

Helium Absorption in the Sun.

GENTLEMEN,—

Referring to the recent correspondence in your columns, I would like to make a few remarks. The doubts expressed by Father Cortie, Mr. Buss, and Capt. Daunt as to the origin of the dark line shown on prints from a photograph taken here by Mr. Nagaraja on May 4, 1907, may, I think, be set at rest by the following considerations.

The plate in question was measured by me with a Hilger micrometer microscope, with the following result :

Bright line at limb	5876.15
Dark line	5876.17

There is thus no sensible displacement of the dark line towards the violet, in fact both lines are slightly displaced towards the red from the normal position of the principal component of D_3 . A further series of measures of other plates taken during 1907, showing the dark and bright lines, give the following mean results, from six determinations of each :

Bright line at limb	5875.96
Dark line	5875.97

The coincidence is therefore very close indeed, and these values are in good agreement with Rowland's value 5875.981, and in very fair agreement with Hale's determination of the principal component, viz. 5875.924.

I may remark that the other plates measured show precisely the same characters as that of May 4, viz. a long dark line extending across the spot-spectrum, but not continuing across the entire spectrum. The individual values of wave-length show a considerable variation among themselves, ranging from 5875.79 to 5876.15. This is to be expected from the circumstance mentioned

by Mr. Buss and Capt. Daunt, namely, that the dark line always appears in disturbed regions where line-of-sight displacements are frequent. (Rotation displacements will not appreciably affect any of these measures.)

So far as I can gather, one difficulty your correspondents have in ascribing the line to helium is the fact that in the photograph it crosses the spot-spectrum, whilst in visual observations the line is seldom seen across the umbral spectrum. This, however, is easily explained as a result of the unsteadiness of the image on the slit plate and the prolonged exposure required. These conditions virtually produce a strong astigmatism in the direction of the lines, and they also tend to wipe out any distortions or irregularities in the different parts of the line.

Father Cortie's suggestion that the line is probably due to a spot-band near D_3 is ruled out by the great extension of the line on either side of the spot; also it is far too strong a line to be mistaken for any of the telluric lines mentioned by him, taking into consideration the high altitude of the Sun when the photographs were obtained.

I think, therefore, that Mr. Nagaraja may claim to have succeeded in photographing this somewhat elusive line, and to be the first to have done so.

It may be worth noting that the absence of any permanent dark line corresponding with bright D_3 does not necessarily imply an equality of temperature between the helium and the photospheric background. Were our eyes sensitive to the ultra-violet rays we should see abundant evidence of the same "anomalous" fact in the hydrogen lines themselves. Thus, the lines $H\zeta$, $H\epsilon$, $H\kappa$, $H\lambda$ are among the strongest chromospheric bright lines in the whole region of spectrum which can be photographed beyond K ; yet these lines have no corresponding absorption lines. The total quantity of hydrogen above the photosphere seems to be insufficient to produce appreciable absorption except in the four strongest lines $H\alpha$, $H\beta$, $H\gamma$, and $H\delta$; and the same paucity of material probably accounts for the absence of a permanent line of absorption at D_3 . It is to be remembered that a much greater depth of material is concerned in producing a bright line at the Sun's limb than is effective in producing absorption. Even quite near to the limb the depth of absorbing gas tends to become but one half that of the radiating gas outside the limb. It is interesting to observe in this connection that, unlike the majority of the Fraunhofer lines, which maintain the same intensity to within a few seconds of the limb, D_3 tends to become darker, as is shown by its much greater frequency of occurrence near the limb than in any other part of the disc*. This may possibly be due to the increased

* The records of D_3 as a dark line (174 in number) made at Kodaikanal in the years 1904 to 1906 inclusive, when freed from the effects of foreshortening, show that the greatest frequency occurs in the region between 15° and 30° from the limb.

depth of the absorbing gas near the limb, which is, however, never great enough to entirely absorb the photospheric light at λ 5875.9. The other much denser gases, on the other hand, appear to be entirely opaque to certain wave-lengths, the light emitted from their dark lines being the intrinsic radiation of the gas itself: these lines therefore maintain a constant ratio of intensity in all parts of the disc to the bright background of continuous spectrum.

Kodaikānal, S. India,
1908, April 5.

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