

II. *Observations of the Total Solar Eclipse of 1842, July 7 (July 8, civil reckoning). By G. B. AIRY, Esq. Astronomer Royal.*

Read November 11, 1842.

IN the past summer, I made a journey to Turin, principally for the purpose of observing the solar eclipse at a place where it would be total. My intention was rather to observe the nature and succession of the general phenomena of a physical character, than to make any precise observations of absolute time, or absolute measure, or to attempt to deduce corrections of the elements of the moon's motion. I carried with me a small telescope by SIMMS, mounted on a short tripod stand, of 1·9 inches clear aperture and about 14 inches focal length. For the use of this, I am indebted to the kindness of Mr. SIMMS. I had carefully tried it on the sun's disc, and had satisfied myself that it was abundantly competent for the observation of those phenomena of eclipses which have excited so much interest: it is, indeed, a very good telescope of its size. I had also a duplex pocket watch.

Having crossed the Alps by the pass of the Little St. Bernard, I had the good fortune at Cormayeur to meet Professor FORBES. We made arrangements at once for journeying together to Turin, and for observing the eclipse in concert. We reached Turin late in the evening of July 5.

The next day was spent in the examination of the instruments and localities of the Observatory of Turin, under the auspices of M. PLANA, and in the inspection of the hill and church of the Superga. M. PLANA was extremely anxious that we should observe the eclipse at the Observatory, where every facility depending on an ample supply of instruments, and an accurate determination of time, could be afforded us. I had, however, long before fixed on the Superga as a station from which I should desire to see, if possible, the grand phenomena of a total eclipse as exhibited on a large tract of country. It may be proper here to mention that the Superga is the highest point of an insulated cluster of hills, perhaps 800 feet above the Po,

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and five miles from Turin. It is completely surrounded by the plain of Piedmont, and commands a most remarkable view ; on the east, over the plain of Lombardy ; on the north-east, of Monte Rosa and the neighbouring high Alps ; on the north, of the mountains of the Val d'Aosta (Mont Blanc itself is hidden by them) ; on the west, of Monte Viso and the Dauphiny Alps ; and on the south and south-east, of the Maritime Alps and the Appennines ; with the plain extending from the foot of the hill to the bases of these mountains in every direction. As the eclipse was to be total for the Superga itself, and for the western and southern mountains, and partial for the northern mountains, I had thought it possible that I might see in great perfection the different phenomena in the different parts of the view. The sequel will shew that in this respect I was disappointed, but that (by chance) a most important advantage was obtained by my adherence to this plan. Finally it was arranged that Professor FORBES should make his observations at the Observatory, and that I should go to the Superga.

On the 7th, the observations to be made were fully discussed, and the series of observations intrusted to each person were drawn out in the form of written instructions. The observations bearing upon physical optics were principally consigned to Professor FORBES ; those of astronomical character to myself. The unfortunate circumstances of weather, however, rendered the former impossible, and in some degree abridged the latter.

The morning of the 8th, at one or two o'clock (civil reckoning), was very dark and lowering ; scarcely a star was visible. I proceeded, however, with a companion, to the Superga, and reached it at a short time before five o'clock. Every facility for viewing the eclipse, from any part of the church or convent of the Superga that I might select, was offered me by the fathers of that establishment ; and, had my object been simply to view the country during the eclipse, I should undoubtedly have stationed myself in the upper gallery of the dome of the Superga. But the platform in front of the portico offered far greater facilities for the placing of my telescope, and more of general convenience ; and, by moving a few steps, I could at any time command the whole plain. I therefore adopted the platform as my station. I think it due to the courtesy of the Italians to remark that, though many persons were present, I did not receive the smallest interruption of any kind from any one. The sun was clear, and I saw the beginning of the eclipse very well.

The power which I used throughout the eclipse was about 27 (as I have since found by the well-known method of comparing a distant object seen in the telescope with a near one seen without it). This power was found very convenient. I had intended, occasionally, to use a higher power, but was prevented from doing so by the following circumstance. The dark glasses adapted to the higher powers were made a little darker than was necessary at Greenwich; not, however, so dark as to prevent the most delicate observation. But, in consequence of the cloudiness of the day of the eclipse, the sun was for the most part so faint that he could scarcely be seen when these higher powers, with their corresponding dark glasses, were employed; and, as the glass for the lowest power was necessarily still darker, it was useless to attempt to combine the eye-pieces for the higher powers with the dark glass for the lowest power. I was therefore compelled to lay aside the higher powers. It is certain, however, that the power which I used was sufficient for the nicest observations which the state of the air permitted, as it shewed very well the atmospheric undulations on the limbs of the sun and moon; and nothing smaller, of course, could be seen with certainty.

The dark glass which was used on the power actually employed was a combination of a purple and a green glass. It gave to the sun's disc a faint yellow-greenish tinge.

As the eclipse advanced (the sun continuing unclouded) I observed a circumstance which I have remarked in every solar eclipse that I have seen. It is, that the limb of the moon is very much more sharply defined than the limb of the sun. This is clearly owing to the difference of intensity of light on different parts of the sun's disc; the intensity near the centre of the disc being much greater than that near the limb; and the degradation very near the limb, though rapid, being gradual. I speak of this as a fact of which I have not the smallest doubt; having long ago observed it in my daily practice as an observer with the transit-instrument and the circle; and having also frequently remarked it as an experimenter when I have thrown the image of a portion of the sun's disc upon a small screen, in which case I have always been able to determine whether the limb was approaching to the edge of the fully illuminated screen, simply by the change of the intensity of illumination. And I allude specially to this fact at present; first, because in contemplating the probable phenomena of the eclipse it had been a particular subject of

conversation between Professor FORBES and myself; secondly, because it may, perhaps, assist to explain a very strange observation which I shall shortly have to mention.

I had carried with me a wax taper in a lantern, which I lighted about the time of the commencement of the eclipse. Whenever I looked round over the country, I also looked at the flame of the taper; I cannot, however, say that I remarked any peculiarity in the colour either of terrestrial objects or of the candle flame. The flame, as the eclipse advanced, appeared much brighter (and must have been visible to a great distance at the totality), and its colour seemed somewhat redder; but I believe that this change takes place in just the same degree when the general light is diminished from any other cause. The surrounding objects did not receive the greenish hue which I have remarked in other eclipses of nine or ten digits: I know not whether this was due to the cloudiness of the day, or to the continued correction of my eye by reference to the light of the candle.

I saw no spots whatever on the sun's disc.

About six minutes before the totality, I specially recorded the remark that there was a slight undulation on the limbs, but that the cusps were perfectly sharp. I cite this particular observation because I find it noted in pencil at the time; but I am quite certain that the cusps were seen perfectly sharp at every other time. The general aspect of objects was now very gloomy.

As the totality approached, the gloom increased rapidly. About two minutes (or perhaps more) before the totality, my companion exclaimed that it was darker towards the Val d'Aosta. I immediately looked in that direction, and am satisfied that it was not darker there. The country, however, looked blacker on that side, partly, I think, because it is more encumbered with wood, and partly, perhaps, because the mountains are nearer than on the south side, and therefore have less of the whitish atmospheric tinge.

At this time, and to the totality, the appearances were very awful. The gloom increased every moment; the candle seemed to blaze with unnatural brilliancy: a large cloud over our heads, whose appearance I had not particularly remarked, but which, I think, was of cumulo-stratus character, became converted into a black nimbus, blacker, if possible, than pitch, and seemed to be descending rapidly; its aspect became terribly menacing, and I could almost imagine that it appeared animated. Of all the appearances of

the eclipse, there is none which has dwelt more powerfully upon my imagination than the sight of that terrible cloud. The sun was very little clouded; his narrow crescent form could be seen with the naked eye when the eyelids were partially closed; there was, however, a dark cloud immediately above him, and fainter clouds about him.

Immediately before applying my eye to the telescope to view the completion of the obscuration, I imagined that the light which the sun cast upon the ground was of a reddish colour. But the light was so very faint that I cannot at all vouch for this observation.

I have now to mention a very strange observation. I was viewing the sun most carefully with the dark glass upon the eye-piece, while the small illuminated ring was closing rapidly; my watch was lying on the parapet on which the short telescope-stand was placed, and I was counting its beats with the intention of observing the time which might elapse between the appearance of Mr. BAILY's beads and the total obscurity: I saw the moon's limb advance to the sun's and cover it completely. I withdrew my eye for a moment from the eye-piece, when I heard my companion remark that the sun was nearly gone. I said firmly, "It is out." On being assured that it was not, I again applied my eye to the telescope, and to my infinite surprise I again saw the narrow ring of the sun's disc, not quite so bright as before: I again saw the moon's limb advance to the sun's limb and cover it. In other words, I saw the totality completed twice. With regard to the *fact*, I can only say that I was at the time most fully alive to every thing which occurred, and that I was specially prepared for an observation which I expected to be one of the most important in the whole eclipse; and I have not the smallest doubt that the thing occurred, under the circumstances in which it was viewed with my telescope, precisely as I have stated. The *explanation* I cannot offer with great confidence; but I conceive that it may be the following. I have already remarked that the light of the sun's disc very near to its limb is considerably less than in those parts of the disc which are a little farther from the limb. This being assumed, it is evident that the interference of a cloud, which was sufficiently dense to hide the faintest part of the disc (at the limb), but not sufficiently dense to hide the brighter parts, would sensibly diminish the sun's diameter. Now I was assured by my companion that there was a cloud upon the sun at the time when I first saw its extinction;

and this cloud, though not sufficient to conceal the edge of the sun's disc from the naked eye, might be sufficient to conceal it, as viewed in a telescope, in which the specific brightness of any surface is much less than to the naked eye, and which also was armed with a dark glass. But if this explanation be valid, it may apply to many other phenomena. I have frequently seen the sun's limb deeply notched; and I have conceived that this was due to irregularity of refraction: it may have been due to irregularity in the transparency of the atmosphere. Mr. BAILY's beads may themselves have depended on this circumstance. I now return to my narrative.

I saw nothing whatever of beads or other irregularity in either of the extinctions of the sun's limb. The cusps were perfectly well defined till they met.

I quitted the telescope and looked round the horizon. The outlines of the mountains could with great difficulty be seen: but every thing, though not black, appeared horribly gloomy. My companion believed that there was a dark-green tinge on every object: I did not remark it. I endeavoured to ascertain whether the darkness could be seen sensibly to travel over the great plain; but could not satisfy myself that it was so: the whole seemed to me to become black at once. Professors PLANA and FORBES, however, on the Turin Observatory (from which the mountains to the north and west are visible, but not the plain), were confident that they saw the darkness travel gradually. It is possible that, from my elevated position, I saw the country too much in detail to observe this: it is possible also, that my eye was applied to the telescope at the critical time. The illumination was so small that I could with difficulty read the divisions on the watch-plate, which was within eight inches of my eye: I did not try a printed book. The clouds were much less distinct than before; but as far as they could be seen, they appeared terribly threatening. But the appearance of the moon can never be forgotten. It was like a black patch fixed in the sky, surrounded by a ring of faint light, whose breadth I estimated to be one-eighth of the moon's diameter (or probably four minutes). The colour of this ring was nearly white, inclining (as I thought) to peach-colour, but its illuminating power was very small. It was brightest at the lower part and to the left: this brightness travelled a little to the right. (It will be remarked that a point to the left of the lowest point was the part last covered by the moon.) The

clouds, however, were so near to the moon on all sides, and a dense cloud was so nearly in contact with it at the top, that it seems exceedingly probable that some of these appearances might depend upon them.

I gazed earnestly at this remarkable ring, and I could not divest myself of the idea that it was produced by the sun's light shining past the moon's body through a portion of our own atmosphere. I wish it to be understood clearly that I do not offer this as an explanation of the ring (indeed, considering the number of miles by which the moon's limb overpassed the line drawn from the place of observation to the sun's limb, I cannot now consider such an explanation feasible). I wish merely to convey the impression which was given to me at the time of viewing the phenomenon. Indeed, I remarked at the time that the appearance was almost exactly similar to that produced by a brilliant street-lamp when its direct rays are just prevented from reaching the eye by a post or by the corner of a building. I think it possible that there might be a very slight radial appearance in the light of the ring; but I do not recollect it with certainty, and I am perfectly certain that it was not sufficiently marked to interfere sensibly with the general appearance of annular structure. The moon appeared to be extremely near; her distance might have been estimated at a few hundred yards. The whole appearance of things was very unnatural and frightening. No stars were seen from the Superga, the sky being covered with clouds; but I found from the reports of MM. PLANA and FORBES, as well as from the conversation of many persons whom I met in general society, that many stars were seen at Turin and at other places in the neighbourhood. I may take this opportunity of stating, that I heard of distinct instances in which horses exhibited signs of very great terror when the totality came on.

I took off the dark glasses, and carefully examined the moon with the telescope. Her disc was distinctly visible as having independent light; and I think that if it had been stronger, I might have seen the large tracts of different brightness on her disc. I could not, however, see the smallest inequality of light, of the nature either of broad dark tract, or dark spot, or bright spot. I looked carefully for a long time (in proportion to the whole duration of darkness), and am confident that there was nothing of this kind to be seen.

While thus looking at the moon, I saw, to my great surprise, some small red flames at the apparent bottom of the disc (the top, as seen with the

naked eye). The number of flames, as I have them impressed on my memory, and as I find them drawn on a small pencil sketch made a few minutes after their appearance, was three; their form was nearly that of saw-teeth in the position proper for a circular saw turned round in the same direction in which the hands of a watch turn: their height was certainly not greater than one-fourth of the breadth of the ring, or probably a minute: the distance between the first and third was, perhaps, forty degrees or more on the moon's limb; their colour was a full lake red; and their brilliancy greater than that of any other part of the ring. On my calling attention to these, my companion saw them with the naked eye. It will be remarked that the part of the limb in which the red flames appeared was immediately in contact with the dark cloud, of which I have spoken; and we attributed them to some irregularity in the density of the cloud's edge.

While engaged in watching the reappearance of the sun, I lost the opportunity of observing how the ring and the flames disappeared. Every luminous appearance, however, and every trace of the remainder of the moon's limb, vanished as soon as the smallest portion of the sun was uncovered. No beads or irregularity of any kind could be observed. The general illumination of the earth and sky was restored with very great rapidity. The clouds soon began to cover the sun, and in a short time it was invisible. In less than half an hour, a few drops of rain fell.

My companion, who had better opportunities than I had of observing the formation of the ring, &c., has given me the following account:—

“A bright line seemed to form round the right side of the moon before the disappearance, but not quite round, so that the ring was not complete; but, at the moment of the total disappearance, the ends seemed suddenly to join and form the complete ring, brightest on the left side, and as if beams of light came out. It continued brightest below, and at one time disappeared on the upper side, but a heavy black cloud was touching it there. Shortly before the reappearance, the brightness increased on the upper side; and immediately before the reappearance there were little beams of flame-colour starting out. There was no defined edge to the ring; it changed sensibly, being brightest first on the left side where the sun had gone in, then below, and then on the right side; the light coming out at each place successively, like little beams from the moon's edge. There was no remarkable change in the colour of the light till the little flame-coloured beams shot

out for a few seconds before the reappearance. The general appearance of the country during the totality was very frightful; but every object, all the distant hills, &c. &c., were distinctly visible: it was like looking at objects through a very dark-greenish glass. The sky in every part, except that in which the sun was, was covered with thick clouds. The sun also was covered by the clouds very soon after his reappearance."

The numerous persons who watched the eclipse from the Superga appeared to notice with great interest the progress of its phases to the totality; and when the sun was actually hidden there burst forth from them, first a low murmur, and then loud sounds of applause. Immediately after the restoration of the sun, the whole crowd dispersed, and nobody seemed to regard with the smallest interest the phases of decrease of the eclipse.

The meteorological circumstances of the atmosphere were evidently much affected by the concealment of the sun. The air after the totality appeared transparent (as it usually does when the ground is cold); and there rested, upon or near to the flanks of the mountains, a series of stratified or cumulo-stratified clouds, at an elevation of less than 2000 feet, with a lower surface very sharply defined, and (as far as I could judge) most truly horizontal through the whole extent to which I could see them, and with a less regular upper surface: the depth of these clouds could not be more than 200 or 300 feet. They had not the smallest resemblance to the ill-defined fog-clouds which hang about the mountains at all elevations in rainy weather, nor to any other clouds that I have seen during the day in these countries. I think that I have seen clouds in the evening which resembled them more nearly than any others.

After the termination of the eclipse, the day became very hot, and the aspect of the country became very similar to that which it usually presents at this season.

It was not till some hours after my return to Turin that I found that MM. PLANA and FORBES had not seen the moon at all during the totality. The region in which the sun and moon ought to have been seen was covered with an opaque cloud: I have little doubt that it was the same cloud which I, from the Superga, saw just above the moon (the azimuths of Turin and the moon being almost exactly opposed), and to which I was inclined to attribute some of the peculiar phenomena of the eclipse.

I fear that I have greatly trespassed upon the time of the Royal Astro-
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nomical Society; and I can offer only this apology: that in describing a phenomenon of such strange character, of which so few authentic accounts exist, there appears to be no possible way of including all those points which are really of scientific interest, except by narrating every thing which was seen, and leaving to others the power of selecting from the mass those circumstances which may possess some real value.

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