CORRESPONDENCE.

To the Editors of 'The Observatory.'

Stationary Calcium in Space.

GENTLEMEN,

In *Nature* of June 16, 1921, Saha pointed out that calcium alone among the elements gives its "resonance" lines, H and K, in a part of the solar spectrum near that of maximum energy, and consequently that this element might be subject to selective radiation-pressure, and would be likely to be expelled from stars hotter than the Sun, such as those of type B showing stationary H and K lines. "Thus, Ca^+ atoms would be driven very far into the surrounding space. They will be prevented from absolutely leaving the system because with increase of distance the solid angle subtended by the disc of the star at the atom would diminish, and a condition of equilibrium will at last be reached." This would, of course, give lines stationary with respect to the star, and in the case of some early-type stars that would mean nearly stationary in space.

It appears to me, on the contrary, that if radiation-pressure exceeds gravity at the surface of a star there would be a residual force driving the gas away at all distances, since gravity and radiation-pressure would both obey the inverse-

square law. The Ca^+ would therefore leave the star with accelerating motion, and this motion would tend to a maximum and become constant.

Now I want to point out that this actually happens with our Sun. At Kodaikanal we have frequently photographed prominences in the H and K lines, which leave the Sun with accelerating velocity and, presumably, are driven into space, never to return. The speed when last observed may be anything between 300 and 500 km./sec.*, but the maximum or constant velocity stage cannot be observed, since prominences cease to be luminous at about a radius from the Sun's surface.

In novæ the same kind of thing happens. During the early stage of great luminosity the absorption-lines H and K and of hydrogen show accelerating velocities; but in this case radiation-pressure ceases to act when the star fades, and so the velocity becomes constant in a few days. In Nova Aquilæ III., according to my measures, this stage was reached about ten days after the great outburst of light, and the final velocity was of the order of 1700 km./sec. for one mass of gas and 2500 km./sec. for another †.

Apart from the novæ, it would seem that all stars of solar type may be expelling Ca^+ as well as hydrogen, and that stars of earlier type and greater surface brightness must be expelling still larger proportions of ionised gases, probably including Na. Is it possible that these gases, expelled in all directions from stars of high luminosity, eventually come into a state of equilibrium with reference to the stellar system, and so give rise to the stationary calcium and sodium clouds? The apparent absence of hydrogen is not a difficulty, since the hydrogen lines are less "persistent" than H and K and the D lines, which are themselves narrow and weak, indicating the last stage of tenuity in these clouds.

If we try to imagine what happens to a solar prominence when it has reached several parsecs from the Sun, it is difficult to see why the velocity should be materially changed. The residual minute forces from the surrounding stars would, one would think, tend to deflect the motion outwards from the plane of the Milky Way, unless there is an excess of dark matter in the stellar system, which would overcome the residual light-pressure of all the stars and attract the gases inwards. It is at any rate difficult to see why the gas should eventually come to rest, or remain at rest relative to the system of stars. The calcium clouds, hitherto observed only in the Milky Way, appear from Mr. Plaskett's results to be absolutely at rest with reference to the stars, and, judging by the fineness of the lines, they also appear to be in a state of supreme internal tranquility.

I am, Gentlemen,
Yours faithfully,
J. EVERSHED.

Ewhurst, Surrey,
1924, January 9.

* 'Kodaikanal Observatory Bulletin 55' (vol. iii. p. 209).
† 'Monthly Notices of the R. A. S.,' lxxix. p. 474.