THURSDAY, FEBRUARY 2, 1871

SPECTROSCOPIC OBSERVATIONS OF THE AMERICAN ECLIPSE PARTY IN SPAIN

THE complete and accurate account of the observations of the American Eclipse party in Spain, under the charge of Prof. Winlock, which was given by Prof. Langley in NATURE two weeks ago, renders any further report of our spectroscopic work almost unnecessary; and yet perhaps a somewhat fuller statement with reference to one or two points may not be wholly superfluous.

Of the four spectroscopes employed, two were what might be called *analysing*, and two *integrating* instruments. The analysing instruments are designed to study separately the spectrum of different portions of the prominences and corona, only a small part of the object being examined at a time; the integrating instruments, on the other hand, deal with the entire mass of light received from the whole luminous body, without distinction of parts. In the first class of instruments, a distinct image of the object is thrown upon the slit by the object-glass of a large telescope, each point in the slit receiving light from only one point in the object. In the second class no image is thrown upon the slit, every point of which receives light from every point in the object; and if a telescope is used at all (as was the case with Mr. Pye's instrument), it must have a field of view large enough to include the whole object, and must have its eye-piece adjusted for distinct vision of a star—*i.e.*, in such a manner that the rays from a star shall be parallel when they leave the eye-piece. In this case the telescope increases the angular diameter and area of the object, and consequently the amount of light received, without otherwise at all changing the conditions.

Prof. Winlock's instrument and my own were of the former class. Prof. Winlock had a spectroscope of two prisms attached to an equatorial of $5\frac{1}{2}$in. aperture, and about 7ft. focus. My own instrument had (during the totality) the dispersive power of seven prisms, and was attached to an equatorial of $6\frac{4}{10}$in. aperture, and $8\frac{1}{2}$ft. focal length.

The instruments of Messrs. Abbay and Pye were of the integrating kind. Mr. Abbay's had the collimator and observing telescope and two of the prisms which belonged to my old five-prism instrument. It was provided with the means of comparing the observed spectrum directly with the spectra of hydrogen, sodium, magnesium, and iron.

Mr. Pye's instrument was much smaller, but as its prism was made of the extra-dense flint, its dispersive power was very nearly the same as Mr. Abbay's; and the addition of a small telescope in front of the slit, magnifying about $2\frac{1}{2}$ times, and thus increasing its light about six-fold, made it, I think, fully the equal of the other in power and efficiency.

Professor Langley has so well stated what we saw, that it is not necessary to repeat it; but I cannot refrain from putting on record that the sudden reversal into brightness and colour of the countless dark lines of the spectrum at the commencement of totality, and their gradual dying out, was the most exquisitely beautiful phenomenon possible to conceive, and it seems to me to have considerable theoretical importance. Secchi's *continuous spectrum* at the sun's limb is probably the same thing modified by atmospheric glare; anywhere but in the clear sky of Italy so much modified indeed as to be wholly masked.

I wish at this time to call special attention to the evidence which we obtain as to the extent of the self-luminous corona, or "leucosphere," as it has been recently named,* by combining the indications of the two classes of instruments.

By my direction Mr. Pye recorded the brightness of the lines which he saw during totality on an arbitrary scale from 10 down. These are his numbers, C 8·5, D_3 5·5, 1474 10, F 3. I suppose the actual amount of light of each kind would be roughly proportional to the squares of these numbers, for we seem instinctively to call one luminous object twice or thrice as bright as another when it would give the same light at twice or thrice the distance.

If so, the numbers representing the relative amounts of light would stand C 72, D_3 30, 1474 100, and F 9, neglecting fractions.

Now, in the analysing spectroscope the case is very different, and it is difficult to make an accurate estimate; but I think those who have been accustomed to observe both C and 1474, would admit that their ratio of brightness is something the same as that between a first and fifth magnitude star; *i.e.*, C is at least 25 times and perhaps 50 times as bright as 1474. Even during the totality, 1474 can hardly be called conspicuous in an analysing instrument, while C blazes like a red Sirius. It seems necessary, therefore, to assume that the area which emits the 1474 light is to the area which gives C, roughly in the proportion of 100 × 25 (or 50) to 72—that is to say, the angular area of the self-luminous corona is from 35 to 70 times as great as that of the red stratum of hydrogen and prominences combined. I suppose these taken together would be about equivalent to a ring 15″ high surrounding the sun, and this would make the self-luminous corona equivalent to another ring from 8′ to 16′ high.

Of course I am aware that the numerical data of this calculation are very uncertain, and I have therefore neglected all considerations of shading and inequality of illumination. But the principle is, I think, correct, and it has this advantage. The presence of a light cloud or haze does not sensibly affect the result, because the calculation is based solely on the ratios between lights of two different kinds in the two different instruments, and these ratios would not be seriously affected unless the cloud absorbed one kind of light more than the other.

With the analysing spectroscope alone the case is entirely different; a light cloud or haze vitiates everything. Thus some of the observers, favoured with a less clear sky than we at Xeres, saw the C and F lines even on the moon, undoubtedly by reflection from thin clouds. I saw myself the C line as far as 6′ or 7′ from the sun, far above any possible hydrogen atmosphere.

Therefore, although Prof. Winlock and myself both saw the 1474 line to a distance of more than 16′ from the sun, I should not dare to lay much stress on that observation as showing the true limits of the self-luminous coronal matter. I base my belief that the limit of 15′ or 20′ is reached by it in

* This name seems inadmissible, except as one of the sub-divisions of the chromosphere.—ED.

some of its angular prolongations, more upon the observations of 1869, when the sky was exceptionally clear, than upon anything seen at this time; and yet all the observations of this year, so far as I can see, accord well enough with the idea.

The two faint lines which I saw last year between D and 1474, and which I thought might also be corona lines, were not seen this year by any one, so far as I can learn. I certainly saw two such lines last year, but I was not then at all positive about their belonging to the corona (I have felt somewhat annoyed by finding them put on the same footing as 1474 in several publications of the last year or two), and my present impression is that they were two of the faint iron lines that often appear in protuberances in that portion of the spectrum.

The question has been raised whether the corona line *exactly* coincides with the 1474 dark line in the solar spectrum. The difference, if any (and I have not found the slightest reason to suspect the least want of coincidence in observations with the whole dispersive power of 13 prisms), is less than $\frac{1}{10}$ of one division of Kirchhoff's scale.

Just before the totality began, I placed the slit of my spectroscope exactly tangential to the sun's limb at the point which would be last covered, and brought the 1474 line, already bright, as is usually the case at the base of the chromosphere, exactly to the cross hairs. After the totality had fairly begun, I moved the equatorial in right ascension until the slit was more than 16′ east of the sun's limb, and the line remained continually visible, though of course growing fainter as the distance from the sun increased. There is not the slightest possibility of mistake, nor of error beyond the limit named, *i.e.*, $\frac{1}{10}$ of one division of Kirchhoff's scale.

And now a few words in relation to the nature of the Corona. It seems to me to be a complex phenomenon, made up of at least four, perhaps five different elements; and in the main I concur with the views put forth by Mr. Lockyer in a recent number of NATURE, with the exception that I should be disposed to assign a greater relative importance to the truly solar portion of the phenomenon than he appears to do.

1st. We have, I think, surrounding the sun, beyond any further reasonable doubt, a mass of self-luminous gaseous matter, whose spectrum is characterised by the green 1474 line. The precise extent of this it is hardly yet possible to consider as determined, but it must be many times the thickness of the red hydrogen portion of the chromosphere: perhaps, on an average, 8′ or 10′, with occasional horns of twice that height. It is not at all unlikely that it may even turn out to have *no upper limit*, but to extend from the sun indefinitely into space.

2nd. This region undoubtedly reflects to us a certain amount of the ordinary photospheric sunlight. This reflected light is of course polarised radially to a considerable extent. Its spectrum ought to show the ordinary dark lines, but they are partly masked in the manner Mr. Lockyer has so happily explained, and partly by the faintness of the spectrum.

3rd. Our own atmosphere, even when clearest, must apparently extend this corona, both outwards, and inwards upon the moon's disc. Since, however, the inner edge of the coronal ring is far the brightest, the inward extension of the corona should be most marked, except at the very beginning or end of totality, and I have no doubt it is: that is to say, at the middle of totality the illumination of the moon's disc gives a somewhat exaggerated measure of the effect of our own atmosphere in extending the corona outwards. Accordingly, I am disposed to think the effect of the atmosphere (when clear) is a very subordinate one, since in 1869 the light upon the moon's disc was only very trifling compared with that even a whole degree from the sun. This atmospheric light would also be polarised radially. Its spectrum would be mainly that of the chromosphere, prominences, and "leucosphere" combined, a discontinuous bright line spectrum.

4th. There must be a large subjective element, for two even skilled observers, standing side by side, describe phenomena differing in very essential points.

5th. I am somewhat inclined to think with Oudemans (see his paper published in NATURE Nov. 10) that possibly *cosmical dust* between us and the moon may play an important part. Assuming a light cloud of such matter, one or two hundred thousand miles above the earth's surface and of great thickness, it becomes easy to account for the straight dark streaks, the varying form (if it does vary), and many other puzzling phenomena of the corona-phenomena which can hardly be produced by portions of our own atmosphere deeply immersed in the lunar shadow, but which, I own, seem to me now less aurora-like and less certainly solar than they did a year ago. I do not see how optical tests by polariscope and spectroscope could discriminate between the effects of such a cloud and those of our own atmosphere.

C. A. YOUNG

POPULAR NAMES OF BRITISH PLANTS

The Popular Names of British Plants. By R. C. A. Prior, M.D., F.L.S. Second Edition. (Williams and Norgate.)

THERE are many botanists who know little of the English names of Plants; and there are many who know these intimately, yet are not botanists. Both classes will welcome this comprehensive volume: and those who possess neither a philosophical nor a popular knowledge of the subject, will yet find abundant interest in a book, which is the work of an accurate scholar and philologist, as well as of a scientific botanist.

Most interesting, and perhaps least expected, is the light which these names throw upon the history of early civilisation. Many of them date from a period antecedent to the European settlement of the Aryan race, and enlighten us as to the habits of our remote ancestors some thousand years ago. We discover from them that the men who continuously advanced through many countries, from the confines of India to the British Islands, were no race of savages, but a comparatively civilised community: that they understood letters; that they had a knowledge of the useful metals; that they possessed the principal domestic animals; that they cultivated the oak, the beech, the birch, the hawthorn, the apple; grew wheat, barley, oats, rye, beans; built timber houses and thatched them; hedged their fields and fenced their gardens.

In a later class of names, which betray the intercourse of our forefathers with Roman cultivation and Grecian poetry, many a strange piece of myth or history lies em-