LARGE-SCALE MAGNETIC FIELD STRUCTURE AT THE EARTH'S ORBIT, ITS CORRELATION WITH SOLAR ACTIVITY AND ORIENTATION AND MOTION OF THE SOLAR SYSTEM IN THE GALAXY

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ABSTRACT

Interplanetary magnetic field data from the different satellites obtained during the period 1963-1973 at 1 A.U. and compiled by J. King have been analysed in heliocentric ecliptic coordinates. The peculiarities of the background interplanetary magnetic field (BIMF) are discussed in relation to the orientation of the solar system in the Galaxy and the variable helioefficiency of the planets. The results of the direct cosmic experiments are evidence of the solar activity being a complex phenomenon of the solar system as a whole.

The main objective of this investigation is an attempt to reconcile interplanetary magnetic field spatial structure with the spatial structure of the variable helioefficiency of the planets. The spatial structure of the variable helioefficiency in the solar system seems to be associated with two important directions: the line of nodes of the galactic equator and ecliptic ($\lambda = 87 \div 267$) and the ecliptic projection of the galactic magnetic field direction ($b'' = 0$, $1'' = 70$; $\lambda = 135 \div 315$) (Vassilyeva et al., 1979). This second direction is specifically manifested itself in the variable helioefficiency of Jupiter and the Earth (for solar maximum and solar minimum) (Figure 1).

In spite of many publications devoted to analysis of IMF data obtained during the period 1963-1973 at 1 A.U., a new treatment of these data have been undertaken. Analysis of the hourly values of B_z^+, B_z^-, B_z, B_R^+, B_R^-, B_R, B_T^+, B_T^-, B_T - component and B, averaged over 30- degrees ecliptic longitude intervals for the 1967-1973 period confirmed the existence of the large scale background interplanetary magnetic field (BIMF). This BIMF reveals itself as a weak signal against the background of the uncorrelated noise, created by the well-known sector structure of IMF. The existence of BIMF with the following features is discussed.

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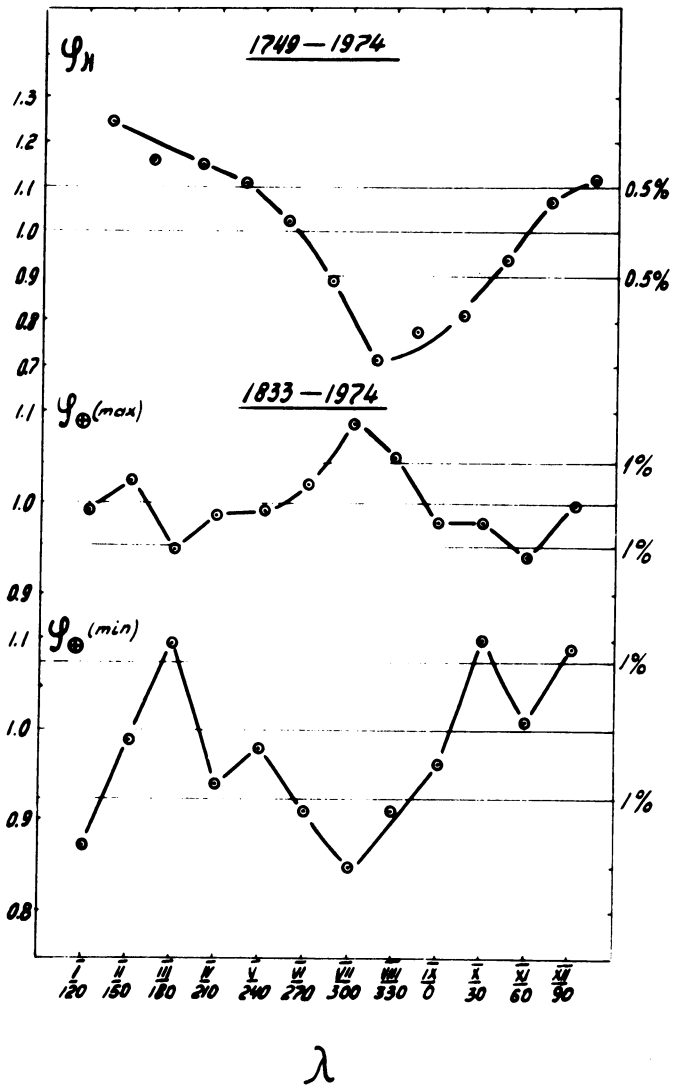

Figure 1. Helioefficiency of Earth and Jupiter.

1. BIMF does not co-rotate with the Sun.
2. The B_R and B_T dominant magnetic polarity are found to reproduce their values and signs at the same longitudes during some years.
3. The vortex structure of BIMF seems to occur, i.e., the circulation of B_T-component over the Earth's orbit is found not to be equal to zero and to be equivalent to the current of $J_z \sim \oint B_T dl \sim 10^9$ amperes within the Earth's orbit.

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4. The reversal of the Sun's dipolar field is associated not only with the well-known reversal of the Rosenberg-Coleman dominant polarity effect in B_R but it is also associated with the reversal B_T-circulation over the Earth's orbit and its breakdown in the 1970-1971 period (Figure 2). The nature of B_T-circulation and its reversal is closely correlated with the relative N-S solar corona rotation (Stepanov and Tyagun, 1976).

5. The distributions of the hourly values of B_R and B_T components over the specific ecliptic longitude intervals, summarized over the period including the reversal of the Sun's dipolar field, shows identical maxima of dominant polarity near two nodes of the galactic equator and ecliptic (Figure 3).

6. Magnetic field strength values of all three components

$$|B_R| = \frac{1}{2}(|B_R^-| + |B_R^+|); \quad |B_T| = \frac{1}{2}(|B_T^+| + |B_T^-|); \quad |B_z| = \frac{1}{2}(|B_z^+| + |B_z^-|),$$

derived separately from "+" and "-" hourly sets averaged over 30 degree longitude intervals during seven years (1967-1973) have the same very accurate character of variation along the Earth's orbit. The amplitude of variations relative to the middle level as high as 4-5% (Figure 4). Maxima and minima of $|B_R|$, $|B_T|$, $|B_z|$ ecliptic variations indicate the intersection of the Earth's orbit with the ecliptic projection of two coincident directions: solar motion to apex relative to the stars of 14-15 magnitude and galactic magnetic field direction ($b'' = 0^o$, $1'' = 70^o$). The $|B_R|$, $|B_T|$, $|B_z|$ variations along the Earth's orbit are in very good agreement with the variations of the Earth's velocity of rotation for the same period (Yagudin, 1978).

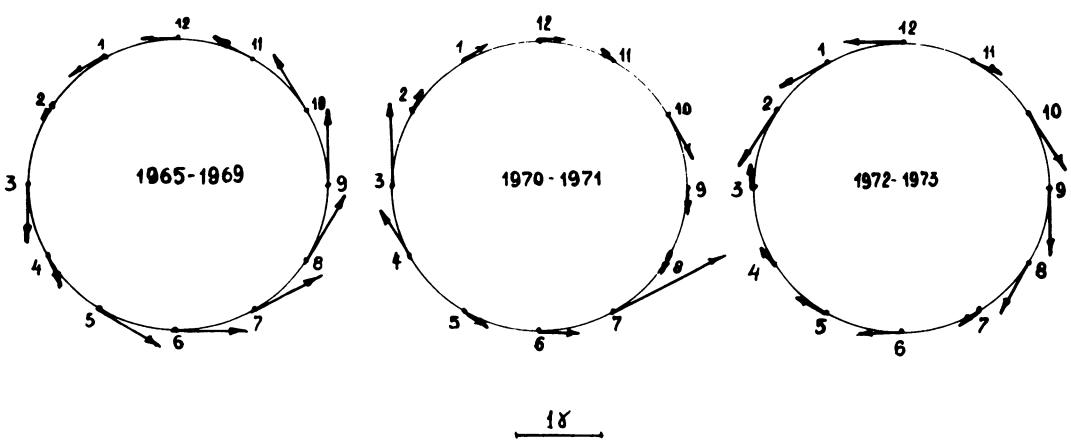

Figure 2. Circulation of B_T along orbit of Earth.

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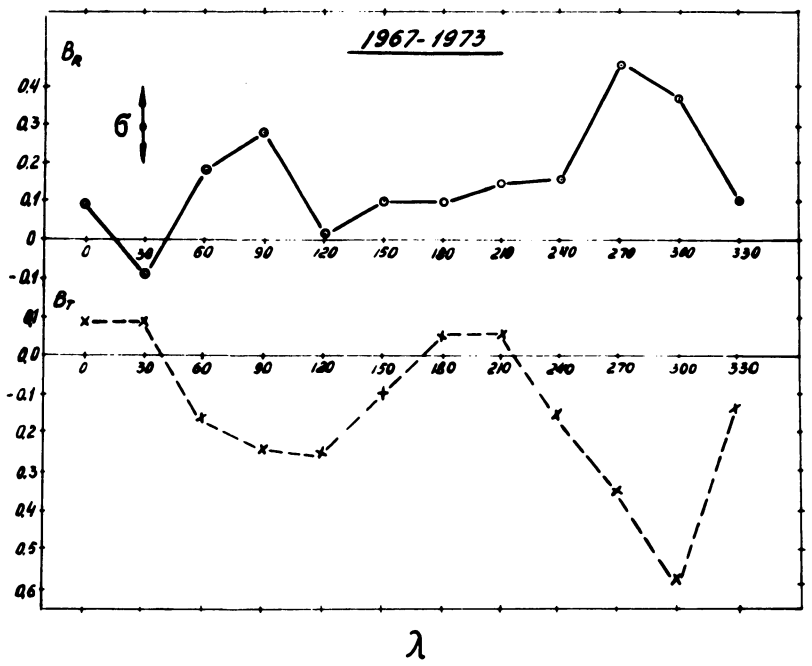

Figure 3. Hourly values of B_R and B_T.

So, side by side with the well-known sector structure of the IMF, which co-rotates with the Sun and is associated with the large scale background solar magnetic field, the large scale structure of BIMF exists also. This structure is correlated with the magnetic field of sunspots, solar dipolar field and the orientation and motion of the solar system in the Galaxy.

This direction of galactic magnetic field (b" = 0, l" = +70), which seems to determine the structure of the solar magnetosphere, especially in the outer solar system, has been discussed in relation to the galactic cosmic rays' peculiarities (Schatten and Wilcox, 1969; Marsden et al., 1976) and the direct geoeffective influence of the Galaxy (Morozov, 1944).

Analysis of BIMF shows that the ecliptic longitude asymmetry in IMF could be exhausted by the effects of the Earth's projection on the Sun. The independence of the mean field magnitude and the average amplitude of the directional fluctuations of heliographic latitude within $\pm$ 7.3° range have been noted by Hedgecock (1975). The discussed features of the BIMF are evidence of the galactic influence upon the solar magnetosphere. Moreover, reversal of the Sun's dipolar field seems to be controlled by the Galaxy. Correlation of the parameters of BIMF with

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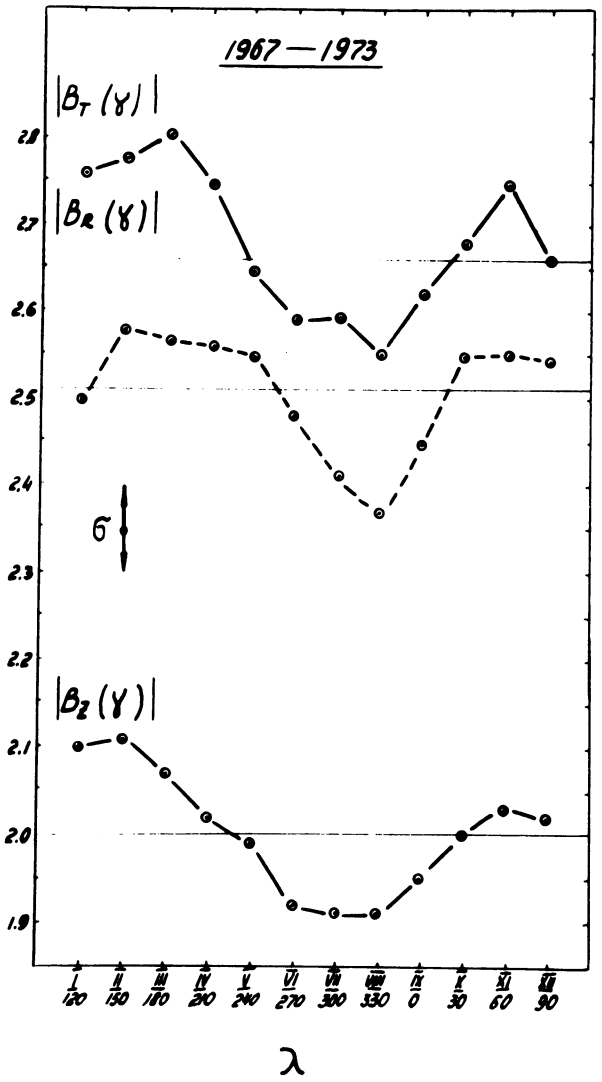

Figure 4. Variation of mean IMF components (see text).

the variable helioefficiency of planets opens an interesting chance to employ planets as probe particles in cosmic experiments.

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