

THURSDAY, FEBRUARY 23, 1871

## THE MEDITERRANEAN ECLIPSE, 1870

## II.

IN my former article under the above title, written from Venice, I gave as shortly as I could the conclusions at which I had arrived as to the results of the various Eclipse expeditions as gathered from the very imperfect information then at my disposal. Since I returned home, I have naturally become possessed of more facts, though even yet the time has not arrived for discussing all the observations as they must be discussed before an absolutely final verdict can be given.

Still, there is so much general interest taken in the recent work, that I venture to return to it at the present time, more especially as I can now print a letter from a distinguished American astronomer, giving his view of the work done, and also as I am anxious to refer to Prof. Young's article which has recently appeared in NATURE.

Prof. Peters, whose long and laborious researches on the sun are well known to all of us, thus writes in reference to my former article:—

"Its perusal has been to me a source not only of pleasure but of much instruction. You have placed on record, with great lucidity, the question as it stood before the Eclipse, and the points to be examined by the various ways of observation for bringing the question nearer to its solution. Although the unfavourable state of the weather over the entire zone of totality, as it seems, from Spain to Sicily, has greatly obstructed the execution of the plans and the extensive preparations made with the liberal aid of our respective governments; and although hitherto, of course, only imperfect, mostly verbal, information has reached us of what the parties really did succeed in obtaining—still the result that is to be drawn from the sum total, as you are showing, seems of importance. The spectroscopic, polariscopic, and telescopic observations altogether agree in demonstrating an interior portion of the corona to belong to the sun. The existence of such a solar stratum is sustained also by my researches on the motion of spots when near the limb, pointing to a refraction on, or rather above, the sun's surface. I concur further in your opinion that the outer, more irregular radiating portion of the corona very likely owes its origin to our atmosphere. It is highly to be regretted that our Etna parties, in elevations respectively of 3,100, 5,500 and 8,000 feet, suffered disappointment from a heavy cloud at the critical moment of totality. Their observations would have been decisive as to the local and atmospheric cause of the radiating coronal phenomenon."

One more extract before I proceed. With reference to the suggestion (based on my observations of injections into the chromosphere) contained in my article, that probably the green line seen in the spectrum of the Corona might indicate a new element lighter than hydrogen, Prof. Young, claiming priority in the suggestion, writes:—

"In *Silliman's Journal*, November 1869, I wrote, 'should it turn out that this line in the spectrum of the aurora does actually coincide with 1474, it will be of interest to inquire whether we are to admit the presence of iron vapour in and above our atmosphere, or whether in the spectrum of iron this line owes its origin to some foreign substance, probably some occluded gas as yet unknown, and perhaps standing in relation to the magnetic powers of that metal.'

"This is the only reference I am able to make here. In my paper published in the Proceedings of the American

Association for 1869, the same thing is, I think, more forcibly expressed. I think you will find it also in my Eclipse Report in the 'Journal of the Franklin Institute' (and in my letter to NATURE last spring).

"The idea that 1474 might represent some new element occurred to me at once when I found it in the Corona, but of late I own I have more inclined to the opinion that it might possibly be a true iron line, and caused by meteoric iron dust of almost infinitesimal fineness; yet I have always felt the difficulty of supposing the complicated iron spectrum reducible to this one line."

I feel it due to Prof. Young to give this extract, though I confess I do not see that the suggestions are similar, nor do I see anything similar in the letter referred to, though I have lighted upon this passage which I had forgotten, which shows the great advance that has been made. Prof. Young last year wrote\* "It is not impossible that the so-called corona may be complex. Some portion of its radiance may, perhaps, originate in our own atmosphere, although I do not yet find myself able to accord with the conclusions of Dr. Gould and Mr. Lockyer in this respect, and am strongly disposed to believe that the whole phenomenon is purely solar." His present views were given to the readers of NATURE three weeks ago, as in the main concurring with my own.

With reference to Prof. Young's article, I am anxious to say one word on the "sudden reversal into brightness and colour of the countless dark lines of the spectrum at the commencement of totality," witnessed by himself and Mr. Pye. I have seen this *once*, and only once, during all my observations, and Professor Young (who enjoys better atmospheric conditions than I do) has never seen it when working with the new method. Now, I hold that the new method is competent to pick up such an envelope as the one referred to by Mr. Longley, if it can pick up an uprush similarly composed; and although of course the vapours competent to give such lines are not far off, as the ordinary observations prove, I do not think they are ordinarily high enough above the level of the photosphere to be seen in this manner. That the number of lines is largely increased when the atmospheric glare is withdrawn, was proved during the American Eclipse.

But to return to the Corona, the main point of attack during the last Eclipse. Since my last article was written I have had an opportunity of inspecting copies of the beautiful photographs taken by Mr. Brothers at Syracuse, and also one of the photographs taken by the Americans in Spain. These, compared with the sketches taken at the respective stations, are very curious. In the Spanish photograph there is a very distinct "rift," or dark space in the coronal region, extending, I believe, almost to the sun, and fainter indications of two other such rifts in another region, not extending so low down in the Corona. So far as the facts have yet been before me, only one of these rifts was sketched. Now, at Syracuse Mr. Brothers also photographed rifts—three rifts; but the sketches did not record a single one. In Prof. Watson's drawing, a copy of which I have now in my possession, there is no indication whatever of them. But there is a much more important fact behind. Of course, if these rifts had been in the same positions in the two photographs, taken at stations so wide apart as Spain and Sicily, the presumptive evidence in favour of the solar nature of the Corona for a distance outside the sun equal to

\* NATURE, vol. i. p. 533.

its diameter would have been overwhelming, and feeling that here was a crucial test to apply to a question which has so long been debated, but never with such interest among the workers as recently, it was with some excitement that I found myself before these two photographs some little time ago with two American astronomers of eminence, for the purpose of endeavouring to settle the question. Suffice it to say that we came to the conclusion that the rifts were not identical, that the two cameras had *not* photographed the same phenomenon, although at first there appeared to be sufficient similarity to make the matter appear doubtful, and, unfortunately, the photographs vary so much in size, and the margin of the American one is so limited, that it will be scarcely possible to make a final comparison until they are brought to a common scale, and superposed the one on the other. I do not think it is surprising that rifts should appear in both photographs, supposing a non-solar cause were at work, for the Corona between the rifts on Mr. Brothers' photograph looks like a very wide ray.

Assuming then for the present that the photographic evidence goes the way of all the other evidence—that in short, the solar corona, including all its fantastic boundaries, has been probably reduced from one, two, or three solar diameters, to six, eight, or ten minutes,—I care not which,\*—let us examine some of the details of the various observations.

In Professor Watson's drawing, the intimate connection between the higher and lower levels of the chromosphere (including the portions not at present observed by the new method), comes out in a very striking way. Mr. Seabroke at my request, made careful maps of the positions of the prominences before the totality commenced, and Professor Watson made his drawing of the Corona, independently of the positions of the prominences. On the homeward journey the map was compared with the sketch, and to use Professor Roscoe's words, "On comparing the two drawings thus independently made, a most interesting series of coincidences presented themselves. Wherever on the solar disc a large group of prominences was seen in Mr. Seabroke's map, there a corresponding bulging out

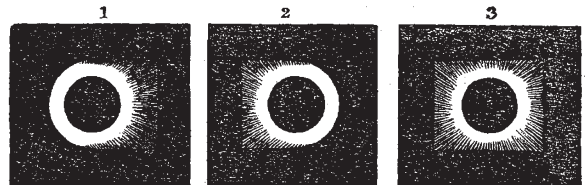
\* I beg here to give the actual words employed by Dr. Frankland and myself in the communication to the Royal Society on the subject. Speaking of the chromosphere, it was remarked "the tenuity of this incandescent atmosphere is such that it is extremely improbable that any extensive atmosphere, such as the corona has been imagined to indicate, lies outside it"—Proc. R.S., Feb. 11, 1869. I never imagined that all the Corona was non-solar. Again, Proc. R.S., No. 116, 1870, discussing the American Eclipse, I state that the chromosphere includes the "radiance" observed in the American Eclipse, of which radiance Dr. Gould wrote as follows:—

"An examination of the beautiful photographs made at Burlington and Ottumwa . . . and a comparison of them with my sketches of the corona, have led me to the conviction that the radiance around the moon in the pictures made during totality is not the corona at all, but is actually the image of what Lockyer has called the chromosphere. This interesting fact is indicated by many different considerations. The directions of maximum radiance do not coincide with those of the great beams of the corona; they remain constant, while the latter were variable. There is a diameter approximately corresponding to the solar axis, near the extremities of which the radiance upon the photographs is a minimum, whereas the coronal beams in these directions were especially marked during a great part of the total obscuration. The coronal beams stood in no apparent relation to the protuberances, whereas the aureole seen upon the photographs is most marked in their immediate vicinity. . . . Whatever of this aureole is shown upon the photographs was occulted or displayed by the lunar motion, precisely as the protuberances were. The variations in the form of the corona, on the other hand, did not seem to be dependent in any degree upon the moon's motion. The singular and elegant structural indication in the special aggregations of light on the eastern side may be of high value in guiding to a further knowledge of the chromosphere. They are manifest in all the photographs by your parties which I have seen, but are especially marked in those of shortest exposure, such as the first one at Ottumwa. In some of the later views they may be detected on the other side of the sun, though less distinct; but the very irregular and jagged outline of the chromosphere, as described by Janssen and Lockyer, is exhibited in perfection."

of the Corona was chronicled on Professor Watson's drawing, and at the positions where no prominences presented themselves, there the bright portions of the corona extended to the smallest distances from the sun's limb." We may remark that these coincidences show the excessive fidelity of the drawing, and make it one of the most valuable of the products of the Expedition.

On former occasions the Corona has been stated to assume a roughly four-cornered form. This was also observed in Spain last December, and seems at last explained by three drawings made by one of the American party there.

At the commencement and end of totality, when the moon unequally covered the sun, the photographs have recorded an excess of light on the Corona on the side where the limbs occur nearest in contact. I am told that this effect in one of Lord Lindsay's photographs is very striking; it is certainly so in one of Mr. Brothers'. In the drawings we have a slightly different effect. At the commencement of totality, when the western or right hand limbs were in contact, we get Fig. 1, at the end of totality the appearance recorded was Fig. 2; the picture at the middle



of totality compounding both these appearances, and being roughly represented by Fig. 3, in which the rectangular appearance comes out in its full strength.

A word now about the polariscope observations. I may remark on this that it is much more easy for us to explain slight polarisation which might be atmospheric, than it is to explain, if we content ourselves with laboratory experiments, strong *radial* polarisation which must take place at the sun. If we assume that gas or vapour of considerable tenuity does not reflect light (although I think this is to assume very much for the gas or vapour *at the sun*, at all events), what is it that reflects light to us at the sun, and reflects it apparently only *above* the level of the intensely incandescent hydrogen? Certainly not solar spray. If we deny reflection to gases altogether, may it not be the continuous portion of the spectrum of the gas itself to which the light is due. But this question of polarisation is certainly one in which very much remains to be done, and it is *consoled* to know that the results obtained now will much facilitate the planning of the next polariscope campaign, which, we may add, should not be deferred beyond the end of this year.

J. NORMAN LOCKYER

#### PHYSICAL LABORATORIES

IN an excellent article in a late number of NATURE, Prof. Fickering has drawn attention to the importance of the practical teaching of Physics, and has shown how this is being done on an extensive scale in America. It may be interesting to trace the similarity between the methods employed by different teachers, and to show what opportunities are and have for some time past been open to students in London for the practical study of every branch of Physics.