Sun-spots and Solar Temperature.

GENTLEMEN,—

Prof. Whittaker, in an article under the above heading in the *Observatory* for October, criticizes the opinions usually held as to the relatively low temperature of sun-spots, and argues that pressure would be an adequate cause for the characteristic phenomena in spot-spectra.

Referring to his statement that "it has never been demonstrated that "'arc' lines are associated with lower temperatures than 'spark' lines," I would point out that Messrs. Hale, Adams, and Gale have shown, in my opinion conclusively, that reduction of temperature is effective in producing the change from spark to arc intensities (*Ap. J.* xxiv. 185). The spectra obtained by them in passing from the spark to the strong arc (30 ampères), and from the strong arc to the weak arc (2 ampères), or the outer flame of the arc, indicated the probability that change of temperature alone was concerned in producing the altered intensities of the lines. And this they afterwards confirmed in a convincing way by volatilizing iron and other elements inside a tube of carbon, raised to a high temperature in an electric furnace. In the spectra thus obtained, where temperature alone could influence the radiating elements, the changes of intensity in the lines were of a still more marked character. From this it would follow, quoting Prof. Whittaker, "that spots are places of relatively low temperature."

Prof. Whittaker further states that "the peculiar stimulus which causes atoms to emit or absorb line-spectra appears in fact to have no direct connection with temperature, but to be primarily electrical in its nature." This statement must not pass unchallenged. Paschen showed in 1893 that heat alone will cause gases to emit their characteristic rays in the infra-red region of the spectrum *. In 1895 I showed that sodium can be made to emit or absorb its characteristic D radiation by heat alone (*Phil. Mag.*, May 1895). Recently I have succeeded in making iodine emit bright lines by raising the vapour to a high temperature in a

* F. Paschen, "Ueber die Emission erhitzten Gase," Wied. Ann. Bd. 50. pp. 409-443.

quartz tube, also under conditions which preclude the possibility of chemical or electric action.

As regards the statement that the low-level region of the chromosphere contains arc lines which are absent from the spectrum of the high-level regions, I would point out that differences of temperature in the chromosphere do not necessarily correspond with differences of level. In my discussion of spectra obtained at the eclipse of 1900 (*Phil. Trans.* A. 201, 457), I showed that temperature conditions corresponding with both arc and spark spectra may coexist at the same height above the photosphere.

Finally, as regards pressure. We have the most direct evidence that the pressure in the region of the absorbing gases in spots does not differ materially from the pressure in the absorbing layer over the photosphere. Humphreys has directed attention to the apparent absence of any pressure-effects in spot-spectra (*Ap. J.* xxvi. 29); and quite recently a series of measures made by me of certain iron lines which are subject to large pressure-shifts prove that, in the particular spots whose spectra I examined, the pressure could not have differed from that over the neighbouring photosphere by more than a quarter of an atmosphere.

While differing entirely from Prof. Whittaker on the above points, I am inclined to believe that the commonly accepted doctrine (originally, I believe, propounded by Secchi) that a spot is a localized mass of relatively cool gas absorbing the light of the photosphere will turn out to be erroneous. There is a considerable amount of evidence which tends to show that the spot-spectrum is in reality the fundamental spectrum of the relatively cool gases which are distributed everywhere over the solar surface. They are specially prominent in spots, on account of the absence of any ascending currents of highly heated material coming up from below in the region of the umbræ. The constancy of the spot-spectrum, which recent researches at this Observatory have shown to be on a par with that of the Fraunhofer spectrum, favours this view; also the fact that the characteristic flutings identified by Prof. Fowler with magnesium hydride are by no means confined to spots, but are to be found over the entire surface of the Sun.

As to the cause of the absence or displacement of the ascending convection-currents, I have no theory to offer. Possibly the presence of vortices in the higher chromosphere, which Prof. Hale believes he has obtained clear evidence of in certain spots, may help to explain it; but I must confess that to my mind this evidence is not altogether of a convincing nature, particularly that relating to the apparent inward movement of a hydrogen flocculus towards the centre of a spot (*Ap. J.* xxviii. Sept. 1908). Such an indraft as is perhaps indicated seems, at any rate, to be a comparatively rare condition, rarer, indeed, than the opposite state. Instances have not infrequently been recorded, here and elsewhere, in which the evidence seems just as clear of an outward tendency. Thus, spot nuclei occasionally seem to belch out

enormous volumes of glowing hydrogen. There can be no question that at the level of the calcium flocculi the normal structure of a spot is radial, and not spiral, as we should expect it to be on any vortex theory.

Solar Physics Observatory,
Kodaikanal, S. India,
1908, Oct. 27.

J. EVERSHED.

Jupiter in Cassiopeia.

GENTLEMEN,—

Referring to Mr. Lynn's letter in the *Observatory* for this month, in which he vindicates Schiller for supposing that Jupiter could be seen in Cassiopeia, I have recently seen the following in Mr. J. F. Moore's 'He Loved but One,' a biographical sketch of the famous Lord Byron. Byron, when a lad, having quarrelled with his mother, had ridden off from her house to take possession of his inheritance. Whilst out he observed a remarkable meteor-shower, which is described in terms that would more than do justice to a maximum display of Leonids. Meanwhile, "Jupiter had climbed to the Lady in the Chair" (p. 6); but this truly portentous event is mentioned without comment.

Yours faithfully,

Southfields, S.W., 1908, Nov. 17.

F. W. HENKEL.