27-Day Recurrence Time Pattern of ΣKp and the Geometry of Solar Plasma Streams

by

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Abstract

The 27-day recurrence time patterns of ΣKp for the periods, 1951 to 1953 and 1961 to 1963 are illustrated with reference to the solar plasma velocity changes measured by Mariner 2.

Mariner 2 spacecraft obtained the data on the interplanetary plasma during the period August 29, 1962 through January 3, 1963. Main results are that (1) a strong correlation is found between the plasma velocity and the geomagnetic index Kp, (2) the plasma velocity shows a marked 27-day recurrence tendency and a close association with M-region geomagnetic storms, and (3) no variation of plasma velocity with respect to the solar distance between 1.0 and 0.7 A.U. can be detected. The daily mean plasma velocity and Kp are reproduced in Fig. 1 adding the daily mean values of H-component of the geomagnetic field and geomagnetic storms observed at Kakioka for the same period. Geomagnetic storms are represented by horizontal full or broken lines which are appended by black triangles and open half circles for SC storms and Sg storms, respectively. The length of the lines shows storm durations and the factors on the line are the maximum range of H-component.

There are close correlations between the solar plasma velocity and ΣKp or H and higher velocity plasmas associate with geomagnetic storms. At the Rotation Number 1770 epoch in Fig. 1, for example, the solar plasma velocity, ΣKp and H show typically a very close correlation each other. But, in general, the correlation between the solar plasma velocity and H is not stronger than that between the plasma velocity and ΣKp. All of these four elements show strongly 27-day recurrence feature as it is shown by thick vertical lines in Fig. 1.

Thus, the nature of solar plasma can be studied by analysing ΣKp index. Then, ΣKp's for the periods from 1951 to 1953 and from 1961 to 1963 are arranged according to the rotation number epoch and are investigated on its 27-day recurrence time pattern. Fig. 2 shows schematically 27-day recurrence time pattern of ΣKp for these periods. Hatched and dotted spaces show the days with $20 \leq \Sigma Kp < 29$ and $\Sigma Kp \geq 30$ respectively. The 27-day recurrence features can be seen around the days which are shown by thick vertical lines. Thus, the periods are divided by thick horizontal

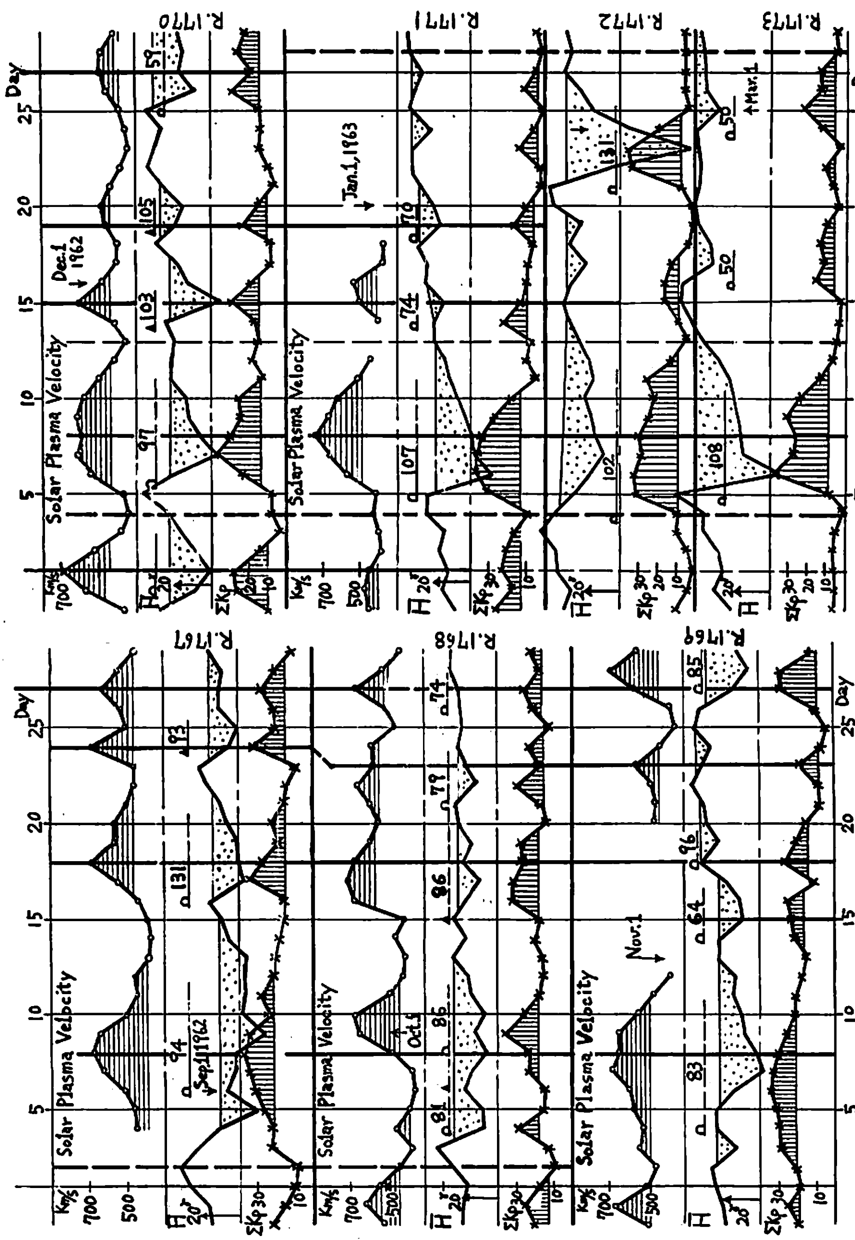

Fig. 1. 27-day recurrence tendencies of the solar plasma velocity, geomagnetic index ΣKp and daily mean values of geomagnetic H-component at Kakioka. (after Snyder, etc)

lines into five sub-periods, [1], [2],……which show nearly a similar 27-day recurrence time pattern. And thick broken vertical lines show days on which maximum peaks of ΣKp appear by the superposed epoch method for each sub-period.

As have been stated previously, these time patterns of ΣKp are nearly equivalent to space patterns of the solar plasma streams, in other words, solar M-regions. Acco-

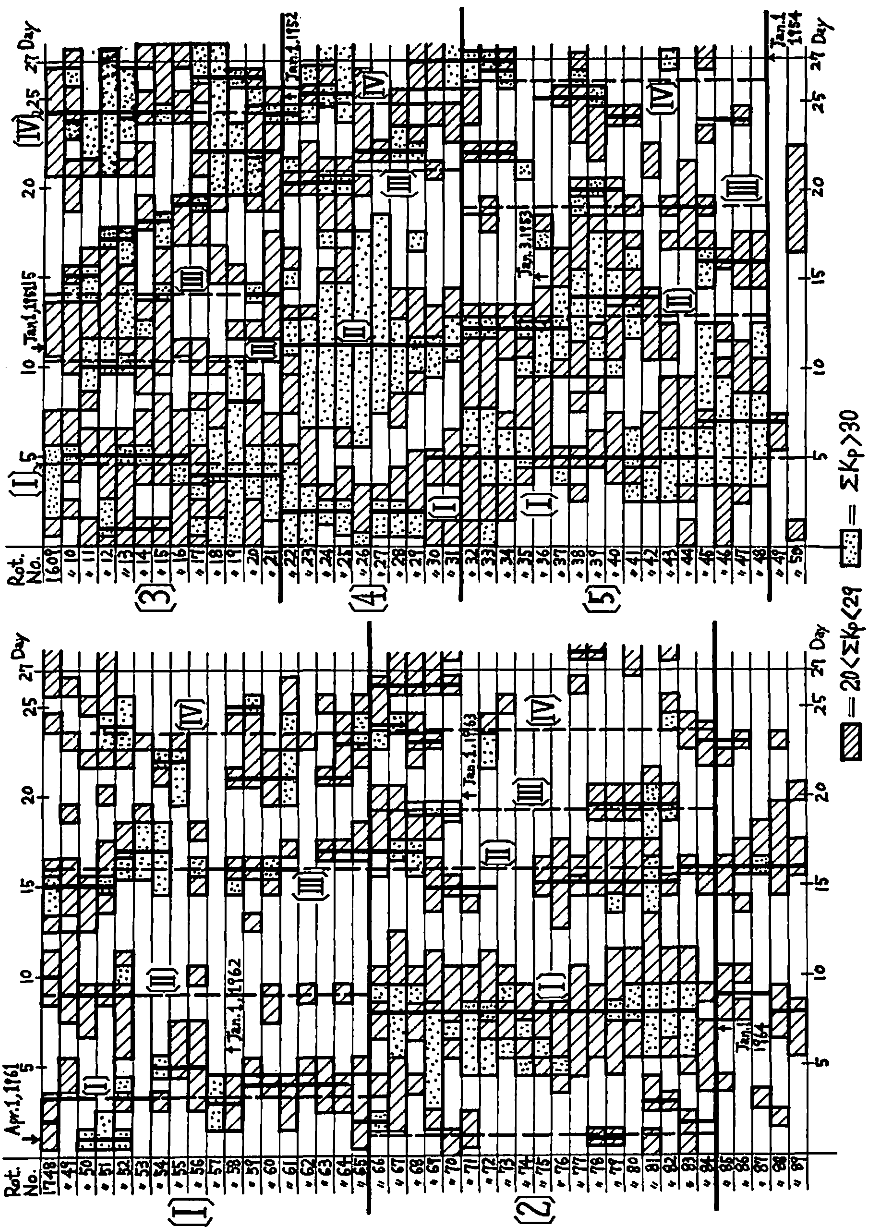

Fig. 2. 27-day recurrence time patterns for geomagnetic activity index ΣKp during the periods from 1951 to 1953 and from 1961 to 1963.

rdingly, the purpose of this note is to investigate morphological characters of higher velocity solar plasma streams (which produces a disturbance of ΣKp=20), for examples, its form, life time and width. There are generally four groups in M-region streams through all the period, though their time patterns are random. These groups are shown by [I], [II], [III] and [IV] in each sub-period. Life-time of the streams varies considerably, however, it is notable that there exists certain one stable and long-lived stream out of four or more solar plasma streams. These long-lived streams continue for about 10-20 cycles.The mean width of the long-lived stream is about 60°-70°.

The geometry of solar plasma streams in the interplanetary space is shown in Fig. 3, assuming the solar stream with the speed 600km/sec. Two broken lines, [1] and [2], show the curvature of the solar plasma stream with a speed 700km/sec and 350 km/sec, respectively. These features are proved by Mariner 2. Namely, the observed time delay between Mariner 2 and the earth fits to the expected one from the above -explained simple form of the stream. The rough trajectory of Mariner 2 is given in Fig. 3 reduceing from the Snyder's figure. According to this trajectory, the time

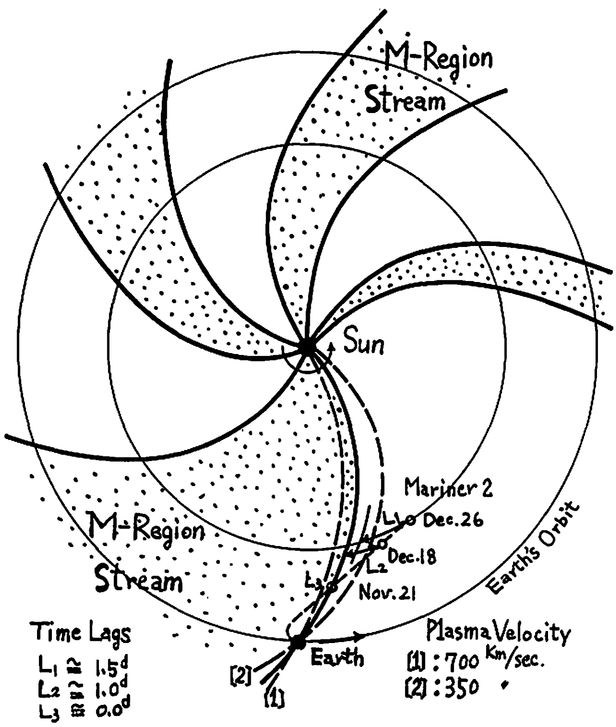

Fig. 3. A sketch of M-region streams with a speed 600 km/sec and the trajectory of Mariner 2 spacecraft.

delay would be much less than about one day except at the end of the travel of Mariner 2. In fact, as can be seen in Fig. 1, any distinct time delay can not be detected for the period from Aug. 30, 1962 to Dec. 15, 1962. But the time lags of the order of one or more days can be detected at the end of the travel, if the solar plasma velocity is compared with ΣKp or H on the Rot. No.1771 in Fig. 1. Namely, the solar plasma velocity delays by about one day around the 6th day of Rot. No. 1771 and by about one-half days around the 15th day of Rot. No. 1771. These time lags are given in Fig. 3 (L_1, L_2 and L_3 on Nov. 21, Dec. 18 and Dec. 26, respectively) After all, these matters are a good demonstration of the fact which the solar plasma stream shows the above-explained Chapman-like simple form.

Finally, it is strongly desired to obtain much more data on the solar plasma with not only long-life but also short-life. These data will give us many interesting imformations on the form of solar plasma streams or clouds and/or on differences of the solar plasma responsible for SC storms and Sg storms (27-day recurrence type storms).

概 要

1951年～1953年および1961年～1963年の期間中の ΣKp-index の27日回帰性について調らべ，これら回帰性に関係する大陽風の形態を簡単に議論する。

References

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