In such a condition as this, the desert-whirls may begin. It is clearly not necessary, in order to produce this result, that the vertical decrease of temperature should be as much as twenty degrees in three hundred feet, as in the case just assumed. In order to pass from the stable equilibrium, through the indifferent to the unstable equilibrium, it is sufficient, in dry air, that the vertical decrease should be greater than 1.6° in three hundred feet, or greater than one degree in one hundred and eighty-three feet. Moreover, it is important to notice, that, according to this theoretical explanation, the condition of indifferent equilibrium is passed before the surface-air is, as Franklin (1753) and Belt (1859) have said, specifically lighter than that above it. This would require a temperature difference of at least 5.6° F. in three hundred feet. It is sufficient that the surface-air shall be potentially lighter, though absolutely (before any motion takes place) heavier, than the higher layers, as Reye first showed (1864); or, in other words, stable equilibrium is lost, and indifferent equilibrium reached, when the surface-air is just enough warmer than any layer above it to make up for the change of temperatures produced in equalizing their densities. Any further excess of surface-warmth brings about theoretic unstable equilibrium. On the other hand, whirlwinds of decided activity will not be formed until the difference of temperature is much in excess of the narrow limits just given, the strength of the up-current increasing with its excess of warmth. Motion of the atmosphere caused by small differences of temperature would be very gentle, and would be perceived only in the 'boiling' of the air, often seen in summer-time over the brow of a hill.

It must be, then, the sun's heat, as was supposed, that destroys the normal stable equilibrium of our atmosphere; and to a disturbance of this kind we can refer more or less directly all storms, and, indeed, all winds that blow about the earth. Without the heat that is constantly showered down on us, we should soon gravitate into a lifeless condition of stable equilibrium, chemical, organic, and physical, and there remain in endless death. But the sun allows no such inactivity on its attendant planets: it keeps them alive and at work.

(To be continued.)

THE FRENCH ECLIPSE EXPEDITION.

P. J. JANSSEN, the leader of the French expedition which visited Caroline Island to observe the solar eclipse of May 6, has made a report to the French academy of sciences, which is published in full in the *Bulletin hebdomadaire de l'Association scientifique*, no. 181. It contains, first, an interesting account of the voyage to Caroline Island, and a brief description of the island, with the difficulties encountered in landing the instruments; then follows a statement of the instrumental outfit and the plan of observations. The search for intra-mercurial planets was assigned to Messrs. Palisa and Trouvelot. The former used an equatorial of 0.16 m. aperture, having a short focus and large field: the latter was provided with an equatorial of the same size, which had a finder of 0.08 m. aperture, thus giving the observer two telescopes. The finder had a field of 4°.5, and was used in examining the region in the vicinity of the sun, while the larger instrument was intended to give the position of any strange object that might be noted by means of its position-circles. In order to avoid the necessity of reading the circles, an attachment was made to both right ascension and declination circles, by which fine marks could be made upon the circles and verniers by the observer's assistants, and the corresponding readings determined at leisure. The finder was also furnished with a reticule containing cross-threads, and a position-circle for use in noting the appearance of the corona, to the drawing of which Mr. Trouvelot gave a portion of the time of the total phase.

The search for intra-mercurial planets was also conducted by the aid of photographic apparatus, which Mr. Janssen thus describes: —

"At my order, Mr. Gautier had prepared an equatorial mounting with an hour-axis two metres long, carrying a strong and large platform, upon which were fastened the following photographic apparatus: a large camera having a lens of eight inches (0.21 m.), made by Darlot, giving a field of 20° to 25° (plate of 0.40 m. by 0.50 m.), and designed for photographing the corona and the region about the sun with reference to the stars there found; a second camera, with a Darlot lens of six inches (0.16 m.), giving a field of 26° to 35° (plate of 0.30 m. by 0.40 m.), for the same purpose; and a very fine apparatus by Steinheil, for studying the corona. A second mounting carried several cameras with lenses of four inches (0.10 m.), giving a great amount of light, and designed to determine by very sensitive plates what are the limits of the corona, — an apparatus of great light-power, the exposure lasting during the whole of totality."

For spectrum analysis the following apparatus was employed: "a [reflecting] telescope of 0.50 m. aperture, having a very short focus (1.60 m.), and supplied with a direct-vision spectroscope of ten prisms; the slit of the spectroscope could be placed at different position-angles, and rapidly opened or closed, at the pleasure of the observer. An excellent finder, supplied with a reticule, was placed near the spectroscope, and distant from it by such an amount, that, when one eye had fixed upon some point of the corona in the finder, the other could obtain the spectroscopic analysis of this point." There was also attached to this telescope a biquartz polariscope by Prazmowski, and a spectroscope for showing Respighi's rings. A

spare mirror of 0.40 m. diameter was carried as a reserve, but was not brought into use, as, by great care, the first was kept uninjured, in spite of the frequent rains and the moisture of the climate.

Mr. Janssen gives the following condensed report of his own observations, drawn up immediately after the observations, in accordance with the plan by which all the observers of the party were governed: —

"My observations were of two classes, — optical and photographic. The optical observations were principally designed to determine whether the coronal spectrum consists of a continuous spectrum as a background with bright lines, or if the Fraunhofer lines exist there generally (an investigation made especially with regard to the question of extra-solar cosmic substances). In 1871 I had announced, that, besides the hydrogen lines, I had established in the spectrum of the corona the presence of the *D* line and of several others.

"In the present eclipse I proposed especially to solve this question. By means of the optical arrangements above described, I have been able to determine that the basis of the coronal spectrum is composed of the complete Fraunhofer spectrum. The principal lines of the solar spectrum, especially *D*, *b*, *E*, etc., were detected so surely that there can be no possible doubt of this fact. I recognized, perhaps, a hundred lines.

"I recognized this composition of the spectrum, particularly in the lower or most brilliant portions of the corona, but not to an equal degree at the same distance from the moon's limb. The details of this will be given and discussed at a future time.

"I studied also the rings of Respighi. The rings did not appear uniform about the moon's limb, but presented peculiarities of structure which will be especially discussed in their relation to the question of the Fraunhofer lines.

"I studied also polarization, but devoted to it only a few moments, using the excellent biquartz polariscope of Prazmowski. The polarization was very well defined, and possessed characteristics already recognized.

"Before the observations, I made a preliminary examination of the corona with the naked eye, and with an excellent telescope by Prazmowski. This examination was for the purpose of guiding me in the subsequent observations.

"All these studies — study of the shape, spectrum analysis, Respighi's rings, polarization — were combined with the view of solving the question of extra-solar cosmic substances. We think that the discovery of the complete Fraunhofer spectrum in that of the corona considerably advances this question.

"*Photography.* — Two great instruments, containing eight cameras, had been prepared for studying the question of intra-mercurial planets, and that of the shape and extension of the corona. With regard to heavenly bodies in the vicinity of the sun, these photographs will require a minute examination; but, with respect to the corona, it can be said that the great power of several of the lenses used [that of eight inches (0.21 m.) and that of six inches (0.16 m.)], and also the length of exposure, permitted us to prove that the corona has an extension very much greater than that shown by optical examination, either with the naked eye or in my telescope.

"Several of our large photographs of the corona have great distinctness. They show important details of structure which ought to be discussed. The shape of the corona was absolutely fixed during the whole duration of totality."

The reports of Messrs. Tacchini, Palisa, and Trouvelot are not given, but are alluded to in the discussion of the results of the observations, which next follows. Mr. Janssen regards it quite improbable that any intra-mercurial planets exist, on account of the negative testimony given by Mr. Palisa, combined with that of Professor Holden of the American party. Mr. Trouvelot's conclusion is less decisive, but the observer wished to re-examine the region of the sky before coming to a final conclusion.[1] The author adds, "When we consider that the bodies discovered by Professor Watson in 1878 can be identified, within the limits of error to which the method employed by that astronomer is liable, with two stars in Cancer,[2] we arrive at the conclusion that it is to-day extremely improbable that there exists one or more planetary bodies of any importance between Mercury and the sun. Our photographs, although not yet completely examined, seem to lead to the same conclusion."

The duration of totality was found by Mr. Trouvelot to be $5^m\ 24^s.1$, by Mr. Tacchini to be $5^m\ 23^s$.

On the subject of the corona, Mr. Janssen thus writes: —

"*The corona.* — Mr. Tacchini's report shows that this skilful astronomer made remarkable observations at Caroline Island, especially with regard to the analogy between the composition of the spectrum of certain parts of the corona and the spectrum of comets. It was part of my plan to examine this correspondence, as is shown by a note drawn up by me long before the eclipse, and which I read to my colleagues when we compared our respective reports. It is a matter which ought to be verified with the greatest care in future eclipses. However, I leave to Mr. Tacchini the task of developing his observations.

"It will be seen from my report, that the principal object of my observations was to decide one point of the composition of the spectrum of the corona which

[1] Mr. Trouvelot observed, near the close of totality, a star which he describes as 'bright, and of a pronounced red color;' but, by some misunderstanding, its position was not recorded by the special attachments to the circles above described. Its position, therefore, cannot be determined, nor the question of its identification be positively settled. The observer announces (*Comptes rendus*, Sept. 17) that he has re-examined the region, and finds no star of the corresponding magnitude and color in the vicinity of the approximate position which he was able to assign to it. "Although," he adds, "the absence of a red star as bright as that which I observed in the eclipse seems quite naturally to lead to the conclusion that the body in question is no other than an intra-mercurial planet, yet as the most necessary elements, such as the position and a disk or a sensible phase, are wanting in my observation, I think I ought to suspend, for the present, my conclusions upon the probable nature of the body."

[2] First pointed out by Dr. C. H. F. Peters (*Astron. nachr.*, nos. 2253 and 2254).

has always seemed to me very important; viz., whether the light of the corona contains an important proportion of solar light. The result surpassed my expectation in this matter. The Fraunhofer spectrum, so complete as I witnessed it at Caroline Island, proves, that, without denying that a certain part is due to diffraction, there exists in the corona, and especially in certain parts of the corona, an enormous quantity of reflected light; and as we know, besides, that the coronal atmosphere is very thin, it must be that in these regions cosmic matter exists in the condition of solid corpuscles, in order to explain this abundance of reflected solar light.

"The more we advance, the more we perceive the complex nature of the regions in the immediate vicinity of the sun; and it is only by persistent and very varied observations, and an exhaustive discussion of these observations, that we can arrive at an exact knowledge of these regions. The great eclipse of 1883 has allowed us to take a step forward.

"*Photography of the corona.* — The result of the studies of the photographs will be given later; for they require a thorough examination, since they record many most interesting phenomena. I will simply say at present, that these photographs show a corona more extended than that given by telescopic examination, and that the phenomenon appeared well defined and steady during the duration of totality.

"*Luminous intensity of the corona.* — I had prepared a photometric measure, by photography, of the luminous intensity of the corona. This experiment showed that at Caroline Island the illumination given by the corona was greater than that of the full moon. The exact numbers will be given later. It should be noted, that this is the first time that an exact measure of the luminous intensity of this phenomenon has been made."

The remainder of the report gives an account of the return journey of the members of the expedition. They visited the volcano of Kilauea on the island of Hawaii, and passed a night in the crater on the edge of the lava lake. Mr. Janssen made some experiments, which, he states, "show some curious coincidences between these volcanic phenomena and those of the solar surface. I was able, also, to obtain the spectrum of the flames which issue from the lava, and to establish in them the presence of sodium, hydrogen, and the carburetted compounds." W. U.

THE HIMALAYAS.[1]

MY predecessor, Sir Richard Temple, selected for the subject of his address to this section last year, 'The central plateau of Asia.' Following him in a measure over some of the same ground, I have selected the mountain region south of the Central Asian highlands, viz., the Himalayas, and more particularly the western portion of that range, as the subject of this paper. I propose considering this mountain chain with reference to its physical features, past and present, and consequently with reference to its geological history, so far as that relates to later tertiary times; i.e., the period immediately preceding the present distribution of seas, land, rivers, and lakes. It is not, however, my intention to enter very deeply into the purely geological branch of the subject.

The Himalayas, the highest mountains in the world, comprise, strictly speaking, only the snowy range seen from the plains of India, bordering upon the course of the Ganges; but we might, I think, use the term in an extended sense, so as to include that which we may call the north-western Himalaya, north of the Punjab, and also the eastern Himalaya, bordering on Assam. The orography of this mountain mass has been recently ably handled by Messrs. Medlicott and Blanford;[1] and I follow them in all their main divisions and nomenclature, which are based upon a thorough understanding of the rocks of the country. Some line must be selected where the term 'Himalaya' must cease to be used, and this cannot be better defined than by the valley of the Indus from Attock to Bunji. On this line we find the great bending-round of all the ranges. To the mountains north of the Indus, on its east and west course, the name 'Himalaya' should certainly never be applied. For this north-west, trans-Indus part of the Asian chain we have the well-known name 'Mustagh,' so far as the head of the Gilgit valley; the 'Hindu Kush' being an excellent term now in common use for its extension to the Afghan country.

The observations made by many of the assistants of the Indian geological survey, more especially by Stoliczka, and more recently by Lydekker, in the Himalayas, combined with those made by myself in the same region, have, when considered in conjunction with the ascertained strike of the granitoid or gneissic rocks, led me to separate the great Central Asian chain into the following five principal divisions, with some minor subdivisions: —

1. The main or Central Asian axis, Kuenlun.
2. Trans-Himalaya.
3. Himalaya.
4. Outer or lower Himalaya.
5. Sub-Himalaya.

In our present ignorance as to the composition of the chain eastward from the Sutlej, we cannot attempt to lay down there any axis-lines of original elevation; but the separation of the line of highest peaks into one range, and the water-parting into another, is an acceptable solution of the physical features, as at present known, of this part of the chain. I think, however, that when this ground is examined, it will resolve itself into a series of parallel ridges, more or less close, and oblique to the line of greatest altitude as defined by the line of high peaks, crossing diagonally even the main drainage-line of the Sanspu; just as we see the Ladak axis crossing the Indus near Hanlé, or the Pir Panjal that of the Jhelum. Sir Henry Strachey's conception of the general structure was the soundest and most scientific first propounded.

[1] Abstract of an address by Lieut.-Col. H. H. GODWIN-AUSTEN, F.R.S., F.G.S., F.R.G.S., etc., president of the section of geography of the British association.

[1] A manual of the geology of India, 1879, p. 9.