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THE OBSERVATORY OF PARIS.

The city of Paris may well claim a position as one of the great scientific centers, its university and kindred institutions having witnessed many of the developments of the sciences and the discoveries of modern times; and particularly so in the science of astronomy, the Observatory of Paris being recognized as one of the centers of astronomical work, its astronomers having from the commencement been associated with the history of the science; the Observatory has, in fact, seen the science of astronomy emerge from its primitive stage of two centuries ago into the remarkable condition of development which we find at the present day.

The foundation of the Observatory dates from the middle of the seventeenth century, at which period the Académie Royale des Sciences decided to create an establishment devoted to physical research and astronomical work. The observatory lies on the southern side of the Seine, being inclosed by the Rue d'Enfer, the Rue du Faubourg Saint-Jacques, and the Boulevard Arago. The condition of the science at the time of its foundation may be imagined when we remember that many of the astronomers of the period had not yet adopted the ideas of Copernicus as to the movement of the planets around the sun, but considered, with the Danish scientist Tycho Brahe, that the sun and moon revolved around the earth, while the other planets revolved around the sun. Colbert took the work in hand, Claude Perrault designed it, and the eminent

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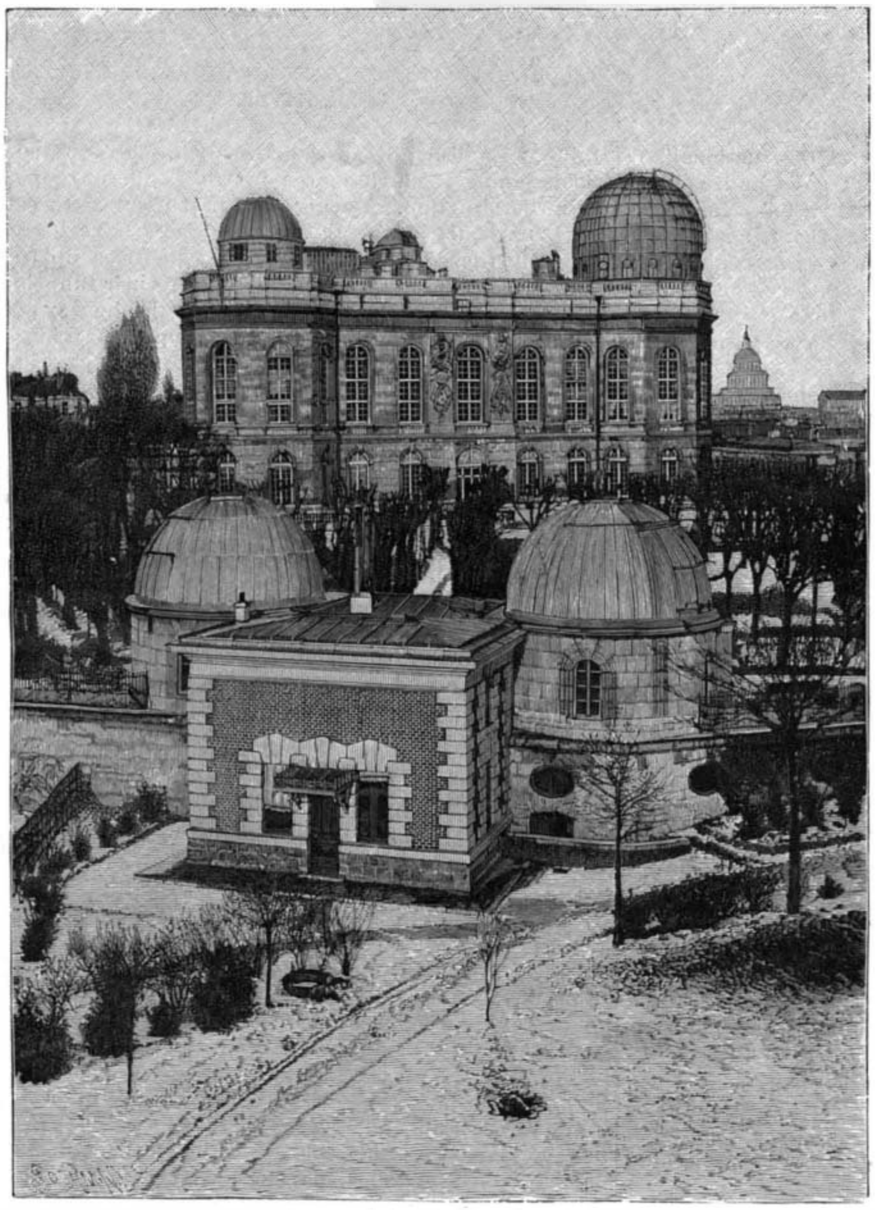
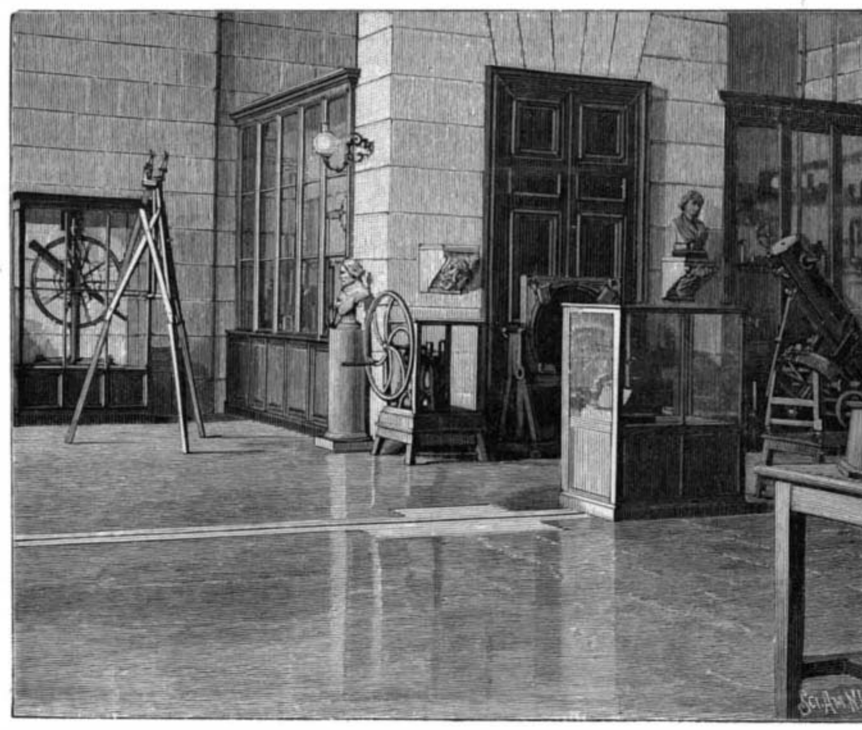


The Observatory of Paris.



The Instrument Room.

The Bent Equatorial Telescope.

The Great Reflector.

THE OBSERVATORY OF PARIS.

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(Continued from first page.)

Italian astronomer Cassini was appointed by Louis XIV. to the presidency of the new Observatory, and during this period he discovered several of the satellites of Jupiter and made observations upon the rotation of the planets. It was under his direction that the "meridian of Paris" was determined, the position of which is shown by a line drawn upon the stone floor shown in our engraving. This meridian divides the edifice into two parts by a line which, prolonged north and south, would reach in one direction Dunkerque on the North Sea, in the other Callioure on the Mediterranean. These two lines, which intersect one another at the central point of the façade, served as a base for the numerous triangles upon which were drawn up in the last century the map of France, known as the map of Cassini, and in the middle of the present century the map known as the "Staff map." According to the observations made at the time of the founding of the Observatory, the meridian is represented by a line of copper bars inserted between marble plates, upon which are figured the twelve signs of the zodiac, according to the custom of the time. At a period somewhat later in the history of the Observatory the eminent mathematician Laplace contributed largely to the progress of the science by his famous work "Le Mécanique Celeste." In the present century the celebrated astronomer and physicist Arago assumed the direction of the Observatory, and by his public lectures awakened an interest in the science, which has ever since continued to increase. It was his successor Leverrier who immortalized himself by his discovery of the planet Neptune, of which, it is well known, he determined the position in the heavens by calculation before the planet had been found by the telescope. This succession of celebrated names shows the important place which the Observatory has occupied during the last two centuries. At the present time a series of important investigations is being carried on; among others may be mentioned the completion of the map of the heavens, for which the photographic plates, obtained by means of a large telescope, are carefully measured and recorded.

In the foreground of our first engraving will be seen the buildings adapted for this purpose, and in the background the main building of the Observatory, begun in 1667 and finished in 1672, each of whose towers, surmounted by a movable dome, contains a large telescope of the form known as "equatorial." The west wing contains a great amphitheater in which the illustrious Arago delivered his lectures. The building also contains the laboratories for meridian observation and other astronomical and astro-physical work; here are found the instruments which have been used by celebrated astronomers and, among others, instruments for determining the speed of light, instruments for making experiments in magnetism, observation of earthquakes, etc. The museum contains the instruments and apparatus used by Arago and Fresnel for the measurement of the velocity of light. Our engraving gives an idea of a few of the historical instruments. The museum was founded in 1879 by Admiral Mouchez, director of the Observatory. Here is the quarter circle used by Lalande in the observation of the 50,000 stars of his catalogue, a collection of German instruments of the sixteenth century, the standards of the metric system, etc. Our engraving shows at the left a cabinet containing apparatus constructed by Breguet for the measurement of the velocity of light; the machine with the fly wheel and crank, and his air pump used to produce a vacuum in the apparatus for determining the standard kilogramme. Next to it will be seen the glass lens cast by Chance, which was to be used in the construction of a large telescope of the focal length of sixteen meters. In front of the case to the right is a telescope of wood used by Foucault, and on the table the apparatus used by M. Wolf for determining the personal equation in the observation of the passages of the stars.

The largest telescopes are placed outside of the main building in the grounds of the Observatory. The great instrument with the staircase shown in our right hand engraving was installed in 1875; the mechanical part was made by the celebrated constructor Eichens, the optical part by Adolphe Martin. It is completely inclosed by a metallic cupola (not shown in the engraving) which slides upon a system of rails, which, together with the staircase necessary for the observer, was constructed in the shops of the Compagnie de Chemin de Fer de Lyon; the movable part weighs 9,000 kilogrammes (20,000 pounds); the instrument is provided with a clock movement having a Foucault regulator. The mirror deserves special mention: the casting of this mirror was intrusted to the works of St. Gobain; the mass of glass as delivered by the works weighed 500 kilogrammes (1000 pounds), which weight was reduced to nearly half by the optical work. The diameter of the mirror is 1·20 m. and the focal distance 7·20 m. The mirror is generally resilvered every year; in 1880 MM. Wolf and H. Guénaire modified the old process of silvering in order to avoid turning the mirror, which in the case of so large a mass is a difficult proceeding; the mirror itself, being concave, is used as a reservoir for the silvering liquid during the process. This instrument was used at first for observations of nebulæ and for stars of inferior luminosity, and afterward in connection with the spectroscope; in 1879 photographs of the stars and also of the moon were made by placing the photographic plates at the focus; these latter were given an exposure of one and two seconds; during the last few years, the instrument has been used by M. Deslandes for spectroscopic research.

Our left hand engraving shows the bent equatorial refracting telescope and its brick tower.

Since 1855 it had been decided to install at the Observatory a large telescope of 16 meters focal distance; the project was taken up in 1880, at the time of the purchase of the large grounds, which served to isolate the observatory from the rest of the city; the optical part was ordered from the constructor Adolphe Martin, who made for the purpose an objective of 0·74 m. diameter; the cupola was to have a diameter of 20 meters, that is, as large as the dome of the Pantheon; the house of Eiffel submitted a project in which the cupola was to be upheld by an arrangement of floats in liquid reservoirs, thus replacing the system of rails generally used; however, at the time of construction it was found the ground was unsuited for this purpose, and the project was abandoned. In its place the present telescope was installed, in 1889; the mechanical part has been executed by M. Gautier, successor of Eichens, and the optical part by MM. Henry. The objective has 0·62 m. diameter and 18 meters focal distance; the upper end may be turned toward the heavens in any direction, while the observer, stationed in the tower, receives the image reflected from a mirror in the bend of the instrument. This instrument is employed for the photography of the moon by MM. Loewy and Puiseaux with remarkable results.

A great telescope is being made by the house of Gauthier et Cie., of Paris, for the exposition of 1900, which will be the largest yet constructed, its objective lens having a diameter of 48 inches. The telescope remains stationary, while the movement of the stars is followed by a large mirror of silvered glass, 7 feet in diameter and 20 inches thick, which is mounted in connection with a mechanism permitting it to follow the movement of the heavens.

The Observatory is a state establishment under the control of the Minister of Public Instruction. It is governed by a director, who oversees the work of astronomers, adjunct astronomers, and assistant astronomers. The administration is in the hands of the director, aided by a council, who, moreover, superintends the scientific surveys, and is charged with the correspondence and the publication of reports.

The work of the Observatory is divided into several different services quite distinct, besides the work already mentioned; the meridian service has at its disposition four telescopes; observations are made upon the sun, moon, Mercury, Venus, and the fixed stars necessary for the measurement of their relative distances and the determination of the time (hour). The lunette and circle of Gambey are used specially for the determination of the co-ordinates of the stars in connection with observations upon the moon. The smaller equatorial is used in research on comets and observation of smaller planets.

The equatorial of the west tower is used principally for observation of nebulæ, comets, and double stars, the occultation of stars by the moon, and the eclipses of the satellites of Jupiter. At the equatorial of the east tower are observed more particularly the smaller planets and comets.

An important service is that of astronomical photography. At the international congress of astronomy held ten years ago it was decided to make a catalogue of stars more complete than that which had been made up to that time. For this purpose the heavens were divided into several zones, each of which was assigned to one of the large observatories, which was to make photographs of the part assigned to it and from these to make the necessary measurements and calculations. At the observatory this work is now in progress and the photographic portion is nearly complete.

Paris. J. GUÉNAIRE.

THE Meteorologische Zeitschrift contains a treatise by Dr. F. Maurer on the regular periodical repetition of cold and warm years. During certain intervals of time, extending as a rule to about fifteen years, there is a recognized change of warm and cold periods. The warm periods, Dr. Maurer says, do not simply include a series of summers of extraordinary warmth, but also a series of mild winters. Similarly, during the cycle of a cold period, not only are the winters more than ordinarily severe, but the summers are far below the average heat. Dr. Maurer affirms that we can predict with tolerable accuracy the time when the next cycle of warm periods will occur. It is due, he calculates, somewhere about the turning point between the two centuries; and he thinks it probable, from the data obtainable, that the early years of the next century will be distinguished by a series of hot, or, rather, extremely hot, summers and a series of exceptionally mild winters.

Science Notes.

The ptomaines of preserved meats are, according to Van Ermenglin (Jour. de Ph.), secretions of a specific bacterium, bacillus bolulinus. The toxin, called by the discoverer "bolulin," is so poisonous that 0·000001 gramme is sufficient to kill a rabbit. Fortunately, the toxin is destroyed by a comparatively low temperature, 60° to 70° C. At 85° the bacillus is also destroyed; cooking is, therefore, a reliable safeguard in the use of salted, smoked, or otherwise preserved meats.

Rainfall in India is variable, says Engineering News. English engineers report as follows concerning the rainfall in the Midnaper and Howrah districts of Lower Bengal: The average annual rainfall in this section is about 70 inches; but observations made at Ban Kura record a rainfall as follows for the four days ending at 8 A. M. on the dates set down:

June 16	0·90	inches.
June 17	6·45	"
June 18	12·48	"
June 19	2·40	"
Total	22·73	"

Magnetic deflection of iron plumb-bobs, in shaft work, is noted by Mr. O. Brathuhn in an article on underground surveying in the Berg und Hüttenmannische Zeitung for 1898. He notes that, in plumbing a shaft 390 feet deep with an iron plumb-bob, he found a considerable error. The explanation lay in a crosscut from the shaft in which a large number of spare rails had been stored with one end of the pile very close to the plumbline. He says that by the induced magnetism of the rails the plumbline was drawn from its perpendicular position to such an extent that the bottoms of two lines were 7·5 mm. further apart than the tops of the same lines, and the line connecting the plumblines at the points of suspension formed an angle of 6′ with that at the bottom of the shaft. The trouble was corrected by using brass plumb-bobs.

O. Noevius has, on purely spectroscopic evidence, given some reasons for suspecting the presence of another undiscovered gas, besides argon and krypton, in the atmosphere. The evidence is not very strong, but appears to deserve further investigation. After eliminating the lines due to electrode matter, the lines due to the spark spectra of nitrogen and argon were catalogued at atmospheric pressure. Some 15 lines, between wave lengths 377 and 486 $\mu\mu$, were found to be common to the blue argon spectrum and the nitrogen spectrum, though rather fainter in the latter. The supposition is that they are due to an unknown gas which remains as an impurity in the preparation of argon, and also, but to a lesser extent, in the preparation of nitrogen. The spectrum shows a single coincidence with that of krypton at 473·6. It is not due to carbon impurities.—Noevius, Wied. Ann.

The Maryland State Geological Survey has just received from France a machine for testing the wearing power of various kinds of rock and stone which has been in use for some time by the French government. It is composed of duplicate revolving cylinders and is worked in a unique manner. The cylinders are hollow, and allow a good sized piece of stone to be placed inside of each. The rod of the machine is attached to the motor, and the cylinders revolve rapidly a number of thousand times. They are opened then, and the fine material that has been ground off is gathered up after the stones have been washed, and is weighed. In this way the experience of years can be gathered in a few hours. Calculations can be made from the result to just what extent the stones experimented with would wear if placed in a roadbed or used to build a highway or public building. The machine is a very valuable one, and Prof. William Bullock Clark, State Geologist, superintended its erection.

In order to render ultra-violet rays visible, we can make use either of photography, which allows us to examine rays down to 100 $\mu\mu$ wave lengths, or of a spectroscope whose lenses are made of quartz or of quartz and fluorspar, provided with a fluorescent eyepiece. These apparatus show rays down to 185 $\mu\mu$ wave lengths, though not so perfectly as the photographic plate; but they are more convenient. A uranium glass plate is placed on the focal plane of the telescope. The parts of the uranium glass which are hit by ultra-violet rays emit visible rays in all directions. To make our eye sensitive to these rays, we must cut off the light coming from the ordinarily visible parts of the spectrum. Soret has done this by turning the Ramsden eyepiece about a horizontal axis through an angle of 45 degrees. In the Zeitschrift für Instrumentenkunde, Dr. F. Martens proposes a simpler method. He introduces a stop with two apertures, the one central, the other eccentric: a little lever releases either opening. When we look through the central aperture, we see the rays which regular refraction has sent down the telescope. When we place the eccentric aperture in position, these rays are stopped by the lever upon which they fall, and we perceive only the diffuse light emitted by the fluorescent uranium glass.