

A New Theory of Sun-Spots.

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SUN-SPOTS, though a very long observed phenomenon, still defy satisfactory explanation. As a result of modern astrophysical research, especially with the spectro-heliograph, the facts known about them are many and any new theory attempting to explain the origin and behaviour of sun-spots has to take note of all these facts.

There was a time, years ago, when the very simple idea that sun-spots arose as a result of a hollow in the sun caused by something of the nature of a volcanic eruption, held the ground; but why these spots never appeared at high latitudes in the sun, and why they are largely confined to the equatorial belt of the sun, could not be given a satisfactory explanation. When you add to it the experimental conclusion of a definitely observed periodicity for this solar activity, this simple explanation becomes almost impossible of acceptance. That the dark appearance of these spots is due to the cooler vapours prevailing in this locality and that the cooling is due to the expansion of the hot vapours from the interior that have risen to the surface is quite possible. But then there is the question why if the vapours are right from the interior at a very much higher temperature, they are not actually hotter than the surrounding surface. It may be answered by limiting the origin of sun-spots to within a shallow surface layer of the sun even as terrestrial volcanic phenomenon. Then no very high temperatures different from that of the surface layer are called for. Then the cooling by expansion might become the more predominant factor and the relative darkness of the spots does find an explanation.

The revolutionising discovery of definite rotations round the axis of sun-spots, made with Hale's spectro-heliograph led to the forecast of magnetic fields associated with these spots. This was brilliantly verified by the observation of Zeeman effect in these spots. It was further observed in this study that the spots generally occurred in pairs and that the succeeding spot or spots have, in general, a polarity opposite to that of the leading spot. Thus, any theory put forward now must explain these additional observations as well.

I have been entertaining an idea for the last few years that such polarised phenomenon in the sun can be explained only on the basis of corresponding polarised happenings. An explanation for this peculiar behaviour of sun-spots must be sought in the swarms of planetary or cometary bodies we know to be going round the sun. The assumption is that these fall into the sun giving rise to the spots and that these are bodies having, like planets, a rotation of their own about their axes. Such an assumption seems to explain almost all the observed peculiarities of sun-spots.

(a) *Observed Periodicity and Latitudinal Effect.*—The sun-spot activity has been resolved into a marked eleven-year period and there are indications of the presence of many other periods superposed on this generally accepted period. If we assume the existence of a planetary, cometary or meteoric swarm of this period, the cyclical nature of the sun-spot activity naturally follows. At perihelion passage, some of these bodies which are distributed along a stretch of the orbit may be sucked into the sun, the impact and superficial entry being almost tangential. The observed superposed periods can be explained either as due to these bodies distributed along the orbit or as due to a number of such swarms of different orbits with corresponding periods. That sun-spots occur only about the equatorial belt naturally follows from the above. The orbits must of necessity be distributed at small inclination to the equatorial plane of the sun—hence the comparative absence of high latitude spots, any progressive shift in latitude of the spots with the advance of the period being explained by the corresponding distribution of these bodies in their general orbit which is quite possible.

(b) *The Magnetic Peculiarities.*—The magnetic peculiarities, so difficult of explanation on any of the older theories, seem to follow readily from the fundamental assumption made above. The assumption of these planetary bodies naturally involves the further assumption that as planets they have rotations of their own round their own axis. Hence, if such a body were to fall into the sun, the consequences can be imagined

to be as follows. The body, spirally converging on to the sun, hits the surface almost tangentially at a small angle and its penetration into the sun might be only to a small depth. If at all it is massive, its total rise of temperature and loss by vaporisation might be only slight during its rush through the solar atmosphere. Hence its penetration into the sun is certain. The angular velocity of its own rotation about its axes is sure to impart a rotation to the region of the sun round the point of impact and this explains at once the observed axial magnetic field of every sun-spot. The partial vaporisation of the body and outrush of the vapours accompanied by expansion and cooling explains the darkness of the spot, and the spectral changes noticed in spots.

Since the entry of the body into the sun is far from normal, because of its high velocity in its orbit, it is sure to get out, a process in which it may be assisted by the centripetal force due to the rotation of the sun itself. If the intense heat explodes the body, the emergence becomes multiple instead of being single and it accounts for the trailing spots being often multiple instead of being single. It is interesting to note at this stage that the direction of rotation imparted to the solar surface at emergence (from our viewpoint) is opposite to that at entry, even though the body continues to rotate all the time in the same direction. Thus the leading spot being opposed in magnetic polarity to the trailing spot or spots finds a ready explanation on this hypothesis. That the trailing group of spots all of them have the same polarity naturally follows. That in a solar cycle the polarity of leading spots remains unchanged also follows. That spots usually occur in pairs also naturally follows if we assume the incident body to emerge out of the sun, probably to skim the surface again giving rise to another set of spots.

Magnetic polarity observed even in localities showing no visible spots also follows, if we realise that some of these incident bodies may be too small to give rise to a spot of appreciable size on the surface of the sun. All the same they give rise to rotations on the solar surface and they are revealed to us as spots by this magnetic effect.

The only remaining aspect calling for an explanation arises from the observation that in succeeding 11-year solar cycles there seems to be a reversal of the magnetic polarity. Our observation and study of sun-spots has not extended through a number of cycles to really justify such generalisations. But inasmuch as the indications are, as stated, we may examine to see how this fits in with our theory. All that one has to make is the further assumption that there are two sets of such planetary bodies going round the sun with a 22-year period with a phase difference of 11 years between them, the individual rotations in the two sets of bodies being in opposite directions.

What these bodies might be, if they are the shattered remnants of comets or planets, if they are the remnants of the arms of a spiral nebulae whose nucleus is our sun are ideas that suggest themselves for further examination. The long period seems to suggest a cometary orbit of great eccentricity and one wonders if any evidence is available for the axial rotation of the comets. Possibly a cometary theory for the origin of sun-spots is not entirely a new idea. But the writer is not aware of any attempt to explain the magnetic polarities and peculiarities of sun-spots on the assumption of the planetary rotations of such cometary bodies. Hence this new theory of origin and behaviour of sun-spots is put forward for further examination by those engaged in the study of sun-spot phenomena.