THE CAMBRIDGE OBSERVATORY.

The Annual Report of Prof. Pickering, Director of Harvard College Observatory, shows that the Observatory has been in a most prosperous condition during the past year, and if the same financial support is extended to it in the future that has been so generously offered in the past few years, it will be enabled to retain its place, inferior to no other Observatory in the country. The work carried on at the Cambridge Observatory consists of observations with the 15in. Equatorial, with the Meridian Circle and Meridian Photometer, together with the attendant reductions; and in the distribution of time-signals over the greater part of New England.

With the large equatorial, many important observations upon the satellites of Mars were made during the opposition of that planet. Employing the method of reducing the light of the planet, by colored glass (a method first used at this Observatory), the number of observed position angles of Deimos was 825; of Phobos, 278; and that of observed distances, 248. The probable errors of one setting were respectively 0.6°, 0.9° and 0.6″. Besides the micrometric work, many photometric observations were made, the results of which indicate that if we assume the satellites to have a capacity for reflecting sunlight equal to that of Mars itself, Deimos has a diameter of about six, and Phobos of about seven miles. The photometric observations upon the eclipses of Jupiter's satellites give reason to believe that by this method the determination of longitudes may be made as accurately as by occultations or lunar culminations. Measurements of the light of planetary nebulæ have been continued. The spectra of nebulæ are also observed through a direct vision prism placed between the object glass and eye-piece of the telescope. The planetary nebulæ retain their shape under these circumstances, obviously indicating that their light is monochromatic. The difference between monochromatic objects and ordinary stars is so marked when thus examined, that a method of detecting small nebulæ was at once suggested, and a comparatively short search revealed three such objects. The most remarkable discovery, however, was in the spectrum of the star Oeltzen 17681, R.A. 18h. 1m. 17s., Dec. −21° 1′, which shows that the light is concentrated in two points of the spectrum, one in the blue, the other in the yellow. A faint, continuous spectrum is also seen.

Between Sept. 24, 1879 and Nov. 1, 1880, observations were made with the Meridian Circle on 277 days, the work being confined to the determination of the absolute co-ordinates of 109 fundamental stars, in connection with which observations of the sun and of Polaris were made as often as possible. Up to Nov. 1, 1880, 183 observations of Polaris had been obtained, 131 of the Sun and 1760 of Fundamental Stars. To furnish the means of measuring the variation of the instrumental changes between one culmination of Polaris and the next, a collimator with focal length of 206 feet was constructed and has given excellent results.

A Meridian Photometer devised by Prof, Pickering has been used in continuing the measurement of the light of all stars visible to the naked eye between the north pole and the parallel of 30° south declination. Over 40,000 separate settings have already been made, and it is probable that the work will be completed in October next. The instrument, as its name implies, is mounted in the meridian and forms polarized images of the pole star and the star to be observed, which are brought to equality by turning a Nicol prism.

The time signals from the Observatory are distributed to the railroads and several prominent jewelers in Boston, and through the railroad companies to many of the neighboring towns. By the co-operation of the United States Signal Service Officer a time-ball is dropped in Boston at noon. The signals are also used in connection with those from the United States Naval Observatory, and the Allegheny City Observatory for the regulation of the New York time service.

During the past year, the second part of Volume XI of the Annals of the Observatory, containing a discussion of 25,000 photometric observations made with the great equatorial, and Volume XII containing the results of observations made by Prof. W. A. Rogers in 1874 and 1875 with the Meridian Circle have been completed and distributed, and six more volumes are in a more or less advanced state of preparation. W. C. W.

WASHINGTON, D. C.

ON THE THERMAL BALANCE.*

BY PROF. S. P. LANGLEY.

When the thermometer is not sufficiently sensitive for delicate investigation of radiant heat, scientific men have been accustomed, since the time of Melloni, to the use of the thermopile, an instrument which, employed in connection with the galvanometer, permits the making of numerous important measures. It has not been improved materially in the last fifty years. Meanwhile, many problems of both high theoretical and practical interest have arisen, which cannot be solved without a more sensitive and accurate instrument. One of these problems is the measurement of the distribution of radiant energy in a pure spectrum, when the rays have not passed through any prism. I could obtain no accurate results with the thermopile. I was forced to invent a more sensitive instrument for this special investigation, and, having done so, I believe it will be of general utility. The principle of the new apparatus has been applied by Dr. Siemens and others to other purposes. I spent several months in making it, as I hope, a useful working tool for the physicist and the physical astronomer. It is founded on the principle that, if a wire conveying an electric current be heated, less electricity flows through it than before. If two such wires, carrying equal currents from a powerful battery, meet in a recording apparatus (the galvanometer) the index of the instrument—pushed in two opposite ways by exactly equal forces—will remain at rest. If one current be diminished by warming ever so little the wire that conveys it, the other current causes the index to swing with a force due, not directly to the feeble heat which warmed the wire, but to the power of the battery which this feeble heat controls.

The application of this principle is thus made: Iron or steel is rolled into sheets of extreme thinness. I have succeeded in rolling sheets of steel made at the works of Miller & Parkin, Pittsburg, Penn., until it took 8000 of them to make the thickness of an inch. Of the platina sheets rolled at the United States Mint in Philadelphia, fifty laid one on another do not together equal the thickness of light tissue paper. Minute strips of these, 1-32 of an inch wide and ¼ of an inch long, were united so as to form a prominent part of the circuit, through which a part of a powerful battery passed to the galvanometer. Experiment proves that an almost inconceivably minute warming of a set of these strips reduced the passage of the electricity so as to produce very large indications on the registering instrument. I have in the course of my experiments thus far, found iron the most advantageous, though other metals are still under trial. The instrument thus formed is from ten to thirty times more sensitive than the most delicate thermopile; but this is almost a secondary advantage compared with its great precision and the readiness with which it is used. The thermopile is very slow in its action. This new instrument, the thermal-balance, takes up the heat and parts with it again in a single second. It is almost as prompt as the human eye itself.

With reference to its accuracy, experiments prove that the probable error of a single measurement made

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