

### *Radial Movement in Sun-spots.*

GENTLEMEN,—

Referring to the letter published in your May issue with the above title, I may mention that Mr. Buss is correct in supposing that displacements of the spectrum-lines in sun-spots must occur when the slit lies in the direction of the node but does not bisect a spot symmetrically through the umbra. I have found that when the slit is placed across the penumbra on the side of the spot nearest the centre of the disc the lines are invariably convex towards the violet, and on the limb side the displacement is always towards the red. This was one of the earlier tests we applied when the general character of the displacements was in doubt, but reference to it was omitted in the communication sent to the Royal Astronomical Society\*.

That the displacements are due to motion, and to no other cause, would seem to be implied by the change in position-angle of the direction of maximum shift, as the spot is presented in varying aspects in its passage across the spherical surface of the Sun. This effect is, in fact, another vindication of the Doppler-Fizeau principle.

This direction of greatest shift has always proved to be the direction of the centre of the disc, but our observations are not good enough to determine it within  $10^\circ$  or so, consequently there is room for the hypothesis of a relatively slow rotation of the penumbral gases superposed upon the radial motion. So far, however, we have obtained no actual evidence that such an outward spiral movement exists.

Our recent work has shown that the radial motion is almost certainly confined to the reversing layer. In the higher chromosphere the absorption-lines  $H_\beta$ ,  $K_\beta$ , and probably  $H_\alpha$ , are usually (perhaps always) twisted in an opposite direction to all the other lines, which indicates an inward movement of the gases concerned. This appears to be an interesting confirmation of Prof. Hale's observation of the movement of a dark flocculus towards the

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centre of a spot, and indicates that the tendency may be a general one.

On the other hand, the hypothesis of a vortex, which Prof. Hale invoked to explain the magnetic field he has shown to exist in spots, would seem to be untenable if we have interpreted our results correctly. If a vortex exists, either above or below a sun-spot, it does not affect the absorbing gases of the reversing layer in the penumbrae.

Not the least surprising feature about these line-displacements is the fact, now brought to light, that they have been observed on many occasions previously, and yet, notwithstanding the prime importance of the subject, no one appears to have made any systematic attempt to investigate the motion. The earliest observation of the kind which I can discover was one made by Vogel on May 6, 1871, and quoted by Scheiner\*, who gives an illustration of a portion of the spectrum, showing the curious double twisting of the lines between two spots, a phenomenon we have frequently photographed when the slit lies across a group of sun-spots.

Kodaikanal Observatory,  
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Yours truly,  
J. EVERSHED.