berg. Prof. Schlegel at first identified them with the Mooruk, but afterwards admitted their distinctness. My belief is that they are probably the same as the next species (*C. westermanni*), although the colours of the neck, as restored in the stuffed specimens, do not quite agree.

7. WESTERMAN'S CASSOWARY (*C. westermanni*).—This species I established on a bird still living in the Zoological Gardens, which we received from Mr. Westerman in 1871. At first I referred this bird to *C. kaupi*, of Rosenberg, until that naturalist showed that the pretended species which he had so named was nothing more than the young of *C. uniappendiculatus*. I then changed our bird's name to *C. westermanni*. I have recently seen two other living specimens of this bird in the Zoological Gardens at Rotterdam. It has been suggested that its true home is the island of Jobie, in the Bay of Geelvink, where Dr. Meyer ascertained the existence of a Cassowary, but was not able to procure specimens.

8. THE PAINTED-NECKED CASSOWARY (*C. picticollis*). —This species was likewise established by me on a specimen now living in the Zoological Gardens, which was obtained by the officers of H.M.S. *Basilisk* at Discovery Bay, on the east coast of New Guinea. It greatly resembles the Mooruk, but differs in its brilliantly-coloured neck, of which I have given a drawing in the P. Z. S. for the present year (1875, Part I.)

9. THE MOORUK, OR BENNETT'S CASSOWARY (*C. bennetti*).—In 1857 Mr. Gould described this Cassowary from a drawing sent to him by Dr. George Bennett, of Sydney, and soon afterwards a living pair were sent to us by our excellent friend, after whom the species had been named. These birds bred in the Gardens in 1864, but we have now unfortunately lost them. Bennett's Cassowary is an inhabitant of New Britain, to the east of New Guinea, and is easily distinguishable from its congeners by its blue throat and back of the neck.

Omitting for the moment the doubtful *C. papuanus*, it will be thus seen that we have tolerably certain indications of the districts in which the other eight Cassowaries are found. It would be very desirable, however, to get further information concerning them, and also to ascertain what is the Cassowary of Jobie, and whether the other islands adjacent to New Britain possess, as is probable, indigenous species of this group.

P. L. SCLATER

ANOTHER MONSTER REFRACTOR

THE experiment rendered possible, now some ten years ago, by Mr. Newall, and made with such triumphant success by Mr. Cooke, is again bearing fruit. Another monster telescope, indeed the largest yet attempted, is now in course of construction at Mr. Grubb's new works, near Dublin. This instrument has been ordered by the Imperial and Royal Austro-Hungarian Government for the new Observatory now in course of erection at Vienna. The object-glass will have an aperture of over 26 inches, probably about 27 inches, according as the discs of glass, which are being manufactured in the rough, by M. Feil, of Paris, may turn out on finishing. The focal length is to be about 32 feet. The general form of mounting will be modified to suit the special requirements of such a monster instrument. The great base casting (weighing some seven to eight tons) will form a chamber (about 12 feet long, 4 feet 6 inches wide, and 8 feet high) for the clock, which will be massive in proportion to the other parts. The axes will all have their friction relieved by anti-friction apparatus. The tube will be entirely of steel, and all the various motions of the instrument, as well as the reading of the different circles, will be available to the observer from the eye-end of the telescope.

A circular chamber of 45 feet diameter has been provided in Mr. Grubb's new workshops, to be covered for the present by a corrugated iron roof 50 feet high. In this the telescope is to be set up, and over this will be meanwhile erected an enormous steel dome, revolving on the system of rollers designed some years since by Mr. Thomas Grubb, and adopted at Dunsink Observatory, near Dublin, and at Lord Lindsay's Observatory. All of this dome and revolving machinery is afterwards to be removed to Vienna. Thus, by taking down the stationary iron roof, when the steel dome is erected over it, the equatorial will be placed in perfect working order, under its own roof in Dublin, for trial. It is proposed to attempt to illuminate the verniers and circles by Geissler's tubes. If M. Feil can, as he hopes, perfect the pair of discs required within twelve months, Mr. Grubb expects to have the whole instrument complete by the autumn of 1878, in which year, we may remark, it is not impossible that the British Association may be invited to Dublin. Should Lord Rosse's reflector be in order and the Vienna telescope complete, Section A will certainly muster in great force.

THE DIFFERENCE OF THERMAL ENERGY TRANSMITTED TO THE EARTH BY RADIATION FROM DIFFERENT PARTS OF THE SOLAR SURFACE

PÈRE SECCHI, in the second edition of "Le Soleil," published at Paris 1875, again calls attention to the result of his early investigations of the force of radiation emanating from different regions of the sun's surface, reiterating without modification his former opinions regarding the absorption of the radiant heat by the solar atmosphere. It will be well to bear in mind that the plan adopted by the Italian physicist in his original researches, on which his present opinion is based, was that of projecting the sun's image on a screen, and then, by means of thermopiles, measuring the temperature at different points. The serious defects inseparable from this method of measuring the intensity of the radiant heat I need not point out, nor will it be necessary to urge that a correct determination of the energy transmitted calls for direct observation of the temperature produced by the rays projected towards the earth. Accordingly, on taking up that branch of my investigations of radiant heat which relates to the difference of intensity transmitted from different parts of the sun's surface, I adopted the method of *direct* observation. The progress was slow at the beginning, owing to the necessity of constructing an astronomical apparatus of unusual dimensions, but having devised means which rendered the employment of any desirable focal length practicable, the work has progressed rapidly. An instrument of 17·7 metres (58 feet) focal length, erected to conduct preliminary experiments, has proved so satisfactory that the construction of one of 30 metres focal length, which I supposed to be necessary, has been dispensed with. Considering that the apparent diameter of the sun at a distance of 17·7 metres from the observer's eye is 162·4 millimetres even when the earth is in aphelion, the efficacy of the instrument employed might have been anticipated. The nature of the device will be readily comprehended by the following explanation :—Suppose a telescopic tube 17·7 metres long, 1 metre in diameter, devoid of object-glass and lenses, and mounted equatorially, to be closed at both ends by metallic plates or diaphragms, at right angles to the telescopic axis. Suppose the diaphragm at the upper end to be perforated with two circular apertures 200 millimetres in diameter, situated one above the other in the vertical line, 360 millimetres from centre to centre; and suppose a third circular perforation whose area is one-fifth of the apparent area of the solar disc, viz. 72·6 millimetres diameter, to be made on either side of the vertical line. Suppose, lastly, that the diaphragm which closes the lower end of the tube be perforated with three small apertures 6 millimetres in diameter, whose centres correspond exactly with the centres of the three large perforations in the upper diaphragm. The tube being then directed towards the sun, and actinometers applied below the three small apertures in the lower diaphragm, it will be evident that two of these instruments will, after due exposure to a clear sun, indicate maximum solar intensity, say 35° C., while the actinometer applied in line with the perforation whose area is one-fifth of the apparent area of the solar disc, will indicate $\frac{35}{5} = 7°$ C., unless the central portion of the solar disc radiates more powerfully towards the earth than the rest, in which case a higher intensity than 7° C. will be indicated by the actinometer referred to. It will be readily understood that the solar rays entering through the perforations at the upper end of the tube, converge at the lower end and pass through the small perforations, causing maximum indication of the focal actinometers as stated. Now, suppose that a circular plate, the area of which is exactly $\frac{4}{5}$ of the apparent area of the sun, viz. 145·2 millimetres diameter, be inserted concentrically in either of the two large perforations of the diaphragm at the top of the telescopic tube. The apparent diameter of the sun being as before stated 162·4 millimetres, it will be perceived that the inserted plate will only partially exclude the solar radiation, and that the rays from a zone 1′ 42″ wide will pass outside the said plate, converging in the form of a hollow cone at the lower end of the tube, and there enter the respective actinometer. The indication of the latter will then show the thermal energy transmitted by radiation from a zone whose mean width extends 49″ from the sun's border. It should be particularly observed that the three focal actinometers employed will be acted upon *simultaneously* by the converged rays, (1) from the entire area of the solar disc, (2) from a *central* region containing $\frac{1}{5}$ of the area, and (3) from a *zone* at the border containing also $\frac{1}{5}$ of the area of the solar disc. It is scarcely necessary to point out that an accurate comparison of the intensity of the radiant heat emanating from the central part and from the sun's border calls for *simultaneous* observation, in order to avoid the errors resulting from change of zenith distance and variation of atmospheric absorption during the investigation. The great advantage of obtaining also a simultaneous indication of the intensity transmitted by radiation

FIG. 1.

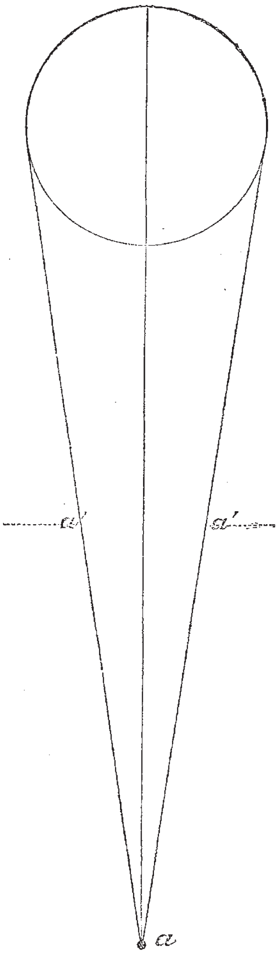


FIG. 2.

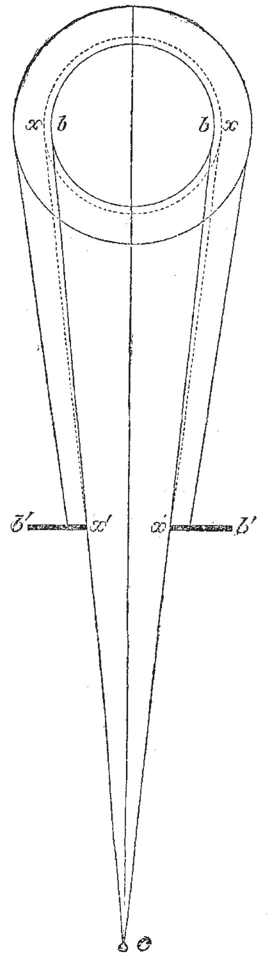
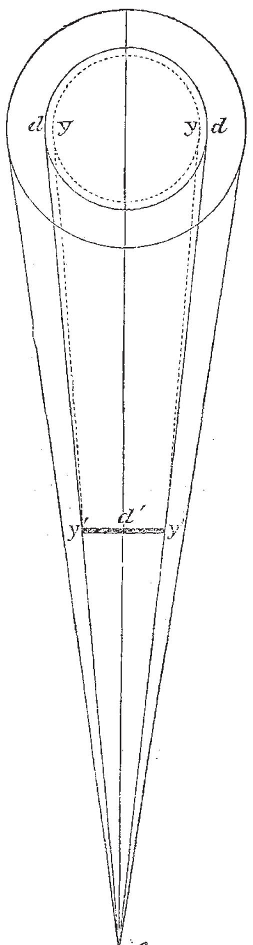


FIG. 3.

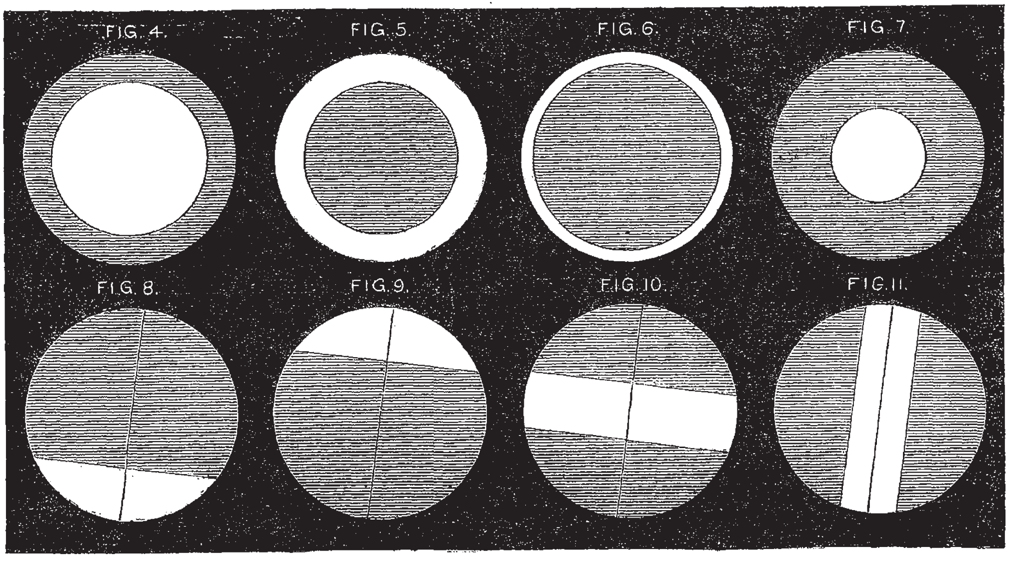


from the entire solar disc is self-evident, since this indication serves as an effectual check on the observed intensities emanating from the *centre* and from the *border*. The latter obviously must be less, while the former must be greater, for a given area, than the indication of the focal actinometer which receives the radiation of the entire solar disc.

The foregoing demonstration, based on hypothesis, having established the possibility of ascertaining by direct observation the temperature produced by the rays projected from certain parts of the solar surface, let us now examine the means actually employed. An observer on the 40th deg. latitude, stationed on the north side of a building 28 metres high pointing east and west, can just see the sun pass the meridian, during the summer solstice, if he occupies a position about 8 metres from such building. Now, if an opaque screen perforated by a circular opening 313 millimetres in diameter be placed on the top of the supposed building, the entire solar disc may be seen through the same, provided it faces the sun at right angles. But if the perforation in the said screen be 140 millimetres in diameter, only $\frac{1}{5}$ of the area of the solar disc will be seen. And if the screen be removed and a circular plate 280 millimetres in diameter put in its place, the observer, ranging himself in line with the plate and the sun's centre, can only see a narrow border 1′ 42″ of the solar disc. Obviously the screen placed on the top of the building might be perforated like the upper diaphragm of the supposed telescopic tube, and a plate resembling the lower diaphragm, secured by appropriate means near the ground, might be made to support the focal actinometers in such a manner that their axes pass through the centres of the perforations of the screen above the building. It is hardly necessary to state that the plate supporting the actinometers should be attached to some mechanism capable of imparting to it a parallactic movement, during the observation, corresponding with the sun's declination and the earth's diurnal motion; and, that some adequate mechanism should be employed for regulating the position of the perforated screen and adjusting the focal distance in accordance with the change of the subtended angle consequent on the varying distance from the sun. It will be evident that since the first-named mechanism rests on the ground, while the latter is secured to a massive building, far greater steadiness will be attained by our simple and comparatively inexpensive device, than by employing a telescopic tube of the most perfect construction mounted equatorially.

With reference to the influence of diffraction, it should be stated that before determining the size of the screens intended to shut out certain parts of the solar disc during the investigation, the amount of inflection of the sun's rays was carefully ascertained. Two distinct methods were adopted: (1) measuring the additional amount of heat transmitted to the focal thermometers in consequence of the inflection of the rays; (2) increasing the *theoretical* size of the screens until the effect of inflection was overcome and the luminous rays completely excluded. Regarding the first-named method of ascertaining the diffraction, it is important to mention that the temperature transmitted to the focal actinometers by the inflected radiation which passes outside of the theoretically determined screens is not proportionate to the inflection ascertained by the process of enlargement referred to. This circumstance at first rendered the investigation somewhat complicated, but it soon became evident that the discrepancy is caused by the comparatively small inflection of the *invisible* heat rays. It will be seen presently that the radiant heat which passes outside of the screens in consequence of diffraction is considerably less than that which would be transmitted to the focal actinometers if the calorific rays were subjected to an amount of inflection corresponding with the enlargement of the screens beyond the theoretical dimensions necessary to exclude the luminous rays.

Let us first consider the method of ascertaining the inflection of the rays by measuring the additional amount of heat transmitted to the focal actinometers. Fig. 1, see illustration, represents the solar disc, a being the focal actinometer exposed to the converged rays, $a' a'$ representing an imaginary plane situated 17·7 metres from a, at which distance the section of the pencil of converging rays will be 162·4 millimetres in diameter, provided the earth is near aphelion. Fig. 2 also represents the solar disc, and c the actinometer exposed to the converged rays; but a perforated screen $b' b'$ is interposed, the perforation being of such a size that only the rays projected by the central half of the solar disc (indicated by the circle $b\,b$) pass through the same and reach the focal actinometer. The screen $b' b'$ being situated 17·7 metres from c when the earth is in the position before referred to, the said perforation must be 114·83 millimetres in diameter, in order that the lines $b\,x'\,c$ may be straight. Fig. 3 likewise represents the solar disc, its area being divided in two concentric halves by



the circle $d\,d$; but in place of a perforated screen, an opaque circular screen d' is introduced at the same distance from the focal actinometer as in Fig. 2; consequently the lines $d\,y'\,f$ will be straight. Now, if the actinometers a, c, and f be exposed to the converged solar radiation *simultaneously and during an equal interval of time*, c and f receiving the heat from one half of the solar disc (the former from the central and the latter from the surrounding half), the temperatures of c and f added together should correspond exactly with the temperature transmitted from the entire solar disc to a. Observation, however, shows that the temperatures of c and f together is 0·091 greater than the temperature imparted to a. Hence an increase of temperature of nearly one-eleventh is produced by the inflection of the calorific rays, one-half being the result of the bending of the rays within the perforation of the screen $b'b'$, the other half resulting from the bending outside of the screen d'. The increment of temperature being thus known, the degree of inflection may be easily determined by drawing a circle $x\,x$ round the circle $b\,b$, covering an additional area of $\frac{0·091}{2} = 0·0455$; and by inscribing a circle $y\,y$ within $d\,d$, covering an area of 0·0455 less than the area of $d\,d$. It will be perceived on reflection that $x\,x'\,b$ represents the angle of inflection of the calorific rays within the perforation of the screen $b'\,b'$, and that $d\,y'\,y$ represents the angle of inflection outside of the screen d'. Demonstration shows that the former angle measures 14″·57, while the latter measures 14″·86, the mean being 14″·71. Having thus determined the inflection resulting from invisible radiation, let us now ascertain the inflection of the luminous rays. As before stated, the apparent diameter of the sun at a distance of 17·7 metres from a given point is 162·4 millimetres when the luminary is furthest from the earth. Now our investigation shows that a screen 167 millimetres in diameter hardly suffices to exclude the luminous rays; hence their inflection amounts to $\frac{167 - 162·4}{2} = 2·3$ millimetres at a distance of 17·7 metres. Their angle of inflection will therefore be 26″·81, against 14″·71 for the dark rays. We have thus incidentally established the fact that the inflection of the luminous and calorific rays differs nearly in the same proportion as the calorific energies of the visible and invisible portions of the solar spectrum.

Our space not admitting of a detailed account of the result of the investigation, the leading points only will be presented. The observations have all been made at noon, the duration of the exposure to the sun having been limited to seven minutes, during which period the actinometers are moved, by the parallactic mechanism, through a distance of about 55 centimetres, from west to east. The intensity of the radiant heat imparted to the actinometers has been recorded by the observers at the termination of the fourth, fifth, sixth, and seventh minute, the exact moment for reading off being indicated by a chronograph. The relative intensities transmitted by radiation from the centre and from the border of the solar disc, first claim our attention. Fig. 6 represents the solar disc covered by a circular screen 145·25 millimetres in diameter, excluding the rays excepting from a narrow zone, the mean width of which is situated 49″ from the border of the photosphere. Fig. 7 shows a screen excluding the solar rays excepting from the central portion, *the area of which is precisely equal to the area of the narrow zone in* Fig. 6. The following table shows the intensities transmitted to the actinometers during an observation, August 25, 1875, the radiation from the solar disc being then excluded in the manner shown in Figs. 6 and 7:—

Time.	Central portion. Cent.	Border. Cent.	Rate of difference.
4′	3°·28	2°·19	$\frac{2·19}{3·28} = 0·667$
5′	3°·56	2°·37	$\frac{2·37}{3·56} = 0·665$
6′	3°·73	2°·49	$\frac{2·49}{3·73} = 0·667$
7′	3°·88	2°·60	$\frac{2·60}{3·88} = 0·669$
			Mean = 0·667

It should be particularly observed that this table records the result of four distinct observations; nor should it be overlooked that although the intensities vary greatly for each observation in consequence of the continued exposure to the sun, yet the rates showing the difference of the intensity of the rays transmitted from the border, inserted in the last column, is practically the same for each observation, the discrepancy between the highest and the lowest rate being only 0·004.* Persons practically acquainted with the difficulty of ascertaining the intensity of solar radiation will be surprised at the exactness and consistency of the indications of our actinometers. This desirable exactness has been attained by surrounding the actinometers with water-jackets, which communicate with each other by connecting pipes, through which a steady stream of water is circulated. By this expedient the chambers containing the bulbs of the several thermometers are maintained with critical nicety at equal temperature, an inexorable condition when the object is to determine differential temperature with great exactness. Apart from this, the chambers which contain the bulbs of the thermometers are air-tight, the radiant heat being admitted through a small aperture at the top of the chamber, covered by a thin crystal.

Referring to the preceding table, it will be seen that the intensity transmitted by radiation from the sun's border, represented in Fig. 6, is 0·667 of the intensity transmitted from the central region represented in Fig. 7, the area of each being precisely alike. From the stated intensity must be deducted the heat imparted to the actinometer by the inflection of the calorific rays. The circumference of the perforation of the screen shown in Fig. 7 being exactly one-half of the circumference of the screen in Fig. 6, while the central region radiates more powerfully than the border, fully one-half of the inflected radiation from the border will be balanced by the inflected radiation emanating from the central region. Agreeable to the previous demonstration relating to Figs. 2 and 3, it will be seen that the unbalanced inflection amounts to 0·029; hence the radiation transmitted from the border zone will be 0·667 − 0·029 = 0·638 of the intensity of radiation transmitted from the central region. We have thus shown by a reliable method that the intensity of the rays directed towards the earth from the border zone suffers a diminution of 1·000 − 0·638 = 0·362 of the intensity of the radiation emanating from the central region. But the mean depth of the solar atmosphere of the border zone, in the direction of the earth, is 2·551 greater than the vertical depth, while the mean depth over the central region referred to is only 0·036 greater than the vertical depth of the solar atmosphere. Consequently, if we accept the assumption that the retardation is as the depth, the absorption by the solar atmosphere cannot exceed $\frac{0·362}{2·551 - 0·036} = 0·144$ of the radiant heat emanating from the photosphere.* It will be found, on referring to the revised edition of "Le Soleil," vol. i. p. 212, that Père Secchi makes the following statements regarding the absorptive power of the solar atmosphere. (1) "At the centre of the disc, that is to say perpendicularly to the surface of the photosphere, the absorption arrests about $\frac{2}{3}$ or more exactly $\frac{62}{100}$ of the total force." (2) "The total action of the absorbing envelope on the hemisphere visible from the sun is so great that it allows only $\frac{12}{100}$ of the total radiation to pass, the remainder, namely, $\frac{88}{100}$, being absorbed." It is unnecessary to criticise these figures presented by the Roman astronomer, as a cursory inspection of our table and diagrams is sufficient to show the fallacy of his computations. Apart from determining the absorptive power of the solar atmosphere, the most important problem which may be solved by accurately measuring the intensity of the radiation emanating from various parts of the disc, is that relating to the sun's emissive power in different directions. In order to decide this question, I have adopted the plan of measuring the energy of the radiant heat transmitted from zones crossing the solar disc at right angles, as shown in Figs. 10 and 11. Should it be found that our actinometers are equally affected by the radiation from these zones, each of which occupies an arc of 30 deg. containing one-third of the area of the disc, the inference will be irresistible that the sun emits heat of equal intensity in all directions. It should be borne in mind that, agreeable to our method, the radiations from these zones are observed simultaneously. The arrangement exhibited in Figs. 10 and 11 hardly needs explanation. Referring to Fig. 10, it will be seen that two segmental screens are employed excluding the radiant heat, excepting from the zone, which is parallel with the sun's equator. Similar screens are employed (see Fig. 11) for excluding the rays excepting from the zone parallel with the sun's polar axis. The curvatures of the segmental screens, it should be observed, have been struck to a radius of ninety millimetres, in order to cut off effectually the inflected radiation from the sun's border. Obviously diffraction has not called for any correction of our observations relating to this part of the investigation, since the inflected radiation from the equatorial zone exactly balances the inflected radiation from the polar zone. It only remains to be stated that repeated observations show that the radiant energies transmitted to the actinometers from the two zones are identical. The result of observations relating to the radiation emanating from the polar regions, represented in Figs. 8 and 9, together with other observations, will be discussed in future communications.

J. ERICSSON

* All my instruments for measuring radiant heat have been graduated to the Fahrenheit scale, which practically is more exact than the Centigrade, owing to its finer divisions. For the benefit of the Continental readers of NATURE, and in order to satisfy English and American advocates of the course Centigrade, the observed temperatures have been reduced to that cale before being entered in our tables.

* In the first edition of "Le Soleil," p. 264, the author assumes that the absorption of the calorific rays by the atmosphere "augments in proportion to the secant of the zenith distance;" in other words, as the depth of the atmosphere penetrated by the rays.

SOME LECTURE NOTES ON METEORITES †

III.

AMONG the mineral constituents of meteorites the unstable sulphides, it is hardly necessary to observe, could with difficulty be conceived as continuing permanently undecomposed, or as being even formed under the ordinary conditions of rock formation on our globe; and the same remark may be extended, though with some limitation, to the metallic iron that is so characteristic and ubiquitous a constituent of almost every, if, indeed, not (as maintained by Dr. Lawrence Smith) of every meteorite. On the other hand, it is to be remembered that the rocks that we are acquainted with on our globe are only those composing its outer crust; rocks which represent the results of the corrosive action of the atmospheric agencies, oxygen, carbonic acid, and water, and their counterpart the ocean, on whatever material the consolidated surface of our planet offered for their action. The endless cycle of mechanical and chemical disintegration, decomposition, and reconstruction would be limited to a shallow shell, and even the fresh matter forced out to the surface in volcanoes, through the contraction of the cooling globe, would consist in all likelihood only of the lower-lying layers of an already to a certain degree metamorphosed material. Whether the inner core of this planet is still in the meteoric condition—that is to say, still may contain such minerals as native iron, associated with nickel, not to say magnesium or calcium sulphides, is a question not to be lost sight of in explaining the high specific gravity of our globe as compared with that of the rocks that form its crust.

† Concluded from p. 507.