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 eyepiece 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

* Read before the National Academy of Sciences, N. Y., 1880

with the instrument can be reduced to within 1 per cent. of the amount to be measured. It will register a change in the temperature of the strips just described, not exceeding 1-50,000 part of a Fahrenheit degree. When mounted in a reflecting telescope it will record the heat from the body of a man or other animal in an adjoining field, and can do so at great distances. It will do this equally well in the night, and may be said, in a certain sense, to give the power of seeing in the dark. A more valuable proof of its efficiency is shown in a series of measurements of the heat of the moon, made under varied circumstances, to guard against error, but each made in a few seconds. All these measurements show that the almost immeasurably minute amount of heat from the moon can be certainly measured by it, even with a common refracting telescope.

CORRESPONDENCE.

[*The Editor does not hold himself responsible for opinions expressed by his correspondents. No notice is taken of anonymous communications.*]

To the Editor of SCIENCE :—

In a recent issue of "SCIENCE," "B. G. W." in a very instructive review of Marsh's monograph on the limbs of the *Sauranodon*, speaks of Darwin's hypothesis regarding *sexdigitism* in man, as reluctantly abandoned by that evolutionist, but as now standing some chances of rehabilitation owing to the discovery of *sexdigitism* as a normal feature of the extinct genus *Sauranodon*. Probably the reviewer has not met with a treatise, in in which a certain discovery of an embryonic peculiarity is detailed, and which explains not only the occurrence of *sexdigitism* but of *polydactylism* in man. As this treatise is in the hands of few comparative anatomists, I may refer to the facts here at some length. In figure 76 on page 137 of Schenk's *Lehrbuch der vergl. Embryologie der Wirbelthiere* (Vienna, 1874), is represented a section taken flatwise through the embryonic human paw. The chondrogenic elements of the mesoblast can be seen arranged in strands, indicating the metacarpophalangeal rays. A sixth ray seems very clearly present, and from some of the other rays lateral processes spring, which in the course of normal development become merged into the main ray, no doubt.

On this head, as well as some others related to the temporary presence of ancestral features in the extremities of the human embryo, I have written as follows in a series of lessons on embryology, published in the *St. Louis Clinical Record:*

At the points where the head and tail were respectively deflected from the trunk the peripheral protovertebrol masses are bulged out, as it were, and thus we have twa anterior and two posterior ill-marked eminences composed of mesoblast elements covered by the cutaneous epiblast. These are the anterior and posterior extremities. The posterior pair is the earliest to be discovered, but it is so rapidly outstripped in growth and development by the anterior extremities, that the belief has become current that the anterior are the first to appear, which is incorrect.

At the time when the hand has become demarcated from the forearm by the wrist constriction, the forearm has not yet become separated from the arm. And in like manner the foot is individualized before the leg and thigh are demarcated. The fingers are developed before the toes, and in both the hand and foot the digital segmentation is preceded by a stage in which there is a fold formed separating a main mass from the aggregate digital mass, and which persists in the adult.

If a surface section be made of an embryonic hand or foot before the digits are formed, we will find that the cell-strands which constitute the basis for each metacarpo-phalangeal ray are not five, as in the adult and developed fœtus, but are from seven to nine (at different periods) in number. This remarkable fact, discovered by my teacher, Prof. Schenk, of Vienna, points, in a manner, to the descent of the pentadactylous animals, to which man belongs, from the enaliosaurians or analogous groups of the jurassic and triassic periods of the earth's history whose fossilized remnants clearly show that they had seven or more fin rays.

To many, another and related fact will prove still more convincing in an evolutional point of view, although Schenk's observation is of more fundamental importance than the following to zoötomists:

Hensen, of Kiel, discovered that, in a *human* embryo of the seventh week, *the fingers and toes are provided with claw-like appendages like the claws of carnivora*, and that these structures are exfoliated to make way for the true nails. Further, he found plantar and palmar eminences like the *foot-pads of the dog, cat and marsupial carnivores.** E. C. SPITZKA.

NEW YORK Jan. 7, 1881.

BOOKS RECEIVED.

WAS MAN CREATED? By HENRY A. MOTT, JR., PH. D. Griswold and Company, New York.

The time is still distant when conclusions will be drawn on the subject of the Origin of Man and many other problems treated by the author of this book. Material is accumulating faster than it can be arranged, but in all probability, a thousand years hence we shall still be without sufficient data and be diligently searching for evidence.

The scientific man is not discouraged on this account, but is well content to work on, adding daily to the great store-house of knowledge, indifferent as to whether final results are arrived at in his own day or in the future.

There is, however, another class of persons in society, who, finding that certain scientific truths, which are undeniable, conflict with revealed religion, desire a more speedy solution of these questions.

Dr. Mott in his book attempts to outline a middle course for those who are forced by scientific discovery to renounce the Biblical teachings respecting the Origin of Man, by showing from a large number of authorities, that a belief in the dual existence of man may be held upon reasonable testimony.

Had Dr. Mott called his book "An Introduction to the Study of the Origin of Man and his Future Destiny," we think it would have been an appropriate title, and would have commanded a large class of readers who are unable to obtain the larger works consulted by the author; and the seventy-five illustrations, which are well selected, would have been of considerable service to such persons in grasping the subject which is naturally complicated to those who approach it for the first time.

DR. IRVINE, of Glasgow, recently exhibited and explained before the Mining Institute of Scotland, his new safety-lamp, which is constructed to emit a loud sound when an explosive mixture of gas and air enters it, and thus consequently indicates fire damp in colleries.

* Development of the Human Ovum Embryo, and Fœtus, *St. Louis Clinical Record*, (Lecture VIII.) June, 1880.