The Problem of the Red Shift in the Solar Spectrum.

GENTLEMEN,—

In *The Observatory*, October 1937, pages 266–271, a paper by J. Evershed, F.R.S., under the above title was published, in which on page 270 he kindly referred to my theory that a light corpuscle consists of a binary system with components of equal mass and opposite charges, rotating round each other and travelling forward with the velocity of light; which leads to the spectral shift of light from the edge of the Sun being twice Einstein's value, and the deflexion of light from stars past the Sun between 1·3 and 1·5 times Einstein's value. Evershed conceded that these predictions appeared to be confirmed by his measures of the iron lines in the red and by Freundlich's observed value of the deflection of stars, but announced that the displacements of the sodium D lines at the limb of the Sun at the centre have precisely the Einstein value.

His fuller paper "The Red Shift of the D Lines of Sodium in the Sun" (*M. N.* **98**, 195, 1938), however, shows that (1) the calcium lines H_3, K_3, like the iron lines, give displacements at the edge which are twice Einstein's value, and still larger values at the centre, but (2) sodium lines

D_1 show no substantial difference between the centre and the limb.

I submit that :—

(i) Evershed had not the advantage of a total solar eclipse, and had to take measurements in full light, when the effect of scattering due to light from the centre is great. (ii) In the moist climate of England D_2 line could not be used in his research at all, owing to a water-vapour line broadening it on the red side. (iii) His measurements of D_1 lines were also in the humid vaporous atmosphere of England, with the Sun at a low altitude, when scattering due to terrestrial atmosphere was large. (iv) The sodium D_1 lines were rather broad, which made it more difficult to measure the shift exactly. (v) As lines of smaller wave-length are subject to greater scattering, measurements of such lines are much more unreliable than of those in the red region of the spectrum. (vi) There may well be surface currents at the solar edge, and so observations should be made at several different solar latitudes. (vii) Undoubtedly there are radial currents on the surface of the Sun, and so the measurements of calcium lines at the centre were not reliable; only the measurements at the edge can be free from such Doppler effects. (viii) Measures of shift near the centre must be uncertain on account of the width of the solar lines when high dispersion is used.

It is therefore submitted that the true test of Einstein's value can be furnished only by measurements of the spectral shift of lines at the edge of the Sun in the red region, least subject to scattering, preferably at the time of a total or annular solar eclipse, when the scattering due to light from the centre would be nil.

My formula for the spectral shift of light at any point on the disc is $(1+\sin^2\alpha)$ times Einstein's value, where α is the angle between the line of sight and the radius of the Sun, which gives double of Einstein's value at the edge.

I am, Gentlemen,
Yours faithfully,
S. M. Sulaiman.

Mr. Evershed writes :—

I should like to point out in reply to Sir S. M. Sulaiman that all my spectra of the Sun's limb have been secured under clear blue skies, and with the Sun at fairly high altitudes, where the effect of scattering is small, and may be assumed to be inversely proportional to λ^4. According to this law, in the line D_1 λ5895 the scattered light from general sunlight would be 1/5th of that near K at λ3930; and since the effect of this superposed light appears to have little effect on the lines near K, where the shift is about 1·9 times the Einstein value, it must be negligible at D.

Again, in the violet region at about λ4400 Royds' measures of eclipse spectra are in good agreement with those obtained in full sunlight, showing no effect of superposed light in the latter, and at D the scattered light would be reduced to 1/3rd of its value in the violet.

I have considered the possibility of an atmospheric line on the violet edge of D_1, which if present would tend to reduce the shift towards red, just as the water-vapour line on the red edge of D_2 vitiates the measures of this line. But there is no evidence of the presence of such a line, which being stationary would be revealed at times when the solar lines are shifted towards red by the relative motion of Earth and Sun.

As to the uncertainty of the measures, the width of the D_1 line has no effect. By the positive on negative method the width of a line has little or no effect on the accuracy with which the positive image may be made to coincide with the negative; and D_1 is particularly easy to measure, as it is symmetrical and with well-defined edges when photographed near the Sun's limb.

The effect of local surface currents on the Sun is a more serious difficulty. These movements affect all measurements of high-level or low-level lines of any element, and can only be eliminated by measuring many spectra, taken preferably at different solar latitudes. In the case of the high-levels odium line, D_1, I have measured series of spectra taken at the equator, in spot-latitudes, and at the poles of the Sun: in all of these regions the mean results are substantially the same, and in good agreement with the relativity effect.

I agree with Sir S. M. Sulaiman that further measures of spectral shifts should be made in eclipse spectra, as these could be photographed very much nearer to the true limb than is possible in full sunlight, and might include the emission lines of the chromosphere.