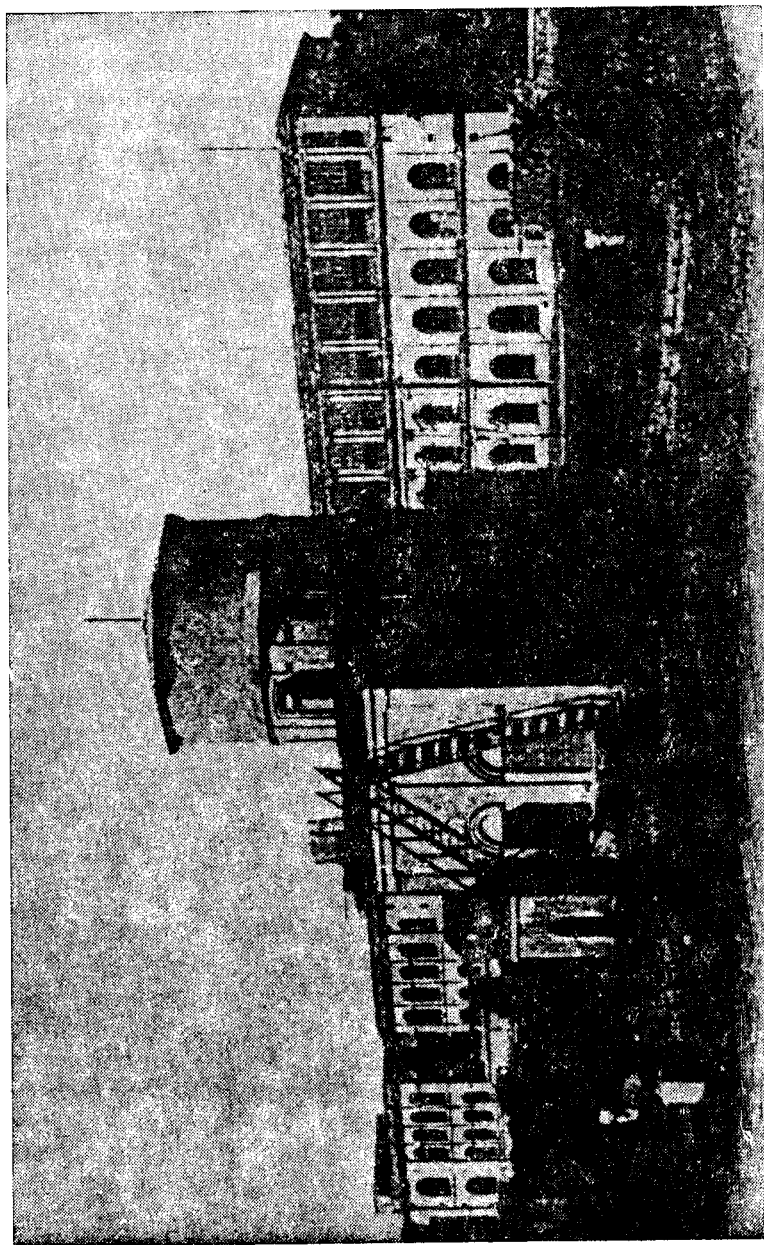


Fig. 3: The Calcutta Observatory in 1875.

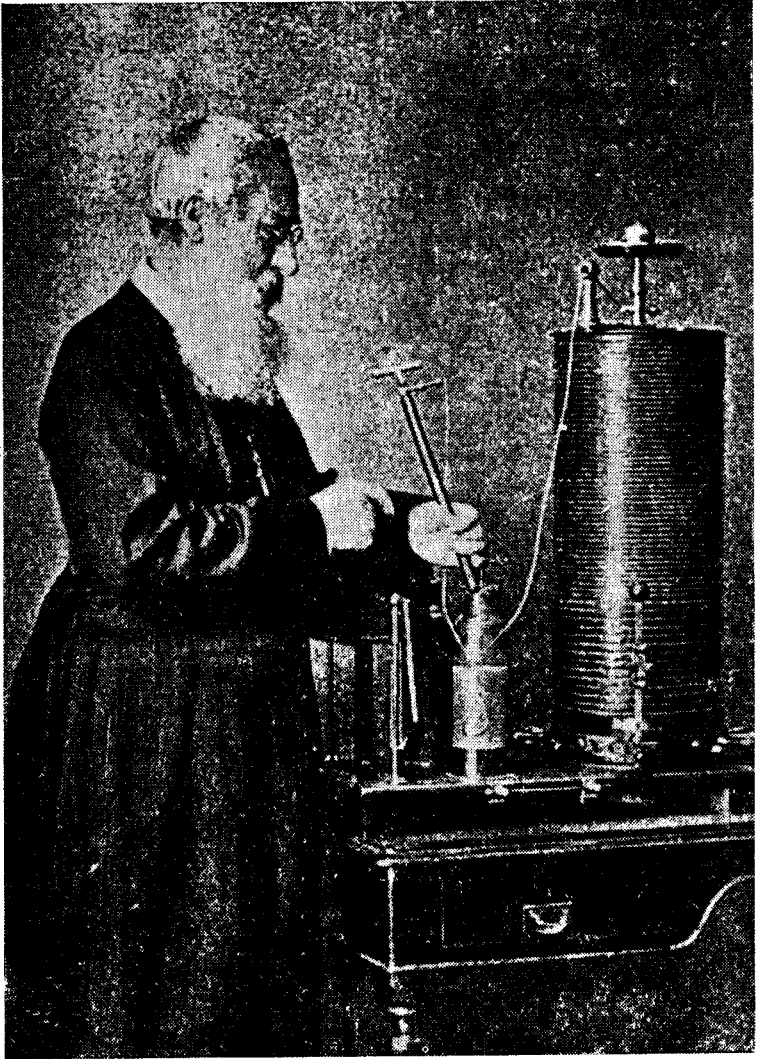


Fig. 4: E. Lafont (1837-1910) in his physics laboratory in 1904.

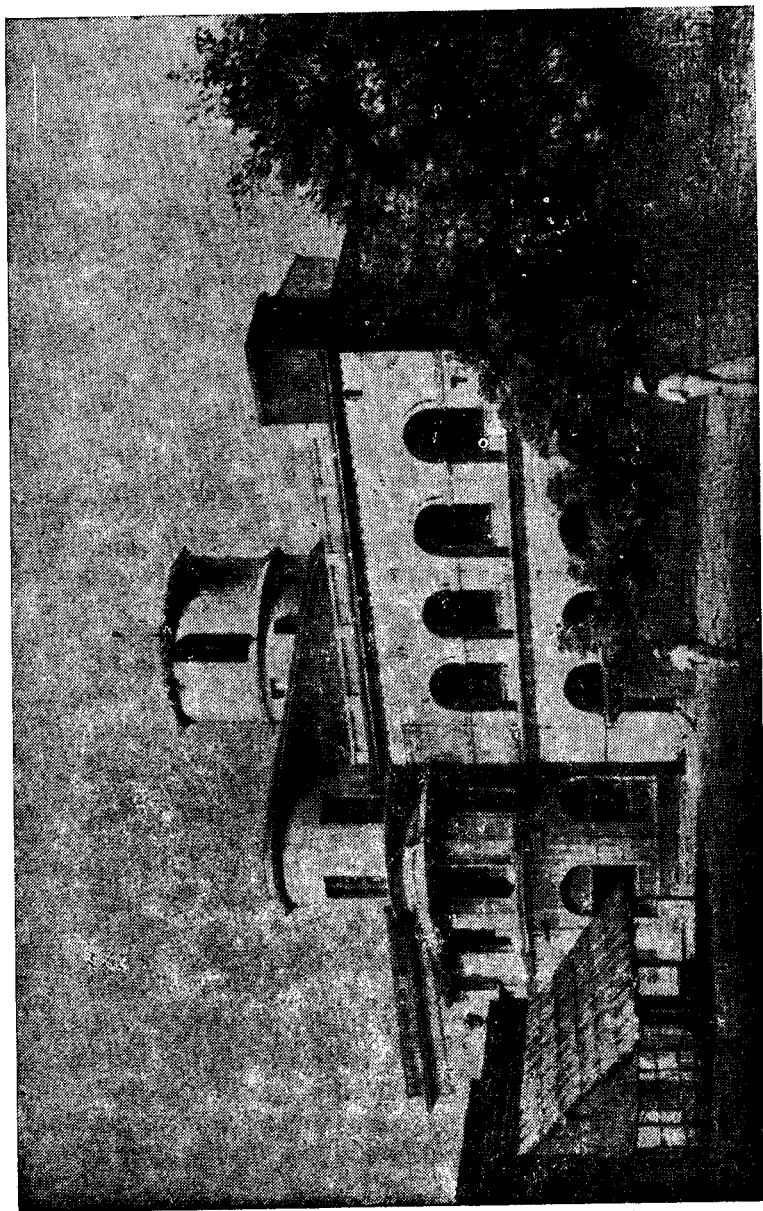


Fig. 5: The Observatory in 1910, after its transfer into the garden of the College.

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HAKHEEM ABDUL HAMEED



JAMIA HAMDARD

(Hamdard University)

HAMDARD NAGAR, NEW DELHI-110062

INDIA