



Figure 7.1: *Observatoire de Paris* (Photo: Gudrun Wolfschmidt)

7. Astronomy and Astrophysics at the Observatoire de Paris in the Belle Epoque

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Abstract

The *Belle Epoque* considered at the Paris Observatory lies from about two decades before 1900 up to the beginning of World War I. Four directors were at its head during those years: Admiral Ernest Barthélémy Mouchez (1821–1892) from 1878 up to 1892, François-Félix Tisserand (1845–1896) during only four years between 1892 and 1896, Maurice Lœwy (1833–1907) from 1897 to 1907 and Benjamin Baillaud (1848–1934) from 1908 up to 1926, a long mandate which ended seven years after the end of World War I. All of them have marked the Observatory and its activities in different fields.

7.1 Admiral Mouchez, a Difficult Succession at the Head of the Observatory

After the difficult period of the collective directorship of the Paris Observatory by the *Bureau des Longitudes*, the French Board of Longitudes, from 1795 up to 1853 the year of the death of François Arago (1786–1853), had come the era of Urbain Le Verrier (1811–1877). His character was more or less difficult but it is known that he suffered from stomachal disease and such people are known for being not easy persons. After the success of the discovery of Neptune, Le Verrier, a man full of authority, developed mostly celestial mechanics when he was asked to be director of the Observatory, in 1854.

All the realizations he made during the years he was responsible of the Observatory activities are very often forgotten: a new and modern meridian circle is installed in 1863, the precision of time determinations is increased and its diffusion made through the electric telegraph; he developed meteorology leading, after his death to the creation, outside of the Observatory, of an independent *Bureau Météorologique*. He was also interested in geodesy, longitude and latitude; he is at the origin of the publication of all the observations performed at the Observatory during the directorship of the *Board of Longitudes* later useful for further developments in the

field of celestial mechanics in the world including uses for space research.

Such was the man to whom Admiral Ernest Mouchez had to succeed. At the death of Le Verrier, in 1877, Mouchez was a man of experience, fiftysix years old being an officer from the French Navy, who had made hydrographic campaigns in South America, Asia, Africa. Mouchez was also an astronomical observer of the 1874 transit of Venus, in view of a new determination of the solar parallax. He was just called to be *contre-amiral* in 1878 when asked to be director of the Paris Observatory the same year.

7.2 Admiral Mouchez's Program and Realizations

In 1847, when attending a meeting of the British Association for Advancement of Science in Oxford, Le Verrier had a lodging close to F. G. Wilhelm Struve (1793–1864), then the successful director of the Pulkovo Observatory he had created in 1839. Invited by Le Verrier to visit him in Paris he came and stayed to weeks at Le Verrier's apartment, in the *Quartier Latin*. Following this sojourn, Struve send a letter in which he answered questions raised by Le Verrier about how to organize new researches in an observatory. Le Verrier will, later, took only partially account of the advices so given but Mouchez will follow others during the eighteen years of his directorship.

As well as during the past decades the ancient tradition of classical astronomy which began at the time of the creation of the Louis XIV' *Observatoire Royal* in 1667, was pursued: time determinations, three instruments in the East Wing of the building and a new meridian circle installed as early as 1878; the telegraphic diffusion of time is reorganized for Paris and enlarged to ports from 1880 and to the main towns of France, in relation with the developpement of the railway.

Beside these current works usual in observatories, Mouchez is at the origin of several new fields of astronomy or related to this domain. One year after his nomination he created the *Musée de l'Observatoire* collecting instruments, objects, out of use, calling others

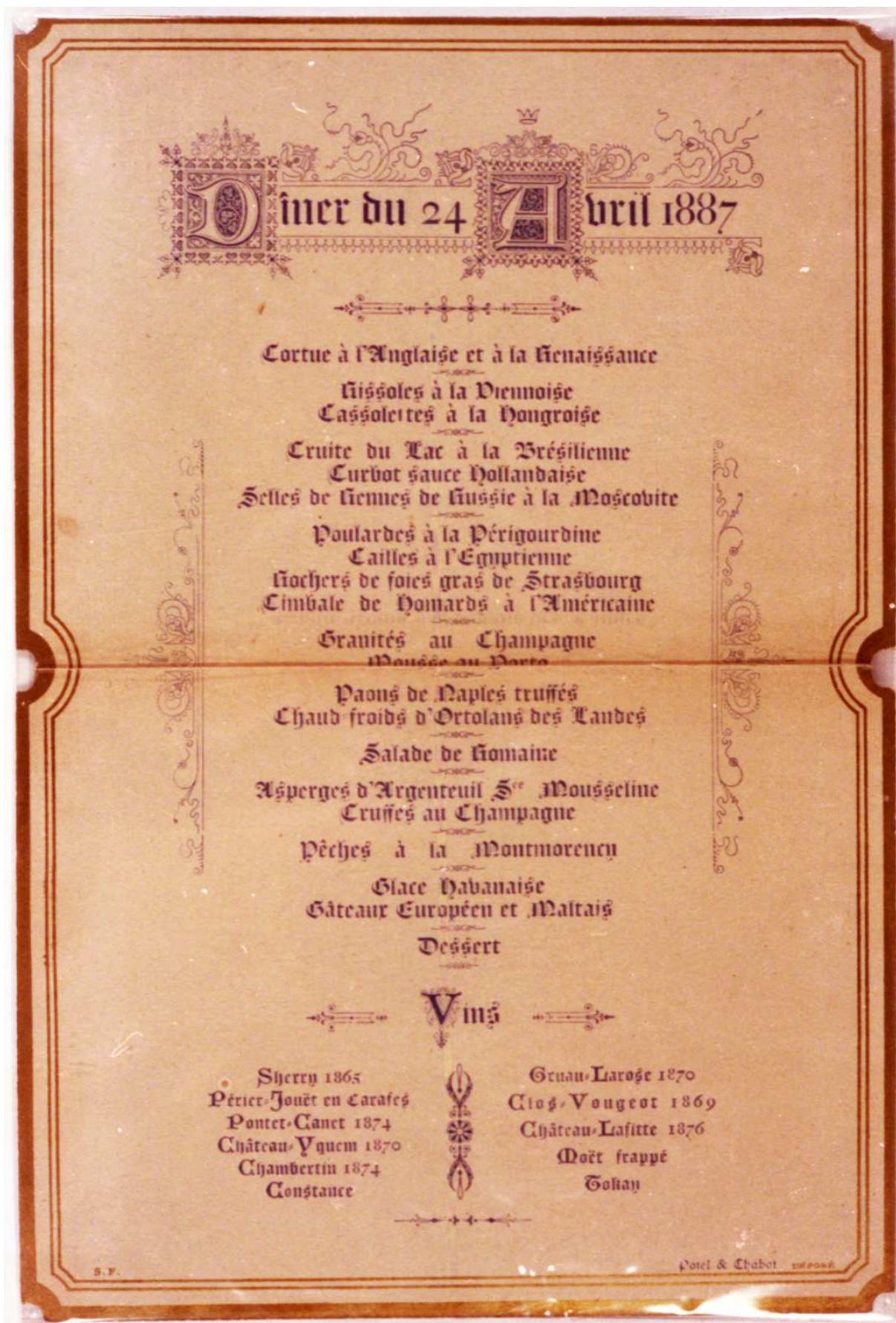


Figure 7.2: Astrophotographic Congress in Paris (1887) (Observatoire de Paris, Bibliothèque)

sites to return those which had been lent by the *Bureau des Longitudes*, requesting photographs from world observatories. He installed all them, on the first level of the building now named *Bâtiment Perrault*, from his architect, Claude Perrault (1613–1688), in what is called *Grande Galerie*; old pieces were displayed in the *Rotonde Ouest*, on the same level, others and photographs were placed in the *Rotonde Est*. The West one was then decorated with portraits of French astronomers while the East one was garnished with portraits of foreign astronomers.

Together with the *Bureau des Longitudes* and the French Navy, Mouchez created, the same year, the observatoire du Parc Montsouris to form to astronomical and geodesic observations astronomers and officers of *La Royale* often so called in France. This observatory, not far from the Paris Observatory, on its south side, was in function up to World War II. Students, following courses at *La Sorbonne* and officers could learn how to use instruments in the parc recently set up at the time of Napoléon III.

Always the same year 1878, Mouchez requested and obtained the creation of a position of vice-director and asked Maurice Lœwy, arrived from Vienna in 1860, to take it. Lœwy having described an *Equatorial coudé* (from the french word for elbow) in 1872, Mouchez decided to install a first one in the park of the Observatory in 1882; a second one will be installed later, in 1890, in an another building dated 1889.

The Henry brothers, Paul (1848–1905) and Prosper (1849–1903) were astronomers at the Observatory being mostly interested in photographic astrometry, photography having taken a great development from the thirties of the 19th century. Several authors succeeded, from 1840, to take pictures of the moon, later of the Sun. Some pictures of very bright stars were obtained from 1857, the year Warren De la Rue (1815–1889) predicted that a cartography of the sky would be obtained in the coming years. In 1882, David Gill (1843–1914), at the Cape, obtained a picture of a comet and, through its queue he was able to see 40 to 50 stars. The idea came to him of mapping the sky up to faint magnitudes.

In 1885, at Paris Observatory, using an astrograph from Gautier (1842–1909), the Henry brothers had installed at the Paris Observatory, were obtained, after one hour, images of stars up to magnitude 16. After exchange of letters, between Gill and Mouchez, an international meeting was organized in 1887, held at the *Observatoire*. At the opening, on April 16, the *Ministre des Affaires étrangères*, in his talk among others considerations, said *Une ère nouvelle s'ouvre pour l'astronomie physique comme pour l'Astronomie mathématique, [...] un moyen d'investigation qui étendra dans une proportion indéfinie la finalité de leurs recherches*. The new era and the way were open to what was called at that time *astronomie physique* not yet *astrophysique*.

There were 56 participants and, in the evenings, festive distractions were offered such as an official diner held in the *Grande Galerie*, including only one lady, the

wife of Mouchez! At the closure, Mouchez said that he considered that the *Carte du Ciel* (the same expression in all languages for this international enterprise and its realization), is a very important one. A Struve, at this time Otto (1819–1905), one of the eighteen children of Wilhelm, was elected president; he was, at that time, the director of Pulkovo Observatory. Several meetings will be organized during the followings years including two during the Mouchez's life; in 1889 during which five observatories joined the eleven of 1887 and in 1891, with new adhering observatories; among them, the new *Specola Vaticana*, just created to join the international enterprise.

Meanwhile, in 1884, the *Bulletin Astronomique* was created, under the leadership of Henri Andoyer (1862–1930) a remarkable teacher, for celestial mechanics, in *La Sorbonne*. This publication disappeared in 1968, being mixed with other publications to give birth to "Astronomy and Astrophysics", from 1969.

En 1889, Mouchez created at the Paris Observatory for Henri Deslandres (1853–1948) a *Service de spectroscopie stellaire* officially mentioned in the 1890 annual Report. Its includes a long texte by Deslandres himself after one year of activity concerning mostly the uses of several instruments: the great telescope installed in 1871 and a siderostat from Foucault (1819–1868), equipped with ancient spectroscopes, modern ones being not yet available.

In 1892, during February, Mouchez organized a *Bureau des mesures des clichés du catalogue* for the *Carte du Ciel* enterprise and surprisingly, in France and perhaps in other countries, a lady (Dorothea Klumpke, 1861–1942), was the head of the bureau. The first measuring machine employed was named macromicrometer; it was dismantled in the sixties of the 20th century.

Eighteen observatories were collaborating to the *Carte du Ciel* when Mouchez died suddenly in June 1892. Under his direction the garden of the Observatory was enlarged up to the *boulevard Arago* just created. At that time, nine services were existing plus the one in charge of the administration. Among them and simultaneously to the *Service de spectroscopie stellaire*, was in existence, under Charles Wolf (1827–1918) a *Service de Mathématique – Astronomie physique – Heure* but mostly, for astronomy physique, works on sismology and its relation with sunspots.

7.3 A few Years under Tisserand

Tisserand's father was a wet cooper in the town Nuits-Saint-Georges, famous for its burgundy wines. At the *École Normale Supérieure*, he went out first and was recruited at the Observatory by Le Verrier in 1866. The last one asked him to make a carefull study of the lunar theory recently published (1860) by his ennemy Charles-Eugène Delaunay (1816–1872) and in which he thought that the brilliant mathematician would find mistakes. Tisserand did not find any but, in doing so, he became

a high level specialist in celestial mechanics. In 1868 he submitted a doctoral thesis giving to Delaunay's theory a more concise form and generalizing the results. Asked in 1873 to be director of the Toulouse observatory recently created and teacher in astronomy at the University.

In 1878, Tisserand was asked to return to Paris to be a teacher in rational mechanics and later, in 1883, celestial mechanics. His success in Toulouse and at the Sorbonne, explain why he was asked to be director of the Paris Observatory after the sudden death of Mouchez. Delaunay had been associated for the creation of the *Bulletin astronomique* in which were published important articles by Henri Poincaré (1854–1912). Tisserand's most important book was his *Traité de mécanique céleste* published in four volumes the years 1889 to 1896, and the last one the year of his death from a fatal stroke. The importance of this treatise can be measured by the fact that it took the third rank after the *Principia* by Isaac Newton (1643–1727) and the *Mécanique céleste* of Laplace (1749–1827) and before the works of Poincaré and Albert Einstein (1879–1955).

Tisserand's *Mécanique céleste*, still in French was republished in *facsimilé* in 1960 for volumes one and two and, in 1990, for the complete set of four volumes. It was said that it was made, mostly, upon request of specialists in the domaine from the US. His name is still known attached to the *critère de Tisserand* related to the apparition of comets to know if they are real new ones or correspond to a return of an old one.

Under his directorship Tisserand pursued in the fields developed by Mouchez following the evolution of researches and taking into consideration the equipment. The Arago refractor was employed for double stars and nebula. He had prepared, before his death, the meeting related to the *Carte du Ciel* to occur in 1896.

7.4 Lœwy, from 1896 to 1907

After the unexpected death of Tisserand, Lœwy and Deslandres are candidates to succeed him. Lœwy, already vice-director under Mouchez and under Tisserand, is chosen while Jules Janssen (1824–1907) who is at the origin of the creation of the *observatoire de Meudon*, in 1875/76, is seventytwo years old. Lœwy is younger of about ten years! Deslandres requested to be moved from Paris to Meudon. After having associated a spectroscope to Foucault's siderostat he had formed, in 1894, the project of a new instrument, the *spectrohéliographe*, at the same epoch as George Ellery Hale (1868–1938) in the US, independently.

Following Deslandres' departure from Paris Observatory, the *Service de spectroscopie stellaire* now mentioned under the form *Recherches spectroscopiques* will disappeared. In 1898, the *Service des équatoriaux*, responsible of all the equatorial refractors, was divided into the *Equatoriaux coudés* with Lœwy, the *Equatorial de la Tour de l'Ouest* under Guillaume Bigourdan

(1851–1932), the *Equatorial de la Tour de l'Est* under Octave Callandreau (1852–1904), the *Carte photographique du ciel* being still, with its Gautier's equatorial, under Paul Henry.

The following year, 1900, last one of the Century, was held in Paris an *Exposition universelle* including what was called the *Grande lunette de 1900*. Many papers had been written on this subject from 1900 up to nowadays. The last one, by Françoise Launay from the History of astronomy group, included in the Paris Observatory Department SYRTE for *Systèmes de référence spatio-temporels*, appeared in the Journal for the History of Astronomy Vol. 38 Part 4 November 2007. This well documented paper includes eighteen pictures; among them an impressive view of the tube of a 60 metre long refractor with a Foucault's siderostat mounting and a general view of the instrument on which is seen the almost 2 metre mirror, nowadays in the Collections of the *Observatoire* together with the photographic objective (including flintglass and crown-glass) having 1.25 m in diameter; Gautier was the maker. F. Launay ends her article with informations and pictures, taken with this instrument by several observers, and very nice for the time being.

The astronomers of the Paris Observatory were not so much interested by the new gigantic instrument. They were engaged in other purely astronomical activities, the *Carte du Ciel*, the *Atlas de la Lune* and in an important astrographic conference (1900, July 19–26) to be held in Paris including decisions to be taken at the international level for the *Carte du Ciel* enterprise. During the same meeting an international campaign for the small planet Eros is decided, in view of a modern determination of the solar parallax; fortyeight observatories will take part in this new international form of cooperation.

Among the photographs presented by the *Observatoire de Paris* at the 1900 *Exposition Universelle*, were included pages of the *Atlas photographique de la Lune*, two observed from 1896 including enlarged ones (diameter 1.38 m) close to the first and the last quarter. The observations performed at the *Grand Coudé* were achieved in 1910, mostly taken by Lœwy himself and Puiseux (1855–1928) with the collaboration of Le Morvan (1865–1933) who, later, published a reduced *Atlas de la Lune* more easy to consult. All those who have travelled among observatories in the world may have seen several of them in each one at least from that time up to the space images of our satellite; they were of very high level quality. The collection of plates is still in the Collections of the Paris Observatory.

Among the new fields of research announced by Lœwy in his annual report for the year concerns mostly the new spectroscope, from Gautier's workshop, to be installed on the *Grand Coudé*. Another field will be a new method by Nordmann (1881–1940), to begin experiences about heterochrom photometry for variable stars. In his 1906 annual report, Lœwy mentionnes that due to the importance of this field, Nordmann will be working mostly in this photometric domain. On the other hand

a *Service d'astrophysique* is recreated, under this name, with Maurice Hamy (1861–1936) at its head. The new spectroscope was installed on the *Grand coude*, the priority of the use of the instrument being the *Atlas de la Lune*.

The *Carte du Ciel* was also an important subject for Lœwy during the international meeting, held to uniformize the astronomical constants. Several of them resulted from a more or less mean of different determinations by several astronomers and, proposed by Lœwy, with one only issued from a further study to be made by Newcomb (1835–1909) from the US Naval Observatory.

Similarly to his predecessors, Lœwy died suddenly in October 1907 during a meeting of the *Conseil des observatoires*. Immediately Henri Deslandres took rank to succeed him, Pierre Jules Janssen (1824–1907) being not yet dead despite his age, eightythree years. Benjamin Baillaud, then director of the Toulouse Observatory and professor at the Faculty for sciences was chosen. Fortunately for Deslandres, Janssen died next December and he was asked to replace him at the *Observatoire de Meudon*.

7.5 Baillaud, Successor of Lœwy

Baillaud, already fifty-nine, was known at the Paris Observatory of which he was a member in 1874 at the time of Le Verrier. After his doctoral thesis, he became supply teacher in 1877 at *La Sorbonne*, when Le Verrier began to be very ill and died in September, and in 1879 he went to Toulouse.

Baillaud was a remarkable organizer and a man full of dynamism. The Observatory will get a more extensive rôle, being a very active participant in the *Carte du Ciel* enterprise. After his nomination, in 1908, as director of the Paris Observatory Baillaud pursued his activities, non only in the field of this domain but also directed research to new and modern ones, and he was an astronomer very fond of international cooperation. Baillaud played an important rôle mostly in two domains: astronomical constants and ephemerides, time and longitude not only useful for the scientists but also for the world in general. Some of these subjects had already been engaged by his predecessor Lœwy.

In the domain of longitude and time, the development of the railways and of the electric telegraph will be at the origin of the evolution. The first modern occurrence of time unification came during a geodetic international congress in Roma, in 1883, followed by another conference, in 1884, in Washington, for time zones including an unique meridian of reference for longitude and time, including also a “universal hour” as said at that time. The system was adopted with the choice of the Airy meridian (Greenwich Observatory) as the international reference. At that time France did not introduced it but, in 1891, time was unified at the national level with the reference to the Paris Observatory meridian.

In 1899 the very first time signals were launched from Hambourg, as Gudrun Wolfschmidt recalled, but nothing special came out. Nevertheless, longitude campaigns were organized under Lœwy from 1902, through the electric telegraph, to determine, with the best possible accuracy, longitude differences between Paris and important towns such as Greenwich, Bizerte, Uccle, Washington. The last campaign ended in 1914, under Benjamin Baillaud. Meanwhile commandant Ferrié (1868–1932), later general, in cooperation with the Paris Observatory, could launch time signals using the altitude of the Eiffel Tower to send them around it, up to five thousand kilometers. The French *Board of Longitudes* was associated in all these operations at that time its president was Poincaré (1854–1912); the very first regular time signals had been sent on November 21, 1910.

This success decided France, in 1911, to adopt the time zones and Greenwich meridian. The following year, 1912, an international scientific congress, held in Paris, made proposal for an international convention for a universal hour to become later *temps universel*. An official similar meeting was held in Paris, in 1913, with the creation in Paris of a *Bureau International de l'Heure (BIH)* under the responsibility of the Paris Observatory, and more or less under the responsibility of Baillaud who received the very effective help of Bigourdan to become director of the BIH, already head of the *Service de l'heure* from 1900. At the end, on October 25, the convention and the decisions proposed in 1912 were officially adopted by the participants but only signed by the duly authorized representatives of their Governments. 1913 was the year before World War I and it was more or less the end of the *Belle époque*.

Another international subject of Baillaud's time was the astronomical constants and the ephemerides. The system adopted in 1896, under Lœwy, was followed, in 1911 in Paris, by the *Congrès international des éphémérides astronomiques*. At the origin, Andoyer from the French Board of longitudes who was in charge of the scientific programme and the meeting organized by Baillaud.

During this Congress, important decisions were taken by the astronomers in charge of the six main national ephemerides: Allemagne, Angleterre, Espagne, Etats-Unis, Italie, France. The most important parts were the decisions to have a coordination of the realization of the ephemerides and to give similar presentation of the data in the different star catalogues and publications of the observations. When using different ephemerides, astronomical, nautical and aeronautical ones, data are easily found by users, even they don't know the language.

Not to be forgotten the rôle Baillaud played for the *observatoire du Pic-du-Midi* beside other people. From 1882, after France became in charge of the recently built observatory in the Pyrenees, he was asked to be a member of the committee in charge of checking for the establishment. In 1901, when in Toulouse, he was asked to study the possibility to equip for astronomical observations the Pic-du-Midi, in the surroundings

of the meteorological station. Experiments were made with a Foucault's reflector of 30 cm in diameter. Under Baillaud's responsibility building for astronomical observers and instruments are installed during the summers of 1904 to 1907, including a large cupola allowing to house a double equatorial with english mounting for an instrument having 6m for the focus. The double instrument, comprising a reflector and a refractor are ready for observations in August 1908 at 2860 meters for the altitude. Baillaud was then moved to the direction of the *Observatoire de Paris*. The international huge level of Baillaud led him to become, at the creation of the International Astronomical Union, after World War I, its first president. In commission 31 (Time) of this union, the BIH was officially created and Baillaud was asked to be its director. It is said that the general name *Unions scientifiques internationales* was his proposal in 1919.

After having been director of the Paris Observatory up to 1927, Baillaud ended his life in Toulouse in 1934.

7.6 Nowadays' Heritage

From the mid19th century up to the *Belle Epoque* several astronomers of the Paris Observatory have played a important rôle, mostly at the French level and, in some fields, at the international one. Among all of them, four successive directors have been men of influence around the year 1900.

Some words can be written concerning their actions which have been of use or have led to actions nowadays. The *Bureau des longitudes* hosted by the building of the *Institut de France* (3 rue Mazarine, 75006 Paris) is still alive, including members being astronomers of the *Observatoire de Paris*. Meteorology, organized by Le Verrier, was separated of the Paris Observatory just after his death, nowadays being the *Météorologie nationale*. The *Musée de l'Observatoire* is installed, from about forty years, as in the past, in the *Grande Galerie* and also in the *Salle Picard* (northern tower), formerly the council room; from about the same time, the Curator of the *Observatoire de Paris*, introduces periodical changes in the showcases to make known, at least during several months to the public, what is preserved in the collections, through tours guided mostly by astronomers, engineers, high level technicians of the establishment. Most of the instruments and documents from the past, together with modern evolution, are appreciated as well by the public and by specialists of scientific subjects.

The *École d'astronomie* installed in the *Parc Montsouris* disappeared with World War II but, from many years, students have exercices organized inside professional observatories as in Paris. The *Laboratoire d'optique* created by Baillaud in 1924, disappeared in

1983, being to small, despite its size, for modern realization. Now, the *Salle Cassini*, its new name, houses exhibitions, colloquia, ... organized by the *Observatoire*.

The *Carte du Ciel* enterprise, so often criticized by the French community of astronomers as being responsible of the slow development of astrophysics in France, was employed, at the US level, in comparing its *Catalogue* with the space data obtained, by the end of the 20th century, from the artificial satellite Hipparcos to derive accurate proper motions of stars. The quality of the plates taken from Paris Observatory around 1900, allowed to remeasure, with a high powerful modern automatic measuring machine, some plates and, by the way, to discover an optical image of a pulsar. The astrometric quality of the site was confirmed, in 1987, by a US specialist of double stars in observing, for a test, very closed binary ones; he was discovering the stability of the images he could not think for the place ...

The *spectroscopie stellaire*, created by Mouchez for Deslandres, reappeared in 1906 with Maurice Hamy up to Henri Mineur (1899–1954), the last one employing for that purpose the *Grand coudé*. Meanwhile, Deslandres had obtained, from he Government of the time in 1926/27, to increase his salary, the junction of Paris and Meudon observatories under his directorship. A decade later, Mineur and Chalonge (1895–1977) obtained the creation, on the Campus of the *Observatoire*, of the *Institut d'Astrophysique de Paris* (IAP) remaining to the *Centre National de la Recherche Scientifique* (CNRS), using the financial credits obtained by the Paris Observatory director of the time. Mineur was director of the *IAP* up to his death; he was a high level astrophysicist, pursuing there researches he had launched when an astronomer of the *Observatoire de Paris*. After the large development of Solar research in Meudon, Astrophysics was mostly developped there, including from 1956 radioastronomy, and later Space Research.

The glassplates of the *Atlas de la Lune* and those from the Paris Observatory programme *Carte du Ciel* are preserved in the Collections of the Observatory. The last ones are employed to get positions of stars obtained one century ago, but they are also used for research of some faint objects, already seen at that time, such as nebulae. The heterochrome photometry by Nordmann became, with Chalonge at the *IAP*, the *photométrie en quatre couleurs*, while research on time, mostly developed under Baillaud is still included in Paris Observatory while the time part of the *BIH* was moved, in 1985, to the *Bureau international des poids et mesures* (Sèvres, France), by Guinot then *BIH* director.

The old domains of astronomical activities have been pursued from the creation of the *Observatoire Royal* in 1667 up to nowadays, of course, in following the evolution of technics and ideas. But new fields have, meanwhile, appeared some of them, of value, introduced around the years 1900. Each epoch brings, in all countries of the world, its proper and specific evolution. *Et c'est ainsi que la recherche avance.*

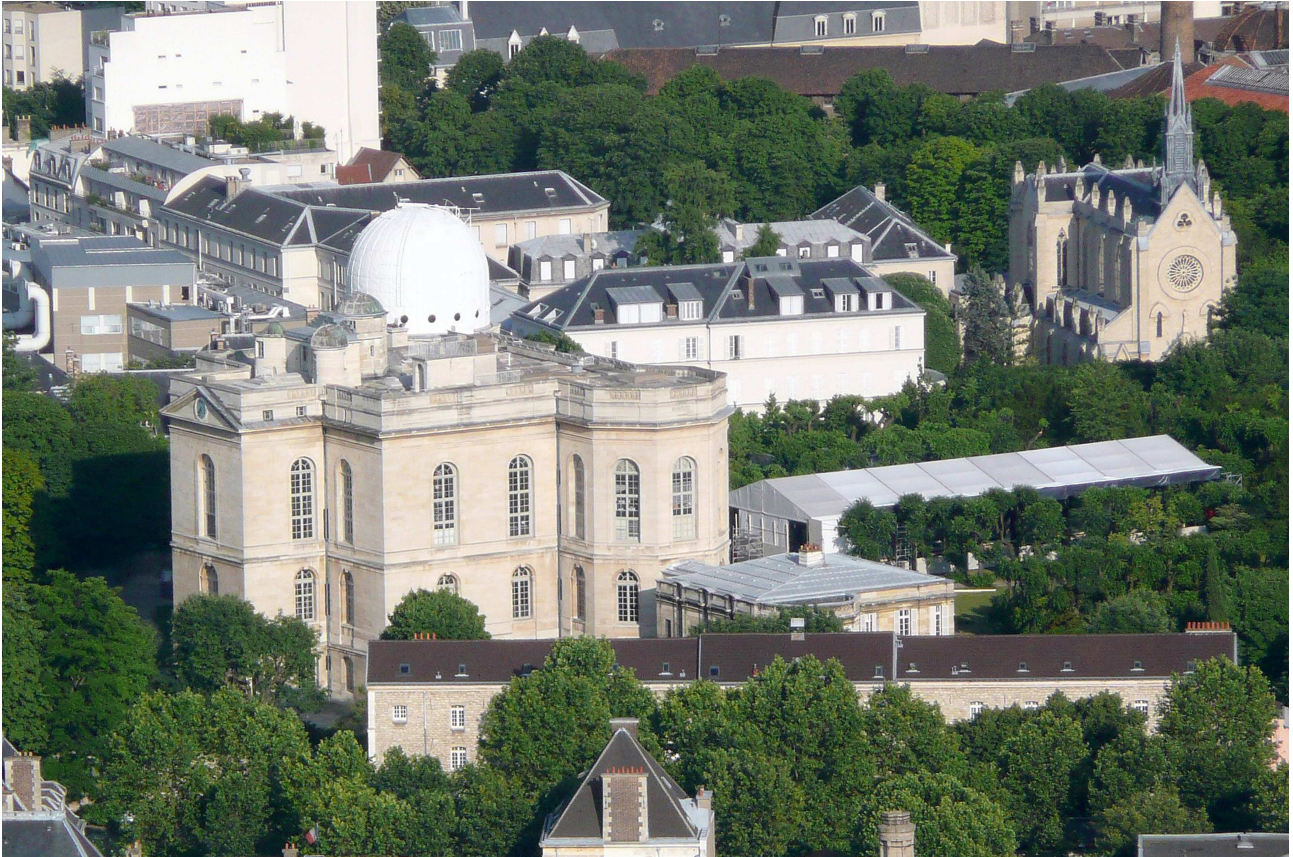


Figure 7.3: Observatoire de Paris: (http://upload.wikimedia.org/wikipedia/commons/4/42/Observatoire_de_Paris.JPG)

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