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VARIATIONS OF Bz-COMPONENT OF IMF FOR VARIOUS TYPES OF SOLAR WIND STREAMS

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Abstract

The most typical variations of the IMF Bz-component for some kinds of solar wind streams, such as high velocity streams (HVS) from coronal holes (CH), magnetic clouds, and quiet heliospheric current sheets (HCS) and streamers are considered. It is found that all these streams are geoefficient because their immanent feature is a change in the IMF Bz sign.

Introduction

Parameters of solar wind streams originating from different sources in the Sun are known to vary within certain limits at the Earth orbit. However, the variability of IMF Bz component, which is the most geoeffecient one, is not determined. When considering IMF Bz variations for the above types of solar wind streams, one can see that this component behaves rather differently. We have considered the most typical variations of IMF Bz for the following kinds of streams: high velocity streams (HVS) from coronal holes (CH), magnetic clouds and quiet heliospheric current sheets (HCS), and streamers.

Results

Propagation of Alfven wave trains from the Sun, which have different periods, is typical for high velocity streams from CH (Tsurutani et al, 1987). IMF Bz variation periods in the body of the same coronal hole stream was considered based on 5-min IMF Bz values during 7 solar rotations using autocorrelation technique. The periods were determined by extreme points on the autocorrelation curve. Fig. 1 presents the mean values of the periods for a sequence of days in the course of the Earth passing through a high velocity stream. The day when the Earth was positioned at the edge of the high velocity stream was taken as a zero day. One can see, that as the Earth moves through the body of the stream, the above periods change from $T=8^h$ at the edge of a high velocity stream to 5^h on the second day. Then the value of the period increases up to ~ 6-7 hours. Sometimes, the oscillation periods of 12-15 hours are displayed. Prior to the 0^{th} day and after the passage through the coronal hole stream, the autocorrelation functions turn out to be aperiodic. Fourier expansion technique was applied for studying higher-frequency range of the energetic spectrum of IMF Bz variation in the high velocity streams from CH by using 5-min resolution data. The bands with periods of T=10-20 min and T=30-50 min have been revealed for all the days. A peculiar feature is, that on the 0^{th} and on the last day of the stream body passage, only highest-frequency harmonics are present (with periods from 10 to 20 min), whereas on other days, i.e. in the body of the stream proper, other periods are exhibited too.

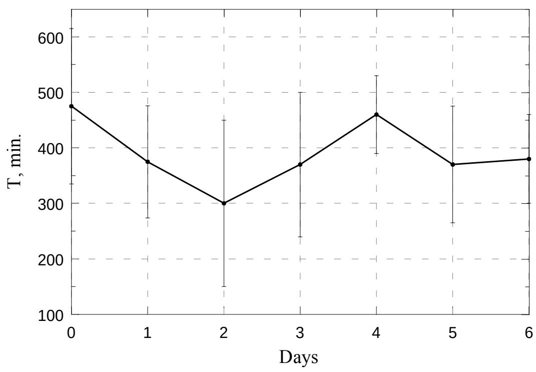

Fig.1. Change in periods of IMF Bz variations during the Earth passage through high velocity streams from CH.

We also considered Bz-component behaviour in such IMF structure as magnetic clouds. It is known (Farrugia et al., 1993a; Farrugia et al., 1993b) that the IMF Bz component in a magnetic cloud varies slowly from minimum (-), passes through 0, and goes to maximum (+) and, vice versa, from maximum down to minimum, on the average, for 12-18 hours. Fig.2 shows hourly averaged IMF Bz values for both distributions typical for magnetic clouds. The calculations were conducted by superposed epoch technique, with the hour of Bz passing through 0 taken as a zero moment. Root-mean-square deviations are provided as well. The averaging was performed over 13 dates for each case. It is clearly seen that there is practically no random long-time excursions of the IMF Bz into the region of the other sign, either prior or after passage through 0.

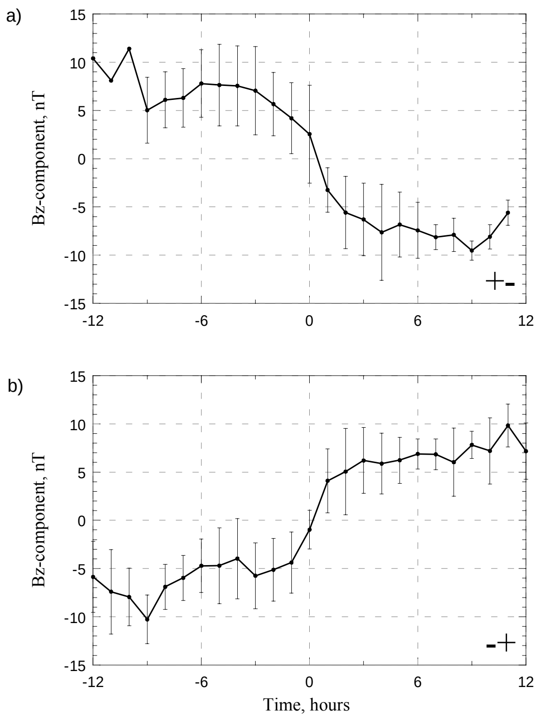

Fig.2. The change of IMF Bz component in a magnetic cloud: a) from plus to minus; b) from minus to plus.

Analogous procedure was applied for quiet heliospheric current sheets (HCS). We calculated the hourly averaged values of IMF Bz at the border of IMF sector structure by superimposed epoch technique, separately for sector's sign changing from plus to minus and, vice versa, from minus to plus. Each of these data sets was divided into two subsets, with IMF Bz taking either negative or positive value after the passage of a sector structure (Fig.3). The hour of sign change in the Bx and By components was taken as zero. The duration of the Earth staying in the stream of a heliospheric current sheet and streamers is 01-15 hours, with passage through the zero IMF Bz 1 hour before or after the passage of the sector structure border. Also shown are RMS deviations. The averaging was performed over 32 dates with HCS sign changing from plus to minus (+-), Bz (+-); over 24 dates for HCS (+-), Bz (-+); over 13 dates for HCS (-+), Bz (+-); and over 18 dates for HCS (-+), Bz (-+). In spite of rather large scattering, one can see that there necessarily occurs a change of the IMF Bz sign.

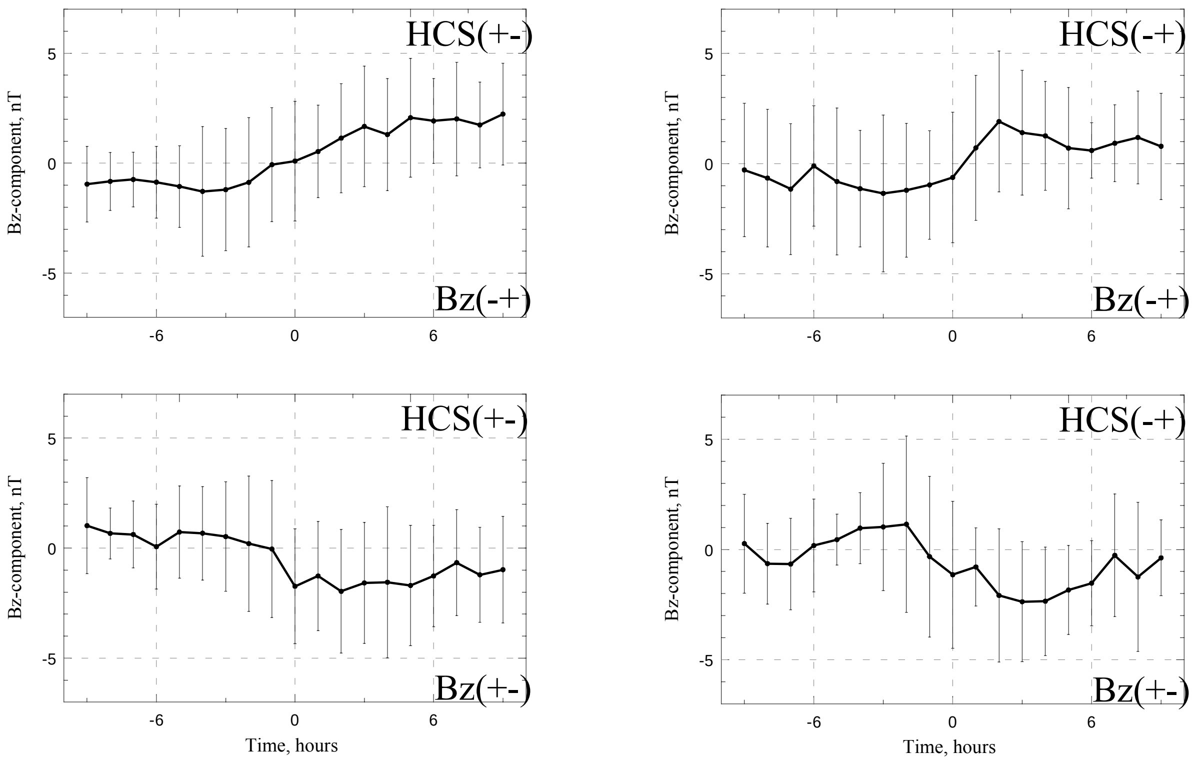

Fig.3. The change of Bz-component when passing the quiet heliospheric current sheet and streamers.

Conclusion

Having studied variations of the IMF Bz component for the high velocity streams from CH, HCS and magnetic clouds, we conclude that all these types of the solar wind streams are geoefficient, as their common intrinsic feature is a change in the IMF Bz sign.

References

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