INSTRUCTIONS FOR OBSERVERS, AT THE ENGLISH GOVERNMENT ECLIPSE EXPEDITION, 1871

II.—Polariscopic Observations

THE chief points to which observers of polarisation should direct their attention appear to be:—

A. What is the nature of the outlying corona?

B. Can the radial polarisation of the circumsolar corona be traced down to the photosphere, or, if not, how low?

C. Is secondary atmospheric polarisation traceable? and if so, does the plane change during totality?

A. We might suppose this to be due—

(1) to circumsolar matter (though at a great distance from the sun) reflecting light,

(2) to circumsolar matter in the state of self-luminous gas,

(3) to circumlunar matter diffracting and, to a certain extent, reflecting light (most improbable),

(4) to lofty atmospheric haze or cloud, of excessive tenuity, diffracting light.

The light ought to be, for

(1) strongly and radially polarised,

(2) unpolarised,

(3 and 4) insensibly or all but insensibly polarised.

Hence polarisation observations would only serve to discriminate between (1) on the one hand, and (2), (3), or (4) on the other.

From the faintness of the object and its considerable extent, the naked eye, armed with a polariscope, might be best. If a telescope be used, it should be of quite low power, and the aperture as large as the breadth of the pupil multiplied by the magnifying-power.

Suppose the polariscope be Savart's, the quartz plates being thick enough (if the naked eye be used) to give bands as narrow as, say, 20″ diameter.

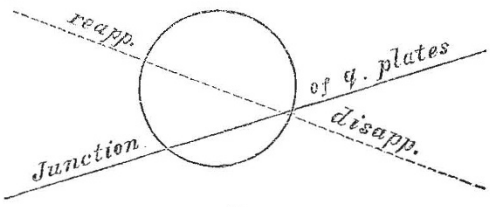

Fig. 1.

Let the observer rotate the polariscope till the bands, if any, seen on the dark moon disappear; then, *without rotating the instrument round its axis*, let him *incline* the axis so as to point at the outlying corona in different directions round the sun, and notice whether the bands spring into existence; and if so, let him sweep *round* the sun, noticing what lies *outside* the clearly circumsolar corona of 5′ or so height, and let him notice particularly by estimation the direction, relatively to the bands, of the radius vector of the region where they are most vivid, or, better, the azimuth of both radius and bands. He should also specify, *provided he can do so with certainty*, whether the bands were black-centred or white-centred. He should also state in his account, and verify the statement by an observation made at leisure before or after totality, whether his Savart is constructed (or set) so as to have the hands *parallel or perpendicular* to the principal plane of the Nicol.

A very useful adjunct to a Savart's polariscope would be a glass reflector, or else a tourmaline, placed so as to cover a small segment of the field of view near the edge. On account of the possible difficulty of illuminating the reflector in the peculiar circumstances of a total eclipse, a tourmaline would seem to be preferable. It should be placed for the naked eye at the least distance of distinct vision—for a telescope, in or in front of the eye-piece, where a real image is formed so as to be seen distinctly—the axis of the tourmaline being parallel to the edge or chord of the segment, and the bands being set perpendicular to this chord. In the event of rotation during the observation, the whole should be rotated together. The question whether the bands are bright-centred or dark-centred, which, in the case of slight polarisation, is difficult to decide, would thus be replaced by the simpler question, whether the bands in the field were of the same character as in the segment (*i.e.*, bright being a prolongation of bright, and dark of dark) or of opposite character.

The observer should previously have practised on the blue sky, rotating his Savart till the bands disappear, and noticing to what degree they are brought back by small changes of pointing without rotation, so as to be prepared for what he is liable to from secondary atmospheric polarisation during totality.

Should only very feeble bands be seen in the outer corona, such as might possibly be attributable to atmospheric polarisation operating through small changes of pointing, it would be well for control to rotate the instrument *a little* till bands are fairly visible on the disc of the moon, and notice whether on passing to the outer corona, *in whatever direction*, the bands, instead of being reinforced, tend rather to be drowned in white light. Should luminous beams or dark rifts be seen in the outer corona, so as to exhibit contrast of light and shade in close proximity, a good opportunity will be afforded of testing whether the light of the outer corona is polarised or not. If it be polarised, then on rotating the Savart, so as to make the bands cut at various indications the boundary of light and shade, the bands will in certain azimuths of the Savart be stronger on the luminous than on the dark side of the edge of the beam or rift. If it be unpolarised, then, whatever be the azimuth of the Savart, the bands will be rather drowned in white light than reinforced on passing from the dark to the luminous side of the edge.

But Savart's and other colour-polariscopes, which are admirable for detecting a slight polarisation in light which is not particularly feeble, break down when the difficulty arises from the feebleness of the light rather than the slightness of the polarisation. In such cases a simple double-image prism, with a diaphragm-tube, is better. Unless those who have seen total eclipses can decide from trial (suppose on the clear sky after sunset, or at night when illuminated by the moon), combined with

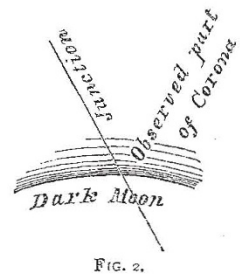

Fig. 2.

their memory of the degree of illumination of the outer corona, it might be well that the observer should be provided with and should try both instruments.

B. For this a telescope will be required with a magnifying power of, say, 16 or 20. A biquartz seems the best instrument, placed at the common focus of the eye-piece (which should be positive) and objective, and combined with a Nicol's prism, or, if it can be procured, a thoroughly good tourmaline. A tourmaline might be placed over the eye-hole, whereas a Nicol might have to be placed in the body of the eye-piece, which, however, is no particular disadvantage if properly done.

Let it be ascertained by previous trial how much a Nicol must be turned from the position in which the two halves are purple alike to make the tints contrast more vividly. Say it is 30°. Suppose the observer on the line of central shadow, so that the limits of disappearance and reappearance will be on opposite ends of a diameter. The biquartz and Nicol have been relatively set so that the line of junction is in the plane of polarisation of light extinguished by the Nicol, turn them together before totality 30° (or whatever other angle may have been fixed on) to either side of the diameter of disappearance, and, pointing the telescope to the place of disappearance (Fig. 1), await totality without dazzling the eye. The moment the sun is covered, apply the eye to the telescope, and notice whether there is a vivid contrast of colour right and left of the line of junction of the quartz plates *all the way down to the dark moon* (Fig. 2), or only in the higher parts of the circumsolar corona.

Be ready to repeat the observation before reappearance, with the telescope pointed to the place of reappearance; and meanwhile, if time permits, repeat Prazmouski's observation by pointing the telescope, without rotation of the analyser, so that the line of junction bisects the moon, and noticing whether the semi-

circles of the corona are purple alike where they abut on the junction, and what is the order of colours in the semicircle on receding from the junction. A record as to which is which of the two halves of the biquartz should be carefully preserved.

Should secondary atmospheric polarisation be so strong as to throw doubt on the results (which may be judged of by noticing the light on the dark moon), it would be well to rotate the analyser till the two halves seen on the dark moon are purple alike, and then alter the pointing of the telescope, and repeat Prazmouski's observation.

It will be observed that the same general principles apply to the elimination of atmospheric polarisation, whether the polariscope employed be a Savart's polariscope, a polariscope with quartz wedges, or a biquartz polariscope.

C. This is of little intrinsic interest, its chief use being to clear up possible doubts as to the results obtained by the observers of A and B. Should there be an observer not otherwise employed, he might be deputed to observe the direction of the Savart's bands on disappearance, both on the dark moon and the surrounding sky, and whether this direction changes during totality. Also it should be specified in which pair of opposite quadrants they were black-centred and in which white-centred. Should this be found impossible or uncertain (the instrument being unprovided with the adjunct mentioned above), the Savart might be used as a simple Nicol by turning it end for end, so that the quartz plates are next the eye; and with this the plane of polarisation might be roughly determined by means of the azimuth of the principal plane of the Nicol when the light most nearly disappears.

Should registration of the azimuth be attempted, the Savart would be fixed so as not to be reversible. In that case the observer might be provided with a double-image prism and diaphragm-tube for separate use in case of need.

Stoppage of stray light in a telescope designed for polarisation

The want of this appears to have occasioned some difficulty at the last eclipse.

The simplest way is by a stop, with a hole just large enough to contain the image of the object-glass. Such exists in the erecting eye-piece, where an image of the object-glass is formed in the body of the eye-piece. It exists too, in a Gregorian or Cassegrainian telescope, where the stoppage is imperative. But in an ordinary refracting telescope, with an inverting eye-piece, the eye-hole (from certain motives of convenience) is larger than in front of (*i. e.* nearer the object-glass than) the bright circle, or image of the object-glass; and unless the tube is sufficiently provided with stops, when a faint object near a bright one is looked at, light from the bright, reflected from the inside of the tube, is liable to enter the field of view. Large instruments are provided with stops; but I fancy smaller instruments are sometimes turned out without them. This should be looked to.

The observer may test the correctness of stopping by taking out the eye-piece, inserting a paper disc with a central hole of the size of the field-glass, turning the instrument nearly but not quite to a bright object, as well as to points more distant from the bright object, and noticing whether the side of the tube, even when viewed in a direction grazing the edge of the hole, is properly dark, so that only the edges of the stops are seen.* On the other hand, the stops should not obstruct a clear view of the object-glass as seen through the hole representing the field-glass, or they will render the outer portions of the object-glass useless.

General Remarks

I consider the observation recommended by Mr. Ranyard (see NATURE, Aug. 24, 1871), very important, IF, after what Prazmouski and Ranyard have done, the point be still deemed doubtful. Prazmouski's observation seems to have been beautifully devised and executed, but carelessly described. It is only by conjecture that I can make sense and harmony with what is known, out of his observations as described by himself. But I think that Mr. Ranyard has at least shown that our conjectural interpretation of Prazmouski's observation is the right one; and if so, the point seems settled.

It is for this reason that, in lieu of No. 3, first half, I proposed something new. What becomes of the magnesium, &c., which the spectroscope reveals low down in the gigantic puffs which the sun emits? The hydrogen must surely carry the magnesium, &c., with it to the higher regions, though the magnesium, &c., would soon be condensed, and so would not be detected by the spectroscope. These substances would exist in the form of an exceedingly fine haze or dust. I use the two words, "haze" to denote a filmy cloud of molten "dust" of solid matter. This haze or dust is capable of detection, and, according to my interpretation, *has* been detected, by polarisation; and it is interesting to know how low down it can be detected. Mr. Stoney's speculations as to layers are utterly inapplicable here, as they imply a state of tranquillity quite unlike what we now know to exist, at any rate in connexion with the puffs.

I don't know why, in the second half of No. 3, Mr. Ranyard prescribes placing the line of junction *across* a sector or rift, *if* by that he means *turning* the eye-piece carrying the quartz plates so that the line is perpendicular with the corona to the sector. It would be more likely to yield results if it cut it obliquely, as represented for the corona in Fig. 2. But probably he only means pointing the telescope so that the junction cuts the rift. If the observer notices contrasting colours, he may *then* proceed to determine the plane of polarisation. G. G. S.

* If reflection occurs from the part of the tube so near the eye as not to appear *within* the field, it will not signify much.

SCIENTIFIC SERIALS

THE *Journal of the Quekett Microscopical Club*. No. 16. October 1871. "Microscopic Work and Conjectural Science," being the address of the President (Lionel S. Beale, M.B., F.R.S.), for the year 1871. This address is chiefly occupied in combating the method, presumed to have been adopted, of depreciating one kind of scientific investigation in order to elevate another, and attacks without ceremony those who would elevate physical science to the disparagement of microscopical observation.—"On the Examination of the Surface Markings of Diatoms by the Oxy-calcium Light," by N. E. Green. The writer of this paper details his examination of such diatoms as Isthmia, Biddulphia, Triceratium, Pleurosigma, &c., as opaque objects by high powers, as one-sixth Ross and one-twelfth Gundlach, through the agency of the oxy-calcium light. The conclusion at which he has arrived is, that the markings on all the above, except Pleurosigma, resemble "craters," the surface "being studded with rows of small shallow craters, the sharp edges of which projected slightly above, while the centres seemed to be below the surface." In Pleurosigma a different structure of the surface was observed. "The lime light brought out most distinctly the bead-like character of its markings; they stood out in bold relief like rows of Indian corn."—The Inaugural Address of the South London Microscopical and Natural History Club, by R. Braithwaite, M.D., F.L.S., is principally devoted to suggestions on the vast field for observation at the disposal of the microscopist.—"On Nucleated Sporidia," by M. C. Cooke, M.A. After describing the general structure which prevails in the genus Peziza of Ascomycetous Fungi, the writer details his method of mounting sections for the microscope in pure glycerine. The nucleated sporidia, so prevalent in this genus, are affirmed to be so affected by this method that in a short time all traces of the nuclei are lost, and the object of the paper is to indicate the doubtful value of nucleated sporidia in specific characters. The true nature of such nuclei and their uses are said to be obscure.

IN the *Revue Scientifique*, Nos. 13—18, are many valuable articles. Further reports are given of the proceedings of the Edinburgh meeting of the British Association, and a translation of Prof. T. Sterry Hunt's address to the Indianopolis meeting of the American Association. We have also a memoir of M. Lartet by M. G. de Mortillet; Helmholtz's paper on the rapidity of propagation of electro-dynamical actions; report of M. Chauveau's lectures on the physiology of virulent maladies; a lecture by M. Claude Bernard on the method and principle of physiology; a translation of P. Secchi's paper on the solar protuberances from the *Atti dell' Academia pontificia de nuovi Lincei*; a biographical sketch of Haidinger by M. Fouqué; reports of the proceedings of the various scientific institutions in France and Belgium; and translations of lectures delivered at the Royal Institution, University of Edinburgh, &c., by Prof. Tyndall, Dr. Carpenter, Dr. Laycock, and others.

SOCIETIES AND ACADEMIES

PARIS

Academy of Sciences, October 23.—The greater part of the communications read at this meeting were devoted to chemical subjects. Of mathematical papers only one was presented—namely, a continuation of M. Chasles' memoir on the determination of a series of groups of a certain number of points on a geometrical curve.—A note was read by M. J. Bertrand on the