"Physics of Auroral Phenomena", Proc. XXVI Annual Seminar, Apatity, pp. 159-161 , 2003

Polar Geophysical Institute

# INFLUENCE OF A CHANGE IN SOLAR MAGNETIC FIELD POLARITY ON THE JOVIAN ELECTRON FLUX INTENSITY

N.G. Skryabin, S.N. Samsonov, I.Ya. Plotnikov *(Yu. G. Shafer Institute of Cosmophysical Research and Aeronomy, 31 Lenin Ave., 677891 Yakutsk, Russia)*

**Abstract.** The Jupiter is a powerful regular source of high-energy electrons (0,2-40 MeV). In this connection their density in the near-Earth space systematically increases with a period of 399 days, which is coincident with the synodic period of the Jupiter. According to our estimations, their energy is sufficient to produce a significant local reduction of the magnetic field in the IMF sector connected with the Jupiter. In this paper the evidence is presented that the electron fluxes in the Jovian sector are controlled by the general magnetic field of the Sun. A treatment of 399-day intervals of the electron fluxes and IMF, obtained from spacecraft data for the period of 1963 to 2000 has been performed by superposed epoch technique taking into account the periodic change of the solar magnetic field polarity. Having adopted the Jupiter opposition day to be an epoch zero, the changes in particle intensity and IMF components under different signs of the general magnetic field of the Sun are found by using a large dataset (9925 days). The times of 399-day variation maxima in different periods of solar activity are compared and a character of their displacement relative to Jupiter opposition moment is discussed.

## Introduction. Current state of the Problem

It is known that the Jupiter is a powerful source of electrons with energies of 0.2 to 40 MeV in interplanetary space. The Jovian particle fluxes, on the average, exceed by many times high-energy electron fluxes of solar origin [1].

The propagation of relativistic electrons is controlled by the interplanetary magnetic field (IMF). Taking this into account, we distinguish in the IMF sector structure the large-scale region, with spiral field lines connecting the Sun and Jupiter. Further we will name this IMF sector as the Jovian one. The increased particle intensity in this region is found in the vicinity of the Earth's orbit from spacecraft electron measurements (in the range 0.1-12 MeV) for the period of October 30, 1973 to December 31, 2000. Based on those results, in [2] we considered the regular dynamics of the IMF Jovian sector during several solar cycles.

In the present paper we continue investigation of this dynamic feature of interplanetary medium and, in particular, examine the influence of the general magnetic field of the Sun (GMFS) on it. It is suggested that the orbital movement of the Earth during each 399 days (synodic period of the Jupiter) reproduces conditions for electron registration in the distinguished sector. By using the calendar of the GMFS positive and negative polarity along with spacecraft data, we have treated the problem of determination of the parameters of relativistic electron 399-day intensity variations and the IMF modulus in different periods of solar activity. The phase characteristics of particle flux variations and IMF under different GMFS polarity are compared with the dates of Jupiter oppositions.

## Analysis and Discussion

The apparatus count Jx10 of the measured electron flux is shown in the upper plot of Fig. 1, the results of treatment excluding the electron bursts $J_{int}$ are in the middle graph. Data during the bursts are substituted by an interpolation between the points before and after increases against the background of gradually varying count level. The smoothing background values of Jqx0.1 ($<J_{int}>$ - moving averages during 81 days) are shown at the bottom. At the top of Fig. 1 there are marks denoting different GMFS polarity. Symbols (+ -) and (- +) are the time intervals of GMFS sign changes.

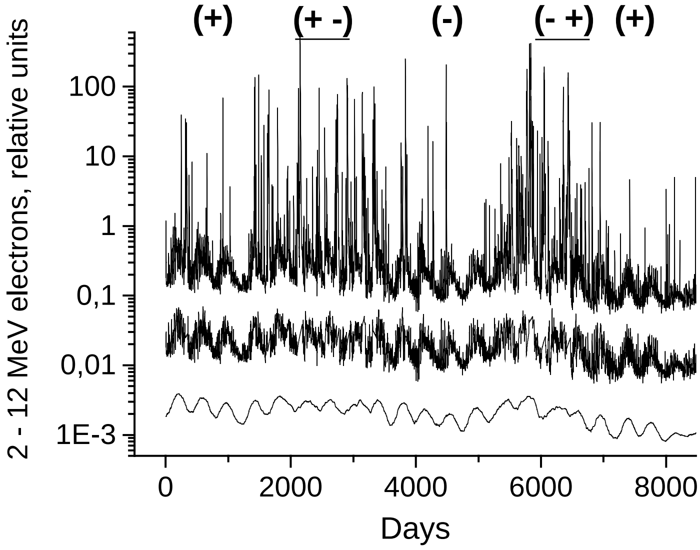


Fig.1. Temporal behavior of relativistic electron flux intensity

Taking into account calendar dates for the Jupiter oppositions, we divided the period from 1973 to 1997 into the 399-day intervals and determined statistical average temporal variations of relativistic electron flux intensity and IMF by the superposed epoch technique. Fig. 2 presents the results of treatment of experimental data $J_q$, J-<$J_{int}$> and IMF $|B|$ for the following calendar periods: a) for (+), b) for (-). With allowing for a possibility of burst generation, the occurrence frequency of bursts (characteristic P) is found from J – <$J_{int}$>. The curves 1, 2, 3 are 399-day variations of the background level for the Jovian electron flux intensity ($\delta J_q$x30), electron burst occurrence frequency ($\delta$P), and IMF ($\delta$B), respectively.

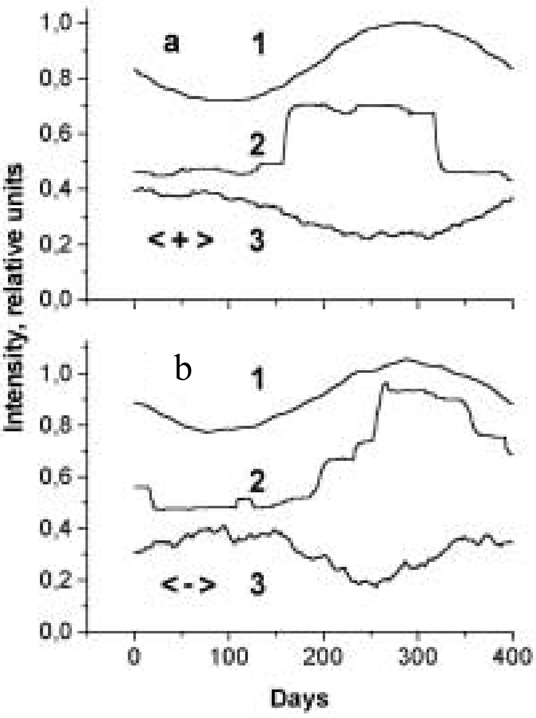


Fig.2. Average 399-day variations of the relativistic electrons and IMF modulus.

Note, that all the curves have extrema near 285 days and only curves 2 on panels (a) and (b) achieve maximum at different times. This means that under positive GMFS polarity the occurrence of the Jovian electron bursts is shifted to earlier times as compared to their occurrence under negative GMFS polarity.

During the selected 285 days the Earth crosses a magnetic field line connecting the Jupiter with the Sun under quiet solar wind conditions. Therefore, the variations presented in Fig. 2 reflect near this field line the spatial distributions in the electron background intensity, occurrence frequency of electron bursts, and IMF value in the Jovian sector along the Earth's orbit. In this case, the polarity defines the GMFS action separating in space the electrons which form the sporadic component (bursts). The bursts differ from the background component, probably, by a pitch-angle distribution. Thus, a change in GMFS polarity effectively influences the Jovian electron flux intensity due to anisotropy of their pitch-angle distributions.

## Conclusions

1. The 399-day variations in the Jovian background electron flux intensity have maximum and those in the IMF have minimum when the Earth crosses the magnetic field line connecting the Jupiter and the Sun.
2. Under positive GMFS polarity the occurrence of the Jovian electron bursts is shifted to earlier time compared to their occurence under negative polarity.
3. The GMFS polarity changes effectively influence the Jovian electron intensity due to anisotropy of their pitch-angle distribution.

***Acknowledgment.*** Authors thank scientists of the University of Chicago, Enrico Fermi Institute, Laboratory Astrophysics and Space Research, Simpson Cosmic Physics Group for submission of electron flux measurement data from IMP-8.

## References

McDonald F.B., Treynor J.G. Observations of energetic Jovian electrons and protons // The Jupiter III. The magnetosphere, radiation belts. M.: Mir. 1979. P.394-424.

Skryabin N.G., Bezrodnykh I.P., Plotnikov I.Ya. et al. The dynamics of Jovian electron flux in the 21-st solar activity cycle near the Earth's magnetosphere // Geomagnetism and Aeronomy. V.41. №4. P.450-453. 2001 (in Russian).