LETTERS TO THE EDITOR.

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Sun-spots and Faculæ.

THE following account of the nature of sun-spots and of the faculæ commonly found associated with them, explains these phenomena by refraction through the sun's atmosphere on the supposition that the centre of a spot is the centre of a high-pressure area or anticyclone.

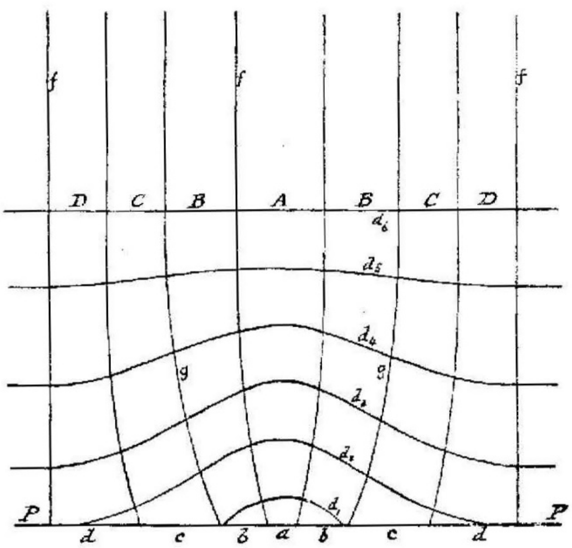
The descending central current in a solar anticyclone is caused by the exterior portion of the sun's atmosphere being at a temperature less than is consistent with convective equilibrium; consequently the whole of the descending column is colder and heavier than the atmosphere at the same level outside the area affected. The result is that the density of the atmosphere near the *base* of the column is increased, as compared with the normal density at the same level, by three different causes, viz.:—

(1) By lower temperature.

(2) By greater pressure, resulting from the upper portion of the column being colder and heavier than the normal at the same level.

(3) By additional pressure, resulting from the downward motion of the column being arrested near the photosphere; hence the pressure at the base is increased by inertia.

In the diagram annexed (a supposed section through the sun's atmosphere at a high-pressure area), the surface of the photosphere is represented by the line P P, and the successive surfaces



of equal density in the atmosphere are represented by the lines d_1, d_2, &c. These surfaces, indicating greater density in the centre of the area affected, must be convex-outwards in the centre, and concave-outwards near the margin, where they join with horizontal equal-density surfaces in the undisturbed atmosphere outside the anticyclonic action.

The area in question is seen from a distant point in the direction of E by the rays of light which emerge from the atmosphere in approximately parallel lines, represented in the diagram by the lines *f f f*. These rays before emerging must pass through the atmosphere by such courses as those represented in the diagram; that is to say, as they cross successive equal-density surfaces, moving as they do from a greater density to a less, they are refracted in a direction *less* perpendicular to these surfaces. The greatest deflection will occur about the positions of the lines *g g*, which cross the surfaces where these are most inclined to the photosphere. The areas A and B B will thus appear dark because they are seen by the light from smaller areas of photosphere, *a* and *b b*. As drawn in the figure the circular area, A, is nine times the area *a*, and consequently its mean brightness would be only one-ninth normal brightness; and the annular area, B B, being three times the area *b b*, would appear one-third normal brightness.

Beyond the greatest deflection lines, *g g*, the annular area on the photosphere is of greater width and less diameter than the corresponding annular area at the surface of the atmosphere. As drawn in the figure, the annular area, C C, is equal to *c c*, and would appear of normal brightness; while the area, D D, is about two-thirds of *d d*, and would appear of one and a half times normal brightness. In this region one or more faculæ would be seen surrounding the spot; one only if the concave-outwards curves of the equal density surfaces were superposed one on another, as in the diagram; while if some series of such curves extended beyond others, more faculæ would be seen.

The occurrence of "eruptive prominences" near (but not at) the position where a spot has disappeared on the margin of the sun, is accordant with an anticyclonic motion round the spot; for this motion premises a rising-up of the lower atmosphere in the outer portion of the area affected. So also the greater width of the absorption-lines of the solar spectrum over a sun-spot, indicating that the absorbing atmosphere is there of greater pressure, is accordant with the theory here advanced.

It should be noticed that the brightness of the surrounding faculæ according to this theory arises simply from the light in which the spot is deficient.

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Sailing Flight.

IN NATURE, May 14, p. 25, you have a notice of two works on flight of birds, and I am rather surprised to see that the theory of upward currents in the air is still adhered to.

In NATURE, November 4, 1880, I laid a few remarks before you on this subject, aided by a little diagram, and on re-perusing this can see little to add to them, and nothing to alter.

It seems to me that upward currents of air, to account for sailing flight of birds, is, firstly, quite needless; secondly, they cannot be seen or proved to exist; and thirdly, the entire absence of such currents can be (at least out here) optically demonstrated.

As stated in my note (November 4, 1880), above referred to, we have two steady winds out here, from N.E. and S.W.; they are not at all violent or gusty—indeed, if directed vertically they could not possibly lift and sustain a 20 lb. cyrus or pelican.

But the utter absence of vertical air currents in our N.W. wind, at the very time the large birds are soaring in it, is beautifully demonstrated by the tufts of cotton, blown from the burst pods of the tall cotton trees, *Bombax malabaricum*.

For many years I have had a rather large telescope, through which to study the Noga Hill villages and cultivation, at six to thirty miles south, and for long was puzzled by the frequent appearance of small white objects, which slowly crossed the field, horizontally, at all distances and elevations, and at a speed of about ten or fifteen miles per hour. At last I found they were cotton tufts, out of which the little seed had dropped, and the beautifully steady and horizontal paths of thousands, at all distances, was often remarkable, at the time the birds were soaring. Anything approaching vertical air currents must have been at once detected, and easily visible. I have for hours watched the sailing, at 1000 and 2000 feet, of Cyrus, called here Korson (*Grus Antigoni*); Pelican, called here Dherra (*Pelicanus*); three Vultures, called here Hogren (*Gyps Inds.*), and two larger kinds; two adjutants, called here Bov Tokla (*Leptoptilus Argala* and *Nudifrons*); one jabiru, called here Telia Hareng.

Now, not one of these birds are ever seen sailing in a straight line, unless when descending. They cannot rise, or even sustain themselves, without flapping the wings, unless in a breeze, and when moving in a curve or spiral.

For the first 200 or 300 feet, in rising, they flap vigorously, and when well above the surface eddies, begin sailing in spirals, rising ten and twenty feet at each lap, wings held rigidly extended, and the tail alone seen to move now and then, and so on to 1000, 2000 and 3000 feet.