MONTHLY NOTICES

OF THE

ROYAL ASTRONOMICAL SOCIETY.

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The Rev. R. MAIN, President, in the Chair.

Walter Parsonson, Esq., Sheffield;
George Knott, Esq., Woodcroft, Cuckfield, Sussex;
Rev. H. Cooper Key, Stretton Rectory, Hereford; and
O. Pihl, Esq., Christiania, Sweden,

were balloted for and duly elected Fellows of the Society.

Account of Observations of the Total Solar Eclipse of 1860, *July* 18, *made at Hereña, near Miranda de Ebro; with a notice of the general proceedings of "The Himalaya Expedition for Observation of the Total Solar Eclipse."* By G. B. Airy, Esq., Astronomer Royal.

In placing before the Royal Astronomical Society an account of my observations of the Total Eclipse of the Sun, of 1860, July 18, it is not so much my own personal observations which I wish to convey, as an account of the general proceedings of a party who, I trust, will be distinguished in future times as associated under the title of "The Himalaya Expedition." And even of these I cannot profess, in this communication, to give the scientific observations. The number is far too great, (from persons either who sailed in the Himalaya, or who were connected with the expedition by friendly ties, I have already about sixty accounts); and the details too extensive. Moreover, in a subject where much of the value of the observations will depend on the comparison of different persons' observations, it may not improbably be found advantageous to break up each account, and to collect from all the different accounts; first, those parts which relate to one part of the phenomena, and

which will aptly form one large chapter; secondly, those which relate to another part of the phenomena, and which will form a second chapter; and so on. I trust to be able hereafter to lay before the Society a comparative account of the observations, framed, probably, on these general principles. Omitting, then, for the present, the details of observations of the mass of observers, I will first give a short account of the expedition generally, and will then subjoin a few words only on my own observations.

Having had the honour of an interview with the Duke of Somerset, First Lord of the Admiralty, on 1859, Nov. 15, I took occasion to call His Grace's attention to the approaching total eclipse, and to submit to his consideration the advantage of appropriating to the use of astronomers a ship, for their conveyance to and from the coast of Spain. Although no answer could then be given to this proposal, the reception of it was so far favourable that I was induced to speak of it, in communications to this Society, as an arrangement which might be expected. Finally, the noble screw-steamship Himalaya, commanded by Captain Seccombe, R.N., was appointed for this service.

In the meantime the Society had received several communications, of a most friendly and very important character, from Charles Vignoles, Esq., whose position as Engineer-in-Chief of the Tudela and Bilbao Railway (the whole of which was to be covered by the shadow of the totality) not only gave him a thorough knowledge of the country, its points favourable for observation, its climate, and its social resources, but also enabled him to employ his own official powers and to use his good offices with the Directors of the Railway, particularly with their Managing Director, Señor Cipriano de Montesino, for giving to astronomers the assistance of the staff of able engineers stationed at different points of the railway. Offers of assistance, of a similar kind, were made by Philip E. Sewell, Esq., Engineer-in-Chief of the Isabella Segunda Railway, extending southward from Santander, to Alar del Rey. These invitations, in addition to other considerations, sufficed to define the course of the expedition. It was arranged that the Himalaya should first touch at the roads of Bilbao, landing there a portion of the party (in which I was myself included) who relied principally on the kindness of Mr. Vignoles for guidance in the selection of stations, and for aids to reach them; and that she should then proceed to Santander to land the remainder of the party, who would receive much assistance from Mr. Sewell. The ship would then lie in the harbour of Santander, and after the completion of the observations she would receive the Santander party, again touch at Bilbao to receive the Bilbao party, and finally return to England.

Mr. Vignoles, and other persons well acquainted with the climate, had strongly insisted on the danger (from the fear of cloudy skies) of remaining in the Biscayan provinces, and

urged that a large proportion, at least, of the observers should cross the Cantabrian Pyrenees into the valley of the Ebro. This arrangement implied an addition of at least two days to the time to be spent in Spain before the eclipse, and as much after the eclipse. It was also thought important to allow sufficient time for the transport of the heavy apparatus to be used by Mr. De La Rue, and for the erection of the temporary buildings in which he proposed to mount it. After consideration of these and other points, the morning of July 7 was fixed for the sailing of the Himalaya from Plymouth Sound.

At an early time I had addressed Lord John Russell, Her Majesty's Principal Secretary of State for the Foreign Department, requesting his intercession with the Spanish Government for such a degree of relaxation of the Police and Custom-house regulations as would permit astronomers to enter Spain with facility and without the charge of duty on their apparatus. In the correspondence which followed, I received letters from His Excellency Don Xavier e Isturiz, Ambassador of the Spanish Government; from Don Antonio Aguilar, Principal of the Observatory of Madrid; and from Don F. de P. Marqua, Principal of the Observatory of San Fernando, Cadiz; and in all of these I was abundantly assured of the interest taken by the Spanish Government in the enterprise, and of their determination to withdraw, for the benefit of astronomers, all the customary arrangements of ports and frontiers, which give trouble and expense to travellers.

The Himalaya sailed from Plymouth Sound, as was arranged, on the morning of July 7. The weather was fine, and the navigation generally agreeable. And nothing will ever efface, from the minds of those who had the pleasure to share in this voyage, the recollections of the kindness and courtesy of Captain Seccombe, R.N., commanding the ship; Lieutenant (now Captain) Versturm, First Lieutenant; John Thompson, Esq., Master; and the other officers of the Himalaya. The table and other accommodations provided by the Admiralty were most liberal, and every arrangement of the ship most comfortable.

In some conferences, on the deck of the Himalaya, an attempt was made to divide among the observers the different classes of observation.

The high land of Cape Machicaco was made early in the morning of July 9, and the Himalaya dropped her anchor in the roads of Bilbao a few hours later. Mr. Vignoles, accompanied by the principal officers of Customs and Police, and other departments, came out in a small steamer to receive and welcome the Bilbao party. The baggage and instruments were nominally examined in transit; the examination consisting, in reality, of lifting the lid of one open box. No passport was examined. The following is (I believe) a list of the party who landed at Bilbao:—

G. B. Airy, assisted by Wilfrid Airy.
Rev. H. A. S. Atwood.
Joseph Beck, assisted by Walter Beck.
Joseph Bonomi.
Warren De La Rue, assisted by E. Beck, Mr. Beckley, Mr. Downes, Mr. Reynolds.
Francis Galton.
Professor Grant.
Charles Gray.
Captain Jacob.
Dr. M'Taggart.
Rev. J. S. Perowne.
J. G. Perry, accompanied by Professor Pole.
Rev. C. Pritchard, assisted by V. Fasel.
Russell Scott.
Otto Struve, assisted by M. Oom and M. Winnecke.
Rev. O. Vignoles.
John Wright.
Together with four ladies, namely Mrs. Airy, Mrs. O. Vignoles, Mademoiselle Struve, and Miss H. Airy.

The Himalaya then proceeded to Santander, and, on July 10, landed the following party:—

James Buckingham, assisted by W. Wray.
H. S. Ellis.
Professor Fearnley.
Rev. H. A. Goodwin.
R. F. Heath, assisted by J. Turner.
R. J. Hobbes.
W. Lassell.
M. Lindelöf.
Professor Lindhagen.
E. J. Lowe, accompanied by Rev. W. R. Almond and Mr. S. Morley.
Dr. Möller.
J. Stanistreet.
Professor Swan.

Of the Santander party I have at present no further account to give, and of the Bilbao party only the following. A kind reception from all parties awaited the astronomers on the Spanish land. The mayors of towns and villages, and the commandants of police, called on us and placed their powers at our disposal. On the day of the eclipse, the telegraphs were reserved for astronomical communications. But I am bound especially to say that the activity and entire self-devotion of Mr. Vignoles, his extensive private hospitality, and that of the gentlemen subordinate to him in the conduct of the Tudela and Bilbao Railway, contributed in a most important degree to the comfort of a large section of the observers, and to the success of their observations. To Mr. Bartlett, also, Resident Con-

tractor for the Railway works, we are indebted for much assistance.

Mr. Vignoles without delay despatched Mr. De La Rue's heavy instruments, &c., to the station which had been selected for him at Riva Bellosa, near Miranda. As early as possible the party were assembled at the offices of the Tudela and Bilbao Railway, and there, under the instructions of Mr. Vignoles and M. Montesino, a selection of stations was made. Omitting from this time allusion to other observers, the station allotted to M. Struve, M. Oom, M. Winnecke, and my own family party, was Pobes.* This is a very small and secluded village on the river Bayas, about two miles south of the remarkable defile of Tetches, where the Bayas issues from the Cantabrian Pyrenees. It is accessible by a good road in the direction of Orduña, Espejo, and Salinas (Anaña), as also by Vitoria and Nanclares. The Bayas, in its descent towards the Ebro, at the distance of little more than two miles, enters another defile, which is bordered on the eastern side by the hill above Hereña (called, I believe, St. Lorenzo), to be further mentioned in this account. The view from Pobes is therefore bounded on all sides by mountains, with the exception of a lateral depression on the eastern side of the valley, south of the Morillas hill, through which the mountains of the lower Ebro are seen. The church of Pobes stands on a steep knoll, perhaps 80 feet above the plain, and the churchyard surrounding it commands a very beautiful prospect.

At Pobes we were all placed under the hospitable care of Christopher Bennison, Esq., Superintendent of an extensive section of the Railway. And none of us will forget the kindness and the attention to all our wants, social and scientific, which we then experienced.

I arrived at Pobes, from Orduña, on the afternoon of Saturday July 14. On the northern side of the mountains the day had been dull and foggy, but on the south side the weather was extremely fine. I found my instruments arrived, and found Messrs. Struve, Oom, and Winnecke, engaged in astronomical observations for the determination of latitude and time. Their station for this purpose was a threshing-floor close to the churchyard. But I found that they had already selected points on the hills near Pobes, on the right bank of the Bayas, as stations for the observation of the eclipse. On viewing the country I had no hesitation in fixing on the hill above Hereña, on the left bank of the Bayas, as a very desirable post for myself.

I employed a part of the evening in endeavouring to judge (by memory) of the degree of darkness in a total eclipse. For this purpose I lighted a wax-candle, such as I had used in 1842 and 1851, and placed it on the parapet of the churchyard; and

* Pobes was the scene of some military movements immediately before the battle of Vitoria.

then, correcting my eye by its light, I remarked the time when, as I thought, the darkness appeared equal to that in the totality of 1851. It was about $8^h\ 30^m$ Greenwich mean solar time. Computing from this the position of the sun, it was about $7°\ 7'$ below the horizon. The evening was splendidly fine.

The next day, Sunday July 15, was magnificent. I went to the hill above Hereña, and found that it entirely satisfied my wishes. The point which I selected was the extreme eastern point, the highest part of the hill. The view of mountain and valley from this point is singularly grand. In the north-west direction, from which side the darkness would approach, the vision is limited at a few miles distance by the Pyrenees; but on the south-east side, in the direction of the retiring shadow, it extends across the Royal Road (from Vitoria to Miranda) and across and along the lower Ebro, to a very great distance. The south side of the hill is a bushy slope; the north side is a low crag of puddingstone, succeeded by a narrow flat and a talus, on which are numerous fine trees of the ilex, so common in that country, many of whose tops rise above the crag; and I could reckon with certainty on sheltering my telescope from any wind.

On the evening of July 15, finger-formed clouds began to show themselves in the north sky, and very soon there burst forth a thunder-and-lightning storm of great violence, which lasted all night. On July 16 and 17, the weather appeared completely changed. The wind blew from the north and was very cold; the near mountains were clouded very low; the distant mountains were invisible; the sun was not seen. The last-mentioned circumstance was unfortunate for me. I had prepared a telescope (constructed as I had previously explained to the Society) with a system of wires engraved on glass, containing, as an essential part, a square defined by crossing lines, within which square the image of the moon was to be brought. Pressure of business had prevented me from making many trials of this apparatus at Greenwich, but I had found that the dimensions of the square were a little too large for the sun, and I trusted that they would exactly correspond to the moon. In fact, they were a very little too large, and delicate manipulation was required for maintaining the moon exactly in the centre. I had relied on the climate of Spain for permitting me to acquire the necessary practice, when the sun should be near its meridian height on the two days preceding the eclipse; but in this hope I was totally deceived.

The morning of July 18 was cloudy; but distant mountains began to show themselves, and the aspect of the sky was improving. With the three companions of my own family whom I have mentioned, with Mr. Stead, one of the staff of railway engineers, and with nine men to carry instruments, I proceeded from Pobes to Hereña and up the hill. The weather steadily

improved, till before the eclipse began it was splendidly fine; a few clouds rather low in the south being all that was left of the late murkiness. My own telescope ($3\frac{3}{4}$-inch aperture, 46 focal length, on tripod stand) was placed a few yards west of the end of the hill; the power used was about 50. The telescope used by Wilfrid Airy ($3\frac{3}{4}$-inch aperture, 36 focal length, on tripod stand) was placed about twenty yards further west; the power used was about 100. I had a duplex watch, Molyneux 1007, beating $\frac{2}{5}$ seconds; Wilfrid Airy had a lever watch, Dent, beating $\frac{1}{4}$ seconds. The rest of the party had no telescopes or trustworthy watches.

Before giving the observations themselves, I will premise some numerical elements necessary for their reduction.

In comparing the observations made at numerous stations, it is evidently desirable to refer all the stations to a common system of geographical co-ordinates; and much of the clearness of our results may depend on the due choice of the system of co-ordinates. Now it appears evident that we want, not terrestrial longitudes and latitudes, but something which will show the relation of each observation to the following two elements,—first, the absolute time of the phenomenon; secondly, the nearest distance of the sun's centre from the moon's centre as seen at the place of observation. These elements are well connected with co-ordinates, of which the abscissa is measured along the central line of shadows, and the ordinate is measured along a line of simultaneous centrality of totality. The lines of which I speak are drawn upon Mr. Vignoles' map. I have therefore taken the measures from that map, using the minute of latitude as the unit of measure. For the zero of abscissa I have taken the western border of the map. The co-ordinates of Pobes, thus defined, are nearly,—

Abscissa 152; Ordinate 19 N.E.

A solar chronometer, Molyneux 2184, was carried from Greenwich. It was usually in the custody of M. Struve, and was undoubtedly treated with all possible care. Comparisons of its indications with Greenwich mean solar time were made before going and after returning, of which the following may here suffice:—

Molyneux 2184, slow on Greenwich Mean Solar Time:

			h	m	s
1860,	June	23	0	2	5·0
	July	5	0	2	39·0
	July	30	0	4	2·4
	August	11	0	4	36·4

The mean daily rates in the three several groups are $2^s{\cdot}83$, $3^s{\cdot}34$, and $2^s{\cdot}83$. The agreement of these gives great confidence

in the uniformity of rate from July 5 to July 30. Adopting $3^s \cdot 34$, we have the following results:—

Molyneux 2184, slow on Greenwich Mean Solar Time:

	h	m s
June 17	0	3 19·1
18	0	3 22·4
19	0	3 25·8

I am informed by M. Winnecke that the errors of the chronometer on Pobes mean solar time (as found by astronomical observation) at these epochs were $8^m\ 18^s \cdot 0$, $8^m\ 15^s \cdot 1$, $8^m\ 12^s \cdot 1$, fast. These give for the longitude of the threshing-floor near the churchyard of Pobes $11^m\ 37^s \cdot 1$, $11^m\ 37^s \cdot 5$, $11^m\ 37^s \cdot 9$. Its latitude was found to be 42° 48′ 5″.

Again we have,

Molyneux 2184, slow on Greenwich Mean Solar Time:

	h	m s
June 17	22	3 22·1
18	22	3 25·5

At these times, Molyneux 1007 was faster by $2^m\ 46^s \cdot 4$ and $2^m\ 52^s \cdot 5$; and Dent was slower by $15^m\ 56^s \cdot 0$ and $17^m\ 9^s \cdot 5$. From these we find with sufficient approximation, at July 18, 2^h to 4^h,

	m s
Molyneux 1007, slow on Greenwich Mean Solar Time	0 35·1
Dent slow	19 31
to	19 37

Finally, as it was my intention to refer angles to wires in the telescope having a definite relation to the vertical, it was necessary to ascertain the angle made by the vertical with the astronomical meridian. On calculation it appears that the angles were,

	h m		° ′
At	2 50	Greenwich Mean Solar Time	46 39
	3 0	... ...	47 41
	3 10	... ...	48 35

During the $3\frac{1}{3}^m$ of totality, this angle therefore changed by about 19′; a quantity smaller than I could answer for in my observations, but which in more delicate measures ought not to be omitted.

I shall now proceed with my observations.

For observations of time, I commenced counting the $\frac{2}{5}$ beats of my watch at some decade of seconds, and counted up to 25 ($=10^s$), after which I again began counting. Thus I observed the first contact at $1^h\ 47^m\ 30^s$ of Molyneux 1007. My eye, however, was directed (in consequence, as I have since found,

of an error in the position of my wires) to a point on the sun's limb about 5° too high; and in consequence I did not perceive the very first contact. I think that it had taken place about 4^s before the time noted. This gives for watch-time $1^h\ 47^m\ 26^s$, or for Greenwich mean solar time $1^h\ 48^m\ 1^s$; which I consider very exact.

On the progress of the eclipse I have nothing to remark, except that I thought the singular darkening of the landscape, whose character is peculiar to an eclipse, to be sadder than usual. The cause of this peculiar character I conceive to be, the diminution of light on the higher strata of air. When the sun is heavily clouded, still the upper atmosphere is brilliantly illuminated, and the diffused light which comes from it is agreeable to the eye. But when the sun is partially eclipsed, the illumination of the atmosphere for many miles round is also diminished, and the eye is oppressed by the absence of the light which usually comes from it.

I had a wax-candle lighted in a lantern, as I have had at preceding total eclipses. Correcting the appreciations of my eye by reference to this, I found that the darkness of the approaching totality was much less striking than in the eclipses of 1842 and 1851. In my anxiety to lose nothing at the telecope I did not see the approach of the dark shadow through the air; but, from what I afterwards saw of its retreat, I am sure that it must have been very awful.

At $2^h\ 59^m\ 30^s{\cdot}0$ of my watch I commenced counting the beats, holding the watch to my ear, and recommencing the counting at the end of 25 beats. When, from the narrowness of the sun's lune, I judged that the totality would occur in ten or fifteen seconds, I withdrew the graduated coloured glass. To my infinite astonishment, while the white sun was still shining brilliantly, I saw in great splendour two red prominences (possibly more than two were visible) and one double floating red cloud. I am not certain whether the red sierra was then visible, or whether it became visible after the white disk had disappeared. But, before the white disk had disappeared, the white corona formed round the moon, I think all at once; and the moon was seen complete, with dazzling sun, brilliant corona, and brilliant prominences. The intensity of light in the corona and prominences was not much increased at the total disappearance of the sun.

The co-existence of all these lights really introduced much confusion in the observation of the time of formation of totality. I found myself counting the beats of my watch up to 45, and I set down the time of totality as $2^h\ 59^m\ 30^s + 45$ beats. But I was afterwards under the impression, and now fully believe, that I had passed one counting of 25 beats; so that the register ought to have been $2^h\ 59^m\ 30^s + 70$ beats. This makes the time $2^h\ 59^m\ 58^s$ of my watch, or $3^h\ 0^m\ 33^s$ Greenwich mean solar time.

In a former communication to the Society I stated my intention to use a system of wires embodying the following conditions: 1. That there should be a square, pretty exactly containing the moon; 2. That there should be a system of 12 crossing lines, or 24 radii passing through the centre of the square, and inclined each to its neighbour at an angle of 15°; 3. That two of these crossing lines should be stronger than the rest, one approximately in the direction in which it was found (by calculation) that the moon would apparently cross the sun, the other in the direction normal to that crossing motion. And I proposed to observe the angular position of any prominences which might be near to the normal line. Mr. James Simms had furnished me with a reflecting eye-piece taking a definite position (as to angular rotation) in the telescope, and bearing such a system of lines etched on the reflecting prism; the position of the strong normal line being a few degrees in error. On bringing the moon into the square I found that there were two appearances which precisely corresponded to my wishes; one a prominence exactly 15° to the apparent left (or on the radius whose angle, measuring from the upper normal in direction of watch-hand-motion, is 345°); the other the double floating cloud, exactly 15° to the apparent right; both being bisected by the radial lines. A third large and conspicuous prominence more to the left, at perhaps 300°, I merely saw with a single glance. There might be others which I did not remark.

[I may take this opportunity of stating that the colour of these appearances was not identical with that which I saw both in 1842 and 1851. The quality of the colour was precisely the same (full blush-red, or nearly lake), but it was diluted with white, and more diluted at the root of the prominences close to the moon's limb than in the most elevated points.]

I proceeded as soon as I could with my measures (to be given below). About the middle of the totality I ceased for a while, in order to view the prospect with the naked eye. The general light appeared to me much greater than in the eclipses of 1842 and 1851 (one cloudy, the other hazy), perhaps ten times as great; I believe that I could have read a chronometer-face at the distance of 12 inches; nevertheless, it was not easy to walk where the ground was in the least uneven, and much attention to the footing was necessary. The outlines of the mountains were clear, but all distances were totally lost; they were in fact an undivided mass of black, to within a small distance of the spectator. Above these, to the height perhaps of six or eight degrees, and especially remarkable on the north side, was a brilliant yellow or orange sky, without any trace of the lovely blush which I saw in 1851. Higher still the sky was moderately dark, but not so dark as in the former eclipses. The corona gave a considerable body of light; I did not

remark, either by eye-view or by telescopic view, any thing annular in its structure; it appeared to me to resemble, with some irregularities (as I stated in 1851), the ornament round a compass card. But the thing which most struck me was the great brilliancy of *Jupiter* and *Procyon* so near to the sun. It was impossible that they could have been seen at all, except under the circumstance of total absence of illumination on that part of the atmosphere through which their light passed.

I returned to my measures, but I was soon surprised by the appearance of the scarlet sierra announcing the approach of the sun's limb. It disappointed me, for I had reckoned on a much longer time. All our party who were aware of the predicted duration fully believed that it must have been very erroneous. How the time had passed I cannot tell. The sun at length appeared, extinguishing the sierra, but the prominence and cloud remained visible, and my last measures were taken after reappearance. The prominence, &c., were then rapidly fading, and I quitted the telescope, not without the feeling that I had not done all that I had intended or hoped to do.

I looked around me, and in the southeast direction and for some time, perhaps ten seconds, I saw nothing remarkable in the atmosphere. About that time, as the light about me grew stronger, the darkness in the south-west attracted attention, and before long it looked as if the very air on that side was composed of blackness and opacity. The mountains along the Ebro were totally lost. A full half-minute passed, I think, before the darkness had so far diminished as not to produce the dominating impression of the scene.

My companions saw nine celestial objects, eight of which were identified by means of Mr. Hind's chart, and the ninth by our knowledge of its position. They appeared to be (using Mr. Hind's numbers of reference), 2 *Regulus*, 3 *Saturn*, 4 *Mercury*, 6 *Procyon*, 7 *Jupiter*, 8 *Venus*, 9 *Pollux* or 11 *Castor*, (not quite certain), 13 *Capella*, and *Arcturus*. *Sirius* and *α Orionis* were hidden by clouds.

I now proceed with my measures. I must premise that I used a reflecting eyepiece, and therefore my image was erect with regard to up and down, and inverted with regard to right and left. My angular measures, which were made in the direction of watch-hand-motion, must be interpreted as made in the opposite direction. The strong normal line which was my zero of angle, was inclined, its upper part apparently to the left or really to the right, by about $9\frac{1}{2}^\circ$, and that quantity must be subtracted from all measures in order to refer them to the upper vertical. Finally, the angle $47^\circ\ 50'$ (found above) must be added (making the entire correction $38^\circ\ 20'$ additive) in order to refer the measures to the north meridian. The following are the measures as recorded; the angles being expressed by number of wire (which is to be multiplied by 15°) and by fractions of intervals of wires (or fractions of 15°). The

number of observations, it is conceived, divide the time into nearly equal parts:—

	Prominence.	Cloud.
No. 1	Measure lost in observing the time.	
2	$23^d + \frac{1}{6}$ interval.	$1^{st} + \frac{1}{6}$ interval.
3	$23^d - \frac{1}{5}$	$1^{st} + \frac{1}{5}$
4	Measure lost in quitting the telescope.	
5	Measure lost in quitting the telescope.	
6	$23^d - \frac{1}{5}$	$1^{st} + \frac{1}{5}$
7	$23^d + 0$	1^{st} + very little.

or the angles from north meridian, measured in the direction opposite to watch-hand-motion, are,

	Prominence.	Cloud.
	° ′	° ′
No. 1	...	...
2	25 50	55 50
3	20 20	56 20
4	...	...
5	...	...
6	20 20	56 20
7	23 20	53 20+

I left the telescope with the impression that the angles here measured had decidedly and distinctly decreased; and so, on the whole, it appears from the numbers, but not incontrovertibly. I wish that I had been provided with better means for delicate motion of the telescope than the rack-and-pinions of the steadying rods.

The end of the eclipse was at $4^h\,9^m\,14^s$ by my watch, or $4^h\,9^m\,49^s$ Greenwich mean solar time, pretty good.

Perhaps the following remarks on the progress made in the observation of successive eclipses may not be without value:—

In 1842, I, with all the rest of the astronomical world, was taken by surprise with the appearance of red projections. In 1851, various important observations of the elevations of projections were made: I cite M. O. Struve's micrometical measures as the most valuable, and I should be glad if my own general observations of disappearance on one side and non-appearance on the other side were thought useful. One observer (I think not more) obtained a good measure of angular position. In succeeding observations which have been made in different parts of the earth, I think that no novelty has been introduced. In 1860 we have got not only good angular posi-

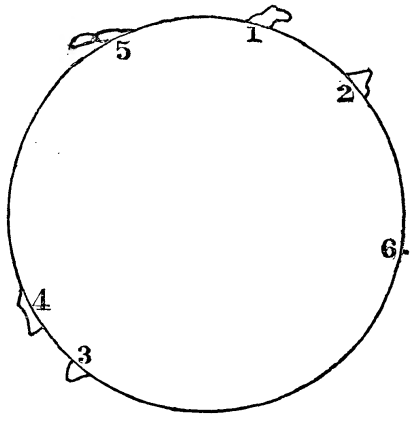
tions, but also fair attempts at measure of change of angle; and this will be seen more distinctly when the results deducible from Mr. De La Rue's photographs shall be published.

It is scarcely possible that I should observe a fourth total eclipse, and I can therefore only offer to future observers the advice upon which I should have acted myself. Whatever be the trouble and expense, and however small the chance of success in the observation, *use a good steady equatoreal, driven by good clockwork, and having easy transversal adjustments for the wire-frame.* With the system of wires that I have used (and which is described in the *Monthly Notices* for 1860, March 9, pp. 187, 188) I am well satisfied.

I extract the following notices from the accounts of my companions.

Wilfrid Airy observed the commencement of totality at $2^h\ 40^m\ 1^s$ by his watch, with the remark that, in consequence of a want of correspondence between the minute-hand and the second-hand, there might be an apparent error of 1^m. The application of the reduction computed above gives for the equivalent in Greenwich mean solar time, $2^h\ 59^m\ 35^s$; which, as compared with my observation, appears to be 1^m too small, but in other respects agrees closely.

By one of those inadvertencies which oppressed almost every observer during the excitement of the eclipse, Wilfrid Airy forgot to withdraw the coloured glass from the eye-piece, and actually observed the red prominences through it. This must be borne in mind as qualifying some of the statements that follow. "As soon as the totality commenced, the red prominences became visible, but I did not observe them before the totality. I did not notice the corona at all through the



telescope. The appearance and position of the prominences were as follows:—[the drawing, from the reversed image, being again reversed here to form a correct image.]

"Prominences 1, 2, 3 seemed to appear all at the same

moment; and 4 might have appeared also at the same time, but I did not notice it so soon. Prominence 5 did not appear till after the others, and was at first extremely hazy, but gradually thickened as the moon passed on. Prominence 4 disappeared about 1^m after the formation of totality, and I did not see it again. After the sun had burst forth, I noticed a prominence which would have been somewhere about 6; and this, as well as 1 and 2, I could see 2^m after the sun had reappeared. (I did not notice 6 before the sun reappeared, because I had left the telescope.) The colour of the prominences was a bright rose-colour, and 4 was brighter than 1, 2, and 3. Prominence 5 was lighter a good deal than the others.

"The stars that I noticed were *Jupiter*, *Mercury*, *Regulus*, *Saturn*, and *Arcturus*. *Arcturus* was bright. I saw no stars to the west of the sun."

[1 and 5 are the two objects whose positions I measured. It appears that Wilfrid Airy saw 5 as a prominence; whereas I, and also Mrs. Airy, who looked into my telescope, saw it as a floating cloud. 2 is the other prominence, which I saw in a glance.]

Wilfrid Airy saw the termination of eclipse at $3^h\,50^m\,4\frac{1}{2}^s$ by his watch, or $4^h\,9^m\,41^s$ Greenwich mean solar time, with the same caution as to possible error of 1^m.

From Mrs. Airy's notes I extract the following:—

"At last [some time after commencement] the light began to be sobered, like that of a summer evening, and soon a gloominess began gradually to creep over the whole scene, as if a storm were coming on. The southern mountains beyond the Ebro began to stand up strangely black. Then a sickly green hue began to creep over the whole nearer landscape. A peculiarly mournful sighing wind, cold and strong, began to rise as if from among the large old trees beneath us on the north side of the hill; and, looking down among them from the edge above, their dark green masses became every moment of a deeper green tinge, while the white old trunks gleamed whiter still. The butterflies disappeared, but the swifts continued on the wing. These appearances grew more and more intense, and all 'instructions' were totally forgotten in the excitement of the moment. It became very cold, and I was glad to wrap myself up in a large Scotch plaid. . . . The crescent diminished to a thread, the gloom everywhere intense. I was particularly struck with the moaning of the wind among the old forest-trees beneath me. The swifts had now disappeared. A deeper gloom filled the sky in the north-west, and came sweeping rapidly on. The moment of totality had come: the whole air was at once filled with darkness, yet it was darkness through which mountain and valley could be distinctly seen. To me it seemed as if we were in the midst of a streaky shower of smoke or fine dust, which, however, was perfectly clear, and which

could not be felt. It was only for a moment that I was struck with this appearance sweeping along the valley between us and the northern hills. The range of southern hills was of an inky black, while the sky beyond them was an intense golden orange. I have often seen a similar, though much fainter, effect in watching a fine summer sunset from the Greenwich Observatory through the smoke of London, when the air has been dry and the smoke very thin. These glorious colours were quite a new feature to me, for at the eclipse of 1842 the sky was entirely clouded. My shadow on the ground was quite black and sharp: the effect was like that of clearest moonlight. I could see the whole country, but I had to stoop in order to see my footing among the stones and shrubs. At the critical moment I forgot to remove the dark glass from my eye, and thus lost what I remember to have been the most striking phase of the whole phenomenon on the former occasion, viz. the starting out of the corona on the right side before the last thread-like crescent of the sun had disappeared on the left side of the moon. On that occasion, however (1842), it was a narrow fringe or border round the moon of soft light, of a uniform breadth, and slightly beaming texture, soon graduating into the darkness outside; while now it was a bright radiating glory of much wider extent, and its appearance made very singular from the projection of four or five brllliant beams at about equal intervals, far beyond the width of all the rest. I saw three bright stars near the sun; I could not, with the unarmed eye, see the red prominences. I looked for a few seconds in the telescope, and then I did see two of these wonderful appearances, but so faint in comparison with those of 1842 that for a moment I did not recognise them. One was a floating cloud, quite separate from and suspended over the upper edge of the moon, nearly divided into two parts by an indent below, of so pale a colour that at first it seemed almost white; but as I looked at it more steadily I perceived that it was of a pale rose-colour, the colour deepest against the upper edge, which was well defined, and becoming gradually paler to he lower indented edge. The other was lower down the edge f the left side of the moon, and not separated from it, but ising from it like those of 1842—a broad cone, cloven at the op; its colour was pale, like the other, and, like the other, it ad a cloudlike and not a solid appearance."

At the reappearance of the sun, "We saw the dark shadow listinctly sweeping away along the valley to the south-east, a ath of darkness, and the clear daylight breaking out behind t."

We descended from our hill-station, and on our way to Pobes we had the satisfaction of learning that M. Struve had been successful in his observations; and in no long time we were gratified by the intelligence that Mr. De La Rue's photographic operations during the totality had entirely answered to