# LETTERS TO THE EDITORS

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## Persistent Solar Rotation Period of 26·875 Days and Solar-Diurnal Variation in Terrestrial Magnetism

FROM an examination of the solar-diurnal variation in the horizontal force of the terrestrial magnetic field at Godhavn, Greenland, it has been established that the amplitude of the daily variation due to disturbance, $S_D$, varies in a regular way over a period of 26·875 days, so that the mean amplitude of $S_D$ on the ninth day of the period is four times as great as that on the nineteenth day. The investigation was made in the following way: the days in the period (seven sequences of 27 days followed by one of 26 days) were numbered 0–26, and the material used consisted of 185 sequences of 26·875 days covering the epoch July 1, 1926–September 11, 1940 (eight periods in 1931 in which the material had not yet been fully prepared being omitted). Only the sequences for the summer months, May–August, were used at first. The daily variation due to disturbance, $S_D = S - S_q$, was determined for the 1st day of the period (mean of the 0th, the 1st and the 2nd day), the 4th day (mean of 3rd, 4th, 5th day), 7th, 10th, 13th, 16th, 19th, 21st, 25th day for the total epoch (66 series). $S_D$ was analysed harmonically, the non-cyclic variation being eliminated at first, and the two first Fourier coefficients were determined (the 24- and the 12-hour term). Fig. 1 *a* gives the amplitudes $c_1$ and $c_2$ as functions of the number of the day. Next the material was divided in three groups: the disturbed summers 1926–31, the quiet summers 1932–36, and the disturbed summers 1937–40. The resulting values for $c_1$ are given in Fig. 1, *b*, *c* and *d*, where the marked points represent the observed values and the full curve is the curve from Fig. 1 *a* multiplied by a convenient factor. Figs. 1 *b*–*d* confirm that the period is persistent throughout the fifteen summers. Comparison of 1 *b*, 1 *c* and 1 *d* makes it probable that the length of the period has an error of $\pm$ 0·025 day.

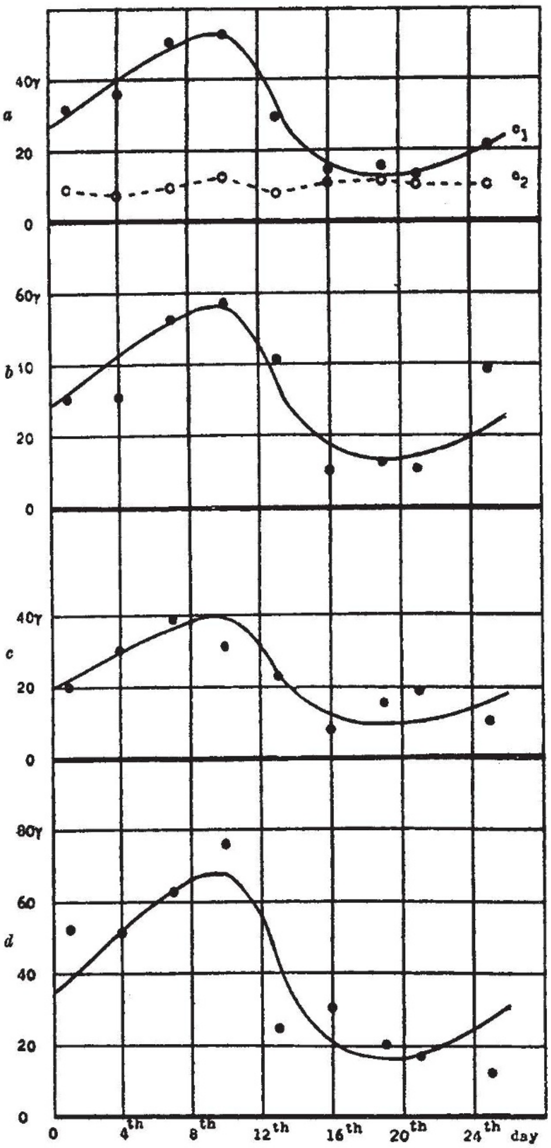

Fig. 1.

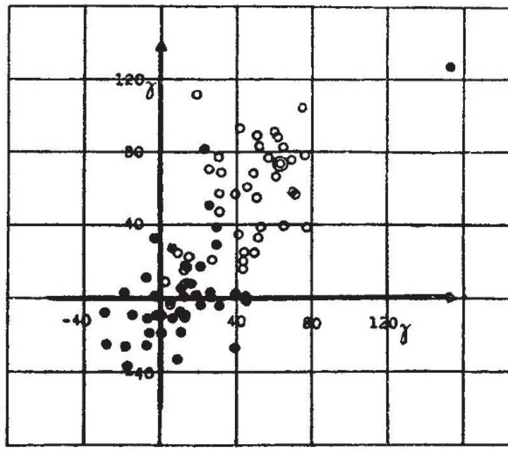

Fig. 2.

The variation of $c_1$ practically vanishes in winter and is not met with at Lovoe, near Stockholm, a little south of the auroral zone, the data for which have been examined for the summers 1937–40. A rough examination of *H* at Huancayo, Peru, during 1932–34 gave a negative result too. The vanishing of the effect in winter shows that a sunlit atmosphere is necessary, but the negative result at Lovoe seems to indicate that the effect is not due to a variation in the emission of ultra-violet light from the sun, but that charged particles from the sun are also a necessary factor. It should be pointed out that the big decrease of *H* that manifests itself as high values of $S_D$ on disturbed days takes place at local noon at Godhavn, just at the hour when the magnetic daily disturbance is at its maximum. It therefore looks as if the high $S_D$'s are due to a co-operative effect between the sunlit ionized atmosphere and the maximum stream of charged corpuscles from the sun. At Lovoe, however, the maximum daily magnetic disturbance takes place at local midnight and the corpuscles hit a dark atmosphere. It seems, therefore, most probable that the effect found at Godhavn is restricted to places north of the auroral zone, where the maximum magnetic disturbance occurs at noon. Unfortunately, the magnetic registrations from such observatories during the second polar-year 1932–33 are of too short duration to serve as a control of the effect found.

The international character-figure, *C*, does not show the period found; but by selecting days of different values of *C*, it has been shown that the amplitude of $S_D$ increases with increasing values of *C* in such a way that this increase is much more marked on the 9th day than on the 19th, so that the mean amplitude $c_1$ for days with $C \geqslant 1 \cdot 0$ is three times as great for the 9th day in the period as for the 19th. This result may be interpreted in three ways: (1) a periodic variation of the ionization by ultra-violet light (unlikely, as this should be a world-wide phenomenon); (2) a periodic variation of the intensity of the stream of charged corpuscles; (3) a periodic variation in the deflexion of charged particles emitted from the sun.

The persistence of a fixed period of rotation of the sun covering fifteen years seems to indicate that the corpuscles giving rise to the $c_1$-variation are controlled from an inner layer in the sun with a fixed speed of rotation.

In order to ascertain whether the regular variation of $c_1$ is restricted to means for many days (in Fig. 1 *a* mean of 198 days) a harmonic dial has been worked out for the 'single' days 10 and 21 (using for every day a mean of three days, as above). Fig. 2 shows the harmonic dial for the 42 single days in the disturbed summers 1926–31 and 1937–40 (the sine-coefficients being abscissæ, the cosine-coefficients being ordinates). Fig. 2 indicates that $S_D$ for almost every day in the 10th day group is that of a disturbed day ($S_D$ for the five international disturbed days is marked as a double circle), whereas for almost every day in the 21st day group it is that of a quiet day (corresponding to point 0·0).

Let $a_{10}$ and $a_{21}$ be the means of the sine-terms in Fig. 2 for the 10th day group and the 21st day group respectively, and $b_{10}$ and $b_{21}$ the corresponding means of the cosine-terms; assuming next that the deviation of a point in a group from the group-mean is accidental, then we can compute the mean error of $a_{10}$, $a_{21}$, $b_{10}$ and $b_{21}$. We find: $a_{10} - a_{21} = 29 \cdot 4 \pm 5 \cdot 6\,\gamma$ and $b_{10} - b_{21} = 46 \cdot 7 \pm 6 \cdot 7\,\gamma$, which is further evidence of the reality of the period found.

The regularity of the curve in Fig. 1 *a* seems to indicate that charged corpuscles emitted from the sun form a broader and more homogeneous stream than previously assumed. This is in good accordance with the fact often observed in the arctic that magnetic days occur at the same hour of the night in sequences of several days.

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