CHARACTERISTICS OF COSMIC RAY POLE-EQUATOR ANISOTROPY DERIVED FROM SPHERICAL HARMONIC ANALYSIS OF NEUTRON MONITOR DATA

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ABSTRACT

We have carried out the spherical hamonic analysis of cosmic ray neutron data from the worldwide network neutron monitor stations during the years, 1966-1969. The second zonal harmonic component obtained from the analysis corresponds to the Pole-Equator anisotropy of the cosmic ray neutron intensity. We have reported some preliminary results on such an anisotropy. In this paper, further studies on this subject are presented. The results obtained confirms our earlier results: Such an anisotropy makes a semi-annual variation. In addition to this, in this paper, it is shown that the Pole-Equator anisotropy makes a variation depending on the IMF sector polarities around the passages of the IMF sector boundary. A mechanism to interpret these results is also discussed.

1. Introduction. The method of spherical harmonic analysis of cosmic ray neutron data from the worldwide network stations is developed extensively by Nagashima (1971). The second zonal harmonic component obtainable from the analysis corresponds to the Pole-Equator anisotropy of the cosmic ray neutron intensity. We have carried out such an analysis and obtained the second zonal harmonic component, using cosmic ray neutron data in the years, 1966-1969. The preliminary results on the Pole-Equator (P-E) anisotropy obtained from the cosmic ray data in 1966 and 1967 were reported (Takahashi et al.,1974, 1975, 1977, 1981, 1984). This paper presents characteristics of time variations of the P-E anisotropy during the three years, 1966, 1967 and the additional year in this study, 1969. The relationship of the P-E anisotropy to the polarity of the IMF sector is also given and discussed.

2. Analysis. Cosmic ray neutron data in daily mean from the worldwide network cosmic ray stations (~40 stations) in 1969 in addition to 1966 and 1967 which were analysed previously are analyzed on the 27 day basis by means of the three-dimensional analysis method by Nagashima, which is given in detail in the papers (Takahashi et al., 1974, 1975, 1977).

3. Results and Discussion. Hereafter, as in our previous papers, a_2^0 means the second zonal harmonic component, i. e. the P-E anisotropy, and also a_2^0's for which the power expo-

nential type spectrum having γ =2.0 and P_0 =100 GV was best-fit in the analysis are used throughout this study.

i) Variation of P-E anisotropy, a_2^0

The results obtained are shown in Figs. 1 - 4. Fig. 1 shows the variation of the mean value, $\overline{a_2^0}$, of a_2^0's during each solar rotation interval during the year, 1969. Figs.2 -3, which have appeared in the papers (Takahashi et al., 1983) are shown again in order to compare the result obtained here with our previous results.

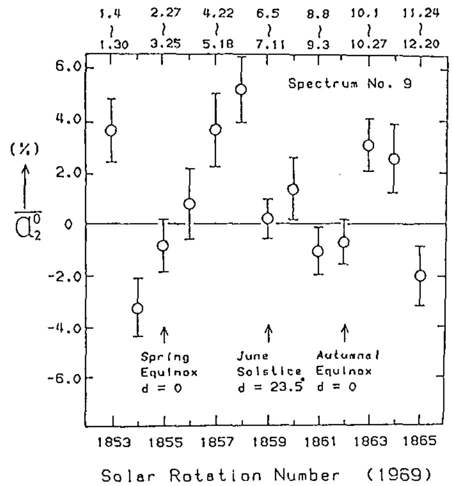

Fig.1. The variation of $\overline{a_2^0}$, which indicates the mean value of a_2^0's during each solar rotation interval in 1969.

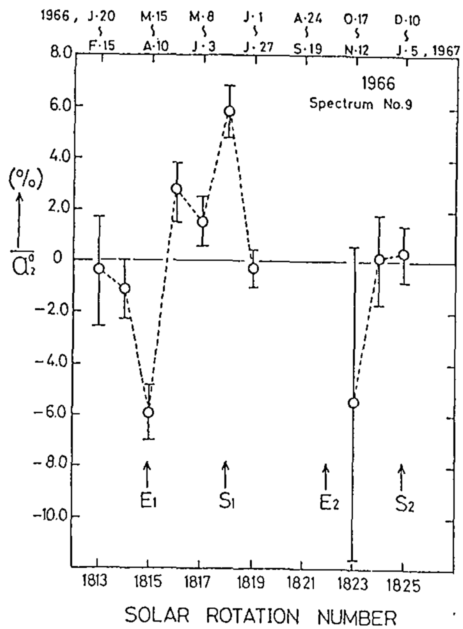

Fig.2. The variation of $\overline{a_2^0}$ in 1966 (Takahashi et al., 1983).

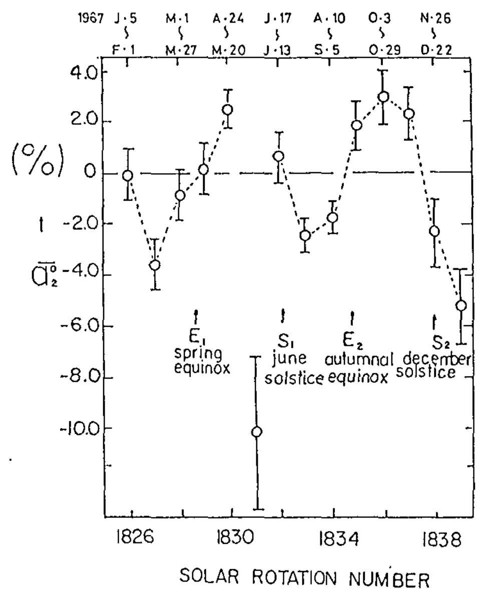

Fig.3. The variation of $\overline{a_2^0}$ in 1967 (Takahashi et al., 1967).

It will be found that Figs.1 - 3 are similar to each other. This establishes that a_2^0 makes a semi-annual variation such as pointed out in our previous papers (Takahashi et al., 1981, 1983, 1984). The suggested mechanism in our last paper also holds good for this phenomenon.

ii) Relationship of a_2^0's to the IMF sector structure

Fig.4 shows that a_2^0 is related to the IMF sector sturcture. It should notice that the relationship of a_2^0 to the IMF sector polarity as shown in Fig.4 is reversed to the contrary to that of the N - S anisotropy, a_1^0, in other wards, the P - E anisotropy is, on an average, negative in the toward (-) sector, where -as the P - E anisotropy is positive in the away (+) sector.

Ely (1977) found the equatorial modulation, EqM, from the analysis of the cosmic ray data obtained from the measurements of galactic cosmic rays, and also has given a mechanism for the EqM, in which he predicts that the EqM would reverse its phase with respect to the sector polarity at each equinox if the mean IMF is parallel to the plane of the ecliptic. The Ely's EqM is not the same as our a_2^0. Nevertheless, such a mechanism as proposed by him may give an important hint for interpreting physically our results obtained here.

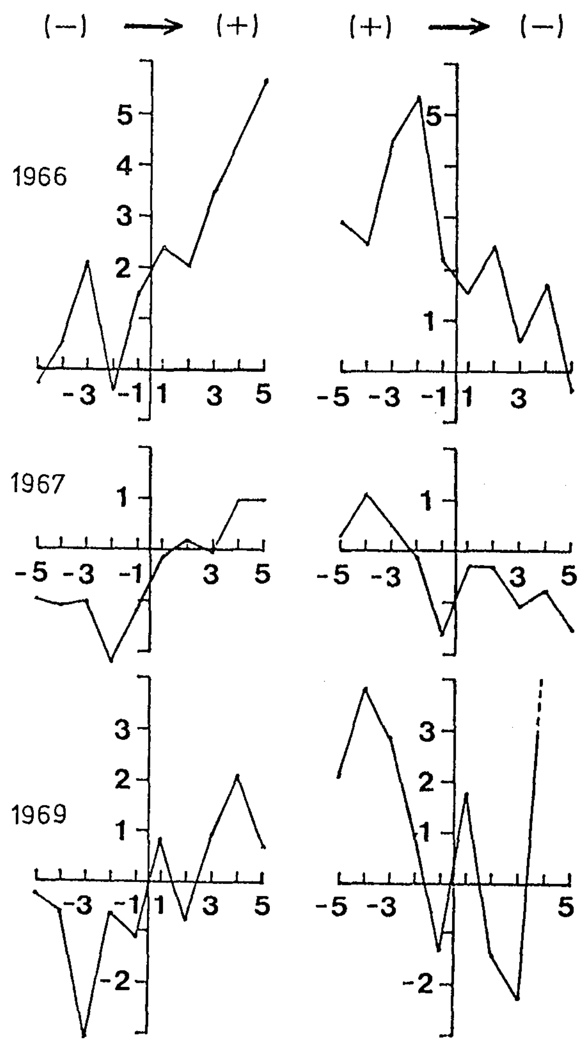

Fig.4. The variation of a_2^0 around the passages of the positive and negative IMF sectors.

4. Conclusions. The following conclusions from the results and discussion mentioned above may be drawn:

1) The P - E anisotropy makes a semi-annual variation.
2) The P - E anisotropy is related with the IMF sector structure and it is positive in the positive (away) sector, whereas it is negative in the negative (toward) sector.
3) The mechanism to interpret physically these results is not yet made clear, but, the mechanism to inter pret the EqM by Ely may be applicable for the results obtained here.

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