

P A P E R S.

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- I. *Account of the Total Eclipse of the Sun on 1851, July 28, as observed at Göttenburg, at Christiania, and at Christianstadt. By G. B. AIRY, Esq., Astronomer Royal.*

Read November 14, 1851.

THE phenomena which had been observed in the total eclipse of 1842 were so remarkable, and the circumstances of the eclipse of 1851, in respect of path and duration, were likely to be so favourable, that I was induced to submit to the Lords Commissioners of the Admiralty a proposal that I should myself go to Sweden, and that one of the Assistants of the Royal Observatory should be sent there, under their Lordships' authority, for the observation of the eclipse. The Board of Admiralty were pleased to assent to this proposal; and I then selected Mr. EDWIN DUNKIN to take a part in the expedition. I soon afterwards learned from Mr. GEORGE HUMPHREYS, formerly Assistant in the Royal Observatory, and now of Caius College, Cambridge, that he was likely to be in the neighbourhood of the path of the total shadow, and that he was desirous of placing himself at my disposal for the observation. I was much gratified at being thus enabled to extend the plan of observation; and I accordingly accepted the services of Mr. HUMPHREYS as one of the Admiralty expedition. Mr. HUMPHREYS was accompanied by his friend Mr. MILAND. The eclipse was well seen by myself as well as by Mr. DUNKIN and Mr. HUMPHREYS. I annex the accounts of these gentlemen to my own; and, with the sanction of the

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Lords Commissioners of the Admiralty, I now beg leave to lay the whole before the Royal Astronomical Society.

In selecting stations of observation, it was an object to fix upon places at some distance apart, both to eliminate as far as possible the chance of interruption by bad weather, and also to obtain observations at points near the centre, and near the north-eastern and south-western boundaries of the shadow. For a position near the centre I selected Göttenburg, as a place easy of access, and celebrated for the first observation by VASSENIUS of the red prominences visible in a total eclipse. For a north-eastern station I adopted Christiania, and I assigned this locality to Mr. DUNKIN. For a south-western station I chose Christianstadt, on the eastern coast of Sweden, and I appointed Mr. HUMPHREYS to that post, with instructions to go some miles to the south if he could find a convenient point; Mr. HUMPHREYS, however, after examination of the country, preferred remaining in the immediate neighbourhood of Christianstadt.

By the kindness of Viscount PALMERSTON the good offices of the Swedish and Norwegian Governments had been engaged in our favour, and every courtesy and assistance was given by the custom-officers and by the civil and military authorities of these different points. And I am bound especially to acknowledge our obligations to his Excellency Baron STJERNELD, Minister of the Swedish Government for Foreign Affairs, for the instructions which at his suggestion had been transmitted by the various departments of Government to the officers under them.

I shall now proceed with the separate accounts.

Observations at Göttenburg by G. B. AIRY.

In the neighbourhood of Göttenburg are many isolated bare granite hills of inconsiderable height (perhaps 500 feet), offering extensive views of the country, and at the same time accessible without great difficulty. After examining (in company with C. F. ENGSTROM, Esq., her Britannic Majesty's Consul) several of these points, I selected for observing-station a hill called Hvaläs (whale-ridge), two or three miles from Göttenburg, commanding a beautiful and pretty extensive view, accessible to half its height by carriage-

road and field-road, and rugged at its top. It may appear strange to fix upon this last qualification as a recommendation; but it was so in my judgment, because in stormy weather it is always possible in rugged ground to find shelter from the wind: and the event proved the advantage of ground possessing this character. The latitude of this station is $57^{\circ} 42' 10''\cdot6$, and its longitude from Greenwich $0^{\text{h}} 48^{\text{m}} 0^{\text{s}}\cdot4$; as inferred by Lieut. PETTERSSON, from a triangulation connecting this point with the Navigation School, of which the latitude and longitude are assumed to be $57^{\circ} 42' 6''\cdot2$, and $0^{\text{h}} 47^{\text{m}} 50^{\text{s}}\cdot6$.

At a meeting of several persons who had come to Göttenburg for the purpose of observing the eclipse, it was suggested that the different persons should choose different stations, separated by distances of a few miles. In consequence of this arrangement, I was not accompanied by any professional astronomer, although I had the society of two English gentlemen (Mr. ENGSTROM and Mr. H. J. PORTER), and of Mr. HASSELGREN, a Norwegian maritime gentleman, who was selected by Premier-Lieutenant PETTERSSON, Principal of the School of Navigation at Göttenburg, to assist me in the reading and registering of chronometer-times: a duty which he discharged with great intelligence and care.

I may take this opportunity of stating that, at the meeting to which I have referred, it was also suggested that no communication of observations should be made among the observers until their formal accounts should be drawn up; and that this understanding has been so far acted on by me, that to the time of writing this account I have not received or given to a Göttenburg observer any description of the phenomena observed at Göttenburg.

I was provided with a 46-inch telescope, of nearly $3\frac{1}{4}$ -inch aperture, the property of the Royal Observatory: a good telescope, which shows the mottled appearance of the sun's disc well. It was furnished with four magnifying powers, and with a graduated dark-glass, consisting of two wedges of red and green glass, and one wedge of colourless glass in the opposite position. This combination exhibits the sun's disc with a yellow tinge. The telescope is mounted on a rather heavy equatoreal stand; the weight of the stand is favourable to stability; and the equatoreal movement, though adapted to the latitude of Greenwich, is convenient even for a latitude so high as that of Göttenburg. I had also brought with me a pocket chronometer (in its box) beating $\frac{2}{3}$ -seconds; but Lieutenant PETTERSSON was so obliging as to lend me, from the store of the Navigation School, a good

$\frac{1}{2}$ -second box chronometer, REID 1106 (keeping mean time nearly), which in observation is greatly preferable. The error of the chronometer was also supplied to me; Lieutenant PETTERSSON was anxious to explain to me that his means of ascertaining clock-error were not perfectly unexceptionable; but upon examining his process I found that so much pains had been taken to remove all causes of inaccuracy, that I was perfectly satisfied with the numbers which he gave me. I was also provided with thermometers for radiation, and with tests for polarization; but circumstances to which I shall allude prevented me from using them.

The morning of July 28 was unpromising; the sky was densely clouded, and a gusty W.N.W. wind sometimes blew the water up in showers of spray from the canals in the streets of Göttenburg. By noon, however, the sky was nearly cloudless. I planted my telescope-stand on the top of the highest rock of the Hvaläs, and secured it by guy-ropes, loaded with stones. As the telescope is steadied by three steadying-rods, I thought it probable that it would be sufficiently immovable to enable me to observe with it even in that exposed position. The wind, however, was so fresh that the telescope was affected by a considerable tremor, and I found it impossible to make a delicate observation. I therefore lowered the telescope to a sheltered place, close on the east side of the highest rock, and there I had no tremor and no difficulty in observing.

About $0^h 57^m$ Göttenburg mean time, I examined the sun's disc, and made a rough drawing of the position of the visible spots. This drawing, inverted (so as to give the appearance which would be presented to the naked eye), and turned by an angle corresponding to the change of position of the vertical on the sun's disc to the time of totality, is represented in figure 1. On the eastern side was one macula of considerable size, and on the western side a chain of small maculæ. Both were accompanied with distinct faculæ, especially on their northern sides; I did not see any other faculæ (except the white interstices in the usual mottled appearance) on the whole disc.* Three days afterwards, I had again an opportunity of viewing the sun; the spot on the eastern side had then advanced farther on the disc, and was followed by another to the south of it, as I have shown by the faint marks in figure 1.

* I understood from Professor CHEVALLIER, and from Mr. DUNKIN, who had examined the sun one or two days previously, that there was then no other spot in sight on the west side.

The eclipse had commenced at $2^{\text{h}} 4^{\text{m}} 2^{\text{s}}$ by chronometer; this time is probably 4^{s} or 5^{s} too late; and with this correction the observation is probably as good as can be made. Chronometer slow on Göttenburg mean time $0^{\text{h}} 48^{\text{m}} 6^{\text{s}}.55$.

The wind had now changed to W.S.W., and it continued to change in the same direction till it became S.S.W. A delicate cirro-stratus had formed itself, and the sky in the south had become sensibly white; and the whiteness increased so rapidly that I very soon desisted from making some radiation-observations which I had begun. The phenomena of the eclipse were, however, as distinctly seen as if the sky had been cloudless.

The only thing worthy of notice during the progress of the eclipse was the extremely mountainous outline of the moon's disc.

About a quarter of an hour before the totality, *Venus* shone out with much brilliancy. No other planet or star was seen during the eclipse. At $2^{\text{h}} 52^{\text{m}}$ by chronometer, the flame of a candle was visible at 2° angular distance from the sun.

The approach of the totality was accompanied with that indescribably mysterious and gloomy appearance of the whole surrounding prospect which I have seen on a former occasion. A patch of clear blue sky in the zenith became purple black while I was gazing at it. I took off the higher power with which I had scrutinised the sun, and put on the lowest power (magnifying about 34 times, as I have since found by comparing the image of a distant scale in the telescope with that of a near scale seen with the naked eye). With this I saw the mountains of the moon perfectly well. I watched carefully the approach of the moon's limb to the sun's limb (a phenomenon which my graduated dark glass enabled me to see in great perfection); I saw both limbs perfectly well defined to the last, and saw the lune becoming narrower and the cusps becoming sharper without any distortion or prolongation of the limbs. I saw the moon's serrated limb advance up to the sun's, and saw the light of the sun glimmering through the hollows between the mountain peaks, and saw these glimmering spots extinguished one after another in extremely rapid succession, but without any of the appearances which Mr. BAILY has described. I saw the sun covered, and gave the signal for time, which was taken from the chronometer at $3^{\text{h}} 7^{\text{m}} 50^{\text{s}}$; and, in spite of the difficulty of reading to which I shall allude, I have no doubt that this register is correct, as my excellent assistant, Mr. HASSELGREN, had kept his

eye carefully fixed on the chronometer, and was listening to its beats. I immediately slipped off the dark glass and *instantly* saw the appearances which I have represented in figures 2 and 3. The former of these, on a small scale, represents (roughly) the general appearance of the moon and the broad corona: the latter represents, on a larger scale, the moon with the prominences.

Before alluding more minutely to these, I must advert to the darkness. I have no means of ascertaining whether the darkness really was greater than in the eclipse of 1842; I am inclined to think that in the wonderful, and I may say appalling obscurity, I saw the grey granite hills within sight of Hvaläs more distinctly than the darker country surrounding the Superga. But, whether because in 1851 the sky was much less clouded than in 1842 (so that the transition was from a more luminous state of sky to a darkness nearly equal in both cases), or from whatever cause, the suddenness of the darkness in 1851 appeared to me much more striking than in 1842. My friends who were upon the upper rock, to which the path was very good, had great difficulty in descending. A candle had been lighted in a lantern about a quarter of an hour before the totality; Mr. HASSELGREN was unable to read the minutes of the chronometer-face without having the lantern held close to the chronometer. I had, prepared for the occasion, a circle described upon a card: I desired much to make a drawing of the prominences, at least of their positions on the limb of the moon, by marking them on this circle; but it was impossible for me to see it; and I was obliged to approach very closely to the lantern, in order to make the smallest memorandum on the card. In this confusion, valuable time was lost, which I could have employed to advantage in experiments of polarisation or photometry. I would recommend any person who may in future observe a total eclipse to be furnished with at least three lights; one to illuminate a chronometer, one to give light for drawing or writing memoranda, and one for photometric or other purposes.

The corona was far broader than that which I saw in 1842: roughly speaking, its breadth was little less than the moon's diameter; but its outline was very irregular. I did not remark any beams projecting from it which deserved notice as much more conspicuous than the others; but the whole was beamy, radiated in structure, and terminated (though very indefinitely) in a way which reminded me of the ornament frequently placed round a

mariner's compass. Its colour was white, or resembling that of *Venus*. I saw no flickering or unsteadiness of light. It was not separated from the moon by any dark ring, nor had it any annular structure; it looked like a radiating luminous cloud behind the moon.

The form of the prominences was most remarkable. That which I have marked (*a*) reminded me of a boomerang. Its colour for at least two-thirds of its breadth, from the convexity towards the concavity, was full lake red; the remainder was nearly white. The most brilliant part of it was the swell farthest from the moon's limb; this was distinctly seen by myself and my friends with the naked eye. I did not measure its height; but judging generally from its proportion to the moon's diameter, it must have been three minutes. This estimation perhaps belongs to a later period of the eclipse. The prominence (*b*) was a pale white semicircle, based on the moon's limb. That marked (*c*) was a red detached cloud or balloon, of nearly circular form, separated from the moon's limb by a space (differing in no way from the rest of the corona) of nearly its own breadth. That marked (*d*) was a small triangular or conical red mountain, perhaps a little white in the interior. These were the appearances seen instantly after the formation of the totality.

I employed myself in an attempt (as I have stated) to delineate roughly the appearances on the western limb, and I took a hasty view of the country; and I then examined the moon a second time. I believe (but I did not carefully remark) that the prominences (*a*) (*b*) (*c*) had increased in height; but (*d*) had now disappeared, and a new one (*e*) had risen up. This state of the moon is represented in figure 4. It was impossible to see this change without feeling the conviction that the prominences belonged to the sun and not to the moon.

I again looked round, when I saw a scene of unexpected beauty. The southern part of the sky, as I have said, was covered with uniform white cloud; but in the northern part there were detached clouds upon a ground of clear sky. This clear sky was now strongly illuminated, to the height of 30° or 35° , and through almost 90° of azimuth, with rosy red light shining through the intervals between the clouds. I went to the telescope, with the hope that I might be able to make the polarisation-observations (which, as my apparatus was ready to my grasp, might have been done in three or four seconds), when I saw that the *sierra*, or rugged line of projections shown at

(*f*) in figure 5, had arisen. This *sierra* was more brilliant than the other prominences, and its colour was nearly scarlet. The other prominences had, perhaps, increased in height, but no additional new ones had arisen. The appearance of this *sierra*, nearly in the place where I expected the reappearance of the sun, warned me that I ought not now to attempt any other physical observation. In a short time the white sun burst forth, and the corona and every prominence vanished. The time noted by chronometer was $3^{\text{h}} 11^{\text{m}} 8^{\text{s}}$, with the remark that the signal was given two seconds too late.

I withdrew from the telescope, and looked round. The country seemed, though rapidly, yet half unwillingly, to be recovering its usual cheerfulness. My eye, however, was caught by a duskiness in the south-east, and I immediately perceived that it was the eclipse-shadow in the air, travelling away in the direction of the shadow's path. For at least six seconds this shadow remained in sight, far more conspicuous to the eye than I had anticipated. I was once caught in a very violent hail-and-thunder storm on the table-land of the county of Sutherland, called "The Moin," and I at length saw the storm travel away over the North Sea; and this view of the receding eclipse-shadow, though by no means so dark, reminded me strongly of the receding storm. In ten or twelve seconds all appearance of the shadow had passed away.

The remainder of the eclipse presented nothing of interest. The white sky became gradually thicker and thicker, till it was almost impossible to distinguish the sun's limb; and the observation of the end of the eclipse was one of the most difficult that I ever made. The time noted by chronometer was $4^{\text{h}} 9^{\text{m}} 51^{\text{s}}$, to which the same correction of $0^{\text{h}} 48^{\text{m}} 6^{\text{s}} \cdot 55$ is still sensibly applicable.

At $2^{\text{h}} 14^{\text{m}}$ by chronometer, the thermometer in the shade read $64^{\circ} \cdot 4$ Fahrenheit. At $2^{\text{h}} 25^{\text{m}}$ it was $63^{\circ} \cdot 0$. At $2^{\text{h}} 59^{\text{m}}$ it was $60^{\circ} \cdot 9$. At $3^{\text{h}} 58^{\text{m}}$ it was $58^{\circ} \cdot 2$. At the end of the eclipse it was $61^{\circ} \cdot 0$.

After refreshment in the hospitable mansion of JAMES DICKSON, Esq., (Öfveräs, situated immediately below the observing-station), we returned to Göttenburg in a heavy rain.

So far as I had opportunities of observing, animals in general were not much disturbed by the eclipse. The cattle in sight from the station on Hvaläs appeared to regard it with indifference. Some cries of birds were recognised by one of my companions as being, before the totality the evening

note, and after the totality the morning note. But, in conversation, I afterwards heard distinctly of several instances of obvious alarm among birds. They were seen flying about in a very disturbed manner, sometimes striking walls: in one case, my informant had laid his hand upon a bird which had fallen to the ground; but whether it had fallen from terror, or from the stunning effect of a blow, could not be ascertained.

Several stars were seen by persons in the neighbourhood of Göttenburg. Two of these, as well as I could infer from the accounts given to me, must have been *Mercury* and *Regulus*.

For the better understanding of the relation between the motion of the moon, and the uncovering or covering of the various prominences, I have shown, in figure 6, the relative positions of the sun and moon at various stages of the totality. The strong circle represents the limb of the sun; the positions of the moon's limb at the beginning, the middle, and the end, of the totality, are represented by the faint line, the interrupted line, and the dotted line, and these positions correspond nearly to the three states represented in figures 3, 4, and 5.

Observations at Christiania by Mr. DUNKIN.

[I give Mr. DUNKIN's account of his observations in his own words.]

The Astronomer Royal having chosen Christiania as the station from which I was to observe the eclipse, I arrived in that city on Tuesday, July 22, in company with several other English astronomers, who had come to Norway for the same purpose. With the exception of Mr. ROBERT SNOW, all left for some other station near to the central line of shadow, and I soon discovered that, of those whose primary object in visiting this country was in connexion with the eclipse, only Mr. SNOW and myself would remain at Christiania.

The instruments which I brought from Greenwich were,—a telescope, which was formerly mounted on the N.W. equatoreal; a black-bulb thermometer, having the bulb placed in a glass sphere, from which the air could be extracted by a syringe; a common thermometer; two glass prisms for dispersion; a doubly-refracting prism; and a NICOL's prism. I had also

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brought a pocket chronometer, but I used in the following observations one by DENT, belonging to the Christiania Observatory. The telescope was of about 3 feet focal length, with an object-glass of $3\frac{1}{2}$ inches aperture, and was mounted with steadying-rods on a tolerably firm tripod stand. It was furnished with three eye-pieces; but, in the following observations, only that with the lowest power, magnifying 38 times, was used. In the eye-piece, two parallel wires are placed, the interval between them being about 1' of space. These wires, during the eclipse, were placed exactly horizontal, so as to enable me to judge of the position of any phenomenon on the limb. All the apparatus, excepting the pocket chronometer, Professor HANSTEEN took charge of, as soon as possible after my landing here.

I was very anxious to select a place which I might constitute my headquarters on the day of the eclipse; and my great desire was, to be in such an elevated position as would allow me to have an uninterrupted view of a large extent of country, and at the same time to be as much sheltered as possible from the wind. The observatory grounds were well situated so far as regards the elevation, but there was a great difficulty in finding a sheltered spot. Shortly after this, I was walking in company with Mr. CROWE (Her Britannic Majesty's Consul-General in Norway) in the private garden attached to his residence, when he pointed out a retired spot, the situation of which was so favourable, that I at once decided on making it my station. The proximity of Mr. CROWE's residence to the observatory was convenient, in consequence of my observing apparatus being deposited there. The place which I had selected commanded an extensive view. Immediately in front, nearly south, was the Fiord, covered with small islands; distant mountains, some of which are at least 15 miles from Christiania, were also visible; to the right was rising ground of several miles in extent, having as back-ground a ridge of mountains; to the left, every part of the city could be seen, and also a series of hills known by the name of Egeberg. The only part of the horizon which was hid was the north, and of that part of the sky I had certainly a confined view. Other parties were, however, placed to command the horizon in that direction.

At 1^h P.M., on the day preceding the eclipse, I marked down the maculæ and faculæ on the sun's disc, on one of my card circles. Near the apparent east limb, as seen in an inverting telescope, I noticed three small dark spots; some well-marked faculæ were in the same place. Faculæ were also seen

near the apparent west limb. On the day of the eclipse, at 2^h P.M., I again examined the sun's disc, and noted down the spots, but I could see no faculæ; probably this was owing to the state of the sky.

During the early part of the morning of the 28th, the sky was covered with a dense mass of cirro-stratus clouds, and to all appearances a wet day was in prospect. Between 10^h and 11^h A.M., the clouds partly cleared away, but the sky never became clear. About half-an-hour previously to the beginning of the eclipse, the clouds, which had been latterly cirrus, gradually formed themselves into a thin cirro-stratus, and covered the greater part of the sky. The effect of this unfavourable state of the weather will be seen by the partial observations which were made through these clouds.

I am satisfied, from what was seen during the time of totality, that the telescope observers here have, in a great measure, lost a magnificent sight; and from the arrangements that were made, I think that this station would have been tolerably complete in carrying out the plan recommended in the "Suggestions." As to myself, I was fully prepared to devote my time more particularly to the phenomena visible in the telescope; paying attention, also, to some polarising experiments. Mr. SNOW also undertook the telescopic phenomena. His telescope has an object-glass of 2 $\frac{1}{4}$ inches aperture, and the defining power is very good. Professor LANGBERG, of the University of Christiania, and two assistants, were well equipped with polarising apparatus, and also with a thermo-multiplier; he would also, as much as possible, notice the effect of the darkness on the country, and other general appearances; Mr. H. W. CROWE, son of the Consul, was also to notice some of the appearances about the time of total darkness; Mr. BENNETT, a resident at this place, was to assist me in my chronometer-readings, and to write down any remark that was necessary. I had also placed one or two others to observe the silk-tree acacia, convolvulus, and other plants.

I have mentioned that the sky became altered in appearance for the worse, about half-an-hour before the eclipse commenced, but the cloud being of the cirrus, or thin cirro-stratus character, the observation of the beginning was not interfered with; in fact, during the progress of the eclipse, up to within a quarter of an hour of total darkness, the cusps of the sun were, though rather faint, remarkably well defined; had the clouds remained in this state, the observations would have been more satisfactory. Ten minutes before totality the darkness was becoming evident; at this time the clouds

were forming into a denser cirro-stratus; and, directly under the sun, an immense mass of cloud seemed coming over. Fortunately it did not reach the sun till after the reappearance.

Five minutes before totality, I took off the dark glass; the sun's light was then so faint, that I could, without the least fatigue to the eye, see the narrow crescent form of the sun: this was a very striking object. The darkness was now very perceptible, the appearance of the sky being similar to an approaching thunder-storm. From this time my attention was devoted chiefly to the telescope. My impression then was that the clouds would prevent any phenomenon from being seen. I am glad that the results have considerably undeceived me; but still I am sure that the effect was lessened in a great degree, more particularly the corona.

As the totality approached, I examined the moon's limb; no mountains were seen, the limb being apparently smooth. Neither could I see the moon's limb beyond the sun's limb.

About 15^s before the beginning of total darkness, the narrow line of the sun broke up into numerous small particles or beads of light. They were of different sizes, some being merely points, while others appeared more elongated; their appearance was of intense brilliancy, and the only thing that I can compare it with is a necklace of diamonds. The effect on the mind at their formation was quite overpowering; I was unprepared for such a magnificent sight. The beads, if I may call them so, were perfectly steady, their only change being their gradual disappearance as the total obscuration of the sun approached. The time noted for the beginning of total darkness was when I lost sight of the last spot of light.

My observations of the corona are very unsatisfactory; of all the phenomena the clouds affected it the most. Traces of it were seen on the whole of the apparent east limb, but on the opposite side of the moon only confused patches of light were visible. So much of the corona as was noticed, appeared at the same instant on the disappearance of the sun, but it was altogether so faint, that I was not able to obtain any result of importance. No traces whatever of polarisation could be perceived; nor could any defect in the prismatic colours be noticed, green being certainly as bright as any other colour.

Twenty seconds after the totality had commenced, a small cloud quite obscured the moon for a short time; when this had passed over I imme-

diately sought for the red prominences. Of these I found three; the first was at an angle of 70° from the vertex towards the east, as seen in an inverting telescope; the second was at an angle of 100° ; and the third at an angle of 135° . The apparent upper one was most curiously formed, having something of a horned shape, and was curved in the direction of the upper part of the field. Its height was about $1' 30''$, the breadth at the base $30''$. It had a most remarkable appearance, and I carefully watched it to see if any change took place in its size. My eye was intently fixed upon it for about a minute of time, and during that interval not the slightest change took place in its form. Its colour was pink, or rose colour, but the shade was not very deep. It seemed to me at the time, from the excessive steadiness of this prominence, and from the fact that I had zealously watched it for so long an interval without its assuming any change, that this object had some connexion with the moon. However, as my observations have been all made under rather difficult circumstances, it is possible that I may be deceived. With the doubly-refracting prism I could not perceive any difference in the brightness of the two images of this prominence. The other two prominences were precisely similar to each other in size, their height being about $40''$, and their breadth at the base $30''$, and tapering to a point at the apex; these also remained perfectly stationary during the last minute of total darkness. As soon as the first ray of light from the sun appeared, they all disappeared instantaneously; I could not perceive the slightest trace of them after the formation of the beads on the reappearance of the sun. This second display of BAILY's beads was again seen in all its beauty, but I did not consider the effect on the imagination to be quite so striking. I did not notice any distortion of the limb either of the sun or moon.

Within two minutes after totality, the clouds, which had been gradually becoming denser, completely obscured the sun, and throughout the remainder of the eclipse very little could be seen. At the ending of the eclipse the sun was invisible. Rain soon began to fall, and continued throughout the night, and also during the greater part of the two following days.

The darkness during the totality was very great, and far exceeded what I had anticipated. I can scarcely find language to describe the state of my feelings when I first took my eye from the telescope to behold, for a few seconds, the extensive range of country before me, enveloped in an

almost unnatural gloom. I could spare but a very few moments for the purpose, but short as the time was, it was sufficient to fix indelibly in my remembrance the awful appearance which was presented to my view. The darkness was not precisely similar to that of night, the outlines of mountains at a distance of at least 15 miles being faintly visible; and yet I found it difficult to read the title-page of the "Suggestions," at a distance of from 10 to 12 inches from the eye. Immediately below me was the Fiord, dotted with its numerous islands. Over this mixture of land and water the effect of the darkness was very peculiar, the water having the colour of a deep purple, and the islands a dusky yellow. From my position every part of the visible sky was covered with cloud, but the density in different parts was very different; this had the effect of making some parts of the heavens terribly black, while others were comparatively brighter. There had been for some minutes a very black cloud under the sun, while immediately above him the clouds were formed of thin cirro-stratus; the effect of the contrast between the densely-blackened mass and the comparative brightness on the other side of the sun I shall never forget. Near the horizon, in the S.W., S., and S.E., the clouds were of a dark yellow colour; but in the north, where small portions of the sky were free from cloud, there was a purple hue. From my place of observation, an extent of country of about 20 miles from W. to E., was visible, and according to those accustomed to observation, the shadow could not be seen to travel across the country, though the darkness was plainly noticed on the western mountains before it reached the eastern. Those less accustomed to observe imagined that they could see the shadow pass across. My own attention was so occupied at the time, that I do not feel able to give any personal opinion on the subject. The silk-tree acacia was affected by the darkness, but the convolvulus seemed not to be affected. Near my position a bird had been singing some time, but at the instant of total darkness it became silent. A few crows also, at the same time, rose together, and flew around us uttering cries.

Mr. HANSTEEN was kind enough to offer me a box-chronometer (DENT, 2103); I accepted it, thinking that, perhaps, I might be able to hear the beat myself, and thus have some check on the chronometer observer. I found, however, that the noise of the wind in some neighbouring trees prevented me from hearing it; I was, therefore, thrown entirely on the skill of one who has never been accustomed to chronometrical observation. For my assistant,

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I had at first engaged Lieutenant KRAG, an officer of engineers, and was satisfied from the practice we had together that he would discharge that duty very well; but on the day before the eclipse he was called away with the majority of the troops to quell some disturbances which had just taken place about 20 miles from Christiania. I was, therefore, unexpectedly thrown on my own resources, and after some little practice, installed Mr. BENNETT as my assistant.

The following are the readings of the chronometer :—

Beginning of Eclipse.....	^h 2	^m 41	^s 48·0
Beginning of Total Darkness	3	44	49·5
End of Total Darkness.....	3	47	24·0

The sun was invisible at the end of eclipse.

The chronometer was compared immediately before and after the eclipse, and was found to be $1^m 58^s \cdot 2$ slow on Christiania mean time. The times above being, therefore, corrected by this quantity, we have,—

Beginning of Eclipse.....	^h 2	^m 43	^s 46·2	Christiania Mean Time.
Beginning of Total Darkness	3	46	47·7	„ „
End of Total Darkness	3	49	22·2	„ „

By further applying the longitude of Christiania, $0^h 42^m 53^s \cdot 9$, as given in the *Nautical Almanac*, we have,—

Beginning of Eclipse.....	^h 2	^m 0	^s 52·3	Greenwich Mean Time.
Beginning of Total Darkness	3	3	53·8	„ „
End of Total Darkness	3	6	28·3	„ „

In consequence of the very cloudy state of the sky, the following readings of the thermometers are of no very great value; but still the readings of the black-bulb thermometer will give some idea of the density of the clouds at various short intervals during the progress of the eclipse. The black-bulb thermometer, after the air was extracted from the glass sphere, was placed in a position so as to receive the full rays of the sun; the free thermometer was placed in the shade, hanging on a bush, and in a full current of air. The readings were all made by myself.

Mr. DUNKIN'S Account of the

Hour and Minute Christiania Time.	Reading of Black Bulb Thermom.	Reading of Free Thermom.	Diff.	State of the Sky.
^h ^{m.} 2 42	86°2	66°0	20°2	Cloudy.
2 50	83°0	64°8	18°2	"
2 56	87°8	65°2	22°6	The clouds are less dense.
3 0	95°3	65°8	29°5	The sun was nearly free from clouds.
3 5	89°3	65°5	23°8	The clouds are a little denser.
3 10	88°0	65°0	23°0	Cloudy; a dense mass seems coming.
3 15	82°1	64°4	17°7	Generally cloudy since the last observation.
3 20	83°2	64°6	18°6	The sun shining through cirrus.
3 25	81°0	64°1	16°9	" "
3 30	77°3	63°2	14°1	The clouds are becoming denser.
3 35	73°7	62°8	10°9	The clouds are thicker than ever; the sun is very faint, and is shining through cirro-stratus cloud.
3 40	69°8	62°2	7°6	Very cloudy; the sun is very faint, and requires no dark glass at the telescope.
3 47	65°2	62°0	3°2	Quite cloudy; the sun is invisible.
4 0	64°5	62°0	2°5	" "
4 15	64°0	62°0	2°0	" "

The sun was never clear after this.

I cannot conclude this short account, without stating that I shall ever keep in my remembrance the kindness with which I have been received by all those with whom I have passed a great portion of my time during my short stay at Christiania. To Professor HANSTEEN and Mr. CROWE I feel particularly grateful for the kind manner in which they, in every matter relating to the eclipse, have anticipated my wishes; and I am sure I shall never have cause to regret having taken part in this scientific expedition, although I have been prevented from making so successful a series of observations as I should have wished.

EDWIN DUNKIN.

Christiania, July 30, 1851.

Observations at Christianstadt, by Mr. HUMPHREYS and Mr. MILAND.

[The following account is principally in Mr. HUMPHREYS' own words.]

Our reception at Christianstadt I feel specially called upon to notice, the Governor having offered us every possible facility and accommodation. And, in mentioning the names of Colonel SILVERSTOLPE and Herr HESSELGRANE, who completely carried out the Governor's kind intentions, I cannot speak too warmly of their unremitting attention to all our wants. Neither must I omit to mention Herr LUDWIG LITTORIN, one of the principal residents in the town, who, at the request of the Governor, most liberally and hospitably entertained us.

Throughout the day, previous to the eclipse, the sun was almost continually obscured with haze and thick fleecy clouds; at intervals, however, when the haze was least dense, the sun's disc was examined, but neither faculæ nor maculæ could be discerned.

The position chosen for observing the eclipse was in an old redoubt in the drilling-field, about a quarter of a mile W. by N. of the town of Christianstadt, where, by ascending part of the fortification, an extensive view of the surrounding country could be obtained.

The instruments used were—

Two Signal-station Telescopes (non-inverting): the power used was about 25.

Two Chronometers—Arnold, 1970, and M'Cabe, 194—(the former was used by Mr. HUMPHREYS, the latter by Mr. MILAND).

One Black Thermometer; and,

Dry, and Wet, Thermometers.

On the morning of the 28th, clouds of a fleecy and cumulus character prevailed, only permitting the sun to be occasionally visible for times of from five to ten minutes; there was a fresh breeze from the W.N.W., and the sky till after the commencement of the eclipse continued to be about three-fourths covered with cloud.

The first contact took place at $2^{\text{h}} 9^{\text{m}} 27^{\text{s}}$ by chronometer; almost immediately afterwards the sun became obscured, and remained hidden for about seventeen minutes; at $2^{\text{h}} 34^{\text{m}}$ the sun became again hidden for about eight

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minutes; after which time, however, till the termination of the eclipse, although clouds prevailed and the sun's place was occasionally hazy, the view of the observers was not impeded.

The readings of the blackened bulb, dry, and wet, thermometers, varied with the passing clouds, and showed no decided diminution of temperature till shortly before the total obscuration.

At 2 ^h 10 ^m the readings were,—		
B. B. 75°·5	Dry 69°·0	Wet 60°·0
At 3 ^h 0 ^m shortly before the Total Obscuration—		
B. B. 66°·0	Dry 64°·2	Wet 57°·0

When the sun's disc became about half obscured, a diminution of light first became perceptible; and at 2^h 45^m the flame of a candle held up before the sun was distinctly visible: from this time till within a few minutes of the total obscuration attempts were made, occasionally, to obtain a double shadow from the flame of a candle and the sun, but none such could be observed.

At about 3^h 0^m the spot marked α on figure 9 was first seen; it was close to the limb, and about 40° from the sun's upper point towards the east. The light had now greatly diminished, surrounding objects began generally to appear of a heavy leaden colour, the wind almost ceased, and a haze of a pale colour began to form about the sun's place, and densely towards the south horizon; about this time, also, an inequality in the southern extremity of the moon's limb was observed; its appearance is marked δ in figure 9.

No portion of the moon external to the sun's limb could be seen before the totality.

The total obscuration took place at 3^h 12^m 4^s by chronometer.

At the instant before the totality no beads were seen, but the last lune of the sun seemed to glisten as it disappeared.

Immediately on the total obscuration the corona was first seen; it seemed to form all at once; by a hasty observation it appeared to be concentric with the sun; it presented the appearance of a succession of annuli, which altogether were in width about half of the moon's radius; it appeared but faintly coloured with a very light violet; bushes of light (perhaps 6 or 7 in number) at equal distances round the corona, appeared as if streaming from its edge,

each bush converging to a point, thus approaching the shape of a star; their extent was about double that of the corona.

Immediately, also, after the instant of total obscuration, the prominence marked (*d*) in figure 10 was seen, about 40° from the sun's upper point towards the east; it was widest at the moon's limb; at the extremity it was cloven into two small tongues, one of which, the northern, was the longer of the two; its height was estimated at about 0.75 of the width between two wires placed in the telescope. (The interval of wires was subsequently found to be about $40''$). In a few seconds (*d*) suddenly disappeared, and the extremity of the prominence marked (*a*) became visible about 135° from the sun's upper point towards the west: as the moon advanced, it gradually increased in height and brightness; it was curved in form, the extremity bending down towards the south; like (*d*) it ended in a double tongue, both tongues, however, being apparently of equal lengths; it appeared of the same width throughout; it was estimated at about 1.25 of the width of the wires; it was accompanied by an equally bright and similarly coloured detached portion, marked (*c*), somewhat like a spider in appearance.

As the totality continued, the prominences marked (*f*) and (*g*) gradually and successively made their appearance, about 150° and 160° respectively from the sun's upper point towards the west; (*f*) was similar to (*d*), only larger in every way; it was estimated at about the width between the wires; the extremity of (*g*) appeared to be only one point, and the prominence itself to be much smaller than the others; it was estimated at about 0.50 of the width of the wires. The prominences were of a beautiful rose colour; the southern edges of (*d*), (*a*), (*f*), and (*g*) glistened with a white bright light; the northern edge, however, of the detached portion (*c*) had that appearance, between which latter and the prominence (*a*) there appeared bright white light.

During the total obscuration some geese cackled, and attempted to fly. Five stars were seen,—*Venus*, *Mercury*, *Jupiter*, *Arcturus*, and *Vega*.* Towards the northern horizon a belt of light, of a strong dusky orange colour, prevailed, and the few detached portions of clouds which remained appeared like black patches stuck on the sky; towards the southern horizon a dense leaden-coloured haze prevailed, with a few detached portions of black cloud.

* These stars were seen by a Professor of the University of Lund, who was staying at Christianstadt.

For a few seconds previous to the reappearance of the sun, the moon's edge appeared to glisten, and some doubt prevailed as to whether the sun had not really appeared.

The reappearance took place at $3^h 14^m 50^s$ by chronometer.

The total obscuration was observed to last $2^m 46^s \pm$.

For a few seconds after the reappearance of the sun the whole circumference of the moon was distinctly visible with the naked eye, appearing to glisten with a white light. Immediately on the reappearance of light a led horse neighed, and became slightly restive.

At $3^h 15^m$, shortly after the termination of the totality, the readings of the thermometers were

B. B.	$60^{\circ}.5$	Dry	$62^{\circ}.0$	Wet	$55^{\circ}.6$
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At $3^h 20^m$ a light breeze sprang up from the N.W. and continued during the remainder of the day; the thick haze likewise prevailing towards the south horizon.

At about $4^h 0^m$, when about three-fourths of the sun's disc had reappeared, the cluster of six spots of different sizes, marked β on figure 9, was first seen; they appeared near the limb about 110° from the sun's upper point towards the west.

The termination of the eclipse occurred at $4^h 13^m 27^s$ by chronometer.

[The rate of the chronometer, as inferred from comparisons at Greenwich, Altona, and again at Greenwich, was not sufficiently regular to allow of the conversion of these times into Greenwich times.]

About half an hour after the termination of the eclipse, the sun's disc was examined; no faculæ could be observed, but the above-mentioned dark spots could be distinctly seen.

At $4^h 30^m$ the readings of the thermometers were,

B. B.	$71^{\circ}.0$	Dry	$65^{\circ}.0$	Wet	$58^{\circ}.2$
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On Wednesday morning, July 29, 22^h , the sun's disc was again examined, when neither of the spots marked α and β could be seen; but two spots marked γ on figure 9 were observed near the limb, about 130° from the sun's upper point towards the east, the one large, the other small.

Total Eclipse of the Sun on July 28, 1851.

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The spot marked α was seen by Professor FABER, of Copenhagen (who was staying at Christianstadt), on Tuesday, July 29.

The making of these observations was much facilitated through the forethought, attention, and kindness of Colonel SILVERSTOLPE (Lieutenant-Governor of Christianstadt), who had a tent pitched, and kept in attendance several men, who were exceedingly useful in helping to fix the instruments, &c.

GEORGE HUMPHREYS.

[Mr. MILAND's account agrees so precisely with that of Mr. HUMPHREYS, that it is unnecessary to give it at length. The following are the only points in which there is the slightest appearance of difference]:—

I did not see the inequality in the southern extremity of the moon's limb, observed by Mr. HUMPHREYS.

My observations of time by chronometer were as follows:—

	^h	^m	^s
Beginning of Totality	3	10	0
End of Totality	3	12	45
End of Eclipse	4	12	0

At 2^h 29^m 30^s the flame of a candle was just visible when held before the sun.

During the totality, I experienced some difficulty in reading the seconds of the chronometer I held in my hand, and was glad of the assistance afforded me by the lighted candle at my feet.

The corona, though very bright, and quite white when first observed, appeared afterwards slightly tinted with pale blue.

JOHN MILAND.

*Mr. MILAND's Account of the**Meteorological Observations made at Christianstadt during the Eclipse
of the Sun, July 28, 1851.*

Greenwich Mean Time.	Black Bulb Thermo- meter.	Free Thermo- meter.	Dry Thermo- meter.	Wet Thermo- meter.	Remarks.	Amount of Cloud 0-10
^h 0 30	[°] 71°0	[°] 67°0	[°] 68°0	[°] 59°8	Masses of fleecy clouds, with cumulostrati about the horizon. Fresh breeze, W.N.W.	7
1 0	73°5	67°0	68°0	59°9		
1 30	73°0	67°0	68°5	60°0		
2 0	71°0	66°0	66°5	59°1		
2 10	75°5	68°1	69°0	60°0	Clear about the sun.	5
2 20	68°0	65°0	65°0	58°3	Cloud over the sun; wind rather stronger, N.W.	
2 30	73°0	68°2	68°0	60°0	Sun clear.	
2 34	..	..	..	..	Cloud over the sun.	
2 40	..	..	..	..	Sun nearly clear.	4
2 42	..	..	..	..	Sun clear.	
2 45	69°0	..	67°0	59°0	Thin fleecy clouds about the sun and towards the W.	
2 50	68°5	65°0	65°5	58°0		
3 0	66°0	64°2	64°2	57°0		3
3 10	..	..	..	..	Wind ceased.	
3 15	60°5	62°0	62°0	55°6		
3 20	..	..	..	..	Very light wind at N.W.	
3 30	62°2	..	61°0	56°0	Thick haze towards S. horizon.	3
3 45	67°9	..	64°0	58°0		
4 20	69°5	..	65°0	58°5		
4 30	71°0	..	65°0	58°2		

The following observations of the effect of the eclipse on sensitive plants were communicated by Professor AGARDH to Mr. HUMPHREYS:—

	<i>Eschscholtzia crocea</i>	<i>Convolvulus tricolor.</i>	<i>Oxalis rosea.</i>	<i>Calendula denticulata</i>	<i>Mimosa pudica.*</i>	<i>Mimosa prostrata.*</i>	<i>Desmanthus virgatus.*</i>	<i>Acacia glauca.*</i>	<i>Mimosa Farnetiana.*</i>
^h 3 45	4 Flores aperti	Flores plur. clausi (1 apert.)	Flores 9 aperti	Flor. 2 aperti	Folia expansa	Folia expansa	Folia expansa	Folia expansa	Folia expansa
3 55	4 Fl. semi- clausi	ditto	ditto	ditto	ditto	ditto	Folia non- nulla semi- clausa	ditto	ditto
4 2	Fl. clausi	ditto	Flor. semi- contracti	ditto	Folia semi- clausa	ditto	Fol. plur. $\frac{3}{2}$ clausa	Fol. semi- clausa	Folia semi- clausa
4 10	ditto	ditto	ditto	ditto	ditto	ditto	Fol. clausa (fere)	ditto	ditto
4 20	ditto	ditto	Folia semper aperta	ditto	Folia clausa petiolis erectis	ditto	Folia clausa	Fol. clausa	ditto
5 0	ditto	Fl. claus.	ditto	ditto	ditto	ditto	ditto	ditto	ditto
* Plantæ juveniles, 2-3 ^{li} anni.									

Observ. Lundæ, d. 28 Jul. 1851.

J. M. AGARDH.

Remarks on the Three preceding Accounts.

The first point which I think deserves attention is the difference in the positions, with regard to the vertical, of the principal curved prominence (*a*). I have no doubt that the position given by Mr. DUNKIN is more correct than my own: that given by Mr. HUMPHREYS, possibly, is in error a little the other way. My observations were made with the right eye; Mr. HUMPHREYS' with the left eye. The wires in my field of view were rather too distant from the centre to be conveniently used, and at the totality I probably relied too much upon estimation. My positions of the spots are likely to be accurate, as I endeavoured to determine the vertical direction carefully. It was my impression, at the totality, that the position of the great curved prominence corresponded very nearly, or exactly, with that of the chain of spots, and that the position of (*d*) corresponded with that of the single black spot; and, if the diagrams are so turned as to make the position of (*a*) correspond with

Mr. DUNKIN's, the prominences and the spots will be nearly on the same part of the limb.

The next point is the evidence given by these observations for the localization of the prominences upon the sun, and not upon the moon. Upon comparing the figures 3, 4, 5, with the diagram 6, it will be seen that the occultation of (*d*) and the revelation of (*e*) and (*f*) are explained by the advance of the moon as an occulting body over the prominences of the sun. And upon comparing Mr. DUNKIN's prominence (*g*), figure 7, with the diagrams, figures 6 and 8, it will be seen that at Göttenburg a considerable breadth around that part of the sun's limb was never uncovered, while at Christiania it was uncovered, especially towards the end of the totality. The diagrams also show that Mr. HUMPHREYS' prominences (*f*) and (*g*) could not possibly be seen at Christiania, though at a proper time they might be seen at Göttenburg; it would appear that they were not seen there as independent prominences, but at a somewhat later time formed part of the general sierra (*f*) in figure 5. These considerations appear to leave no doubt that the prominences belong fundamentally to the sun.

The third point, perhaps the most remarkable of all, is the difference in the form of the prominences, especially the great curved prominence and the small detached floating cloud near it, as seen at different places. I do not see how it is possible to reconcile these but by the supposition of something like mirage. I may add that from a communication by Premier-Lieutenant PETTERSSON, who observed in the outskirts of the city of Göttenburg itself, about two miles from my station, it appears that there was as great difference between his observation of the form of the prominences and mine as between Mr. HUMPHREYS' and mine. This would seem to show that the apparent form depends on circumstances strictly local; but what those circumstances can be I am utterly unable to divine.

G. B. AIRY.

1851, November 14.

*ISLAND OF BUE, West Coast of Norway.**Observations by Rev. T. R. ROBINSON, D.D., and Professor CHARLES PIAZZI SMYTH.*North Latitude $61^{\circ} 9' 42''$. East Longitude $0^{\text{h}} 17^{\text{m}} 24^{\text{s}}$.

This party was conveyed to the place of observation, about 60 miles to the north of Bergen, in the steam-vessel belonging to the Board of Commissioners of Northern Lights, who had kindly allowed a *détour* to be made from their periodical visitation of the Shetland lighthouses, for this scientific purpose. Sir F. BEAUFORT had likewise been most obliging in placing at the disposal of the observers a variety of instruments, and amongst them several valuable telescopes, with portable equatoreal stands, and armed with micrometers. These, together with some furnished from the Edinburgh Observatory, allowed of ALAN STEVENSON, Esq., C.E., Capt. ANDERSON, and the first and second mates of the steamer, being added to the number of accurate optical observers, while other parts in the general scheme were to be filled by the Secretary and several of the Commissioners of the Board.

The objects proposed were physical observations on whatever should occur during the totality of the eclipse. Great correctness, therefore, of the absolute time, and of the position of the point of observation, was not of any great moment. The spot was reached on the morning of the day of the eclipse, amidst cloudy and rainy weather. A landing was effected on the Bue Island, the outermost of the series which line the Norwegian coast, having a clear horizon in the direction of the sun at the time of the eclipse.

The sun coming out through the clouds soon after ten, sights for the time were obtained with a sextant and artificial horizon, which were employed again at noon for the latitude; while the chronometer had its error and rate determined a few days after at the Edinburgh Observatory, whence the results for the geographical position of the place are deduced.

The sky during the above observations was, with few exceptions, covered pretty uniformly with thin clouds, which, though much dimming the brightness

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of the sun, and occasionally obscuring it altogether, did not appear to spoil the definition of the limb. This state of things continued during the eclipse; and the sun, when seen at all, and that was only during the time between the commencement of the eclipse and the commencement of the totality, was always veiled by clouds more or less thick. These circumstances prevented the beginning of the eclipse being properly observed, but the commencement of the totality was apparently seen in a much more satisfactory manner, though through clouds. The result, however, showed some startling differences, which may be useful cautions when anything important depends on an observation, of one side only, of even a solar eclipse. During the totality the clouds increased greatly in thickness, and rain commencing soon afterwards, nothing more was seen of the sun all that day.

The observations of time were as follows :—

Phenomena.	Local Time.	Green. Time.	Observer.	Remarks.
	h m s	h m s		
Beginning of Eclipse . .	2 11 37	1 54 13	Prof. Smyth	The eclipse had commenced.
Beginning of Totality . .	3 12 37	2 55 13	Dr. Robinson	
„ „	3 12 42	2 55 18	Dr. Robinson	Dr. Robinson, who gave a second signal which was not heard by the person at the chronometer, thinks that it was 5 ^s after the other.
„ „	3 14 33	2 57 9	Prof. Smyth	

During the time when Dr. ROBINSON's signals were being given, Professor P. SMYTH continued to see the sun's limb of a very visible breadth and well defined, but faint through clouds. But he observed at Dr. ROBINSON's signals sudden depressions in the brightness of the surface, and at last, when he also gave the signal for the beginning of totality, the limb seemed to vanish at once, while having still a sensible breadth and being well defined. These variations may have been the effect of the passing clouds; but Professor P. SMYTH is rather inclined to think, from their instantaneity, that they must have been produced by variations of the solar light itself, and that the fact of such variations would probably be much more evident when the sun was almost obscured by a thick cloud than when totally uncovered, as the eye is so very much more sensible to a certain amount of difference in the brightness of two objects when they are both faint, than when they are both bright; as may be tested by looking at a double star, when the components

are not very different in size, first with a small telescope, and then with a very large one. These variations in brightness, combined with the general decrease of illumination, which is always obscured from the centre towards the limb of the sun, would, apparently, contract the limits of the sun differently to different observers, according to the power of their instruments: in the same manner, indeed, in which Mr. AIRY accounts for his having seen in the eclipse of 1842 the commencement of totality happen as distinctly and decidedly as he could observe, twice over; considering that the varying cause resided altogether in the clouds.

Dr. ROBINSON's telescope was an Admiralty one, 4 feet in focal length: Prof. P. SMYTH's, the 5-feet achromatic, presented to the Edinburgh Observatory some years ago by the Rev. Mr. SHEEPHANKS: the object-glasses were the same size, nearly 4 inches; but while Dr. ROBINSON used a micrometer eye-piece magnifying 120 times, Prof. P. SMYTH employed a large lens comet eye-piece magnifying only 48 times. Moreover, while the stand of Dr. ROBINSON's was merely three legs, connected at top and having rather shakey equatoreal brasswork to support the telescope, that of Prof. SMYTH's was a very solidly-built structure of wood, loaded with large iron weights below, and having unusually large bearing surfaces in the moving parts, with violent means of clamping; all which circumstances may have enabled him to continue to see, in his telescope, the faint exterior limb of the sun, after it would have vanished to him in the other. Indeed, from the sensible and well-defined breadth of the strip of the sun at the moment when all went out at last to him, he is pretty confident that, with a more powerful telescope, or in a clearer atmosphere, the totality would have been made later.

During the progress of the eclipse, spots on the sun and lunar mountains were searched for. One spot only was seen, and that close to the limb 10° N. of the equatoreal diameter on the E. limb; several well-marked lunar mountains were seen 3° S. of the same.

As the phenomenon proceeded, there was a remarkable appearance of streams of dark descending clouds under the sun: those over the sky, generally, were of the cirro-strati character, verging to nimbi, and near the ranges of mountains on the mainland were heavy cumulo-strati: the descending streams were rather between cirri and nimbi; and collecting from round about the locality of the sun, and gradually converging lower down, they assumed an appearance as if flowing downwards through a large funnel.

The air was sensibly becoming darker and colder every moment, and the sea-birds, by collecting and screaming about the rocks, seemed to be preparing for their night's rest. A series of thermometrical readings, beginning at 66° F. and ending at 55° F., were obtained by Mr. Commissioner URQUHART, from 2^h to 3^h ; but the effect of the eclipse was too much masked by the clouds and rain to make them available. The same circumstances prevented all hope of seeing the *edge* of the approaching shadow of the moon passing over the earth; and, of course, for any observation of the corona, red prominences, &c. during the totality.

When this supervened, the *sudden* loss of light gave the impression of something darker than an ordinary night. The clouds, doubtless, greatly increased the fine eclipse effect, for they now densely covered almost the whole of the sky; the southern, eastern, and western sides being even closed in with heavy nimbi and distant falling rain. But towards the north, in the horizon, there was a strip of sky two or three degrees high and thirty or forty long, which was pretty clear; and in this direction was range beyond range of mountains, the more distant covered with perpetual snow, and probably not less than 100 miles off. The colours seen in this portion of the sky were not unlike those which may be witnessed under similar atmospheric circumstances, about half an hour after sunset in the autumn season in our own country.

Near the western end of this clear opening were some radiating streaks of cirri-cirrostratic cloud, evidently much lower than the superincumbent mass; and while this became portentously dark, and of a deep grey, they were strongly illuminated, of a coppery red colour, apparently by the reflexion of the sun's light through the opening from some of the distant mountains, where the eclipse was not total. As, however, the totality advanced, and the boundary of the shadow included a greater and greater extent of those northern mountains, the radiating bands became less faintly illuminated, and at last became even darker than the clouds above. While this display lasted, the effect was very startling and Domdaniel, especially as seen from the telescope station, where, from its being in a slight hollow, little else could be commanded; and the sight proved quite enough for the Norse peasants and fishermen who had gathered about us during the operations, for they made off immediately, and tried to hide themselves from what they believed to be approaching destruction. The birds now ceased their cries, as if convinced

that it was night ; but one large gull, which had been, perhaps, surprised by the approaching darkness at a distance from home, went sailing about with apparently a loss of all purpose.

The even density of the clouds over all the region of the sun completely precluding every hope of observing any of the fainter telescopic phenomena, the observers left their stations and ascended a neighbouring eminence to view the scene.

On all sides was the sea thickly studded with rocky islands, some hardly rising above the surface of the water, others shooting up into lofty mountains with perpendicular precipices, and giving the impression of a polar sea covered with confused icebergs, and seen on a dark and stormy night. The present darkness, however, though somewhat appalling to the senses, and sufficient to make a ship in the neighbourhood stop its course and furl its sails, was not, after all, so very intense ; as not only small print could be read, but the marks of a pencil could be seen in sketching the appearances.

Perhaps the peculiar quality of the light had some effect ; sea and land all partook, more or less, of a sombre dark-greenish hue. But as the eye, striking on more and more distant mountain peaks, at length reached those in the north, under the lurid streaks of sky above mentioned, where evidently the sun was still shining, then, from the utter darkness of our place of observation, and the clearness of the air, the precipitous markings, and the light and shade of those far-off ranges, were brought out with a degree of vividness which appeared quite supernatural ; and so much the more so on considering that, had that bright sky in the horizon been but an ordinary morning or evening effect, those mountains would merely have formed a dark mass against the light : but now it was clear, from their illumined detail, that a veritable sun must have been shining on them from on high, though all the rays by which we were illuminated were faint level ones, coming through that opening without heat or strength. These rays, too, being derived only from the yellow borders of the sun, gave, when they reached us, a ghastly appearance to the faces of those upon whom they struck.

The lamps which had been prepared for the observers to write down their observations by, were shining all this time in the hollow, as conspicuously as if at night.

By degrees the under edges of the banks of cloud above the opening

began to be tinged with coppery light, and then a sudden increase of the general illumination announced the totality at an end; while the rain beginning soon after, and continuing uninterruptedly for the rest of the day, prevented anything more being done.

CHARLES PIAZZI SMYTH.

RINGERIGET.

Observations by Lieutenant KRAG (Translation).

(*In a Letter to J. R. CROWE, Esq., Her Majesty's Consul-General at Christiania.*)

Having received marching orders for Ringeriget, I was deprived of the pleasure I had anticipated from being the assistant of Mr. DUNKIN, in observing the total eclipse of the sun on the 28th of July last: but as I have felt a great interest in and a wish for making these observations, I procured before my departure two telescopes, of two Norsk ells in length,* and a dark glass, in hopes of being able to make some use of them.

Although I am aware my observations are too insignificant to be of any importance, still I consider it only right to report them, so that you may, if you think fit, lay the same before Mr. DUNKIN.

I placed myself on an eminence, commanding an extensive view of nearly forty miles in circumference. The heavens were partly covered by light clouds; but owing to a strong blast of wind at the time, I had several opportunities of observing the sun in the intermediate breaks as the clouds passed off, which gave me time to acquaint myself with the management of my telescope. I had no chronometer, but had set my watch with the Observatory of Christiania, consequently I was able to judge the time the eclipse would commence: unfortunately a heavy cloud obscured the sun at this moment, so that I was unable to observe the first contact.

When the eclipse had already advanced two digits, I noticed no change of colour, either in the objects around me or in the heavens. The sun remained uncovered until about nine digits, when a thin cloud came over it. This, however, was just dark enough to allow me to observe the sun through

* Rather more than four English feet.

my telescope without any dark glass: when six or seven digits had been advanced, I fancied it became darker, though not considerably.

For some minutes I was prevented by the increasing body of the clouds from observing the sun, but noticed the decrease of light on the environs until the clouds again dispersed, leaving the sun perfectly free, and forcing me to have recourse to the dark glass. Fortunately no more clouds appeared; consequently, I could quietly observe with the telescope, from the time the eclipse was eleven digits. The barometer and thermometer were at the same time noted by my assistants, whilst my servant was placed to observe the fowls and chickens: I had tied my horse to a tree by my side, in order to witness what effect the totality would have upon him. As before stated, I had a very extensive view, and could clearly notice the shadow, on the approach of total darkness, travelling across the country, and gradually increase until the darkness was at its height; and I am perfectly certain it did not come on instantaneously.

In descriptions of eclipses I have read that the unearthly darkness leaves a certain unpleasant impression; this, however, was not the case with me: on the contrary, I thought it a most impressive, though awful, sight. It was not, however, so dark as I had contemplated, being able to read a book and faintly to distinguish distant ridges of mountains.

On the horse, the sudden change from light to total darkness seemed to have no effect; an old woman, quite contrary to the generality of her sex, showed no curiosity, but quietly lighted her candle, and with perfect indifference continued her work.

I continued my observations in the telescope; and the reflexion from the earth was so powerful, that the moon appeared almost the same as when seen by daylight at the same time as the sun, and, consequently, lighted by his rays.

The moon's edge was surrounded by a perfect, shining, white border (I suppose the corona), and outside this again I observed a narrow light violet stripe.

I observed two flames, which seemed to burn on the edge of the moon and nearly on opposite sides. I presume you have seen the cotton taper used with spirits for lighting lamps or pipes: the flame appeared to resemble this, perhaps a trifle redder. Having impressed them on my memory, I attempted to see them with the naked eye, but to no avail.

On my right, the horizon was lighted by the first returning sunbeams, and I could notice how it gradually became more and more light, which I believe was owing to the sun's reflexion on the surrounding clouds.

At this moment a most interesting sight appeared, as the heavens and the country on my right were lighted by the sun's rays, whilst on my left, at the distance of fourteen miles, the country still lay covered in total darkness: it was, however, but temporary, and I soon observed returning light in the lowest parts of the horizon. On the horse the return of light seemed to have no striking effect; he only appeared as if recovering from a doze, and stared in astonishment towards the quarter from whence the light returned.

My servant reported that the fowls all sought their house on the approach of darkness, whilst the chickens commenced fighting, and did not cease before the return of light, when all joined in a grand chorus.

My assistants observed the barometer and thermometer before and after the eclipse; the first remained stationary, the other fell four degrees, but rose again on the reappearance of light. The most singular thing, however, was, that the wind, which, as before stated, blew hard in the early part of the eclipse, totally ceased, leaving the lake below me smooth and calm as glass. No sooner had the shadow passed ere the wind commenced anew, with the previous force. I was not single in observing this, but several persons remarked and confirmed the same.

The whole time from totality until the end of the eclipse, the sun remained clear and unclouded, so that I had a perfect view; I could not discover any change of colour.

CHRISTIANIA.

Observations by ROBERT SNOW, Esq.

Latitude $+59^{\circ} 54' 5''$. Longitude $-0^{\text{h}} 42^{\text{m}} 59^{\text{s}}.8$. (*Ast. Nach.*)

The morning of Monday, July 28, at Christiania, was tolerably fine, with intervals of bright sunshine, yet not without some suspicious clouds in the sky. As the time for the eclipse approached, the weather altered for the

worse, and the whole region about the sun was covered with thin cloud. Through this, however, the beginning of the eclipse was seen, and observed, at the time given below. During the progress of the obscuration, I thought the limb of the sun was better defined than the limb of the moon, though no lunar mountains were made out with any certainty. The horns or cusps were singularly sharp and well defined.

Nothing anomalous was perceived until the totality approached, when the disappearance of the sun began to take place by the breaking up of the extremities of the horns into detached morsels of light, scarcely to be called bead-like, as they were not round, nor quite steady, but slightly waving and undulating towards the points of the horns.

The beginning of total darkness was observed at the time given below ; after which, the corona about the sun and moon became visible in the telescope, and to the naked eye, although it was viewed through pretty thick clouds. In the telescope it by no means appeared to be uniformly disposed, but in irregularly radiating bundles or masses. At the same time three very bright, but unequal, and not very well-defined prominences, made their appearance. (Pretty nearly as in Plate II. fig. 7.)* One of these, marked *a*, was of considerable magnitude, and put on a distinct horned appearance, bent in the direction expressed in the diagram. This one was considerably larger than the other prominences, but they were all pretty equal in intrinsic brightness. There was that about this larger prominence which made me suspect that had I seen it aright, in a clear sky, it would have appeared filamentous about the extremity. I have said that I saw three bright prominences ; but on referring to the sketch made on the spot, I find a *fourth*, marked, nearly diametrically opposite to *a*, and drawn with a zig-zag outline, as if my impression had been that it had two summits. But I have not in my mind the vivid recollection of this one that I have of the other three. Perhaps some excuse is due to the haste, not to say agitation, of the moment. As the total darkness went off, the broken and wavy patches of light at the fine extremities of the incipient cusps reappeared, but not in so striking or marked a manner as before. The end of total darkness was observed at the time given below.

* Mr. SNOW's drawing agrees so precisely with that of Mr. DUNKIN here referred to, that a separate sketch is not required. The fourth prominence is the *b* of Mr. GRAY, Plate III. No. 2.

All the phenomena connected with the total disappearance were viewed through a pale blue glass attached to the eye-end of the telescope, which threw a grey tint over the whole. There were but few spots on the sun's disc; but there was a group of five or six small spots, which had been undergoing marked changes as observed during the last day or two, accompanied by well-marked faculæ, not far from the place of the luminous horn on the limb; and a pretty large dark spot was coming on much about the situation of the fourth luminous prominence; which latter, however, I will not positively assert that I saw, although it is my belief that I did see it.

The telescope made use of was brought from England for the purpose; an excellent refractor by DOLLOND, 45 inches focal length, and $2\frac{1}{4}$ inches aperture. The power employed was about 35. The instrument was mounted on a pillar-and-claw brass stand, with an adjustable equatoreal block, set to the latitude of the place, on a solid stone pillar in the garden of the Christiania Observatory. This situation was assigned to me by the courtesy of Professor HANSTEEN. The spot commands an uninterrupted view of the sky, and an extensive and exquisitely beautiful panorama of the city, the Fiord, and surrounding hills. As the eclipse advanced, daylight waned as if a terrific thunder-storm were impending; nor could anything be imagined more striking than the sickly tint of the near foliage, and the lurid appearance of the entire surrounding prospect; and when the total darkness took place, it was not easy to decipher the figures of a watch held in the hand; and yet, which was curious to witness, the distant hills were very visible, whilst a deep yellow light, like dim sunset, appeared beneath the clouds in the south. No stars were seen, in consequence of the clouds which covered nearly all parts of the sky. In the north-east alone was the open sky visible, and there the effect was most unnatural, and resembled the tone of a hard and exaggerated painting grown dusky with age. It is much to be regretted that at Christiania the weather and state of the sky was very unfavourable; no one portion of the eclipse having been seen clearly and free from cloud.

Upon this occasion every facility and kindness was offered to me by Professor HANSTEEN; and I have great pleasure in adding that I received personally every attention from the Consul-general, Mr. CROWE, and his family, and the offer of every convenience in their power that could further the observation of the eclipse.

The observed times were made with a good pocket-watch by FRODSHAM,

which was compared with the Christiania Observatory sidereal transit-clock, on the day of the eclipse, both before and after it took place. These comparisons give an error, slow, of the watch, at the first comparison, of $12^s.2$, and at the second of $13^s.8$, applying which to the time observed by the watch, the following results were obtained :—

Beginning of the Eclipse	^h 2 ^m 43 ^s 38	Corrected Mean Time at Christiania.
Beginning of Total Darkness	3 46 53	————
End of Total Darkness.....	3 49 28	————
Duration of Total Darkness.....	0 2 35	————

The end of the eclipse was obscured by clouds.

Observations by N. B. YOUNG, Esq.

(*Extract of a Letter to the Astronomer Royal.*)

I send you, according to promise, the particulars of the eclipse as observed by my relative and myself at a point seven English miles north-north-west of Christiania.

The total obscuration commenced at $3^h 44^m 20^s$ Christiania time, kindly given to me previously by Mr. DUNKIN; and continued for $2^m 25^s$. Unaided by telescopes we could observe none of the peculiarities incidental to a total eclipse, beyond the extraordinary solemnity as well as suddenness of the darkness cast on the landscape far and near. A dull, rose-coloured corona around the moon's disc, and some coruscations, or rather waves of light at some distance east of the sun, which I believe I recognised before the total obscuration commenced, are what we most particularly remarked.

DRÖBAK.

Observations by Capt. BIDDULPH, R.A.

The position taken up by a small party, of which I formed one, could scarcely be equalled. An open space on a ridge of some elevation near

Dröbak, 18 English miles south by west of Christiania, afforded us a view over an extensive landscape, bounded on the north-west by the mountains about Ringeriget, about 35 miles distant, and stretching away to the south-east to a distance scarcely less. Having thus an extensive view in the direction of the advance of the great shadow, and on all sides an horizon unobstructed by near objects, I anticipated observing with great pleasure the pictorial effect of the eclipse. Nor was I disappointed.

During almost the whole eclipse the sun was obscured by a rather dense cirro-stratus cloud, rendering a dark glass occasionally unnecessary; and only once, about a quarter of an hour before the total darkness, casting any definite shadow; and thus rendering the means of appreciating the amount of light by comparing the shadows impossible. The decrease of light when the sun was about half covered, seemed very little; and up to the time of its being three quarters covered and after, by no means so much as the ordinary observer would expect. There was, however, a very sensible diminution of colour, the landscape became cold, and the lines of dense forest assumed a dull grey colour. For a long time the red roof of a house, facing the north-east, the quarter from which most light could come, retained considerable brilliancy of colour, and I used it as a test of the difference which might be produced, and, fortunately for my enjoyment of spectacle, secretly believing that I should not during the whole time lose sight of this red roof.

I had been observing the passage of the moon over the sun with a common reconnoitring telescope, and finding that from the continuance of the cloud, and the general overcast nature of the sky to windward, the sun could not be clear during the totality, I laid down the telescope at about two and a half minutes before the sun was completely covered, determining to watch intently the effect of the coming shadow. Even now, and for the remainder of the two minutes, there was considerable light; I thought then, about as much as at three-quarters of an hour to an hour after sunset. The red roof was still visible. To the north-west the sky was almost completely overcast. Cirro-stratus, stratus, and some very far distant cumulus, reflecting considerable light. I had observed about the time I laid down the telescope, that a gap in the clouds, almost unnoticed before (for the blue sky where seen was of a very light watery colour), became gradually darker, deepening to an intense blue purple, and almost black soon after: rapidly, the farthest distant clouds no longer reflected light, the shadow commencing at the horizon and

spreading itself upwards. The whole north-west sky for 30° became of the deepest purple, more intense than any thunder-cloud I ever saw. An island of cumulus hanging low, and much nearer than the distant hills, was now brilliantly lighted, compared with the dark back-ground; reflecting the colour and light of the east and south-east, which was close to the horizon, bright and ruddy. I can best describe that the coming of the shadow could be appreciated by the sensation of darkness coming over one as a thick dark atmosphere spreading itself over sky and land to the north-west, and more distinctly on the clouds and sky overhead. At last the light cloud I saw distinctly put out like a candle. The red roof was gone: the horizon no longer visible. I looked up, and the last bright ray of the sun had been covered, and only a faint trace of the corona appeared through the mist. The rapidity of the motion of the shadow and its intenseness produced a feeling that something material was sweeping over the earth at a speed perfectly frightful. I involuntarily listened for the rushing noise of a mighty wind. It was a sight more grand than those who have not seen it can possibly conceive, and far beyond my powers of description. I could, now that we were in the middle of the totality, distinctly observe that we were on the north side of the central line of shadow; to the south it was dark and black, while to the north-east it was yet light—that is to say, the horizon was visible. I watched it speed away to the south-east. The coming light showed itself close to the horizon to the north-west, and the mountains were visible, and soon—far too soon—cloud after cloud, and distance after distance, was rapidly lighted up. The sun's limb showed itself, and the shadow, like a huge dark vapour, had passed over and soon disappeared below the south-east horizon.

During the time that the sun was covered, which was as nearly as I could make out three minutes and a half, the light was of a deep blue purple. A few wild flowers, blue and yellow, and red strawberries, which I had previously collected together, hastily, in a group, gave me some idea of its nature. The red was not reflected at all, blue tolerably, yellow not; and yet I thought the blossoms of the clover, which are more of a crimson purple, were distinguishable.

Unable previously to form any idea of so wonderful a spectacle, I was beyond measure delighted, and felt that for it alone it was worth going any distance. To see a partial eclipse I now thought nothing, so immensely grand was it to watch the passage of the shadow.

The clouds did not permit a view of any stars, and yet so dark was it that I felt sure at the time that many would have been visible. Having noticed the amount of light at midnight on the night before, and the number of stars then visible, I was able to perceive that it was far darker.

The thermometer rose immediately the sun reappeared, and was by the time that the moon was three-quarters off the sun's disc, three-quarters of a degree of RÉAUMUR higher, having risen from $13^{\circ}\frac{1}{4}$ to 14° .

FYLDPAA.

Observations by MM. JACKSON and KING.

The eclipse was viewed by myself and by Mr. KING of Ipswich, at a village named Fyldpaa, situated about forty miles S.S.W. of Christiania, and four miles west of the port of Tonsburgh. The day was not favourable for observation, as in the forenoon the sky was obscured by cirrous clouds, which, as the day wore on, increased in density. From the time that the eclipse commenced, dark masses of cloud frequently intervened, totally obscuring both the sun and moon. As the interesting moment of total eclipse approached, the clouds threatened to prevent any view of the phenomena, and in the anxiety of the moment I missed the opportunity of noticing the formation of the corona, if, indeed, it could have been seen through the clouds that at that time prevailed. Mr. KING watched the commencement of total eclipse by means of an astronomical telescope with a power of 40. Intent upon seeing the phenomena called BAILY's beads, he paid little attention to the corona. No appearance of the beads was detected by me; the thin crescent of the sun was suddenly covered, but one speck of light seemed to hang upon the moon's disc, similar to a star previously to occultation. A few seconds after total eclipse, I was enabled to see the moon through a hand telescope, from which the intermediate lenses had been removed. Three rose-coloured protuberances were immediately visible on the moon's extreme limb. Excepting that the objects were more distinct, and that I could more particularly notice that in the "rose-coloured protuberances," the colour of the edges was more intense than in the middle, I saw no other phenomena

when looking through the larger telescope. But the principal rose-coloured protuberance seemed gradually to elongate and to acquire a sharper termination; just before the conclusion of total eclipse the form became that represented in Plate III. No. 1. At this time a fourth protuberance arose behind the moon. It was above the other three; but no sooner was it revealed, than suddenly a pale red tinge passed over the lower edges of the moon, followed by a mingled light of pale colours; when, in an instant, the light of the solar crescent shone forth, and the rose-coloured protuberances at once vanished. The phenomena of the beads could not be seen through the telescope of less power; but Mr. KING distinctly saw them by means of his large telescope. This account is very imperfect; but the attention of myself and my friend was distracted by anxiety on account of the cloudy state of the sky, and, above all, by the astonishment which possessed our minds on witnessing a scene, of the grandeur of which we had previously formed no adequate conception.

STEPHEN JACKSON.

TUNE, *near* SARPSBORG.

Observations by W. GRAY, Esq.

I observed the eclipse from the top of an eminence near the church of Tune, near Sarpsborg, about 200 feet above the sea, commanding the best range of horizon which I could obtain, the country being covered with low rounded granite hills, and not particularly favourable. Approximate latitude, $59^{\circ} 14' N.$, longitude, $44^{\text{m}} 18^{\text{s}} E.$ My telescope was 53 inches focus, aperture $3\frac{3}{4}$ inches, power 60.

The beginning of the eclipse was not visible. At $2^{\text{h}} 30^{\text{m}}$ Greenwich time the clouds became much thinner, the moon was half advanced on the sun's disc, and the irregularities of her limb were beautifully defined.

In endeavouring to observe the general phenomena of the approaching shadow with the naked eye, as well as the moment of commencement through the telescope, I failed in noting accurately the time. The duration was about $3^{\text{m}} 10^{\text{s}}$. As the umbra approached, the clouds appeared in violent motion from the fluctuations of the shadows on them, and darker purple overhead than

the darkest thunder-cloud: in the horizon, lurid yellow and orange. In the north-west was an opening into the clear sky, which suddenly changed from a misty blue into the most lovely celestial blue, and this darkened to indigo. What injury the clouds caused to the astronomical observation was compensated by the strange horror they added to the scene. (See STUKELEY's letter to HALLEY, 1724. STUKELEY seems well pleased that the sky was quite cloudy on that occasion.)

As the moon advanced, the sun's limb broke into numerous irregular beads of light. Having kept a dark glass on, I lost what I am informed was a very splendid sight, the diamond-like appearance which these presented to the undefended eye. I viewed the corona with the naked eye. It appeared a ring of white light in the clouds, of a diameter nearly twice that of the moon, gradually fading away to the outer edge, glowing, but without any radiations, and resembling in that respect Mr. AIRY's drawing of the eclipse of 1842, in the *Astronomical Society's Memoirs*, and not Mr. BAILY's.

Having removed the dark glass, before which I lost a good deal of time, being confused by the quick succession of phenomena and the excitement of the persons near me, the prominence *a* (Plate III. No. 2), on the moon's western limb, struck me at once; it appeared to be $1\frac{1}{4}$ in height, and half that in breadth, and tapered to the top; nearly opposite was a broader prominence, *b*, fainter, and more delicately shaded, of which the northern end was highest. Having marked their situation, and again examined the corona with the naked eye without discerning the prominence, I again looked through the telescope and saw the first-noticed prominence, *a*, apparently shot out as a gas-jet when fully turned on, and with a portion curved to the south; and between it and the north point two other prominences, *c* and *d* (the second, *b*, on the eastern limb being still in view and more distinct than before). My impression at the time was that a further clearing of the clouds had brought them into sight.

The curved prominence, *a*, was now fully $1\frac{1}{4}$ in altitude. There was a dark shade in the curved portion which increased its resemblance to a gas-jet, and the rest was rose-colour, not uniform, and very pale, like the innermost part of the petals of a rose.

The opposite prominence, *b*, was $1'$ in altitude; its form was a trapezium, the northern end being highest; its rosy tint was more decided than the other, and was not uniform.

I did not minutely notice *c* and *d*; they were nearly square and apparently tuft-like and ragged, and indistinct at the base. I estimate them at 50" in size.

I judge by comparison with the interval of two fixed wires, which I have ascertained to be 57", and I marked the situation of *a*, 15° south of the parallel of declination; *b*, 5° north of ditto; and *c* and *d* nearly at distances of 30° and 60° north of the parallel of declination. But the parallel of declination is only very roughly estimated.

During the totality the light appeared to me equal to that of a clear evening on the 2d August following, in latitude 59°, at 1½ hour after sunset. The outlines of the hills were distinctly visible. The seconds on the chronometer were read with perfect ease, but its face had a peculiarly cold and ghastly appearance. The dreariness of the scene arose not from absolute deficiency of light so much as from its quality:—

“ Void of light,
Save what the glimmering of those livid flames
Cast pale and awful.”

The sky was too cloudy to permit any stars to be seen.

The reappearance was preceded by a red light on the limb, and the sun's limb broke out at once in several beads.

The sun was very speedily obscured by clouds, and the further progress and end of the eclipse were invisible.

The cloudy state of the sky impeded radiation-observations of the thermometer; but for half an hour before and after totality the march of the black bulb thermometer appeared pretty steady.

A party of ladies and gentlemen, a few yards from me, appeared very sensible of the cold, and hurried home the instant the sun reappeared.

As to the effect on animals, I have heard various contradictory accounts; but all agreed that the swallows, which were chasing their prey in the twilight, were strangely discomposed; the bees ceased working; the cocks crowed.

I may mention here, as bearing on the subject of the beads, that on my voyage home I observed the sun set in the sea, which was perfectly calm and the sky cloudless; the disc appeared to project on the sea, and the last visible portion was first dilated, and then vanished *suddenly*; but the moon,

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two hours after, at setting, steadily and gradually disappeared without any such projection or distortion.

The following observations of temperature were made during the eclipse :

Barometer, 29°·83. Brisk wind from south-west.

Supposed 1 ^m 12 ^s fast on Local Time.	Bulb of Black Glass in Sun.	Dry Bulb in Shade.		Wet Bulb
h m				
2 30	65°	65° { This appearing to be exposed to reflected heat, I changed its position a little. }		59°·5
2 45	63 [Sun cloudy, invisible]			
3 15	65 [Sun clearer]	62·5		58·5
3 30	60·5	60		56·8
3 45	58·5			
	Totality ended at 3 ^h 53 ^m 4 ^s [3 ^h 51 ^m 52 ^s Local Time]			
3 55	57	56·5		54
4 15	62·5	57·5		54
4 30	58·5 [Sun invisible]	58·5		54·5
4 45	59·0	59		55
5 0	59·5 [Eclipse over]			

FREDRICHVAARN.

Observations by ROBERT STEPHENSON, Esq. and Captain ANDREWES.

The morning was very fine, and the sky almost cloudless. Wind from the S.W. and rather chilly. The temperature of the air in the shade reached 70° just previously to the eclipse taking place.

I observed with an equatoreal telescope 3¼ inches' aperture, with a power of 35. Captain ANDREWES took the times, and observed with a sextant. A little while before the eclipse commenced, the sky became rather clouded, but not so much so as to prevent very distinct and continuous views of the phenomena to be observed.

The moon's limb came in contact with the sun at 1^h 51^m 30^s, by Captain

ANDREWES' chronometer, which he stated to be slow $10^m 40^s$ on Greenwich mean time, as found by observation several days before. Three small spots were observed on the sun's disc; but their positions were not noted. During the progress of the moon over the sun's disc nothing remarkable presented itself until the moment of total obscuration, which took place at $2^h 54^m 17^s$. Capt. ANDREWES took the following angular distances between the cusps:—

At $2^h 29^m 35^s$	Angle $30' 0''$	At $2^h 46^m 38^s$	Angle $29' 0''$
$2 30 28$	— $30 0$	$2 47 6$	— $28 30$
$2 32 47$	— $30 0$	$2 50 7$	— $28 15$
$2 36 57$	— $29 50$	$2 50 49$	— $28 10$
$2 45 59$	— $29 0$		

At $2^h 43^m$ a circular halo was observed to encircle the sun, with a radius subtending $22^\circ 56'$.

The crescent of the sun before disappearing was gradually reduced to a fine thread of light, which broke up into fragments. In a second or two after this took place, a rose-coloured flame shot out from the lower part of the west limb of the moon, which in form resembled a sickle. It increased in size very rapidly, and then two other rose-coloured prominences, one above and the other below, started out, neither of them so peculiar in shape, but evidently of the same character. The red prominences first made their appearance as red specks at points which almost instantaneously became their summits by the extension of their bases. Besides these three very remarkable prominences there were between them other lurid points, with indistinct lurid lines scattered along or near the circumference of the moon. The largest of the three prominences presented the appearance at one moment of an irregular solid mass standing out from the moon and visible only on one side; that is, one side was in shadow, and the illuminated side resembled a rose-coloured sickle. See Plate III. No. 3.

No measure of the height of this protuberance was made, but it appeared to be about the twentieth part of the moon's diameter. At one moment the scene brought to my mind some of those highly-coloured pictures of Vesuvius sold at Naples. The three chief prominences looked like burning volcanoes, and the lurid spots and lines reminded me of dull streams of cooling lava.

The sun reappeared at $2^h 57^m 47^s$. The reappearance of the sun was remarkably instantaneous, presenting not a fine thread of light, as it had

done on disappearing, but a series of spots of silver light, which gave the idea of globules of mercury rushing amongst each other along the edge of the moon. In two or three seconds their apparent motion ceased, and they settled into a steady crescent. This was scarcely completed when the rose-coloured prominences disappeared entirely. The corona which appeared round the moon was like the halo round the heads of saints in old pictures, but not so uniform in the intensity of light. The rays seemed somewhat separated, giving the effect of a multitude of distinct divergent lines of light. The appearance was probably much interfered with by the fleecy clouds which floated in the field of view of the telescope. The corona might otherwise have been smoother and more gradually softened off. The darkness was great, but sufficient light remained during the whole time of the total obscuration to enable a sketch to be made of the position of the red prominences, and one person might distinguish another at the distance of seventy to eighty yards. The thermometer on the grass fell to 58° , and the atmosphere was damp and cold. The eclipse was shortly followed by heavy rain. The accompanying rough sketch (Plate III. No. 3), made at the time of observation, shows the relative positions and apparent magnitudes of the red prominences.

TROLLHÄTTAN FALLS.

Observations by W. LASSELL, Esq.

My observations were made at Trollhättan Hotel, within a few hundred yards of the celebrated Trollhättan Falls, and situated about 40 miles north of Göttenburg, in Sweden. I was accompanied by my friends Mr. STANISTREET and Mr. WILLIAMS, who, with myself, had come from Liverpool for the purpose of observing the eclipse. The geographical position of the place is in latitude $58^{\circ} 17' 30''$, and longitude east from Greenwich $49^{\text{m}} 8^{\text{s}}$; elevation above the sea level about 200 feet.

The weather had been for some days very unfavourable, so that a single set of altitudes of the sun for time, on the afternoon of the 27th, was all that

we had to depend upon for ascertaining the local time; except, indeed, such rude approximation as we might be enabled to get from estimation of longitude and Greenwich time, so far as it could be kept or carried on by our watches. The morning was gloomy; wind strong from south, or a point or two to the west, with light flying showers; the clouds moving rapidly and in masses. A consideration of the state of the weather, in relation especially to the strength of the wind, determined me, about two or three hours before the commencement of the eclipse, not to repair to the field I had previously fixed upon as the place of observation, but to observe from an upper room situated at an angle of the hotel, having two large windows fronting respectively the N.E. and S.E., and affording, therefore, a view of 270 degrees of azimuth, with an uninterrupted and distant horizon through the greatest part of it. Towards noon there were "breaks" in the clouds, and occasionally the sun looked out; but not in time to get any altitudes for his hour-angle.

The telescope used was by MERZ of Munich, of 2.55 inches aperture and $32\frac{1}{2}$ inches focus, in a portable form, but mounted on a rude wooden polar axis, extemporaneously made the day before I left home, which answered admirably in steadiness and general convenience. The eye-piece used was a negative or inverting one, and gave a power of 35 times. Shortly before the first contact the sky became clearer, the sun being visible and obscured by turns; and when he shone out unclouded, it was with unequalled intensity, my dark glasses breaking successively with most alarming rapidity. I was driven to my wit's end, fearing I should not have a single bit of dark glass left with which to defend my eye. I interposed a large piece of neutral glass immediately behind the field lens of the eye-piece, where it would not be exposed to so much concentration of the rays; but, to my dismay and astonishment, even *that* split across after observing a few minutes. As a *dernier ressort*, and only a few minutes before the first contact, I diminished the aperture to 2 inches, and also heated the slide of dark glasses over the flame of a candle, until I could not bear to touch it, and then immediately applied it to the telescope, keeping it constantly pointed to the sun, in order that the glass in use might not cool again. This answered perfectly, and the sky having now become more steadily favourable, I sat down to wait for the contact.

Only two spots could be discerned on the face of the sun, and those but

small; the preceding, however, having three or four small dots in the neighbourhood of the larger one, together with some small irregular lines of faculæ. None of these could be observed in any other part of the sun. The estimated position, referred to a parallel of declination, was 288° for the preceding spot and 90° for the following, measuring from the north point round by east. The estimated position of the first point of contact was 284° , to which place, as nearly as I could point it out, my eye was constantly directed. At the moment, the sky was clear, and my eye directed to the spot, so that I saw, I am persuaded, the very first impression of the moon's limb. It took place at $2^{\text{h}} 10^{\text{m}} 32^{\text{s}}$ by my watch, well observed; and touched the first spot at $2^{\text{h}} 12^{\text{m}} 36^{\text{s}}$; not quite so well observed, as a cloud came over at the moment. The magnifying power used was 35, and aperture 2 inches; the sun's edge sharp and well-defined, subject, however, to occasional serrations.

When the moon had advanced about one-third over, I examined the limb carefully for mountains, and observed that rather above (or south of) the diameter of parallel there were four or five well-defined summits,—one more prominent and isolated than the rest. Some of these were, apparently, much more elevated in proportion to the base than any I have ever seen on the moon's limb projected on the clear sky. The limb in other parts was a little irregular, but not so as to have any decided peaks like those before mentioned; and, indeed, it must be understood that, although evident and indisputable, the irregularities, with the power employed, appeared but as minute objects. As the moon advanced, there did not appear to me to be any very obvious difference of brightness of different parts of the sun's disc; and I watched very carefully the solar cusps as they grew progressively more acute, even until they were extremely fine and did not include more than 50° or 60° of the sun's circumference, without detecting any distortion whatever of their symmetrical and beautiful form. I tried even to question myself whether there might not be some bending outwards of either cusp when it became extremely thin, but I could not persuade myself that such was the fact. The utmost I could arrive at was a *suspicion* whether they might not be in the slightest degree, when *very* thin, bent outwards—inwards, I am sure they were not.

As the totality approached, which it seemed to do with amazing and fearful rapidity, after the cusps were reduced to about 50° , I looked carefully for “BAILY's beads,” as well as for any *drawing out* or osculation of the limbs

about to touch, *but I could perceive none*. It is true, the thin line of light broke up into pieces immediately before extinction; but I remarked that it was precisely where the remarkable prominences were situated that these “beads” appeared, and I could perceive no phenomenon in them which the projection of these mountains would not explain. The last portion of light disappearing was a little north of that part of the crescent which had appeared to be the middle and thickest part immediately before. There were no “beads” sufficiently large to be well recognised in any other part of the crescent of light than the part opposite to the moon’s prominences.

At 2^h 52^m clouds were passing, and all the portion of the sky below the sun to the south-west was covered with broken clouds; and six minutes later paleness was observed to be coming over the landscape. The aspect of the clouds advancing from the south-west suddenly and remarkably changed into an immense number of light, round clouds, like masses of carded wool, together with some of denser formation; and one, an immense, dark, and peculiar cloud, occupying a position just under the sun—most menacing for the totality. The appearance of these clouds, generally, reminded me strongly of the bed of the Gotha (almost at my feet) immediately below the principal Falls, where it is one mass of foam, struggling and spouting into clouds of mist and spray.

At 3^h 4^m the landscape became strikingly paler, the shadow of the house and other objects being but slightly contrasted with the feeble sunshine. The instant of total obscuration took place at 3^h 13^m 6^s.8, and the reappearance of the sun at 3^h 16^m 26^s.0, making the duration of total darkness 3^m 19^s.2. The times were, I think, well observed, and the phenomena very instantaneous.

I may attempt, but I cannot accomplish, an adequate description of the marvellous appearances, and their effect upon the mind, which were crowded into this small space of $3\frac{1}{3}$ minutes,—an interval which seemed to fly as if it were composed of seconds, and not of minutes! Perhaps a naked-eye observer would more fully grasp the awful effect of the sudden extinguishment of light,—the most overpowering of these appearances,—for, my eye being directed through the telescope, I must have been less, though sufficiently, struck, with the unprecedented sensation of such instantaneous gloom. The amount of darkness may be appreciated from the fact that, on withdrawing my eye from the telescope, I could neither see the seconds’ hand of my watch, nor the paper sufficiently to write the time down; and was only able

to do so by going to the candle which I had by me burning on the table. Probably the suddenness of the gloom, not giving time for the expansion of the pupil of the eye, increased the sensation of apparent darkness; as I was obliged to repair close to the candle for the requisite light. After registering the time, I looked out for a few moments with the naked eye over the landscape, north and south. The north was clear, and the line of horizon could be distinctly seen. The sun covered by the moon, looking like a black patch in the sky, had now the corona very nearly symmetrically formed around it; but the moon appeared to my unassisted eye to be not very round or smooth at its edge,—more as if one had rudely cut out with a knife on a board a circular disc of card,—the edges somewhat jagged and irregular in outline.

The corona itself was perfectly concentric and radiating, some of the rays appearing in some parts of the circumference a *little* longer than in others; but the inequality was not great. I am unable to say whether the corona when *first* formed was at all excentric, for, as it is evident that any one observing with a telescope up to the moment of obscuration must have time to take off the dark glass before the corona can be seen, and as I had also to note the *time*, the centres of the sun and moon must have been pretty closely approximating before I again applied my eye to the telescope. It was, indeed, a great exercise of self-denial to spare the time from the exciting phenomena, which was necessary for accurately recording the duration of total darkness; but being inclined to think such record would be disregarded by many observers, I took my resolution to secure it.

Continuing my survey with the naked eye, I observed that the masses of clouds remained at this time still below the sun; but they had become more evanescent at their edges, which extended, indeed, up to the sun, so as to cover him with a slight haze, not sufficient to interfere at all with his visibility, or in any degree with his distinctness through the telescope; but sufficient to prevent my recognising any star in the neighbourhood of the sun but *Venus*, which was bright enough to be seen without looking for, though evidently situated in much thicker haze. *Mercury* was in haze, which made it hopeless to look for him. I think the darkness of the northern sky was quite sufficient to have shown stars of the first magnitude, though I could not discover any. It appeared to me to be much darker than it was at midnight at Christiania. I was greatly surprised by the light of the corona,

to which I should almost be inclined to apply the term brilliant, though it has been described to be “extremely feeble;” and I think it was nearly, if not quite, sufficient to account for the remaining light on the sky and landscape. Moreover, had there been no clouds (which appeared to me to reflect the light of the corona), I think the darkness would have been obviously greater. I know it is rather vague to make such a comparison; but I think the corona gave nearly as much light as the full moon ordinarily does.

No time remained for shadow-experiments, or trials to ascertain what size of print could be read; and having noted the above phenomena with as much precision as I could, I turned hastily to the telescope,—power 43, 2.55 inches aperture (which, indeed, I had used as soon as the light and heat of the sun had become sufficiently reduced), and now the most wonderful and exciting spectacle of all presented itself. I had intended to direct my attention pointedly to the detection of the “red flames,” which I had heard described as but faint phenomena. My surprise and astonishment may, therefore, be well imagined when the view presented itself instantly to my eye as I am about to describe, or rather to attempt to give a notion of.

In the middle of the field was the body of the moon, rendered visible enough by the light of the corona around, attended by the apparent projections from behind the moon, of which I have attempted to sketch the position. (Plate III. No. 4.) The effect upon my own mind of the awful grandeur of the spectacle I feel I cannot fully communicate. The prominences were of the most brilliant lake-colour,—a splendid pink, quite defined and hard. They appeared to me to be not quite quiescent; but the moon passing over them, and, therefore, exhibiting them in different phase, might convey an idea of motion. They are evidently to my senses belonging to the sun, and not at all to the moon; for, especially on the western side of the sun, I observed that the moon passed over them, revealing successive portions of them as it advanced. In conformity with this observation also, I observed only the summit of *one*, on the eastern side, though my friends, observing in adjoining rooms, had seen at least two; the time occupied by my noting the time and observing with the naked eye not having allowed me to repair again to the telescope until the moon had covered one, and three-fourths of the other. The point of the sun’s limb where the principal “flame” appeared was (I judged) a few degrees south of the place where the cluster of spots was situated, and

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the flame which I observed on the eastern limb was almost exactly where the eastern spot was situated. As, however, some prominences appeared adjacent to parts of the sun's limb not usually traversed by spots, the attempt to trace a connexion between them fails. The first burst of light from the emergent sun was exactly in the place of the chief western flame, which it instantly extinguished. No flames were observed near the north or south portions of the sun's limb, nor, indeed, any others in any portion of his circumference, except those in the figure. The moon's western limb was much smoother, and had not mountains upon it like those on the eastern. From the varying lengths of the red flames it is difficult to give an accurate estimation of their magnitude; but the extreme length of the largest, on the western limb, may have been about $2\frac{1}{2}$ minutes. This estimation is rather rude, as I was so absorbed in contemplating their general phenomena that I had not time for exact measurement.

As the moon went off, the sky thickened, and the later portion of the eclipse was very imperfectly seen—the last contact not at all. The sky soon became completely overcast, and about 9 P.M. rain commenced, which apparently continued through the night.

WM. LASSELL.

Trollhättan Hotel, 29th July, 1851.

P.S. All the times above quoted are times by watch, whose error on the 28th, at the time of the eclipse, was presumed to be fast for Greenwich $5^m 57^s$, or slow for the place of observation $43^m 11^s$. This error was deduced from altitudes of the sun obtained on the 29th and 30th, in addition to those of the 27th. On comparing the errors and rates thus given, as indicated by two excellent duplex watches, I do not think that the above error can be misstated to the amount of more than one or two seconds.

Observations by GEORGE WILLIAMS, Esq.

On the 18th of July I left Liverpool, and on the following day sailed from Hull in the company of two friends; after touching at Christiania, we arrived at Gothenborg, in Sweden, on the 24th, from whence we proceeded to Troll-

hättan, the place from which we had decided to view the eclipse. The few days which intervened were occupied in making the necessary preparations, selecting a neighbouring eminence for the observations, and inspecting the magnificent waterfall. The sky for many days had been overcast, and much rain had fallen.

On the morning of the 28th (the day of the eclipse), the heavens appeared covered with one impenetrable stratum of clouds, and the wind became so high that we at once abandoned the idea of setting up the instruments in the open air, and determined to make our observations from the windows of our rooms, which fortunately commanded a considerable extent of view, ranging from about N.E. by S. to N.

As the day advanced, we watched the aspect of the sky with intense anxiety. A little before noon the clouds began to break; occasional gleams of sunshine appeared; these increased in duration until, at length, the sun shone forth in full splendour.

Two spots were now visible on the sun's disc,—one large one, somewhat broken up, near the preceding limb, and a smaller one near the following limb: Plate III. No. 5, *a* and *b*.

The heat of the sun now became intense; the two dark glasses which I had been in the habit of using for the last five years gave way and cracked. My friends also lost several; we were thus deprived of the use of these when they were the most needed. This intensity of the sun's rays may possibly be due to the clear and highly transparent atmosphere of Sweden.

I had brought with me an inverting telescope of $2\frac{1}{4}$ inches aperture and 42 inches focus; a micrometer being fitted to the eye-piece for taking rapid approximate measurements.

At about $2^h 45^m$ P.M. the telescopes were placed in position, and at $2^h 53^m 48^s$ local mean time I observed the first contact. A thin film of clouds now covered the sun, but without materially interfering with distinct vision. The moon made rapid progress over the sun's disc.

Daylight began perceptibly to wane when about $\frac{9}{10}$ ths of the sun's diameter was eclipsed; the landscape then assumed a sombre appearance, which rapidly darkened into an awfully black hue.

Under a power of 110 the mountains in the moon were visibly defined against the sun's disc. The position of these, as I observed them, is given in Plate III. No. 6. fig. 1; they were situated chiefly on the southern cusp. As

totality approached, the sun's uneclipsed limb presented the appearance of a most brilliant golden thread of a segmental form; this instantaneously broke up into beads and strings of light, presenting the phenomenon known by the name of "BAILY's beads." These I observed on the southern cusp *only*, and in positions corresponding with those of the mountains seen in the moon. Their appearance is represented in Plate III. No. 6, fig. 2. This phenomenon appears to me to be clearly accounted for by the sun's rays shining through the spaces or valleys between the mountains in the moon.

On the disappearance of the beads, the duration of which was very brief (perhaps 4 or 5 seconds), the corona and red prominences became visible. Plate IV. No. 1 is a representation of the sun during its total obscuration. The two red prominences drawn on the following limb were the first seen; their form was conical, the bases being towards the sun; the base of each was about two-thirds of its height; they subtended an angle of about $38''$, making their height upwards of 17,700 miles. As the moon advanced these soon disappeared.

On directing the telescope to the preceding limb, three more prominences came into view. The highest of these, as shown on the sketch, appeared like an inverted cone; the apex being towards the sun, it resembled fire violently shot forth from an orifice, diverging and decreasing in intensity as it ascended until it was lost in the light of the corona. The appearance of the prominence next in succession was wonderful beyond description. After ascending vertically to a vast height, it bent off nearly at right angles in a southerly direction, extending itself nearly to an equal distance southwards. As the moon progressed in her orbit, it increased in size and brilliancy. It resembled fire: the edges were not well defined, especially towards the extremity; and it appeared to me to be surrounded by vapour, which was more perceptible towards the extremity. It occupied 1.33 intervals of my micrometer; the value of the interval being $1' 15''.69$, gives to this prominence an angle $1' 15''.69 \times 1.33 = 1' 40''.92$, or the enormous height of upwards of 47,200 miles.

The last prominence I observed was situated a little below the one just described, and on the same limb; it also resembled fire. Its edges were better defined, but in size it was inferior to the two last.

The corona, which was formed at the moment of total obscuration, shone with a feeble light; equal, perhaps, to about one-third that of the full moon.

The light was divided by radial lines, and presented the appearance of brushes of luminous rays shot from behind the moon. It was brightest next the edge, and decreased in intensity as it diverged, until it was lost in the surrounding darkness at a distance of about one-third the moon's diameter from its edge. I was unable to observe whether it was concentric with the sun or moon.

On withdrawing my eye from the telescope the scene around was awful in the extreme. The opposite pine-covered hill had assumed a black colour, —the whole face of the country appeared supernaturally altered. Words would fail to describe it, or my own feelings on the occasion; it was a moment of intense excitement. *Venus* was distinctly visible. I saw no other planets or stars, in consequence of the thin film of clouds I have before alluded to. The northern horizon, to an altitude of about ten degrees, was clear, and resembled the eastern sky about half an hour before daybreak. The largest of the red prominences was distinctly visible to the naked eye; it was likewise seen by a friend at Gothenburg. I also observed indications of the others with the unassisted eye. The corona was likewise visible, but owing to the state of the sky it was not so clearly defined as when seen through a telescope.

Having taken a rapid survey of the general phenomena, I applied my eye again to the telescope, a few seconds before the reappearance of the light. The first rays extinguished the corona and red prominences, and rendered necessary the immediate protection of the eye with a dark glass.

The computed duration of the total obscuration on the central line, opposite to Trollhättan, was $3^m 21^s$; its actual duration at Trollhättan, as observed by one of my friends, was $3^m 19^s.2$: it was a period so fraught with interest, and so much had to be seen in this brief interval, that it appeared to pass away in a few seconds, giving time for a general survey only, a minute inspection of each of the phenomena being out of the question.

Very shortly after the termination of the totality the clouds again collected, and the last contact was completely hidden from view. I had, however, seen the principal phenomena much more favourably than might have been expected from the previous or subsequent state of the weather; and I felt grateful for having been thus permitted to witness the wonders connected with one of the most stupendous of the Great Creator's works.

On the 29th I obtained a view of the sun for a short time, and observed

a second spot had made its appearance on the following limb, the position of the two for this day being indicated by *b'* and *c*. (Plate III. No. 5.) The coincidence of these two spots with the two red prominences seen on the same side during the total obscuration deserves attention. It appears to me probable that a connexion exists between the spots on the sun's disc and the red prominences; the appearance of the second spot on the following limb on the day after the eclipse, and agreeing with the second red prominence, favours this supposition. The large spot on the preceding side, marked *a*, Plate III. No. 5, corresponds also in a remarkable manner with the position of the largest of the prominences.

The effect produced on individuals by the eclipse differed much. I have heard that in many parts of Sweden it occasioned much terror amongst the inhabitants, and that in one place the clergyman of the district participated in no small degree in this feeling of alarm. At Trollhättan it was treated with unseemingly levity, and the disappearance of daylight was hailed with a loud laugh by those seated under our windows.

Observations by JOHN STANISTREET, Esq.

The telescopic observations were made with a $3\frac{1}{2}$ -foot refractor by DOLLOND, of $2\frac{3}{4}$ inches aperture, the power used was about 80, inverting the image.

The weather at Trollhättan had for several days been very unpromising, and on the morning of the eclipse the sky was obscured by clouds; but about two hours before the commencement of the eclipse there was a remarkable change in the weather, the clouds were broken up, and driven by a stormy wind across a sky of intense blue, and the sun shone forth with extraordinary brilliancy and power.

At $2^h 53^m 45^s$, Trollhättan mean time, I observed the first contact of the moon's limb; but I ought to mention that this was seen a few seconds earlier by my friend Mr. LASSELL, whose account of the phenomena observed at Trollhättan during the eclipse is so full and accurate, that I should have

deemed it superfluous to record any observations of my own, and I am induced to communicate the present account only in deference to his opinion and wish that I should do so.

Nothing remarkable was observed by me during the progress of the eclipse until near the period of total phase, but several eminences and depressions were visible upon part of the moon's advancing limb, and one of the mountains stood out pre-eminent.

The sun's disc had been previously examined, and two spots were observed; one a small compact spot very near the eastern limb, and another (or rather an assemblage of spots intermixed with streaks of light or faculæ) at a short distance from the opposite or western limb.

At 3^h 45^m, Trollhättan mean time, the day became very perceptibly darker, and a large cloud beneath the sun appeared of an unnatural and awful blackness. The sky was again almost covered with clouds, exciting apprehensions lest the sun should be obscured during the total phase; but, happily, that portion of the sky remained clear.

At 3^h 55^m 50^s, Trollhättan mean time, I observed the moon's contact with the eastern spot. Whilst noting the time I observed the light diminish with awful rapidity, and it seemed as if a great pall of shadow was descending upon the earth. I was so much overcome with this sensation that I continued to gaze upon the impressive scene for a few moments before I again applied my eye to the telescope. When I did so, the upper portion of the thin film of light was broken into several detached parts or "beads." This effect was evidently due to the mountainous region of the moon's limb at that point, as no beads were observed at the lower portion of the crescent, where the moon's limb appeared to be free from any sensible prominence; and the roughness of the moon's limb accounted satisfactorily for the division of the crescent into separate portions or "beads" of light.

At the instant of total disappearance I omitted to note the time, although I was at the moment counting the beats of the watch, and I thought no more of time until the total phase had passed away.

I can hardly blame myself for this forgetfulness, when I recall to mind the highly-exciting phenomena that arrested my attention during the short period of total obscuration, a period in reality of about $3\frac{1}{3}$ minutes, but which I could not have estimated at more than one-third of that time, such was the absorbing interest of the phenomena.

The corona was formed at the instant of total obscuration, and several bright pink-coloured masses, or “prominences,” were immediately observed on both limbs of the sun (or rather, on both sides of the moon’s disc, which now obscured the sun). Their colour appeared to me to be like that sometimes seen upon the edge of a sunlit cloud at sunset, being of a very bright crimson, or rather roseate hue.

I first observed, on the eastern limb, a large mass or “prominence,” coinciding very nearly, if not exactly, with the position of the solar spot before noticed; and I believe there was another similar, though perhaps fainter, prominence, immediately above it: but although I now think I have a distinct recollection of seeing the latter, yet, as I had not drawn it in the sketch made immediately after the eclipse, until reminded of it by my friend Mr. WILLIAMS, I cannot now assert this upon my own observation, especially as I was at the moment much excited by the grand and unexpected phenomena, that drew away and rivetted my whole attention to the opposite limb. There, three distinct pink-coloured masses were observed, apparently in contact with the moon’s disc, and one small cloud-like mass of the same colour apparently detached from it; but one of the former attracted particular attention. It was a large prominence, curved in form like a man’s arm, and it appeared to alter its shape rapidly, unfolding more and more of the curve as the phase proceeded. Just previous to the reappearance of the sun’s limb, this prominence subtended an angle very nearly equal to once and a-half the interval of the micrometer wires in the eye-piece, the value of which interval I have since ascertained to be 68". Plate IV. No. 2.

This sketch shows also the approximate position of the other prominences; but my attention was so much absorbed with the largest of them, that I feel less certain about the truthful delineation of the rest, except, indeed, as to the small detached cloud-like mass, which I noticed very particularly, as shown in the sketch; and I thought I could distinctly perceive this become more and more distant from the moon’s disc, until the moment when the sun’s returning light extinguished it.

There could be no doubt whatever that the other prominences on this limb were gradually revealed as the moon passed away from over them, and they unquestionably appertained to the sun (or solar atmosphere), and not to the moon.

I feel quite certain also that the projection or root to the larger promi-

nence (as shown in the sketch) was really observed, and that it became visible as the moon passed from over it. I thought the light of the largest prominence flickered, and looked like the boughs of a tree, but I have been reminded that such an effect may have been due to disturbance of our atmosphere.

During the total phase I withdrew from the telescope, and gazed for a few moments upon the scene, which was indescribably grand, and even awful in its aspect. Where the sun had lately shone in all its glory, there was now only a circle of absolute blackness, surrounded by a halo or corona of faint light; and a deep gloom had fallen upon all things, which, by contrast with the recent sunlight, might well be termed darkness. *Venus* was very bright, but the clouds, which nearly covered the sky, obscured the other planets and the stars that were known to be there.

It were vain to attempt any written description of such a scene; but I was afterwards reminded of the effects produced in some of Martin's pictures, where, by false lights and deep shadows, he has sought to suggest preternatural appearances to the imagination.

The darkness may have been less profound than I had anticipated, but the effect was more deeply impressive; and that the darkness was considerable may be inferred from the fact, that during the total obscuration I attempted to mark with a pencil the position of some of the prominences upon a card, on which a circle of about four inches in diameter was strongly drawn with Indian ink; and when this was afterwards examined the pencil marks were found to be at some distance from the circle, and were, in fact, quite useless as indications of the points of the sun's limb where the prominences were seen.

On my return to the telescope my attention was chiefly occupied by the largest prominence, which appeared to change its form very rapidly as the moon revealed the lower portions of it, and just before the light heralded in the sun's limb it appeared as if it were thrust out bodily from behind the moon's disc.

In another instant the burst of sunlight extinguished all the phenomena which had so enchained my attention, and gave me calmness and leisure to remember how many points of great interest had been wholly forgotten during the excitement.

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Very shortly after the total phase, the barometer was observed at 29·75, having fallen ·025 since the commencement of the eclipse, although it had been gradually rising throughout the day. The sky was now covered with hazy mist, and the sun became more and more indistinct, and was at last altogether lost to view shortly before the last contact, which could not be observed at Trollhättan. The wind fell suddenly, and the clouds did not again disperse, and the evening was thick and rainy; so that the eclipse was observed by the happiest chance during the only sufficient interval of clear sky seen during several days.

It may be interesting to note, that on the day after the eclipse another spot had made its appearance near the sun's eastern limb, just above the one before described, and that the position of this new spot must have corresponded very nearly with that of the second prominence on that limb of the sun. This spot was again seen on the 30th July, on our journey to Stockholm, but circumstances prevented any accurate observations of the spots after that date.

The morning after the eclipse was very wet, but on the evening of the following day the weather became remarkably fine, and continued so during the remainder of our stay in Scandinavia.

LILLA EDET, *on the Göta River.*

*Observations by R. C. CARRINGTON, Esq.**

I sailed from Hull by the Courier steam-packet, on July 19, for Göteborg, on the coast of Sweden, and arrived there on July the 24th.

The instrument that I took with me for the observation of the eclipse was an ordinary astronomical telescope of $3\frac{1}{2}$ inches aperture and about 4 feet focal length, lent me by Mr. W. SIMMS of London, the definition of which

* Plate V., which was engraved for a private publication by Mr. CARRINGTON, has been very kindly furnished for the *Memoirs*.

was very good. It was fitted with one eye-piece, of a power of about 70, having a pair of wires fixed in the focus, a little out of the centre of the field, parallel to one another, at a distance apart of one minute of arc. A slide, containing ten coloured glasses, considerably varied both in colour and depth of tint, was provided, which moved in a groove at the end of the eye-piece. I also took with me a NICOL's prism polariscope, a good thermometer by BARROW, the scale-errors of which are very trifling, a trustworthy pocket-compass, a portable spirit-level, and such other things—tools, for instance—as seemed likely to be of use.

At Göteborg I met with Mr. G. P. BOND, of the Observatory of Cambridge in the United States, who was desirous of placing himself as nearly as possible on some part of the central line of shadow. We agreed to go together to the village of Lilla Edet, on the Göta River, the position of which place, as given on a large and trustworthy Swedish chart, was found to be $58^{\circ} 7'$ north latitude, $12^{\circ} 8'$ long., east of Greenwich. The eclipse was central at $58^{\circ} 5'$ north by $12^{\circ} 8'$ east. To this place we went by steam-boat, on July 25th, and there we remained till the 31st. It was our intention to observe the eclipse from the same spot, but the very unfavourable appearance of the weather on the morning of the 28th made it advisable to separate, and we took our observations at a distance of two miles apart; Mr. BOND stationing himself a little out of the village on one side, while I went to a high rock, previously selected, which was a mile and a half distant on the other. Our accounts are therefore independent, and the particulars given below depend on my testimony alone.

The weather previous to the 28th was highly unpromising: it rained the whole of the 25th and the greater part of the 26th; the 27th was showery, and the morning of the 28th overcast, showery, and unsettled; but fortune favoured us at the critical time, and it became perfectly clear some time before the first contact.

We received great assistance while at Lilla Edet from Mr. S. MYGIND, the overseer of the canal, who was well acquainted with English, and took great interest in the approaching event. I am indebted to him for the use of his boat and the services of three of his men, in conveying my instruments, and in erecting a scaffolding of poles for a tent, and support for my telescope.

It was while engaged in these preparations, some three hours before the eclipse, that the first signs of clear sky appeared; by the time they were finished only a few cirri remained: these quickly dispersed, and during the eclipse not a cloud passed over the sun. The definition of the sun was unusually good; there was none of the boiling on the limb generally seen.

I began my observations a short time before the first contact, by noting down the positions and forms of the dark spots and light streaks on the sun, referring them to the vertical, and in this and other operations I found a glass which gave the sun a pale green colour the most convenient. These spots are represented in Plate V. fig. 1, but of necessarily exaggerated size, and are there given in their true position; each group consisted of one or more small spots surrounded by a few bright streaks.

The thermometer was pretty constantly observed throughout the eclipse; the readings will be given afterwards. It hung within the tent, at about two feet above the ground, far enough from me not to be affected by the heat of my body; the times were noted by my watch, which I laid on the ground, and are local times within about a minute.

The moon's preceding limb was very rugged: Plate V. fig. 2, represents the principal inequalities, as seen when about one-third advanced on the sun: first, two small mountains, among many others less marked; below them a repetition of the same on a larger scale, and still further below a long and well-marked valley. A little exaggeration in the figure has been unavoidable.

My attention was much directed to the forms of the cusps; they frequently seemed blunted when viewed through smoked glass, but sharp again after resting the eye for an instant; as seen through the telescope, they were always perfectly sharp and well formed, with one marked exception, at 3^h 45^m local time, when the lower cusp appeared for nearly a minute, as represented in Plate V. fig. 3. For the short time after the totality that the sun was visible no irregularity of form was seen.

I several times looked carefully with the telescope for any trace of the moon beyond the sun, but without being able to find any: neither could I during the totality, in a rapid glance, perceive any light or shade on her surface. The gloom which preceded the totality came on insensibly at first,

but latterly very rapidly; it was murky and unusual in kind. I looked round the horizon for some seconds, at the time when the sweeping of the shadow might be expected, but could not leave the telescope long enough to say that it did not take place; however, I saw nothing of the kind. At that time it was very gloomy in the north-west; not black, but nearly so: in the north-east and south-west the sky was angry red, and reminded me of a sunset during high wind; while in the south-east it was quite bright, and the hues were those of a sunrise. Overhead it was gloomy, but I could see a swallow, at a great height, flying very fast towards the south-east.

The disappearance of the sun I watched carefully with the telescope; for a short time the portion of light remaining appeared uniformly thick, with sharp cusps; without any notice it flew into numerous little lines: these lines contracted into dots, some again breaking up, the dots contracted, and the sun was gone. These appearances, forming the phenomenon of BAILY's beads, are represented in Plate V. fig. 4. At the time, the ruggedness of the moon's limb seemed sufficient to account for the breaking up of the light; but a recollection of the great regularity of size and arrangement of the dots, which is strongly impressed upon my memory, goes greatly against such an opinion. At the reappearance of the sun, I was too late to watch the repetition of the phenomenon, my attention being directed elsewhere.

The moment that the last trace of the sun was gone, I drew out my slide of coloured glasses, and while doing so cast a rapid naked-eye glance at the sun, around which the corona was already formed. I only allowed myself time to notice that its light was a pure white, brightest next the moon, and insensible at a distance of one-fifth of her diameter, and that it blended into the sky in one shading off. I caught sight of one star, which I believed to be *Mercury*, but which may have been *Regulus*; I have no doubt others were visible, as this was a very palpable object.

I immediately saw with the telescope a small pink prominence at an angle of about 100° from the upper limb, reckoned towards the east; it was of the form of a haycock, and rapidly diminished: in 10 seconds it was no longer seen. I did not count the number of seconds, but I saw it decidedly and only long enough to be certain afterwards that it was no delusion, and to have no doubt about its position. In stating the position, I am allowing for inversion by the telescope.

I then directed the telescope all round the moon, and at once saw three other flames, in the position of 2, 3, and 4, as given in Plate V. fig. 10; 3 and 4 were so remarkable that I abandoned 2 after noting its angle of position, and remarking its general appearance. My whole attention till the sun reappeared was given to the two flames numbered 3 and 4; as I had previously determined to make quite sure of the nature of any motion that might be shown, if opportunity offered. I have no manner of doubt on my mind when I state that these spots increased in size so as to be five times as large when they disappeared as when I first saw them. This change is represented in Plate V. figs. 5, 6, and 7, which, I may state, do not more palpably represent the growth than it was seen by me. Their colour was pink, of the hue seen on ripe fruit, and appeared tinged with white. It seemed to me that No. 3 grew more than No. 4; but I cannot say this with any great degree of confidence; it had the appearance of a mighty flame bursting through the roof of a house, and blown by a strong wind. The figures give its form pretty well, which was highly suggestive of motion; I cannot, however, depose to having seen the slightest change of its outline, or any traces of structure on its surface. Flame 4 was simpler in form, and, if I am not mistaken, a little forked towards No. 3; it was my impression that both of these flames touched the moon's limb, but I did not sufficiently notice this circumstance. I was greatly astonished by the appearance of five or six *bows of light*, which seemed to connect these flames above. I noted down their colour as yellow, shortly after the end of the eclipse; they maintained their relative position till all vanished, and the highest bow was estimated as 2 minutes of arc distant from the moon's limb, by comparison with my fixed wires, the highest flame as $1'5$, very shortly before the end of totality.

I was too much taken by surprise at the reappearance of the sun to notice whether these flames were traceable for any length of time after the restoration of the light. Haze at this time developed very rapidly, and in about ten minutes a solar halo was traceable: by the end of the eclipse the sun was quite obscured, so that the separation of the limbs could not be observed.

I proceed to add some other particulars, omitted above, in order to avoid confusion.

Total Eclipse of the Sun on July 28, 1851.

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The thermometer observations were,

Local Times.	Fahr.	Local Times.	Fahr.
h m		h m	
2 47	63 ^o ·5	4 14	59 ^o ·2
3 0	62·3	4 18	59·0
3 5	64·1	4 22	58·8
3 15	65·6	4 25	59·0
3 28	66·5	4 28	59·0
3 31	65·5	4 35	59·3
3 35	64·2	4 40	59·7
3 40	63·5	4 46	60·4
3 53	61·9	4 50	60·5
4 0	60·5	4 56	60·6
4 8	60·0	5 5	60·9
4 13	59·6	5 21	61·5

which were taken in such shade as four thicknesses of sail-cloth furnished. It will be seen that the total fall of temperature was 7^o·7 Fahr. and that the minimum took place about 21 minutes *after the reappearance* of the sun. I perceived no chill at this time, but a man who was with me, who had remained as a guard to prevent unforeseen interruption, got up and buttoned his coat, and on my questioning him answered that he felt cold.

The degree of darkness during the totality was less than I was prepared to expect; I had had a lantern lit, which proved quite needless, as I could read my watch at a glance where it lay at my feet, and found, on looking at the title-page of the *Suggestions*,* which I had previously fixed up at a distance of three yards, that it was all legible enough: it is also my impression that the outline of the country was visible, and the position of the river.

I made frequent trials of the Nicol's prism on the sun's diminishing disc, as seen through smoked glass, before totality, and again more at leisure after totality till prevented by haziness, but failed in perceiving any traces of polarisation. I had the curiosity to try it also on the corona for an instant, but with the same result. It is necessary to add that I took the precaution to ascertain that the instrument was in a proper state, exhibiting the usual rings and brushes readily when directed to the blue sky at a sufficient distance from the sun.

* *Suggestions to Astronomers for the Observation of the Total Eclipse of the Sun, &c., drawn up by a Committee of the British Association.*

No irregularity, prominence, or hollow, was seen on the moon's following limb, when on the sun after the totality.

It occurred to me, while watching the flames, to try my left eye; the appearance was precisely the same as with the right, which I had been pretty constantly employing at the telescope for an hour. I have thought it worth while not to omit stating this, as a fatigued eye is not always above suspicion.

The distance of the fixed wires at the focus was found to be, as nearly as possible, one minute of arc, by transits of two slow stars, taken on the first opportunity after the eclipse.

The positions of the flames, spots on the sun, and so on, were observed inverted, and noted down on cards so cut as to prevent mistakes of position; but are in the engraved figures given in their natural positions, referred to the vertical.

I was prepared by previous accounts to experience at any rate somewhat of involuntary dread during the darkness, but my sensations were very different; I felt simply that I was witnessing a phenomenon of darkness; and I further saw none of the unusual appearance of flame of a burning candle, or unnatural colours; probably being forewarned I was forearmed, for I am by no means proof against such sensations.

On returning to the village, Mr. BOND called my attention to the circumstance of most of the people being dressed in their best clothes, and after noticing passers-by for a short time, we had but little doubt of it: whether the quotation from the loss of the Abergavenny, "Some appeared perfectly resigned . . . but the most prominent idea was that of putting on their best and cleanest clothes," is at all to the point, or too fanciful an explanation, others can judge for themselves. The prospect of the eclipse had occasioned considerable alarm in the minds of many of the country people; so much so, that some farmers in a district called Warmland, not far from Lilla Edet, did not plough their lands in the spring; but such an incident is not to be taken as a sample of Swedish intelligence in general.

I shall close this account by answering certain questions from the *Suggestions*, Appendix II.

1. Whether the prominences have hard and permanent, or waving and ill-defined outlines?

Hard and well-defined outlines; in one case very suggestive of waving, but not seen to wave.

2. Whether they are invariably broadest at the base, and have on the whole a tapering shape ?

Yes, in every case.

3. Whether they seem to stand erect, or whether any or all of them are aslant . . . ?

The two that stood alone, namely, those numbered 1 and 2, were erect and symmetrical, of the form of a haystack, broad at the base and rounded at the top ; but the system of two, in which the bows were seen, was different, and the prominences were in this case bent towards one another.

4. Whether any appear isolated ; and if so, how the space between the red patch and the moon's limb is occupied ?

No such instance came under my notice. See a remark that follows on the account of Dr. BOUSTEDT.

5. Whether any appear to grow up or to diminish ; and if so, whether such change is what the moon's motion would naturally account for ?

It has been stated in the former part of my account, that such motion was seen, both of decrease and increase, and attentively watched ; it is only necessary to add that the changes are fully accounted for by the moon's motion, and thence to conclude that these prominences are appendages to the sun of immense magnitude, and of corresponding importance. I have frequently used the word "flame" in speaking of the prominences, but merely as a short term of expression.

To this reprint I may be allowed to add two remarks, after reading the accounts of other observers.

1. BAILY's beads were seen by more than one person at the reappearance. All agree that there was no sensible inequality of outline in the moon's receding limb.

2. Red prominences were seen by some, corresponding to part of the sun's body on which solar spots are never seen to form.

The following accounts were given to Mr. BOND and myself on the day after the eclipse. Mr. MYGIND's in English, the other two in Swedish. I give the first verbatim, and translations of the others, as accurate as I have been able to make them by the help of a very imperfect Swedish dictionary.

Observations by Mr. S. MYGIND, Overseer of the Canal at LILLA EDET.

(See Plate V. fig. 8, which is an exact copy of the original, on a somewhat reduced scale.)

The darkness during the total eclipse appeared to me not greater than what is usual on a summer evening, in this part of the country, in the beginning of July, at eleven o'clock.

Directly after the commencement of the total eclipse, a small flame was seen, somewhat crooked, and as it appeared to me, bending towards W. and S., or perhaps S.W.: it was of a reddish colour; a smaller one, rather of a round shape, was seen close to it and below it. How long they remained in sight, I cannot say for a certainty, as other persons were looking through my spy-glass at times.

A horse grazing near the place where I stood, continued feeding as long as I could see it. A flock of sheep was heard bleating during the total eclipse by another person of the company.

Of all the persons in company with me, three ladies and a child included, not one seemed the least afraid, but all were greatly delighted.

Observations by Mr. L. SVANGREN. (Translation.)

About eight or ten minutes before the beginning of the eclipse the centigrade thermometer showed $+23^{\circ}$ in the sun, and $+17^{\circ}$ with a north aspect; but at the end of the totality, $+18^{\circ}$ towards the south, and $+13^{\circ}$ towards the north.

Immediately before the totality I heard all the cocks in the neighbourhood crow; and a canary-bird, which was singing cheerfully, stopped and seated himself on the highest perch in his cage for as long as the eclipse lasted: hundreds of small birds, which I had not previously seen, and which were swallows and a few sparrows, flew about like mad things, seeking trees and bushes, as places of concealment, as if afraid to remain in the air.

A cow and two dogs, which were let into the yard where I stood, showed no alarm, and ate greedily of food given them just at the totality.

The night violet, which shortly before the beginning of the eclipse had

little of its agreeable scent about it, smelt strongly during the totality. It should be remarked that a young lady who was troubled with a cold, and before the eclipse could not perceive any scent of flowers, could however perceive the strong smell at that time.

A bee seemed to hasten home. A cat belonging to a neighbour ran to our maid-servant, and showed its uneasiness by mewing.

The corona which surrounded the moon was white in colour and glittering, and was most intense at the part nearest to the moon. I saw a certain flame, but I cannot say with confidence; however, there seemed to me to be an elevation of reddish hue in the corona, and a spot of widening figure,* like the following sketch, in situation, form, and relative size.

For the observation of the corona, I used a telescope showing objects in their natural, not inverted position.

Observations by Dr. JOHN BOUSTEDT. (Translation.)

(See Plate V. fig. 9.)

A.M. Weather cloudy, with rain. The wind blew from the S.W. till after the totality, when it fell calm and the day became overcast.

When the moon began to eclipse the sun, there appeared on the left-hand edge of the moon, or that which was before the sun, on the extreme edge, a small dark prominence.

When the eclipse became total, there appeared round the moon a bright white ring, which was even, except that it seemed somewhat rugged and more extended towards the left of its upper part.

Between the left and upper part there appeared, stretching beyond the limb of the moon, and connected with it, two red spots (1); below the middle, on the right-hand side, a longer spot, crooked or hook-formed in shape (2), the upper part of which appeared blue, but the lower part rose-red and fainter in colour at its lower edges; below the last-named, a smaller red

* The account of this flame is so doubtful, that I have not given this gentleman's figure: the position he assigned it was 45° east of the upper point; but he could not say that it might not have been at the opposite side. The part of his account of most interest is that relating to the scent of flowers.—R. C. C.

spot (3), *not connected with the moon's limb*, between which and the spot the white ring [corona light—R. C. C.] surrounding the moon was visible, near the lower part to the right (4); near the upper part a red spot (5). The colour of the spots appeared to * * * nearest the moon's limb.

All the spots, with the exception of No. 2, projected from the moon's limb at right angles, and were of a rounded shape. When the sun's right limb began to appear, at the ceasing of the totality, the above-mentioned spots disappeared.

Centigrade Thermometer.

	Sun.	Shade.
Beginning of Eclipse	+ 25°	+ 19°
At half Eclipse	22	17
At Totality	17	15½
At 4 ^h 15 ^m	19	15
At 4 ^h 45 ^m	18½	16
At the Termination	+ 18	+ 16¼

The sun thermometer was not very trustworthy, and by a comparison with the shade thermometer made beforehand indicated 1°½ higher than it.

The barometer during the totality indicated 27·9 French measure; or 29·6 English measure.

Swallows flew about confusedly during the eclipse. A wagtail remained quiet, and fed its young. Two dogs, one four months old, and one older, lay still during the eclipse, but refused meat that was offered them. Horses were quite quiet. Cows, which were lying down in a meadow at the beginning of the eclipse, continued there while the totality lasted, when they got up and went to the gate to go home.

Remarks by Mr. CARRINGTON on Dr. BOUSTEDT'S Account.

This gentleman, it seems, saw six if not seven flames; two of them at 45° east of the upper limb, which I must have overlooked, and besides these one of a remarkable kind between the two composing the group, to which my entire attention was given. It was not connected with the moon's limb. I saw nothing of this flame; and on the other hand, Dr. BOUSTEDT saw nothing of the bows seen by me, as he told me afterwards.

On being asked if the hooked flame moved or grew, he replied that he could not say, but that its point seemed to wave like a flame in a wind.

GÖTEBORG, or GÖTTENBURG.

Observations by Lieut. C. A. PETTERSSON, Director of the School of Navigation.

I have the honour to communicate to you my observations of the total eclipse of the sun on the 28th of July. The place of observation is the School of Navigation, which is in latitude $57^{\circ} 42' 6''.2$ N. and $0^{\text{h}} 47^{\text{m}} 51^{\text{s}}$ E. of Greenwich.

I employed my small telescope by PISTOR and MARTINS, which has an aperture of 48^{mm} .* The beginning of the eclipse was observed with a power of 68, but for the other phases I used a power of 40, which gave me a field of $1^{\circ} 8'$.

According to the recommendations given in the *Addendum to the Suggestions*, &c. I examined carefully the disc of the sun, some time before the eclipse commenced, in order to discover the spots and faculæ near the limb. I perceived a considerable group of spots surrounded with faculæ towards the western limb, and a single spot with a facula near it, towards the eastern limb. See Plate IV. No. 3.

The beginning of the eclipse was observed at $2^{\text{h}} 53^{\text{m}} 3^{\text{s}}.9$ Göteborg M.T. The portion of the moon which was first projected on the sun, being very much jagged, and, consequently, easily remarked, I consider this observation pretty good.

About 15^{s} before the totality I saw, through my red glass shade, the continuation of the limb of the moon beyond the limb of the sun, both above and below the luminous segment which still remained. I now expected at every moment to see BAILY's beads, or strings, but I saw nothing of the kind. When the last ray of the sun disappeared at $3^{\text{h}} 55^{\text{m}} 58^{\text{s}}.2$ Göteborg M.T.† the dark disc of the moon, which was very dark, and of a greyish brown tint, was instantaneously surrounded with the pale light of the corona. The rays of the corona were apparently directed to the centre of the double disc, and

* Or about 1.9 inches.

† This should, doubtless, be $3^{\text{h}} 55^{\text{m}} 52^{\text{s}}.2$. I think that I gave the signal 1^{s} too late, and conceive that my assistant read the chronometer 5^{s} too forward. The calculated duration is $3^{\text{m}} 16^{\text{s}}$, which cannot be far wrong, as Göteborg is nearly in the central line of the eclipse.

shaded gradually away in the dusky sky. Along that part of the limb of the moon where the sun disappeared there was seen, for a few seconds, a rose-coloured light, which was projected on the white colour of the corona. I saw on the same limb two flames or prominences of a white colour, near together. The smaller was curved and very bright. The other formed an isosceles triangle; the limb of the moon being the base. This flame was not so bright as that first mentioned.

New appearances on the west limb of the moon now attracted my marked attention. Two prominences of a light rose colour, and very brilliant, which gave me the idea of gaseous inflamed matter, sprung up. The smaller soon left the limb of the moon, and floated freely like a cloud in the inner and most luminous portion of the corona, gradually quitting the limb. The other, which was curved towards the former and greatly inclined to the limb, increased as the moon advanced, and finally attained a length which I estimated at 2'.

The relative position of these prominences might lead to a suspicion that they had been originally united, and that some force (such as a wind in the solar atmosphere) had bent and separated them. I saw no motion, except that which was due to the progressive motion of the moon, either in the prominences or in the rays of the corona. The rays of the corona, which somewhat resembled those of the *aurora borealis*, were not all equal in length, and some were more brilliant than the rest. I remarked in the corona some fasciculi rather darker than the general tone. These were perpendicular to the limb. One on the eastern limb especially engaged my attention. They were like openings in the corona.

Five seconds before the end of the total eclipse I perceived on the limb of the moon, just where the sun was about to reappear, an aurora of rose-colour, which formed a base to the great prominence above described. At 3^h 59^m 8^s·2 Göteborg M.T. the first ray of the sun was perceived.

The sky becoming more cloudy as the end of the eclipse approached, it was with difficulty I observed this phase at 4^h 58^m 2^s·6 Göteborg M.T.

I have attempted to represent the phenomena which I saw in the following figures:—

Plate IV. No. 4, represents the moon surrounded by the corona at the middle of the eclipse.

Plate IV. No. 5, represents the prominences and the aurora immediately

before the end of the eclipse. I made sketches of these appearances during the eclipse; the darkness was not so great as to prevent my doing this without much difficulty, although I had no additional light.

It is very remarkable that the flames or prominences on the two limbs seem to correspond exactly, as far as I could judge, with the spots upon the sun. Their connexion is more probable, as spots were not seen at other places on the sun's limb on the days which preceded and followed the eclipse. It is true that I saw on the day following, at two o'clock, a new spot on the east limb, which became visible by the rotation of the sun; but this spot was very near the former one.

During the eclipse, my assistant, M. ESPELUNEL, measured the diameter of the moon with a good sextant by CARY. The mean of these measures gave as the value of the semidiameter $16' 33''\cdot 8$. The value in the *Nautical Almanac*, applying the correction mentioned in the Preface to the volume for 1853, is $16' 41''\cdot 8$. The difference is probably due to errors of observation.

I determined the latitude of the School of Navigation by circum-meridian observations of the sun with an excellent reflexion-circle by PISTOR.

1848.	June 12	Latitude = $57^{\circ} 42' 5''\cdot 2$ N.	8 observations
	13	6' 8	8
	15	6' 2	16
	16	10' 6	8
	17	9' 0	16
	23	9' 0	8
1851.	May 29	2' 4	16
	June 28	3' 9	20
	July 1	6' 8	20
		Mean = $57^{\circ} 42' 6''\cdot 2$	by 120 observations

For the longitude I have the following determinations:—

Occultation of <i>Jupiter</i> , May 19, 1850 (Padua and Altona)	$0^{\text{h}} 47^{\text{m}} 49^{\text{s}}\cdot 34$ W.
Occultation of <i>Aldebaran</i> , Sept. 26, 1850 (Christiania and Breslaw)	$0^{\text{h}} 47^{\text{m}} 54^{\text{s}}\cdot 24$
Mean	$0^{\text{h}} 47^{\text{m}} 51^{\text{s}}\cdot 8$ W.

A chronometer (SÖDERBERG, 266), carried once between Stockholm and Göteborg (time of passage $4^{\text{d}} 9^{\text{h}}\cdot 7$), gives the longitude $0^{\circ} 47' 50''\cdot 6$.

The longitude will be improved when I am able to obtain more corresponding occultations.

Observations by WILLIAM SWAN, Esq., F.R.S.E.

I observed the eclipse from a hill about a mile to the north of Göteborg, situated in latitude $57^{\circ} 42' 58''$ N., longitude $0^{\text{h}} 47^{\text{m}} 45^{\text{s}}.3$ E., in company with Mr. EDWARD W. LANE, Advocate, of Edinburgh, who kindly rendered me his valuable assistance in making the observations for time.

The telescope I used was furnished by Mr. ADIE, of Edinburgh. It has a good object-glass of 2.1 inches aperture and 31.5 inches focal length; and the eye-piece employed in observing the eclipse magnified about 28 times. A dark glass, which was kindly lent me by Professor CHEVALLIER, consisting of a coloured prism achromatised by a prism of colourless glass, slid in a groove before the eye-piece, so as to admit of being instantly removed. This glass made the sun's image appear yellow, slightly tinged with green.

As considerable discrepancies occur in the positions assigned by different observers to the red prominences seen at the eclipse of 1842, I made use of a position-micrometer, devised for the purpose of rapidly determining their places on the sun's limb. A circular plate of metal, 8 inches in diameter, was attached, by a collar passing through its centre, to the sliding tube of the telescope, to which it was firmly clamped, so as not to turn round. This plate was covered with a disc of card on the side next the eye-end of the telescope. Inside the tube carrying the plate, another tube carrying the eye-piece slid smoothly, so as to admit of being freely turned round. The latter tube was furnished with two *springy* arms pointing in opposite directions in front of the plate, like the hands of a clock, and having steel points by which holes could be pricked in the card disc. A small level was attached at right angles to one of these arms, and parallel to the card disc. In the eye-piece were fixed three equidistant parallel spider lines; the outer two being placed at an interval equal to the moon's apparent diameter, calculated for the time of the total phase of the eclipse; so that when the outer wires were made to embrace the moon's disc, the middle wire would pass through its centre. The instrument was adjusted for observation, by causing the middle wire to coincide with a plumb-line, seen at a distance, through the telescope; while, at the same time, the bubble of the level was brought to the middle of its tube by turning the arms, which were then securely clamped to the tube carrying the eye-piece. It is evident that if,

after this adjustment, the bubble was again brought to the middle of the tube, while the outer wires were made to embrace the sun's disc, the middle wire would pass through its vertex; and two holes being pricked in the card, the line joining them would represent the sun's vertical diameter at the time of observation. If next, while the sun was still kept between the outer wires, the middle wire was made to bisect any object at its limb, and holes were again pricked in the card, the angle between the lines joining the respective pairs of holes would measure the angular distance of the object from the sun's vertex. In this manner, the positions of the red prominences, seen during the total phase of the eclipse, admitted of being rapidly registered on the card without ever removing the eye from the telescope.

The observations of time were made by means of a box-chronometer by ADAMS of London, obligingly furnished by Lieutenant C. A. PETERSSON, of the Navigation School of Göteborg. It was compared with his standard chronometer about 3^h 15^m before the commencement of the eclipse, and again on the following day after an interval of 24 hours.

The weather, which had a very unfavourable aspect, improved rapidly before the commencement of the eclipse. An extremely thin cirrus cloud, however, continued to overspread the sky; but this did not sensibly impair the definition of the sun, which was remarkably good, until some time after the total phase, when the sky became more thickly clouded.

During the progress of the eclipse the cusps continued quite sharp, until the sun was reduced to an extremely narrow crescent of 90° or less, when they were sensibly rounded. This appearance became more and more decided, until, at length, the moon's limb was quickly joined to that of the sun by numerous thick lines, which occupied nearly all the remaining crescent of the sun. The spaces between the lines were at first rudely rectangular, but gradually became rounded, so as to resemble a string of bright beads, after which they finally disappeared. The same phenomena were seen in a reverse order after the total phase; but the beads were not so numerous as before.

The moment BAILY's beads were gone, I looked at the sun with the naked eye, and saw the corona already fully formed. The darkness at first seemed very great, owing to the contrast of the recent sunshine; and Mr. LANE found it necessary to use a candle in reading the chronometer. The horizon, chiefly towards the north, was filled with light of a magnificent orange-yellow, or amber colour, by which I had no difficulty in writing down the

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time of the commencement of the totality. It was a ghastly spectacle to behold a black sun, surrounded by a pallid halo of light, and suspended in a sky of sombre leaden hue; and there was so much to observe in the effects of the eclipse on the appearance of the landscape, that, probably, about 15^s elapsed before I looked again through the telescope, having previously removed the dark glass. The first object that attracted my attention was a remarkable hook-shaped red prominence, situated $110^{\circ} 30'$ to the west of the sun's vertex; and immediately afterwards I saw another red prominence with a serrated top, resembling a chain of peaked mountains, which was situated a little below the first, at $132^{\circ} 40'$ to the west of the sun's vertex. At the risk of offering what may be deemed a whimsical comparison, I can best describe the form of the hook-shaped prominence, by saying it resembled the Eddystone or Bell Rock lighthouse transferred to the sun, with its top beginning to fuse, and bend over like a rod of half-melted glass.*

The prominences increased very sensibly in height, during the progress of the total phase, until at length the hook-shaped one had attained an altitude which I estimated at more than 2' of space. Both had remarkably definite outlines, and their forms were permanent so long as they remained visible; the only change being that they increased in height, and became wider at the base, evidently owing to the moon's motion gradually disclosing those parts of them which were nearest the sun's limb. They were of a full rose-tint, and were distinctly visible to the naked eye by the strong red tinge they imparted to the corona in their neighbourhood.

The corona cast no sensible shadow. To the naked eye it appeared slightly tinged with pale purple or lavender-colour, which, perhaps, was owing to the contrast of the strong yellow light in the horizon, for when viewed through the telescope it was silvery white. It was distinctly radiated, and showed no trace of annular structure. The most striking feature it presented was the appearance of brilliant beams of light, which shone out in various directions. They were sharply defined, and brighter than the rest of the corona; and they were visible to some distance beyond its general outline. The most remarkable of these objects was a mass of light of a tolerably regular conoidal form, with its base towards the sun, and the cur-

* The calculated angles of position from the sun's north point are, for the hook-shaped prominence $282^{\circ} 8'$, and for the serrated prominence $259^{\circ} 58'$. The hook-shaped prominence, as seen by me, closely resembled Mr. DAWES' figure in the *Royal Ast. Soc. Notice for Jan. 1852*, but seemed rather more slender towards the top.

Total Eclipse of the Sun on July 28, 1851.

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vature of its sides somewhat concave outwards, situated $28^{\circ} 30'$ to the east of the sun's vertex.

The first of the following tables contains the observations, by means of the position-micrometer, of the red prominences, and of the only spots visible near the sun's limb on the day of the eclipse, with the times of observation; the second, the times of the different phases of the eclipse; and the third, a series of thermometrical observations. The latter were made by means of two small but very accurate thermometers, by ADIE of Edinburgh, which were suspended in the shade.

Object Observed.	Time of Observation. Göteborg Mean Time.	Angle from Sun's Vertex.
Group of Spots $1'5$ from Sun's Limb....	^h ^m 1 37	$96^{\circ} 30'$ West.
Single Spot $1'$ from Sun's Limb.....	1 40	62° East.
Hook-shaped Red Prominence	About 3 58	$110^{\circ} 30'$ West.
Serrated Red Prominence	About 3 58	$132^{\circ} 40'$ West.
Bright Rays in Corona	About 3 58	$28^{\circ} 30'$ East.

Observed by MESSRS. SWAN and LANE. Latitude, $57^{\circ} 42' 58''$ N. Longitude, $14^{\circ} 47' 45''$ E.		
Object Observed.	Göteborg M. T.	Remarks.
Commencement of Eclipse	^h ^m ^s 2 53 4.4	About 2 ^s too late.
Beginning of Totality	3 55 52.6	
End of Totality	3 59 8.1	Possibly too late.
End of Eclipse.....	4 57 57.8	

Göteborg M. T.	Dry Thermom.	Wet Thermom.	Göteborg M. T.	Dry Thermom.	Wet Thermom.
^h ^m 2 45	66°	60°	^h ^m 4 10	57°	55°
3 0	64	59	4 30	58.5	56
3 15	62	57.5	4 45	60	57
3 30	61	56.6	4 55	62.3	59.5
3 45	60	57	5 5	62	58.5
3 50	57.8	55.5	5 30	61	57.5

Observations by the Rev. TEMPLE CHEVALLIER.

I observed the eclipse from a platform, 45 feet above the ground, at the top of the Gotha Kellare Hotel, in Göttenburg. This station is about $2\frac{1}{2}$ English miles N.W. of the hill where the observations of the Astronomer Royal were made. It commands an extensive horizon in all directions. The telescope which I employed was presented by the late Duke of NORTHUMBERLAND to the Durham Observatory. It was made by Ross; has an aperture of 5 inches and a focal length of 7 feet 2 inches. It was mounted equatorially upon a temporary stand, which was sufficiently steady in itself; but the wind, which blew strongly from W.S.W. during the eclipse, was occasionally troublesome. The power employed was about 180. The darkened glass, made by SIMMS, was a wedge of red glass, combined with colourless glass, in the manner recommended in the *Suggestions, c, b*. A diaphragm to limit the aperture of the object-glass was employed for the first half-hour after the beginning of the eclipse, and then removed. In the field of view were two parallel wires subtending an angle of $48''$.

The weather, which was unpropitious in the morning, became favourable a little before the beginning of the eclipse.

The moon was first observed at $2^h 53^m 54^s.1$ Göttenburg mean time, when it had already advanced sensibly upon the sun's disc; and at $2^h 55^m 7^s.1$ the moon eclipsed the darkest part of a spot upon the north-western edge of the sun.

When the moon was further advanced, two very marked prominences, the summits of which subtended about $50''$, were observed upon the moon's edge; and at $3^h 29^m 30^s$ they were about $1' 36''$ south of the middle of the moon's advancing limb. There were two much smaller roughnesses north of those prominences.

During this part of the eclipse the sky was in many parts clear. At $3^h 3^m$ there was a light haze over the sun, and towards the south. This haze never entirely disappeared, and increased so as totally to obscure the sun before the termination of the eclipse.

When the sun was about two-thirds eclipsed, I carefully compared the

light of the different parts, and estimated that the light near the middle of the disc was to the light near the edge in the proportion of 3 to 2.

At $3^{\text{h}} 44^{\text{m}} 30^{\text{s}}$ the general light was sensibly diminished; shadows became dim; and the whole surrounding landscape had a strange, awful appearance. At $3^{\text{h}} 49^{\text{m}}$ the darkness was still greater. The haze about the sun assumed an inky hue, and streaks seemed to be formed in it. At $3^{\text{h}} 52^{\text{m}} 28^{\text{s}}$ an arc of about 45° of a coloured halo was formed above the sun; but almost immediately vanished.

Just before the total phase, the moon eclipsed a spot upon the north-eastern edge of the sun, at $3^{\text{h}} 55^{\text{m}} 7^{\text{s}}.9$.

As the field of view in the telescope was too small to take in the whole uneclipsed portion of the sun, I directed my attention particularly to the upper cusp. Its extremity appeared nearly sharp; but the light was there less bright than in the other parts; and the whole cusp was in appearance more like a liquid than a solid. As the cusp became narrower, the light had a fluctuating motion, and seemed to fail by running along the sun's edge, trickling away like drops of quicksilver down a narrow groove, so as partially to interrupt the continuity of the rim of light, but not so as to form any fixed bands of alternate light and darkness.

The total obscuration was noted at $3^{\text{h}} 55^{\text{m}} 54^{\text{s}}.9$.

At this instant it was impossible not to take the eye from the telescope to look round upon the astonishing spectacle. The moon appeared as a black spot, surrounded by its luminous corona, the radius of which was about a sixth part greater than the radius of the moon. The sky about the moon was of a purple hue, but towards the north and south, near the horizon, of a clear deep red colour, of a more uniform tinge than the usual twilight. I saw *Venus* conspicuously bright, so as instantly to catch the eye; but I did not look for *Mercury*, which, however, was seen by others to the left of the moon, as well as *Jupiter* near the meridian. I was told also that *Regulus* was seen. The hills, from six to ten English miles distant, were distinctly visible; and during the whole time of total obscuration the figures on the face of the chronometer could be seen, and pencil-writing could be read.

During the progress of the eclipse, the usual noise accompanying the occupations of a busy town had prevailed. Especially a number of men, engaged in driving piles, accompanied their labour in hoisting the rammer with a musical chant. But at the instant of total darkness all this was

changed to a dead silence, which continued till the reappearance of the sun. The cocks began to crow a little before the sun was obscured, were silent during the darkness, and began to crow again as the light reappeared.

By leaving the telescope for a few seconds, I had lost the opportunity of observing, as I had intended, the advancing portion of the moon's edge immediately after the obscuration of the sun; and I then brought into the field of view the opposite side of the moon, from which the sun would emerge, and observed in that portion of the disc three bright prominences (Plate IV. No. 6). That which was near the lowest part of the moon's disc was a pink protuberance, the base of which was about half a minute wide, rising to a single-peaked ridge about half as high as the base. The form of this changed but little. The two others, to the left of this, were much higher and larger in extent. They rose each from a narrow base and with a waving outline, extending in the upper part into a long flag-like position, tinged at the edge with a delicate pink colour, brighter than that of the other parts. Their appearance was that of brilliantly illuminated clouds, at a great height in the atmosphere after sunset, stretching away horizontally and forming a continuous substance, but of great tenuity. The resemblance to clouds was so exact, that I examined carefully whether the appearance did not arise from illumination of the slight haze surrounding the sun. But careful inspection convinced me that the objects were certainly connected with the sun; for the separation of the edge of the moon from them, as she moved onwards, could be distinctly seen. About a minute before the end of total darkness, I estimated the height of this portion of the protuberance from the sun to be one and a-half times the width of the wires, or $1' 12''$. As the eclipse advanced, the light from behind the moon became like the brightest twilight, rising higher and higher above the moon's surface, and forming a brilliant red edge until it was effaced by the reappearance of the sun's dazzling white light.

I omitted to notice the manner in which the light extended itself along the cusp of the sun at the end of the total darkness. Soon after the end of the total phase the haze over the sun increased in density, and obscured the sun before the end of the eclipse.

I was indebted to Lieut. PETERSSON, Superintendent of the Navigation School, for a box-chronometer, compared with the standard chronometer at his observatory before and after the eclipse; and also for sending one of the

students of the school to note the time. The times so noted, corrected for the error and rate of the chronometer, are those given above; but as this was the first occasion on which the student had been so employed, the results are not entitled to the same weight as if the time had been noted by a practised observer.

In order to form some judgment of the degree of light during the total obscuration, I requested a gentleman present to endeavour to find at what distance from a screen a wax taper in a lantern should be held, so that any shadow thrown by the corona should be equal in intensity to the shadow thrown by the taper. The corona cast no sensible shadow; but the general light of the sky was sufficient to render the shadow cast by the taper imperceptible when the taper was 193 inches from the screen.

On the 3d of November, 1851, when the moon was ten days old, one hour past the meridian, and shining very brightly, at 9^h 30^m P.M., I found that the same taper, in the same lantern, 152 inches from a screen, cast a shadow equal in intensity to that cast by the moon. When the taper was removed to 576 inches, the shadow was extremely faint; but, with great attention, it could be discerned until the taper was removed to 828 inches.

These experiments are evidently not susceptible of much accuracy, especially as the two comparisons were made by different persons; but the result seems to show that the light of the sky during the total eclipse was considerably brighter than that of ordinary moonlight.

I subjoin some notes of the eclipse taken by an observer who was with me:—

The telescope was a clearly-defining astronomical telescope, with an aperture of an inch and a-half, and 18 inches focal length, magnifying about ten times.

“Light, fleecy, white clouds covered the face of the sun, from the time of the beginning of the eclipse till after the totality. When the sun was half eclipsed, the lights and shadows began to weaken, and the colour of the sky and landscape to fade, but all uniformly. As the sun became more hidden, I could see nothing of the dark part of the moon, nor any spots upon the moon.

“As the sun disappeared I saw four black bands, so distinct and sta-

tionary that I could at the time note which appeared first, and which next, and number them. (Plate IV. No. 6.) The instant it became dark, the corona was there; how it was formed I could not see. It was of a pale yellowish colour; a bright ring about one-seventh of the moon's diameter nearest the moon, and light rays of the same colour, branching out all round beyond, to rather more than half the moon's diameter (Plate VI. No. 2.) The limit of the brightest part was distinct; but the rays faded away so as to leave no definite edge to the outer part of it. There was a very bright part where the sun had just disappeared, and a darker part where the sun afterwards appeared. The corona was of the same breadth all round. I could examine it very well without a glass of any kind; but there was light enough to enable me to read pencil notes without any difficulty, the paper being laid on the table at which I was sitting. *Venus* and *Mercury* were quite bright. I saw no stars. The whole of the sky and landscape were covered with a deep yellow light; and the horizon was lighted with a bright deep red, especially in the north-west and south-east. Everything was very still. Cocks had begun to crow before, and dogs to bark; but they were quiet during the darkness, and began again when the light reappeared. The whole town was silent during the darkness.

“When I looked through the telescope again, the corona was quite visible through a coloured glass. I watched it where the sun was to appear. A bright red prominence was first seen, which developed itself into the limb of the sun, and became barred across with distinct black beads, or, more correctly, straight black bars. (Plate VI. No. 3.) The prominence was narrow when it first appeared, and became wider as more came out; and I took it to be a portion of the sun coming out before the rest. The black bars on the contrary, as the sun reappeared, became narrower, finally leaving their hold altogether; and the sun was clear of the moon, and the moon's edge quite even. The only thing I can compare it to is a thin piece of India rubber when it is torn in two, and little pieces of it give way before the rest. The edge of the sun had a totally different appearance in coming out and in going in. Then, it was a definite smooth portion of a circle; now, one part appeared first, then a little bit somewhere else; and it seemed to be two seconds before it assumed the appearance of a limb intersected by bars, and three seconds more before the bars quite disappeared. As soon as the

sun came out the corona was gone, I could not tell in what manner. When the light came back, everything appeared to waken into life; and the noises in the town and country began again to be heard.

“Distant objects and the outlines of hills were quite visible during the darkness.”

RÆVELSBERG near ENGELHOLM.

Observations by JOHN RUSSELL HIND, Esq.

Mr. BISHOP, with his usual zeal for the progress of astronomical science, having expressed a wish that his observatory should contribute either directly or indirectly to the accumulation of facts connected with the phenomena of the total eclipse, and having proposed to me a journey to the zone of totality, I proceeded to the southern part of Sweden, in company with my friend the Rev. W. R. DAWES, about the middle of July. As we agreed that our observations should be entirely independent, I confine my remarks to those appearances which presented themselves to my own eye.

The observations were taken at a small village called Rævelsberg, one mile north of the town of Engelholm, in Sweden, and about 200 yards from the high road to Laholm, Rævelsberg church lying south of our station, and the promontory known as Kullen Point, with the intervening bay of Engelholm, about W.S.W. I employed a telescope by DOLLOND, of $1\frac{1}{2}$ inch aperture, with a magnifying power of about 20; the definition of the limbs in this excellent little instrument was extremely good, and I question whether a larger telescope would have enabled me to see more during the short time the sun was obscured, considering that the wind was blowing briskly at the time, and a more cumbrous mounting than that I used would have been required for a larger instrument. The day was fine until ten minutes after the reappearance of the sun, when clouds rapidly overspread the sky, and would have prevented an observation of the end of the eclipse had it been our intention to wait for it; but having occasion to cross the Sound before dusk, we were on our way to Helsingborg before the termination of the partial phase.

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The first contact of the limbs took place at $3^{\text{h}} 0^{\text{m}} 18^{\text{s}}$ mean time at the station; but this is merely approximate, as observations of the times of contact formed no part of our proposed plan. During the progress of the eclipse I looked repeatedly for any appearance of light or colour upon the moon's surface. For thirty minutes nothing of the kind was perceptible, but at $3^{\text{h}} 40^{\text{m}}$ her surface appeared of a dull coppery red, and the outline of her disc could be traced by the contrast of this ruddy tinge with the neutral tint of the field of the telescope. When about two-thirds of the sun's disc were covered, I thought I could distinguish two faint rays of light, shooting off as tangents to the moon's limb at the cusps, and on removing my eye from the telescope for a few seconds, and again applying it, the same appearance presented itself, but was not visible more than one minute. No spots could be discovered upon the moon's surface, though I looked frequently and attentively. Her limb was exceedingly rough, from the numerous mountains near the edge of her disc; one gap near the southern cusp being quite conspicuous at $3^{\text{h}} 51^{\text{m}}$ local time: the definition was excellent throughout.

Shortly before the commencement of totality, a large mountain close to the south cusp suddenly appeared to shoot forward and connect itself with the sun's limb, leaving a very small lunular portion of his disc visible; south of the bright crescent, a few seconds later, the same appearance was noticed in respect to other irregularities on the moon's limb, and *BAILY's beads* were formed. The only remaining portion of the sun's illuminated disc presented something of the appearance of a string of luminous beads, *but of irregular size and shape*, the largest corresponding to the gap or valley near the south cusp already mentioned. It was impossible, in viewing this phenomenon under the most admirable sharpness of definition I ever witnessed, to avoid the conclusion that BAILY's beads are caused by the sun's shining along the valleys and between the mountain ridges near the limb of our satellite, the effect being greatly exaggerated by irradiation.

Owing to my attention having been arrested by the unexpected distinctness of the beads, I omitted to remove the dark glass for a few seconds after the sun had gone out, and, consequently, did not witness the sudden appearance of the corona. On looking without the dark glass, five seconds after the commencement of totality, this luminous ring was conspicuous. Its colour was pretty nearly that of tarnished silver, but this might be attributed

to the intervention of an excessively thin cloud, without which the corona would probably have appeared perfectly white. It was brightest near the moon's limb, and thence gradually faded in brilliancy to a distance equal to one-third of her diameter, where it was lost in the general ground colour of the heavens. Rays of light, of a paler colour than the corona itself, streamed off in several directions from the moon's limb and extended beyond the limits of the luminous ring. The light of the corona seemed to flicker, but I noticed nothing at all resembling circular motion. The corona was visible *on the western side* at least five seconds after the reappearance of the sun.

On first viewing the sun without the dark glass, after the commencement of totality, three rose-coloured prominences immediately caught my eye, and others were seen a few seconds later. (See Plate VI., No. 4.) The largest and most remarkable of them was situate about 5° north of the parallel of declination, on the western limb of the moon: it was straight throughout two-thirds of its length, but curved like a sabre near the extremity, the concave edge being towards the horizon. The edges were of a full rose-pink, the central parts paler, though still pink. Twenty seconds, or thereabouts, after the disappearance of the sun, I estimated its length at $45''$ of arc, and on attentively watching it towards the end of totality I saw it materially lengthened (probably to $2'$), the moon having apparently left more and more of it visible as she travelled across the sun. It was always curved, and I did not remark any change of form, nor the slightest motion during the time the sun was hidden. I saw this extraordinary prominence *four seconds after the end of totality*, but at this time it appeared detached from the sun's limb, the strong white light of the corona intervening between the limb and the base of the prominence.

About ten degrees south of the above object I saw, during the totality, a detached triangular spot of the same rose colour, suspended as it were in the light of the corona, which gradually receded from the moon's dark limb as she moved onwards, and was therefore clearly connected with the sun. Its form and position with respect to the larger prominence continued exactly the same as long as I observed it. On the south limb of the moon appeared a long range of rose-coloured flames, which seemed to be affected with a tremulous motion, though not to any great extent. The bright rose-red of the tops of these projections gradually faded towards their bases, and along the moon's limb appeared a bright narrow line of a deep violet tint: not far

from the western extremity of this long range of red flames there was an isolated prominence, about $40''$ in altitude, and another of similar size and form at an angle of 145° from the north towards the east. My attention being mainly confined to the curved flame and the neighbouring detached spot, I cannot state from observation whether the others altered their apparent magnitudes in the same way as the moon passed over the sun.

The surface of the moon was decidedly reddish purple at the beginning of totality, but the reddish tinge disappeared before its termination, and the disc assumed a dull purple colour. A bright glow like that of twilight indicated the position where the sun was about to emerge, and three or four seconds later the beads again formed; this time instantaneously, but less numerous and even more irregular than before. In five seconds more the sun reappeared as a very fine crescent, on the sudden extinction of the beads. Ten minutes after the end of the total eclipse clouds began to form about the sun, and very quickly spread over the sky.

I noticed a sensible diminution of daylight twelve minutes after the commencement of the eclipse. It was especially remarked about the sea and mountains of Kullen Point. At $3^h 30^m$ the distant landscape assumed a misty appearance. At $3^h 40^m$ the diminution of light was very decided; every object looked misty. The sea had a dull, gloomy aspect. At $3^h 49^m$ objects north of us appeared as though they were illuminated by a vivid flash of lightning, or by the electrical light: the air felt chilly, and the horizon in every direction seemed to have closed in upon us. The sky, where clear, had gradually changed from an azure blue to a deep violet. Five minutes before the totality the whole landscape appeared gloomy and unnatural, the sky was intensely blue, and the air strikingly damp and chilly. My eye being applied to the telescope from this time until after the sun had gone out, I saw nothing more of the effects upon the earth and its atmosphere until about 25^s after totality had commenced; but on glancing round for a few seconds I found, that in the short interval which had elapsed since my previous view the whole aspect of nature had changed in a most remarkable degree. The southern heavens were now of a deep sombre purple, or purplish grey; the corona, of course, distinct to the naked eye, but by no means brilliant: in the zenith and northwards the sky appeared as though it had closed in upon us, and was of an intense violet colour, which gradually deepened towards the horizon into a dull purple. From W.N.W. to

N.N.W., and then after a short break from N. to about E.N.E., the sky was occupied to an altitude of perhaps 20° with bands of light of a deep orange red, the spaces intervening between the bands appearing of the brightest purple hue, and completing the most astonishing and appalling phenomenon that it is possible to imagine. The darkness was not like that of night; the landscape seemed to be overspread with a dark olive tint; and yet I think objects were visible at a greater distance than they would be under the same degree of darkness in the evening. On the reappearance of the sun I noticed, as one of the most curious effects of the eclipse, the gradual brightening up of the country in the north, and the rapid retreat of the dark olive shadow before the approaching sunlight.

The accompanying roughly-executed sketch (Plate VI., No. 4), may afford a better idea than words can do of the appearance of the red flames to my eye. As it is merely intended to show the relative positions of these remarkable prominences, I have not attempted to make it a picture of the total eclipse by introducing the corona.

The position of my observing station was about $56^{\circ} 55' 3''$ N. latitude, and in longitude $12^{\circ} 52' 4''$ E. of Greenwich.

Observations by the Rev. W. R. DAWES.

The place of observation, to which, in company with Mr. HIND, I had proceeded in the earlier part of July 28, was a slightly elevated portion of a field, distant by estimation some four or five hundred yards to the N.N.E. from the church of Rævelsberg, and about two hundred yards to the east of the high road from Engelholm to Laholm; being, therefore, about one English mile from Engelholm to the north-east. An extensive prospect was visible from this spot. To the west lay the bay of Engelholm, called Skelder Wik, bounded on the south-west by the promontory, at whose extremity stands the Kullen, or Kolaberg,—a bare hill of considerable elevation and bold outline. To the north and east stretched a long range of hills, whose distance probably varied from ten to fifteen miles, the whole of the intervening plain being in view. To the south the horizon was formed by the

wooded heights beyond Engelholm, and to the south-west at a smaller distance by the village of Rævelsberg.

Having agreed with Mr. HIND that we would make and record our observations without any communication with each other, I shall confine myself entirely to the statement of the phenomena which presented themselves to my own eye.

Believing that a telescope of moderate size, and an eye-piece of rather small magnifying power, having a large and distinct field, would be the most suitable for satisfactorily displaying all the principal phenomena, I employed an excellent achromatic by DOLLOND, whose aperture is 1.6 inch, and focal length 20.2 inches. The eye-piece principally employed magnifies twenty-nine times, and has a field of about $1^{\circ} 36'$, which is pretty distinct to its circumference. This telescope was mounted on a floor-stand, having a small table as a stretcher of its legs, surmounted by a stout brass plate, to which is firmly attached a socket at an angle of about $56^{\circ} 20'$, and, therefore, producing in the latitude of the place of observation an approximate equatoreal motion when the plate was levelled and its position rectified in azimuth. This mounting proved to be very steady and convenient.

The eye-piece above mentioned, magnifying twenty-nine times, was furnished with two very stout spider's lines, crossing at right angles in the centre of the field; and also with a wire, parallel to one of them, considerably removed from the centre, whose thickness subtended an angle of about one minute (subsequently ascertained to be $58''$) on this telescope, intended as a rough scale, with which any small object observed during the eclipse might be compared. Other eye-pieces were provided, magnifying from 18 to 132 times; and all were furnished with *sliding* adapters, that they might be changed with the utmost rapidity. A sliding frame, carrying eight pieces of glass, each of which was of a different shade of neutral tint, was applicable to all the eye-pieces. Several loose discs of neutral tint glass were also at hand, to be used, if required, instead of the sliding frame.

Previously to the commencement of the eclipse, the lines in the wired eye-piece were adjusted to an equatoreal and polar direction by making a spot on the sun travel along one of them; and this process was repeated when, after the use of other powers, the wired eye-piece was again applied.

The solar spots were very few on the day of the eclipse. One small group was a minute or two of arc from the western edge in the north-western

quadrant; and a single spot, of small size and symmetrical form, was very near the eastern edge, at about 88° from the north point of the sun's circumference. No others were seen worthy of notice.

The commencement of the eclipse was excellently observed with the power 29; but as observations of time were not contemplated, the error of the watch had been only approximately determined. The local mean time of commencement was supposed to be about $3^{\text{h}} 0^{\text{m}} 16^{\text{s}}$.

The portion of the moon's limb which was advancing on the sun was found to be extremely uneven; and one remarkably large mountain was situated about 15° of the moon's circumference to the south of the point which made the first impression on the sun's border. The whole of the moon's limb was carefully and repeatedly scrutinised with high magnifying powers, in order to fix upon my mind the positions of its principal projections.

At $3^{\text{h}} 40^{\text{m}}$ local mean time the light had very obviously diminished.

At $3^{\text{h}} 43^{\text{m}}$ the southern cusp was a little blunted by a lunar mountain.

At $3^{\text{h}} 52^{\text{m}}$ objects began to look *purplish*. The hills appeared near and peculiarly distinct, as they often do, especially in the evening, when the sky is heavily overcast before rain, but more purple. The countenances of persons near looked livid.

At $3^{\text{h}} 54^{\text{m}}$ the sky near the sun began to be covered with a thin hazy cloud; yet the limbs of the sun and moon continued to be well defined in the telescope, especially that of the moon. The air felt chilly. A thermometer, which before the eclipse began had stood at 82° in the sun, now stood at 63° . This difference is, no doubt, partly to be attributed to the thin cloud, which might probably have produced a decrease of 5° in the solar heat if there had been no eclipse.

At $4^{\text{h}} 1^{\text{m}}$ the light in the field of the telescope was remarkably blue.

During the whole eclipse, up to within a few minutes of the totality, the edge of the moon, both on and off the sun's disc, was very carefully examined to ascertain if it were at all illuminated. For this purpose various magnifying powers were used, and different shades of neutral tint, up to the lightest which my eye would bear. While these examinations were made, *the sun was placed just outside of the field*, and the focus of each eye-piece was nicely adjusted to distinct vision near the circumference of the field. *No illumination of the moon's limb was ever perceived.* At one time I thought there was

some appearance of its outline just off the northern portion of the sun's disc, but, on altering the position of the objects in the field, the appearance also varied; proving that it arose from some reflexion of the sun's light from one of the eye-glasses. The sun was at that time in the field; but when it was excluded, no such appearance presented itself. As the eclipse advanced towards the total obscuration, a thin hazy cloud covered the sun, and caused a slight diffusion of light around it; but its colour and appearance on the moon in no way differed from what it was on the sky at an equal distance from the sun's edge.

Within about five minutes of the total obscuration, I adjusted the focus of the eye-piece (power 29) with great care on the edge of the moon, noting particularly its prominences, which were sharply defined, notwithstanding the haze which covered that part of the sky. About one minute before the disappearance of the sun, a portion, perhaps $1\frac{1}{2}$ minute of arc in length, was separated from the rest of the very narrow crescent at its southern extremity by the protrusion of a remarkably large mountain on the moon's border. In a few seconds afterwards, a very small piece at the point of the same cusp was separated from the portion already cut off.

About three or four seconds before the totality, the fine crescent was broken up into several pieces, or "beads," eight or ten in number; but they did not all appear at the same instant: they were not round, and were very unequal in length; *the dark intervals between the bright portions corresponding exactly with the positions of the mountains on the moon's edge, and evidently caused by them.* These intervals were largest towards the southern extremity of the crescent. I was particularly struck with the fact, that the lunar mountains broke through the crescent while it yet appeared to be considerably broader than the extent of their own projection beyond the general outline of the moon's circumference. This was very observable in the case of the largest of them, which divided the crescent so long before it seemed capable of doing so, as to take me quite by surprise. The lunar mountains had thus the appearance of being *drawn out into narrow black threads*, reaching to the exterior edge of the sun. This curious phenomenon I attributed, on subsequent reflection, to the effect of *irradiation*, increasing the apparent breadth of the narrow crescent, and, consequently, increasing to the same extent the apparent length of the prominences which broke through it.

Within a minute or two of the totality, the sliding frame of dark glasses was withdrawn, and a glass of light neutral tint was held in my hand. At the time of the breaking up of the last visible portion of the sun, this glass was laid aside, and the phenomena of the "beads" and the formation of the corona were viewed through the telescope with the undefended eye.

I was so intent upon the phenomena of the disappearance that I did not notice whether the corona was at all visible on the opposite side before the total extinction occurred. The corona did not appear to me to be formed *instantaneously* on the disappearance of the sun. About one second, or a second and a half, elapsed before I received the impression of the full brightness of the corona. It seems very probable that this may have arisen from my having viewed the formation of the "beads" without a dark glass, by which my eye may have been disqualified for the immediate perception of a light so comparatively feeble as that of the corona. When fully seen, I thought it was both brightest and broadest at the part where the sun disappeared; and that throughout the duration of darkness it was decidedly brighter at the southern edge of the moon than at the northern, giving me the impression that it was concentric with the sun, rather than with the moon. Its extreme breadth I estimated at half the diameter of the moon; about one-third of its breadth next to the moon's edge being much brighter than the part more distant, which faded away rapidly. The constitution of the corona seemed to be somewhat flocculent, but it was not annular, nor interrupted by radii except towards its border, beyond which rays of light extended to the edge of the field of the telescope, being a distance in angular measure of above thirty-two minutes from the sun's circumference.

A large card, on which was inscribed a circle roughly divided into arcs of five degrees each, was held in my hand, ready for marking upon it with a pencil the approximate positions of any remarkable protuberances or other phenomena, which might present themselves round the circumference of the moon during the total obscuration.

The thick spider's lines in the eye-piece being visible on the corona enabled me to estimate with considerable precision the positions of the various phenomena.

Commencing at the north point of the moon's circumference, as seen projected on the corona, and proceeding round it by the eastern side (the

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right-hand side in the inverting telescope), the phenomena observed were as follows. (See Plate VI. No. 5.)

Throughout the whole of the quadrant from north to east there was no visible protuberance, the corona being uniform and uninterrupted. Between the east and south points, and at an angle of about 115° from the north point, appeared a large red prominence of a very regular conical form. When first seen it might be about $1\frac{1}{2}$ in altitude from the edge of the moon; but its length diminished as the moon advanced. The position of this protuberance may be inaccurate to a few degrees, being more hastily noticed than the others. It was of a deep rose colour, and rather paler near the middle than at the edges.

Proceeding southward, at about 145° from the north point, commenced a low ridge of red prominences, resembling in outline the tops of a very irregular range of hills. The highest of these probably did not exceed $40''$. This ridge extended through 50° or 55° , and reached therefore to about 197° from the north point, its base being throughout formed by the sharply-defined edge of the moon. The irregularities at the top of the ridge seemed to be permanent, but they certainly appeared to undulate from the west towards the east: probably an atmospheric phenomenon, as the wind was in the west.

At about 220° commenced another low ridge of the same character, and extending to about 250° , less elevated than the other, and also less irregular in outline, except that at about 225° a very remarkable protuberance arose from it to an altitude of one minute and a half or more. The tint of the low ridge was a rather pale pink; the colour of the more elevated prominence was decidedly deeper, and its brightness much more vivid. In form it resembled a *dog's tusk*, the convex side being northwards and the concave to the south. The apex was somewhat acute. This protuberance and the low ridge connected with it were observed and estimated in height towards the end of the totality.

A small double-pointed prominence was noticed at about 255° , and another low one with a broad base at about 263° . These were also of the same rose-coloured tint, but rather paler than the large one at 225° .

Almost directly preceding, or at 270° , appeared a bluntly triangular pink body, *suspended*, as it were, in the corona. This was separated from the moon's edge when first seen, and the separation increased as the moon advanced.

It had the appearance of a large conical protuberance, whose base was hidden by some intervening soft and ill-defined substance, like the upper part of a conical mountain, the lower portion of which was obscured by clouds or thick mist. I think the apex of this object must have been at least one minute in altitude from the moon's limb when first seen, and more than one minute and a half towards the end of total obscuration. Its colour was pink, and I thought it paler in the middle.

To the north of this, at about 280° or 285° , appeared the most wonderful phenomenon of the whole. A red protuberance, of vivid brightness and very deep tint, arose to a height of perhaps one minute and a half when first seen, and increased in length to two minutes or more as the moon's progress revealed it more completely. In shape it somewhat resembled a *Turkish cimeter*, the northern edge being convex and the southern concave. Towards the apex it bent suddenly to the south, or upwards as seen in the telescope. Its northern edge was well defined, and of a deeper colour than the rest, especially towards its base. I should call it a *rich carmine*. The southern edge was less distinctly defined, and decidedly paler. It gave me the impression of a somewhat conical protuberance, partly hidden on its southern side by some intervening substance of a soft or flocculent character. The apex of this protuberance was paler than the base, and of a purplish tinge; and it certainly had a flickering motion. Its base was from first to last sharply bounded by the edge of the moon. To my great astonishment, this marvellous object *continued visible for about five seconds*, as nearly as I could judge, *after the sun began to reappear*, which took place many degrees to the south of the situation it occupied on the moon's circumference. It then rapidly faded away, but *it did not vanish instantaneously*. From its extraordinary size, curious form, deep colour, and vivid brightness, this protuberance absorbed much of my attention; and I am therefore unable to state precisely what changes occurred in the other phenomena towards the end of the total obscuration.

The arc from about 283° to the north point was entirely free from prominences, and also from any roseate tint.

Some indulgence must be craved for the estimations I have given of the length of the different protuberances. The difficulty of forming a correct estimate adapted to any particular instant during the obscuration was greatly increased by the *variation*, both of their actual and comparative lengths,

arising from the moon's motion ; as it was obviously impossible to estimate them all at the same moment of time.

The colour of the moon during the totality was a purplish black. No striking variations of light were observed upon its surface ; but there was so much of a more imposing character to notice during the brief continuance of total darkness, that there was no time to spare for scrutinising the moon's disc.

Immediately after the sun's reappearance the thermometer stood at 57° . The air felt chilly and damp ; and a mist of considerable density was found to have arisen, obscuring the valley and the bases of the distant hills. This did not subsequently clear away ; the sun became densely clouded, so that the termination of the eclipse could not be observed ; and the whole character of the day was completely changed.

At the beginning of the eclipse there was a light breeze from the west, which gradually died away as the eclipse advanced, and about the middle of it there was nearly a calm.

During the total obscuration the colour of the heavens to the south, the east, and the west, was a deep purplish grey, extending considerably to the north of the zenith. But within about 50° of the horizon to the north-west, north, and north-east, the sky, where free from clouds, gradually assumed an appearance as if viewed through a deeply-smoked glass ; the colour becoming somewhat yellower as it approached the horizon, which on that side was probably from ten to fifteen miles distant. But, however various the actual distance of the horizon in different directions, it appeared to have closed in upon us on every side, while the sky seemed to have descended, and to be almost in contact with the earth. The black body of the moon, surrounded by a magnificent glory, presented an object from which it was difficult to avert the eye ; and all else assumed an aspect of horrible and unnatural gloom, which can scarcely be recalled to mind without a shudder.

As it was thought desirable to note the duration of darkness, I counted the beats of my watch from the instant of the sun's disappearance until twenty seconds had elapsed—keeping my eye to the telescope, that I might observe the formation of the corona and other concomitant phenomena. On looking at my watch I could not see the seconds on its dial, and consequently relinquished the attempt to note the time. While putting my watch down, I dropped a pencil which I had in the same hand with my watch, and

being unable to see it on the ground, I was obliged to take another, which I had fortunately placed within reach.

At the reappearance of the sun, the interruptions of the narrow luminous line were very few and small; only two or three at irregular intervals were noticed. On subsequently examining this part of the moon's limb as projected on the sun, it was found to be nearly free from obvious irregularities.

The only effect which I observed on the animal creation was exhibited by a calf which was feeding near us. Immediately on the disappearance of the sun it began to low most piteously, and continued to do so till the sun reappeared, when it quietly returned to its grazing.

The duration of the total obscuration was probably about one minute and a half.

The place of observation is, approximately, in north latitude, $56^{\circ} 16'$, and longitude east of Greenwich, $0^{\text{h}} 51^{\text{m}} 36^{\text{s}}$.

P.S.—In the accompanying drawing (Plate VI. No. 5) of the appearances attending the total eclipse, the red prominences are represented of about the greatest height which was estimated, without respect to any particular instant of time; their size being in due proportion to the diameter of the moon. The outline of the low ridge of elevations at the southern limb, and in the south-western quadrant, has no pretensions to accuracy, being intended merely to give the impression I received of their general appearance. The outlines of the more remarkable protuberances are as correct as could be derived from the pencil sketch made during the totality, and my recollections recorded immediately afterwards.

HELSINGBORG.

Observations by Capt. F. P. BLACKWOOD, R.N.

On my arrival here I was visited by an officer of the Danish navy, who informed me that he was directed to accompany me to the Island of Born-

holm. As however, on inquiry, I ascertained that I should have to wait there a week before I could get away again, and my leave of absence being only for three weeks, I decided on going to Helsingborg in Sweden, which would be just within the southern limit of totality, and where I hoped my observations would be equally useful.

Having, therefore, selected a convenient spot, just outside the town, and which afforded a fine view over the Sound, taking in the Castle of Elsinour, and the island where TYCHO BRAHE had his observatory, we fixed our telescopes, and obtained the time by means of single altitudes of the sun in the quicksilver, using a good sextant, and determining its index error for the observation. My own telescope is a good one of FRAUNHOFER's, having a 3-inch object-glass, and a power of 32, with a neutral glass to protect the eye; this gave me a very clear image of the sun, leaving ample room for the prominences to show themselves, should we be so fortunate as to see them. I used the whole of the object-glass for the observation.

My friend, Lieut. GOODENOUGH, of the Royal British Navy, who was so kind as to accompany me, and to assist me in observing the phenomena, used a small telescope of $1\frac{5}{16}$ English inch aperture, with a power of 20. Before the commencement of the eclipse two maculæ were plainly visible on the sun's disc; the upper one (and which was rather composed of a group of small ones than one decided spot), about 50° to the left of the vertex; the lower one about 20° to the right of the sun's lowest point, and consisting of one large and one small spot. It will be considered that my description alludes to the phenomena as seen inverted.

The weather had been very fine and clear in the forenoon, the wind from the north-west with light fleecy clouds, but towards two o'clock cumuli arose from the horizon, which increased very much during the eclipse, and which much interfered with the accuracy of the observation and the beauty of the phenomena.

The first contact took place at $3^h 1^m 12^s$ mean solar time at Helsingborg. This I consider to be about 5 seconds of time too late, as the sun was partially clouded over, and we lost the exact moment of first contact. The black bulb thermometer showed 81° ; thermometer, in shade, 67° .

I observed the advancing edge of the moon to be very rough in its outline, and a considerable irregularity of form on her upper limb within a few degrees from the upper cusp.

3^h 40^m. A thin veil of clouds came over the sky, the light of the sun becoming sensibly diminished. The cusps were perfectly sharp. The total obscuration took place at 4^h 3^m 35^s (correctly noted and clearly seen), when a hazy appearance of bright light made its appearance round the whole circle of the moon's circumference, excepting at the upper part, where, for the space of about 70°, the moon's limb was surrounded by a narrow crescent of a reddish violet tinge, something like the flame from a coke fire.

One red prominence only was seen, very irregular in its form, and rising to a height of certainly two minutes from the moon's limb. This curious, faint, flame-coloured object, sprang from a position about 20° to the left of the moon's vertex, and whilst I was occupied in making a rapid search round the moon for similar flames, the sun's light reappeared. The duration of the totality, by my estimation (as well as by the opinion of several gentlemen who were standing by and watching the eclipse with the naked eye), did not much exceed 30 seconds. I was so surprised at the shortness of the duration of the totality, that neither my friend nor myself were prepared to note the time of the light reappearing; but, as at Elsineur Castle, a distance not much exceeding two English miles and a half due west, the eclipse was not total, I do not think the duration could have been of a longer period than the time I state, if, perhaps, it were as much. This red prominence had not a decided outline, it was wavy and irregular in form, and, indeed, more like a faint flame of fire, as seen through a highly refractive stratum of hot air, than anything else I can compare it to. It was not visible to the naked eye; but there was a film of cloudy strata about the sun which may have caused a duller appearance to myself, and to the naked-eye observers as well. It did not in the slightest degree resemble an Alpine mountain tinged by the sun's light, either in colour or form. The sketch (Plate VI. No. 6) will convey some idea of it, and of the detached bit of flame accompanying it.

On looking over the sea a sort of sickly neutral green colour covered it, and appeared to tinge the atmosphere; but at no time was the darkness sufficient to hinder our reading the dial-plate of the watch. At the totality the sun and shade thermometers both gave a like reading of 63°.

During the latter part of the eclipse, thick, hazy, and filmy clouds came on and obscured the sun, which was only partially and occasionally visible. The termination of the eclipse could not be observed in consequence.

I trust that I have made myself clear to you, but the rapid completion of

the totality may (as you may well conceive) have hindered my obtaining the time of its hiding as correctly as I could have wished; and, indeed, precluded my paying close attention to the form, dimensions, and principal feature of the single prominence that we saw. We saw no aureole, or rays shooting out; it was simply a band of white light surrounding the moon.

CHRISTIANSTADT.*

Observations by Colonel SILVERSTOLPE.

In the forenoon it was blowing from the west. Half an hour after the beginning of the eclipse, the wind diminished remarkably. At the same time the brightness of the sunshine lessened also. Some few minutes before the total eclipse, the weather was quite calm. At the same time also, in the part of the firmament where the sun was, some light clouds of condensed vapour were seen.

The *total* eclipse was observed to occupy a time of $2^m 41^s \frac{2}{3}$, the observation being made on a watch which was put in motion at the very moment of the disappearance of the last beam of the sunlight, and stopped at the first reappearance of the same light. The gloria around the moon at the total eclipse was light violet, nearly white, and seemed not to be of a quite regular roundness, but in some part waved. The northern part of the horizon, to a large extent, was yellow-red, and very clear, like the lowest part of the west horizon at sunset, but still not bright; the firmament above dark, as well as the earth underneath.

But one star (*Venus*) was seen by the observer at the right hand, or in the north, from the sun. The weather continued to be calm.

When, after the total eclipse, the sunlight reappeared, the increase of the daylight seemed to proceed much more quickly than the diminution of the same before the total eclipse.

In the moment before the eclipse being total, it could not be observed

* The locality is the same as that of Mr. HUMPHREYS' and Mr. MILAND's observations.

that the shadow of the moon was running fast over the country from the west to the east, only that the daylight quickly diminished. The whole eclipse continued $2^h 4^m$. The calm of the weather held on during the whole decrease of the eclipse. The evening was also calm.

Two horses in the neighbourhood of the observer stood quiet during the total eclipse.

LILLA EDET.

Observations by G. P. BOND, Esq.

The place of observation which had been fixed upon for its convenience of access, and as a point lying precisely in the central line of the total shadow, was the small town of Lilla Edet, in Sweden; in latitude $58^{\circ} 7' N.$; longitude $12^{\circ} 8' E.$ The telescope used was an achromatic by FRAUNHOFER, of 21 lines aperture, provided with a power of about 30, having a clear field of $55'$. For the use of this admirable little instrument I was indebted to the kindness of M. RUMKER, of the Hamburg Observatory. The elevation from which the eclipse was observed lies on the south-east side of the village, rising one hundred and fifty feet above the river, and commanding an extended view in either direction, perhaps fifteen miles, of the valley of the Götha river. Mr. R. C. CARRINGTON, of the Observatory at Durham, occupied a station on the opposite bank, a mile and a half up the river. Twelve miles north of us, at the Trollhättan Falls, were MESSRS. LASSELL, WILLIAMS, and STANISTREET; and thirty miles to the south-west, at Göttenburg, were collected a number of scientific observers: among whom were Mr. AIRY, Prof. CHEVALIER, MESSRS. SWAN, LANE, ADIS, &c. All of whom were successful in noting the principal phenomena.

The weather, which had been sufficiently unpromising for two or three days previous, suddenly cleared up, an hour or two only before the first contact, and continued in a favourable state until after the end of the total phase; indeed, I have rarely noticed a more perfect definition of the sun's limb than was presented in the course of the obscuration.

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Nothing remarkable was noticed at the first contact, nor until a considerable portion of the sun's disc was covered, sufficiently so to make an impression upon the illumination of the surrounding landscape. As the crescent of light narrowed, the contour of the lunar mountains, on the south side especially, evidently produced an irregularity in the form of the cusp when the definition allowed the outlines of the surface to be traced distinctly up to the intersections of the two limbs. A remarkable instance of this occurred seven minutes before totality, when I thought a marked distortion of the south cusp easily distinguishable as an effect due to the rugged outline of the moon's limb at that point; the same appearance was noticed by Mr. CARRINGTON, and figured in his "Account." As the total phase approached, the narrow thread of light, to which the cusps were reduced, was interrupted, and in many instances disconnected from the rest of the segment, by black spaces, which rapidly enlarged, apparently driving before them the outside points of light like beads from a string. From a comparison of the two phenomena, I should be inclined to the opinion that the appearance of these "beads" requires a further explanation than is furnished by the interception of light by the more prominent lunar mountains, which would, of course, first complete the internal contact; there may be some optical effect which better meets the case. It may be worth while to notice that the outline of the beads was well defined, and the direction of their motion (off the cusp) opposed to that of the atmospheric undulations.

It was some ten or twenty seconds after the total phase was complete before I withdrew the screen of coloured glass from the eye-piece; through it, however, though sufficiently dense to protect the eye from full sunlight, the corona was instantly visible. It proceeded, without any intervening dark space, directly from the moon's limb, where it was much the brightest, its radiations extending to a distance about equal to the sun's semidiameter, though it presented no definite outline externally: its colour was white, without any tendency to separate into rings of different tints. It was not, however, uniformly diffused in all its parts; there was, indeed, testimony from some intelligent persons in the vicinity to the effect that there was a "brush," or tail of light, extending from the north following side. The corona continued to be visible to the naked eye, at least half a minute after the reappearance of sunlight, on the side opposite to the exposed limb: in fact, the edge of the moon off the sun was plainly visible; the character of

this segment of the corona was precisely what it was previously, only, no doubt from its greater distance from the dazzling light of the sun, it was strongest on the part of the circumference furthest from the cusps.

Of the rose-coloured prominences, now become so noted among the phenomena of a total eclipse, the position of five was recorded : of others, only a vague recollection was retained. The first seen was nearly in the same parallel of declination with the sun's centre, and on the following side, in right ascension, the remaining four being on the preceding side. Reckoning from the *apparent* upper limb (the telescope inverted objects) towards the following limb, the angles of each by a rude estimate were,—

<i>a</i>	124°	from the apparent vertex.
<i>d</i>	240	—
<i>b</i>	280	—
<i>c</i>	290	—
<i>e</i>	330	—

Of these, *a* was on the side being covered by the moon; whether by fading away, or more probably by being eclipsed, it disappeared entirely before the end of the totality. At or near the middle of the eclipse it was less evident than at first, and soon after was not to be seen at all. *d* and *e* were noticed only incidentally; the more extraordinary features of *b* and *c* diverting the attention. The moment the eye was directed to the preceding limb, *b* was by far the largest. Its upper end was bent towards *c*, with which it was connected in a most remarkable manner by a faint arch or arches of light, much less brilliant than that of either of the flames, and approaching to a white colour: at all events, not decidedly red. Of the existence of this bow I can speak with perfect confidence. It was concave towards the sun's edge, and had a less radius of curvature. Besides this, there were other indications of a disturbance of the structure of the corona in the immediate neighbourhood of *b* and *c*; the precise nature of which I could not afterwards recall, but which conveyed a pretty distinct impression that the two phenomena were physically connected.

Of all the prominences it may be said that they had the appearance of flames, or clouds brightly illuminated, much rather than of mountains or solid projections of any kind; a notion which, at all events, must be discarded. A wave-like or sudden motion in the forks and streaks, of which the promi-

nences seemed made up, was not seen, though watched for; the analogy of structure suggesting at once the idea of flame, to which they have frequently, and not without reason, been compared. It is hardly necessary to say, that if they be appendages to the sun, its distance would preclude the likelihood of motion being detected in so short an interval of time.

My impression is, that some portions of the rose-coloured light existed quite detached from the limb.

At least ten seconds before the sun reappeared, a decided illumination of the moon's limb assured me that the end of the totality was just at hand; the warning could not be mistaken. The rose-light of the prominences extended in a faint edging over the limb, until, at the moment before the edge of the sun flashed out, the moon's limb through an arc of 60° literally glowed with rose-tinted light; to which the intense and purely white sunlight instantly succeeding, afforded the strongest possible contrast. But not the slightest indication of the formation of the beads of light seen at the commencement of total darkness was observed: a reason for this may be suggested in the fact of there being at the time no screen on the eye-piece, and the eye may have been too much dazzled at the sudden reappearance of sunlight, after some minutes of darkness, to perceive the phenomenon, had it taken place. It is manifestly, however, one of inferior interest to those of the corona and prominences.

The occurrence of the flames *a*, *b*, and *c*, over regions occupied by conspicuous spots previously and subsequently visible on the solar disc, which is sustained by my observations of the locality of each class of objects, as far as their rudeness will justify a conclusion of so much importance, points to a possible connexion of the two.

FREDERIKSVÆRN.

*Observations by J. C. ADAMS, Esq., President of the Society, and
Mr. LIVEING.*

Latitude, $58^{\circ} 59' 33''\cdot 9$ N. Longitude, $40^{\text{m}} 15^{\text{s}}\cdot 5$ East.

The approach of the total eclipse of July 28, 1851, produced in me a strong desire to witness so rare and striking a phenomenon. Not that I had much hope of being able to add anything of scientific importance to the accounts of the many experienced astronomers who were preparing to observe it; for I was not unaware of the difficulty which one not much accustomed to astronomical observation would have in preserving the requisite coolness and command of the attention amid circumstances so novel, where the points of interest are so numerous, and the time allowed for observation is so short. Certainly my experience has now shown that I did not exaggerate these difficulties; but I have at least the satisfaction of having formed a far more vivid idea of the phenomenon than I could have obtained from any description; and I think that if I should ever have another opportunity of observing a total eclipse, I should be prepared to give a much better account of it than I can of the present.

I left Hull, by steamer, on the evening of Saturday, July 19, together with a large party of astronomers bound on the same errand with myself. In the afternoon of Tuesday the 22d, we arrived at Christiania, where I landed with several other passengers, the remainder of the party going on to Göttenburg. We had no trouble in getting our instruments on shore; the Norwegian Government having, in the most liberal and enlightened spirit, ordered the custom-house officers to allow them to pass without examination. This favour, I afterwards found, we owed to the kind offices of Professor HANSTEEN, whose acquaintance, as well as that of several other eminent professors of the university, I had the happiness of making during my short stay at Christiania.

On Thursday the 24th, in company with my friend Mr. LIVEING, of St. John's College, Cambridge, I proceeded by steamer to Frederiksværn, the point selected for making the observation, as being one easily accessible, and situated almost exactly on the central line of the path of the moon's shadow. Here is one of the royal dockyards, containing a small observatory for giving time to the shipping. The officers of the dockyard showed us much attention, and were anxious to render us every assistance in preparing for the observation. To Lieutenant RUS, in particular, we are under the deepest obligations. On Friday the 25th we inspected the observatory, and examined the neighbourhood with the view of selecting a favourable spot for the observation. It rained heavily during the whole of Saturday, so that our prospects were not very encouraging, but on Sunday the weather improved, and on the morning of the eventful day, Monday the 28th, the sky was bright and clear, with the exception of a few light clouds, which, however, became more numerous as the day advanced, and at length overspread the heavens, as fresh vapour was brought up by the wind, which blew quite a gale from the south-west. I had intended to observe the eclipse from the summit of a rocky island lying just off the dockyard, and commanding an extensive prospect over the sea, though the view on the land side is cut off by a lofty ridge of rocks rising behind the town. The violence of the wind, however, made it necessary to choose some sheltered position for the instrument, and I fixed upon one in an angle within the ramparts of the dockyard. The telescope which I employed was one of DOLLOND's, which was kindly lent me by the Master and Fellows of St. John's College. The aperture of the object-glass is $2\frac{1}{4}$ inches, and its focal length 42 inches. The astronomical eye-pieces belonging to the instrument giving too small a field of view, I employed a terrestrial eye-piece, with a magnifying power of about 20. The field was limited by a diaphragm having small teeth of different sizes arranged at intervals of 45° around its circumference, in order to enable me to estimate the position and magnitude of any small object that might be seen.

As the eastern limb of the moon advanced over the sun, I observed that it appeared uneven in several places, and two mountains were particularly noticed on the edge, about 5° apart and near the eastern extremity of the moon's horizontal diameter. The cusps, too, as they were approaching each other, occasionally appeared to be somewhat blunted. I could see no trace

of the moon's limb extending beyond the sun's disc. As the crescent became very narrow, it seemed to be in a state of violent agitation, and at last, just before the totality, it broke up into several parts. These, however, were not like the "beads" described by Mr. BAILY, but were quite irregular, being evidently occasioned by the inequalities on the moon's limb. As the totality approached, the gloom rapidly increased; still, enough light remained up to the moment of total obscuration to render the change which then took place very marked and startling. For a few moments I felt somewhat confused, and did not immediately remove the dark glass. I then applied my eye to the finder, and saw the corona surrounding the dark body of the moon. The light of the corona was pale, not sensibly coloured, and gradually faded away in receding from the moon's edge. Its average breadth was perhaps about a third of the moon's diameter, but it extended considerably farther in some directions than in others, its boundary being very irregular. It did not appear to consist of rays, and there was no marked annularity of structure, so that I could not decide whether it was concentric with the sun or the moon.

I now quitted the telescope and looked first at the moon and then around on the sky. The appearance of the corona, shining with a cold unearthly light, made an impression on my mind which can never be effaced, and an involuntary feeling of loneliness and disquietude came upon me. I had previously ascertained the position of the principal stars and planets, but none of them could be seen on account of the clouds. I did not notice any peculiarity in the colours of surrounding objects. The light remaining was only just sufficient to enable me to read off the face of a box chronometer which I had with me. A party of haymakers, who had been laughing and chatting merrily at their work during the early part of the eclipse, were now seated on the ground, in a group near the telescope, watching what was taking place with the greatest interest, and preserving a profound silence.

About forty or fifty seconds after the commencement of the totality, I returned to the telescope, and cast my eye round the disc of the moon. The light of the corona did not seem to be uniformly diffused round it, there being a patch brighter than the rest near the point where the sun's last rays had disappeared. At the point nearly opposite, or about 105° from the upper point of the moon, measured towards the west, I noticed a

rosy-coloured prominence, about one minute in altitude. The upper or northern boundary of this was well defined, and had nearly the form of a quadrantal arc of a circle meeting the moon's limb perpendicularly, the concavity being turned downwards; the southern boundary was also somewhat concave downwards, but the illumination near it was less, and diminished gradually, so that it was difficult to ascertain its exact form. The appearance was somewhat like the enlightened portion of a hemispherical mountain standing on the moon's limb and illuminated on its northern side, whilst more than half the hemisphere on the opposite side was invisible. After watching this for a short time, I observed that its altitude was gradually increasing, and my attention became in consequence entirely engrossed by it. The southern boundary of this prominence soon became better defined than at first, while the northern boundary remained perfectly even and well defined throughout. The altitude continued to increase till the moment of the sun's reappearance, when it amounted to nearly three minutes. The form of the prominence now resembled that of a sickle, and it projected nearly perpendicularly from the moon's limb, the part nearest the moon being nearly straight, but the curvature gradually increasing in approaching the point, which was sharp and turned downwards. The breadth at the base was, perhaps, two-thirds of a minute. There was no sensible, or at any rate, no marked change of form in the several parts after they had once been seen, but only a gradual lengthening by additions at the base, of such a kind as would have been occasioned by the motion of the moon if the prominence had really belonged to the sun. My impression, however, is, that the increase of length was greater than can be accounted for by the moon's motion, and that it proceeded more rapidly towards the end of the totality than at first, but I cannot feel certain on this point. A little before the end of the totality, the corona seemed to become brighter in the neighbourhood of the prominence, which was close to the point where the sun was about to reappear. On account of the clouds, I felt no inconvenience in observing the reappearance without the intervention of a dark glass. As the first ray of the sun appeared the corona vanished, and at the same moment the prominence seemed suddenly to contract and change its form, the point of it disappearing and the remaining part becoming detached from the limb of the moon. In about a second more the whole had vanished. I did not notice any interruption to the continuity of the sun's limb in its reappearance, like that with which I

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had been struck when it disappeared, the moon's western limb being apparently much more regular than the eastern.

The clouds now grew rapidly thicker, and completely hid the sun from view before the end of the eclipse.

At the small observatory the eclipse was observed by Lieutenants SMITH and HJORTH, two officers of the Norwegian royal navy, and also by the well-known French traveller, M. D'ABBADIE. Lieut. SMITH, who was specially charged by Professor HANSTEEN with the determination of the time, found the following results:—

	^h	^m	^s	Mean Time at the Observatory.
Beginning of the Eclipse	2	41	40·3	
Beginning of the Totality	3	44	52·3	„ „
End of Totality	3	48	17·8	„ „

The end of the eclipse could not be observed.

According to Professor HANSTEEN, the longitude of the observatory is $2^m 39^s \cdot 3$ west of Christiania, or $40^m 15^s \cdot 5$ east of Greenwich, and its latitude $58^\circ 59' 33'' \cdot 9$ north.

Lieut. HJORTH compares the appearance of the prominence described above to that of the flame of a candle acted on by the blowpipe.

Besides this prominence, which was the only one seen by me, Lieut. HJORTH observed two much smaller ones to spring up a little before the end of the totality, on the same side of the moon as the former, one being above and the other below it.

Mr. LIVEING, who observed the eclipse from the same spot with myself, has kindly communicated the following observations, taken with the naked eye.

“The first appearance I noted was the formation of a halo round the sun soon after the eclipse commenced; light clouds were at the same time flitting across the sky. When the totality approached, the passage of the shadow was not so rapid but that I could see the clouds to the north-west grow dark before the last direct beam of the sun was extinguished. And at the reappearance of the sun it was still more remarkable; the clouds to the north-west lightened up, making it much lighter where I stood; and I had time to exclaim that the sun was going to appear, and to turn my eyes towards him, an appreciable interval before he actually showed himself.

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The first appearance was a single point of light, like a very bright star, increasing in size, of course, very rapidly.

“I did not observe that the landscape was peculiarly livid; it had a cold appearance, but much such as it often has after sunset; and the only clear part of the sky, towards the south-east horizon, had quite an orange hue, also such as is not unusual after sunset; and it remained nearly the same colour the whole time of darkness.

“I looked for colour in the corona, but could see none; neither did it appear to me divided by a dark ring, or to be regular or well defined on the outside; in four points it certainly appeared to project to a greater distance than at the intermediate points, and these four points were at unequal intervals; but I did not watch it long enough to observe how far this might be due to the clouds which covered it, and which had now become much thicker than at first. As I did not expect to be able to observe it, I had no means of exactly measuring the intensity of the light; but I could not distinguish the features of people about four yards from me; and a candle at about the same distance threw a well-defined shadow.

“A crow was the only animal near me; it seemed quite bewildered, croaking and flying backwards and forwards near the ground in an uncertain manner.”

I have also been favoured with the following interesting account by another friend, who observed the eclipse in company with several other persons, from an elevated point about thirty-three miles west of Christiania, which commands an extensive view of the surrounding country.

“We observed the eclipse from the Skuderud Sæters, about nine miles north-east of Fossum, and nearly on the same parallel as Christiania. We had smoked glasses, and also a small telescope smoked. The eclipse appeared to begin about $2^h 45^m$. As the shadow increased the change in the appearance of the country was most curious. The light became pale; our shadows were sharply cut, as by moonlight, but the light was more yellow. A deep gray twilight seemed to come on. Perhaps two minutes before the totality a dark, thick shade appeared over the west and north-west mountains, which drew nearer, till, when the eclipse became total, it entirely surrounded us, though it was paler or less dense towards the east. But on the instant that we were in complete shade, a bright orange streak of light appeared on the horizon to the north-west, spreading west and south. The corona was orange. Bright, pale, and very irregular yellow rays streamed round like the glories round the

heads of saints. Many stars were visible, but *Venus* was the only planet pointed out to me. The totality lasted $2^m 50^s$ to the best of our reckoning; but before the sun reappeared the clouds thickened rapidly, and afterwards we only caught stray glimpses. For a minute after the totality was passed, the dark shade lingered over the south and south-east.

“The following remarks are numbered with reference to the *Suggestions* drawn up by a Committee of the British Association.

“16. We noticed no variation of colour in the sky.

“18. The corona appeared to be formed instantaneously all round; equally broad; not divided into rings.

“22. The corona cast no shadow. I read the word ‘Observation’ at three yards, the remainder of the title at two, the interior print at the usual distance in my hand. I read the same at the same distances at $10^h 30^m$ the following evening, the book facing west; and at six, four, and two yards distance by sunlight.

“24. The outline of all the mountains was perfectly distinct.”

I cannot close this account without expressing my sense of the kind hospitality which I met with during a subsequent tour of six weeks in Norway. To Mr. CROWE, Her Majesty’s Consul-general at Christiania, whose kindness is so well known to all English travellers in that country, I feel particularly bound to return my warmest thanks.

MARIENBURG, in *Prussia*.

Observations by H. F. TALBOT, Esq.

On my arrival at Berlin, I was informed that the eclipse would probably be well observed both at Dantzic and Königsberg, several excellent astronomers having placed themselves in those cities. It appeared to me that it was exceedingly desirable for observers to scatter themselves along the line of the central phase, so as to multiply the chances of a successful observation

and diminish the risk of disappointment from passing clouds. After full consideration, I fixed upon the little town of Marienburg for the place of my observation, it being the nearest town which, in my opinion, combined the requisite conditions, and which was, nevertheless, not likely to be resorted to by many observers. In this respect I chose well, for I could not learn, upon after inquiry, that any astronomer besides myself observed in that locality.

Besides the advantage of its position, not far from the line of the central phase, I also knew that Marienburg possessed more objects of interest to the tourist and the traveller than any other small provincial town which lay within any convenient distance. And as I find that the impressions received by the many observers of this celebrated eclipse have been greatly modified by the local circumstances in which they found themselves, whether on hill or valley, upon sea or land, so I think it will be proper to give a short account of the place in which it was my lot to witness this rare and remarkable phenomenon.

Marienburg is a little town of considerable antiquity, and of very great historical interest, having been at a remote period the capital city of all this portion of North-eastern Europe. Here the knights of the Teutonic Order, to whom the Pope, of his own authority, had given the land, on condition of their reclaiming the wild inhabitants from paganism—and whose chief, called in German the *Hoch-meister*, and in old English documents the “Master of Pruce,” was in reality the sovereign of the country—erected a strong and magnificent castle for their residence, whose remains, still in excellent preservation and full of objects of interest, attest the formèr power of the Order. An ancient image, twenty-two feet high, of the Holy Maria, patron saint of the city, named from her *Marienburg*, stands in a recess of the outer castle walls.

I arrived at my destination here on the 26th July, in ample time to make the few requisite arrangements. On looking round me for a proper locality, I saw that the little inn called the *Hoch-meister*, in memory of the knights of ancient times, offered a free and open prospect towards the castle. Here, therefore, I resolved to station myself, my only doubt being lest, at the hour of the eclipse, the sun might be obscured behind the lofty walls of the ancient fortress. The afternoon being fortunately fine, enabled me to see that there was no danger of this mischance, the sun passing at a sufficient elevation above the walls.

I had brought with me from England a good achromatic, of three feet focal length and three inches aperture. A carpenter, under my directions, made a simple and effective rest for the telescope, which answered perfectly, the instrument being very steady and easy to manage. I had also provided myself with a selection of papers, printed with different sizes of very small type, and arranged for convenient observation. Their legibility or the contrary, during the eclipse, was expected to prove a sufficiently accurate criterion of the degree of darkness caused by it.

The morning of the 28th July was fine, but as the day advanced, a north-west wind prevailing, the weather frequently changed, and gave rise to an alternation of hopes and fears. About noon, clouds covered all the sky; but these passed away again, and the fine weather returned. About two o'clock I ascended an elevated point of the ancient and deserted fortifications, commanding a wide uninterrupted prospect towards the north, with the object of forming some opinion as to the weather which the observers at Dantzic and Königsberg were likely to have. I saw that in the direction of both those cities the heavens were serene and unclouded. In other directions, however, there were vast masses of white cloud, with a very bright sky appearing in the intervals between them. It was, therefore, evident that the success of the observation would depend on the casual position of these masses of cloud at the critical moment to each observer; a thing evidently impossible to foretell an hour beforehand.

Having taken this general survey of the sky in every direction, I returned to my room to be ready for the observation.

My apartment possessed windows in two directions, north-west and south-west. The weather was at this time very fine, and the sun's disc appeared in the telescope with the most perfect definition. I used a low power of remarkable distinctness, to which I am very partial. The sun's disk was unusually free from spots. I observed only two small groups. One of these, consisting of two spots and some *faculæ*, was situated near the western edge of the disk; the second was a larger and blacker spot, of elongated form, close to the eastern edge, and near to this there probably was a smaller spot, situated on the very edge of the disk, which was invisible at the time, but became visible a few days afterwards by the sun's rotation. I mention the spots more particularly, because I am convinced that they

have some close connexion with the rosy flames which are seen in total eclipses to issue from certain points of the circumference of the disk.

Precisely at the expected moment, 3^h 32^m, I observed the first impression of the lunar disk. In about two minutes afterwards, the first group of solar spots was occulted. The eclipse then advanced steadily for some time, giving occasion for no particular observation beyond the gradual diminution of the brightness of the daylight. When a considerable part of the sun's disk was eclipsed, a bank of fleecy white clouds began to cover it, passing slowly over the sky from N.W. to S.E. This cloud was seen approaching with much uneasiness, for although its limits could be seen, and a very clear sky behind it, yet it was feared, from its great extent and its slow rate of progress, that it would not pass over in less than an hour. As the cloud passed on, however, it became thinner, and the coloured glasses being now laid aside as useless, the progress of the eclipse was distinctly watched with the telescope through a veil of cloud, the sun appearing as a perfectly white crescent, growing momentarily thinner and thinner. A few seconds, however, before the total immersion, a thick fold of cloud obscured the crescent, and the observation of the immersion was lost. I instantly withdrew my eye from the telescope to contemplate the scene around me. Before me rose the towers of the feudal castle, seen in a gloomy and livid light, such as, perhaps, never before had shone upon its walls. The sky overhead was hung with lurid clouds, but in the distant south-eastern horizon there was a clear band of sky, which I had seen not a minute before, of its usual blue colour. This was now changed into a deep orange-yellow. It is difficult by description to convey any idea of this awfully darkened landscape. Some have compared it to the effect of a thunderstorm at sunset. I shall not attempt any comparison. A hurried glance at the scene presented at that moment was all that time permitted. I now made haste to observe, as accurately as I could, the degree of obscuration which prevailed. The printed papers lay ready at hand. The type of ordinary size was very plainly legible, and therefore at once thrown aside. I then took up the types of decreasing size, and carefully noted the smallest of these which was legible.

A total obscuration of the sun had been predicted of about three minutes at Marienburg. Not more than one had elapsed, while making these hasty

observations, when I was startled by a bright light which shone forth suddenly in the clouds. My first rapid impression was that the sun was emerging, and that the predicted time had proved erroneous; but instantly applying my eye to the telescope, I saw that it was the corona around the moon, which was seen through an opening in the clouds. My whole attention was instantly absorbed by this spectacle. The whole of the moon's disk was displayed, as black as ink, against a luminous background. At the point nearly where the first contact had taken place, two red flames or fiery eminences appeared upon the edge of the moon. One of these ascended to a great elevation, and then curved itself at right angles in a most extraordinary manner towards the other, which was altogether detached from the disk, and floating in the air like an island of light. I saw no other than these two; perhaps, because I was so entirely absorbed in their contemplation. A veil of cloud now again began to pass over the lunar disk, which, while it perplexed the observer, at least enabled him to observe and chronicle the fact that the bright red eminences are visible through very considerable thicknesses of cloud. The cloudy veil then again became thinner, and a very strong concentration of light was seen in one point of the corona, conveying the impression that the sun was about to emerge at that point. Just before the emersion of the sun, a multitude of small red flames started suddenly into view upon the edge of the disk, like a jagged or serrated line of fire. This new and interesting spectacle had, however, hardly lasted two seconds, when the disk of the sun reappeared in a very brilliant line of light, broken into many portions, and put an end to this series of curious and wonderful phenomena.

Soon after the emersion the last portions of the clouds passed away, and during the remainder of the eclipse the sun was unclouded. The last contact was observed at $5^{\text{h}} 33^{\text{m}} 30^{\text{s}}$. The finest weather prevailed during the remainder of the day and in the evening, enabling me to make a corresponding observation during the evening twilight to that which I had made during the total obscuration. By a careful observation of the time when the printed papers became illegible in the evening twilight, I arrived at the conclusion that the darkness which prevailed at Marienburg during the total eclipse of the 28th July, was about equal to that which occurred one hour after sunset the same evening.

Additional Remarks.

The effect of the phenomenon on animals appears, in some instances, to have been very marked. One that came to my own knowledge I will briefly notice. On the morning of the eclipse, a Prussian officer with whom I was conversing told me, that the only observation he intended to make would be this—that he should mount his horse and ride alone by the side of the river (a branch of the Vistula, of considerable width), to see what effect, if any, would be experienced by his horse! On hearing of this intention, I somewhat marvelled. But there is an old proverb, *Quot homines tot sententiæ*. Meeting this officer again in the evening, I asked him if he had put his purpose in execution? He replied that he had done so, and had very nearly lost his life in consequence; for the animal was seized with such a panic terror on the extinction of the sun, that he was scarcely able to master him, and both steed and rider were in the utmost danger of being precipitated into the river.

2. *On the observed Degree of Obscuration during the Eclipse.*

This was observed at the south-west window. The corresponding observations in the evening twilight were as follows:—

The printed paper which was the object of comparison became illegible at the south-west window at 8^h 55^m, but remained legible at the north-west window until 9^h 5^m, at which time a star of the first magnitude, *Arcturus*, was visible in the twilight. The degree of obscuration thus indirectly determined by observation of the printed papers appears, therefore, to agree well with the direct observation made by many persons, who affirmed that some stars of the first magnitude were visible during the eclipse.

3. *On the Red Flames.*

It appears to me a probable conjecture that the solar spots are openings in the sun's luminous atmosphere, caused by the eruption of torrents of inflammable vapour; and that the vapours, rushing through these openings, ascend into the upper regions of the solar atmosphere in flames of immense elevation. If this hypothesis is true, the flames must nearly correspond as to position with the observed solar spots; and this, I apprehend, is rather confirmed than otherwise by the few observations which have been hitherto directed to this point.

Whatever opinion may be formed as to the exact nature of the fiery eminences, there can be no doubt that they are real phenomena of stupendous magnitude. They belong to the solar orb, and not to the lunar, for they are gradually eclipsed by the advancing lunar disk, as appears from the testimony of many observers, though I did not myself observe this fact. They are no more to be ascribed to the effects of optical illusion than the mountains and cavities of the lunar disk are to be explained away in that manner.

As the moon has no atmosphere, a solar ray cannot suffer any diffraction unless it touches in its course the lunar surface, or at least passes within an inch of it. But the light which comes to us from the summit of one of those fiery eminences does not pass within fifty miles of the lunar surface, at the time when the eclipse is central. I have considered these brilliant phenomena as vast masses of inflammable vapour, but without intending any comparison of them with anything terrestrial, for the sun has a constitution altogether *sui generis*. The sole point of resemblance is in the exertion of vast mechanical force, which is implied in their forcing their way through openings, which we call spots, in the sun's luminous atmosphere.

I also consider that the whole surface of the sun is covered with similar red flames, of lower elevation, because they were seen at the point where the sun was emerging, and it is very improbable that they existed only at that particular point of the surface.

For some days after the eclipse, the German newspapers were filled with accounts of it, several of which I examined, and found them to be well accordant with each other. I have translated the following account from the *Berlinische Nachrichten* of the 1st August, Supplement, page 1. The observers, six in number, were favoured with perfectly serene weather. Their place of observation was in the neighbourhood of Dantzic.

Observation of the Total Eclipse of the Sun on the Hill of Redlau, near Zoppot.

The inhabitants and guests at the Baths of Zoppot, wishing to make a common observation of the eclipse, instead of associating themselves with Messrs. MAUVAIS and GOUJON of Paris on the Bishop's Hill near Dantzic, preferred, for the sake of convenience, to resort to the hill of Redlau, also called the Eagles' Forest, situated near the lake, half a German mile north of Zoppot, from whence the view extends on the north to the promontory

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called Oxhöfft, distant $1\frac{1}{4}$ German mile, while on the south and south-east a wide plain, adorned with many villages and woods, extends itself beyond Dantzic, Neufahrwasser, and the mouth of the Vistula; besides which, a great part of the sandhills on the Nehrunger Strand are visible. During the forenoon of this day the hopes of a good observation were very doubtful, since the weather only just before the beginning of the eclipse cleared up sufficiently to allow of a sharp observation of the sun's limb. This state of the atmosphere fortunately continued unaltered, without any cloud passing over the sun, during the whole time of the eclipse. The first impression of the moon's disk on the sun was so conspicuously seen at $3^h 31^m$, with a 2-foot Fraunhofer, and $2\frac{1}{2}$ -foot Dollond, both of which had an aperture of $1\frac{1}{4}$ -inch, that the true commencement of the eclipse must have been one minute earlier. The next quarter of an hour the sky was rather watery, but afterwards, until the arrival of the total darkness, it was quite clear. At $4^h 2^m$, when six digits were eclipsed, the first trace occurred of an orange-coloured light on terrestrial objects; ten minutes later there was a diminution of light visible to every one. Oxhöfft was already shrouded in evening twilight. Swallows flew timorously through the air. At $4^h 13^m$ the power of a burning-glass began to fail; at $4^h 18^m$, when nine and a half digits were eclipsed, a dark grey light was seen over Oxhöfft; at $4^h 23^m$ the burning-glass had quite lost its effect; at $4^h 25^m$, when eleven digits were eclipsed, there was a decidedly orange illumination of earthly objects. During the last minutes before the total obscuration, the countenances of men assumed a pallid green colour. The moon's shadow passing over the country was ill-defined; it had a very dark colour, between dark violet and brown, and a bank of gloom rose high over the horizon. The last ray of the sun disappeared at $4^h 30^m$, after the first appearance, a few seconds earlier, of the luminous corona (better called the crown of rays). The darkness came on suddenly with the extinction of the sun's light. This moment, together with the crown of rays now shining out in brilliant beauty, and the coming forth of the stars, made an impression of joyful astonishment upon the assembled multitude. The remaining twilight was about as bright as that of the moon in her first and last quarter, and one could read even small printed type and distinguish the features of the human countenance. The crown of rays had, from its very intense but not dazzling splendour, the greatest resemblance to the halo round the head of a saint; it

formed a white-shining ring, equal in breadth to half the moon's radius, out of which twelve to fourteen white rays extended themselves, inclined to each other at equal angles, and of the length of the whole radius. These rays appeared somewhat larger on the upper than the under side of the moon. No change nor movement could be seen in them during the three minutes' duration of the total darkness, and their brightness lost but little of its effect when seen through a telescope furnished with a light green eye-glass. On the right side, and somewhat below, were seen, even by the naked eye, two shining red points of light; the upper one appeared first, and half a minute later, the under one, at an angular distance from the upper one of almost 45° . By most observers three stars were seen, *Venus*, *Mercury*, and *Jupiter*, especially the first, beautifully bright; but by some four stars were seen, the fourth in the east, at an equal altitude with *Jupiter*. To distinguish more stars became impossible, from a light stratum of clouds which now overspread the southern heavens, and which were strikingly illuminated with a peculiar, almost never-before-seen, colouring, of brownish-violet. A boy of five years old, in the assembled company, clung to his father, and began to cry bitterly; and so did two little children of a peasant woman, of which one clung to its mother's bosom. A little spaniel dog went almost to sleep on its mistress's lap, but the event made no impression on a large and very lively dog, which ran as usual after a stone thrown by its master. At $4^h 33^m$ the re-appearance of the first sunbeam caused a feeling of joy to the whole assembly, which shone on every countenance. This feeling was favoured by the mild temperature, resembling that of a fine summer night, which had reigned during the total obscuration. After a very few minutes the illumination made the impression of full daylight upon the eye. At $4^h 39^m$ *Mercury* and *Venus* were still visible to the naked eye. At $4^h 44^m$ the burning-glass inflamed objects again, and the stars were no longer visible. At $5^h 31^m$ the eclipse ended, and the weather remained fine and beautiful until the end of the day.

(Signed)

GLAUBITZ.
W. LEHMANN.
OELSCHLAGER.
VON NOTTENBURG.
SCHÖLER.
STIEMER.

Zoppot, July 28, 1851.