

COMPARISON OF THE SPECTRA OF THE LIMB AND OF THE CENTRE OF THE SUN *

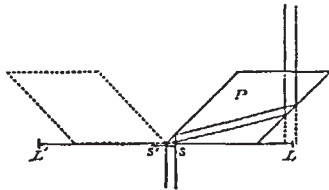
A COMPARISON of the spectrum of the edge of the sun with that of its centre is of great theoretical interest; but any comparison other than by direct juxtaposition must be very unsatisfactory, and the more so as the differences are less. In order to obtain spectra of two different portions of the sun side by side, where the slightest variations may be detected, I have constructed a small prism with four polished sides, its bases being parallelograms. This is so placed that one face rests upon the slit plate of the telespectroscope, and has its acute edge perpendicular to the slit at its middle point. The instrument may then be directed so that the image of the sun falls with its centre on the uncovered portion of the slit, while the light which forms the edge of the sun, falling perpendicularly upon the first surface of the prism, suffers two interior total reflections and a displacement depending upon the form of the prism. A glance at the figure, in which $s s'$ is the slit, $L L'$ the diameter of the sun's image, and P the prism, shows that no light from the covered part of the slit will reach the collimating lens except that which has been reflected from the two sides of the prism. The relation of the acute angle (ν) and the distance between the reflecting sides (t) to the focal length of the great telescope (F) and the width of the spectrum (a) is given by the formula,

$$2t \sin \nu = F \tan 16' - a.$$

The sides of the prism not fixed by the equation admit of considerable latitude, but should be made to approach the lower limit in order that the planes of the direct and transmitted images may be as little separated as possible. Of course t and ν should be so proportioned that the reflections may be total.

The instruments with which the following observations have been made are those belonging to the observatory of the Sheffield (U.S.) Scientific School, consisting of an equatorial telescope of 9 in. aperture, and 118 in. focal length, by Clark, and a spectroscope of Young's form by the same maker. The spectroscope has a dispersive power of 12 prisms of 60° . In most of these observations an eye-piece of high power has been adapted to it, which gives a separation of the D lines equal to 64 minutes nearly. In the small prism placed before the slit, a is equal to 0.4 in., a quarter of the length of the slit.

When the instrument is properly directed and in adjustment, we see a very narrow black line dividing the spectrum longitudinally into two parts of widely different intensity; the fainter,



belonging to the limb of the sun, is marked on its edge by the bright chromosphere lines. Upon comparing these two spectra, certain differences are recognised besides that of intensity, by far the most marked of which are exhibited by the lines δ_1 and δ_2 , which become sharper and less hazy near the limb. The line δ_3 possesses the same characteristic, but to a less degree; C and F also become sharper in the same region. Excepting these and the D lines it requires very close examination to detect any variation. There is, however, a line in the red at 768.1 of Kirchhoff's scale which is strongly marked near the centre of the sun's disc, but disappears entirely, to my power at least, within $16''$ to $20''$ from the limb. Two other lines below F, at 1828.6 and 1830.9 of the same scale, exhibit nearly complementary phenomena, *i.e.*, they are strongly marked near the edge, but much fainter at the centre. These latter lines also become greatly strengthened over the penumbrae of spots. The line 768.1 is not thus affected. These are all the differences which I have invariably seen in repeated examinations since February 17.

Others have, however, been suspected. Certain lines, which are strengthened in a region of spots like those above mentioned, appear to be strengthened also near the edge, but do not

* Made at the Sheffield (U.S.) Scientific School. Communicated by Prof. Newton.

undergo so marked a change. It is obvious that the differences should be most pronounced in the clearest sky, and such is the case. The closest examination has extended only from B to a short distance above F, as the plate glass of which the small prism is made has a decided yellow tint and absorbs the blue rays strongly.

Since the light from the border of the sun undergoes a general absorption, which reduces its intensity to much less than one-fourth that at the centre, according to Secchi's measurements, and yet the spectroscopic character is changed so slightly, it is impossible for me to escape the conviction that the seat of the selective absorption, which produces the Fraunhofer lines, is below the envelope which exerts the general absorption. But the phenomena of the faculae prove not only that this envelope rests upon the photosphere, but also that it is very thin. The origin of the Fraunhofer lines, then, must be in the photosphere itself, which is in accordance with Lockyer's views.

Any effects which the chromosphere might produce, we would anticipate finding most evident in the lines of those gases which are readily detected there. A reference to the observations shows at once a compliance with this anticipation in the lines of hydrogen, magnesium, and sodium. The line 768.1 is not less strikingly in concordance, if it be regarded as 768.7* (the ? indicates doubt as to the tenths of the scale, and * absence of a corresponding black line) of Young's Catalogue of Chromosphere Lines. The lines 1828.6 and 1830.9, with others of the same class, probably have their origin in the medium which exerts the general absorption, and thus are allied to our telluric lines. It also seems probable that the chromosphere is too transparent to reverse many of its lines. That this is the case in the helium lines is tolerably certain.

In the apparatus described, two similar prisms were also placed over the slit in a symmetrical position. The spectra of two opposite edges of the sun were thus brought together, and the change in refrangibility due to the sun's rotation was very clearly shown.

CHAS. H. HASTINGS

Newhaven, April 3

THE "INSTINCT" QUESTION

FROM the many additional communications we have received on this subject, we make the following selection.

With regard to a sense of direction, Mr. George C. Merrill, of Topeka, Kansas, writes as follows:—

I have learned from the hunters and guides who spend their lives on the plains and mountains west of us, that no matter how far or with what turns they may have been led in chasing the bison or other game, they on their return to camp always take a straight line. In explanation they say that unconsciously to themselves they have kept all the turns in their mind.

Mr. C. Bygrave Wharton, of Bushey, Herts, writes:—

As a left-handed and left-legged man who has more than once been lost in the bush in New South Wales, my experience may possibly be of interest to Mr. George Darwin and others. Invariably I unintentionally bore to the left; and once, after wandering for about six hours, just as I was giving myself up for lost, I discovered that I was within a hundred yards of the place from which I had started having performed a large circle to the left. It will thus be seen that though my left leg and arm are the stronger, there is always a tendency to walk in a circle to the left.

Mr. William Earley, of the Gardens, Valentines, sends the following interesting observations on the habits of wild rabbits:—

As is well known, the doe rabbit does not produce her young in any ordinary rabbit warren, or "run," but invariably selects a quiet out-of-the-way situation wherein to form a nursery for them. Now the reason for this peculiar practice has always been attributed to the fact that they leave their legitimate homes at this all-important period, simply because the male parents invariably destroy the offspring if an attempt be made to breed them in the permanent home or warren. I incline to believe we must look elsewhere for the explanation.

Firstly, then, a close atmosphere seems all-important to her development, as the old doe rabbit not alone denudes her breast of its natural fur covering wherein to ensconce them warmly all