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DIURNAL VARIATION OF GALACTIC COSMIC RAY INTENSITY ON QUIET DAYS

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ABSTRACT

A detailed study of the diurnal variation on long term basis has been performed on geomagnetically quiet days using the experimental data of the cosmic ray intensity from the world-wide neutron monitoring stations. During the period when the polarity of the solar magnetic field in the northern hemisphere of the sun is negative the phase and amplitude of the diurnal anisotropy on quiet days has been observed to remain almost constant. When the polarity of solar magnetic field in northern hemisphere changes from negative to positive, a shift in the phase of the diurnal anisotropy on quiet days towards earlier hours is observed and the shift is found to be maximum during minimum solar activity periods 1953-54 and 1975-76. Further, when the polarity of solar magnetic field changes from positive to negative in the northern hemisphere of the sun the phase of the diurnal anisotropy on quiet days recovers to its usual direction of corotational anisotropy and is observed to remain almost constant till the polarity of the solar magnetic field does not change. Furthermore, during the period when the polarity of solar magnetic field in the northern hemisphere of the sun is negative the amplitude of the diurnal anisotropy on quiet days is observed to remain almost constant. And when the polarity of the solar magnetic field in the northern hemisphere of the sun changes from negative to positive the amplitude of the diurnal anisotropy on quiet days is observed to decrease quite significantly. The decrease in the amplitude of the diurnal anisotropy on quiet days is maximum during 1976. Further, when the polarity of the solar magnetic field changes from positive to negative the amplitude of the diurnal anisotropy on quiet days recovers to its usual value and is observed to remain almost constant.

1. Introduction. It has been shown (Kumar et al., 1981, and references therein) that daily geomagnetic index A_p correlates

well with both the diffusive as well as the convective components of the convection-diffusion theory. Also, this is a parameter which is least affected on quiet days in particular, evenwhen the days with abrupt fluctuations in IMF are quite frequent. This has led for the study of the diurnal variation of galactic cosmic ray intensity on quiet days on a long as well as short term basis.

2. Experimental Data and Analysis. The data of the neutron monitors for the stations, shown in figure-1, are used in the analysis. The data has been corrected for meteorological effects. The long term effects have been removed by the method of trend correction. Thus obtained magnetically most quiet days cosmic ray intensity data is subjected for the harmonic analysis and the average values of the amplitude,the phase of the first harmonic component of neutron intensity for different stations are obtained. Essentially, whole of the period has been divided into four parts- (i) before 1956 including 1953-54; (ii) after 1971 and earlier than 1978; (iii) after 1960 upto 1968 and (iv) 1981 and onwards. During the periods (i) and (ii) the polarity of the solar magnetic field in the northern hemisphere is positive, where as during the periods (iii) and (iv) the polarity of the solar magnetic field in the northern hemisphere is negative.

3. Results and Discussion. The long term plots of yearly average values of the geomagnetic disturbance index-A_p for the interval 1957-81 for all the days as well as for sixty most geomagnetic quiet days and sixty most geomagnetic disturbed days are represented in figure-2. It is apparent from the figure-2 that there is a marked variation in the plots for all days and disturbed days from year to year, particularly, for years of high sunspot activity. However, we noticed a very smooth and small variations for the quiet days which proves the importance of selecting most quiet days and in deriving the daily variations for these days only, to represent the long term or short term behaviour.

The interstation dispersion for the yearly average values for the magnetically most quiet days have already been plotted and shown (Kumar et al.,1981). It has been noted that the dispersion is small as compared to changes fron one year to another. This is found to be true even for the most recent period for which we have limited amount of data.

In this presentation we have used the data for Deep River neutron monitoring station for which the pressure corrected hourly cosmic ray intensity is available for an extended period of time. The average values derived for each year for the neutron monitoring station Deep River have been shown in figure-3 without making any correction for the effect of the geomagnetic field. Earlier[1] the vectors derived for different stations were corrected to derive the space vectors to facilitate comparison between different stations. The interstation agreement can not be judged by comparing the observed

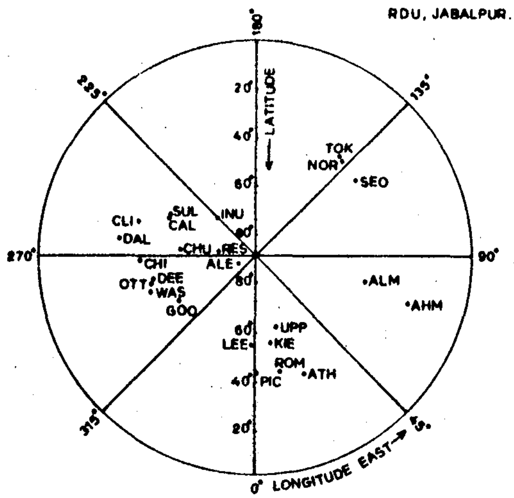

FIG. 1. ILLUSTRATES THE GEOGRAPHICAL LATITUDES AND LONGITUDES OF THE NEUTRON MONITORING STATIONS USED IN THE ANALYSIS.

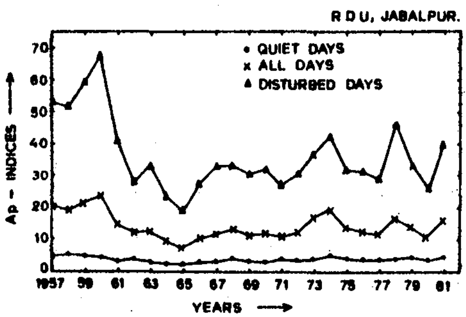

FIG. 2. VARIATION OF Ap-INDEX DURING THE PERIOD 1957-81 ON QUIET DAYS, ALL DAYS AND DISTURBED DAYS.

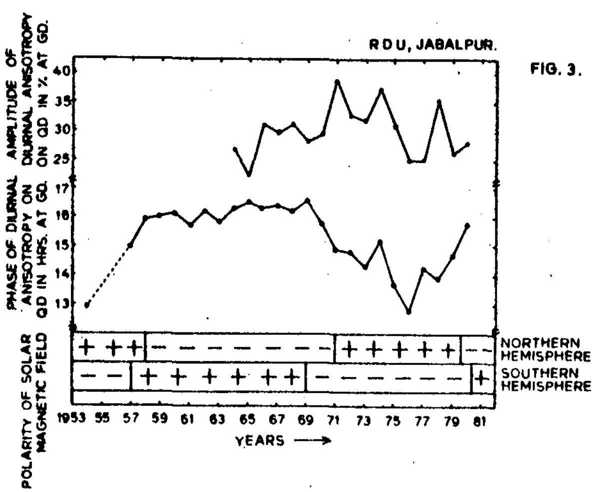

FIG. 3. VARIATION OF THE AMPLITUDE AND PHASE OF DIURNAL ANISOTROPY ON QUIET DAYS AT GROUND AND POLARITY OF SOLAR MAGNETIC FIELD IN NORTHERN AND SOUTHERN HEMISPHERES DURING DIFFERENT YEARS.

amplitude and phase in space because the geomagnetic corrections are different for different stations. So far, it is not clear that β and R_{max} are constant during period of 11-year or more, and hence the constant geomagnetic corrections generally applied on a long term basis is not very effective.

It is quite apparent from the figure-3 that during the period when the polarity of the solar magnetic field in the northern hemisphere of the sun is negative the phase and amplitude of the diurnal anisotropy on quiet days are almost constant. When the polarity of solar magnetic field in northern hemisphere changes from negative to positive, a shift in the phase of the diurnal anisotropy on quiet days towards earlier hours is observed and the shift is found to be maximum during minimum solar activity periods 1953-54 and 1975-76. Further, when the polarity of solar magnetic field changes from positive to negative in the northern hemisphere of the sun the phase of the diurnal anisotropy on quiet days recovers to its usual direction of corotational anisotropy and is observed to remain almost constant till the polarity of the solar magnetic field does not change.

Earlier results (Yadav and Badruddin, 1983) have indicated that on an average the two solar cycles when the northern hemisphere of the sun is dominated with negative polarity and when the northern hemisphere of the sun is dominated with the positive polarity, show different behaviour of diurnal anisotropy. This was done by considering all the 365 days in the year. We have considered the average of only magnetically most quiet days for the same interval (1964-68) and (1972-76) as well as for (1960-68) and (1972-78) to compare the effect of polarity reversal on diurnal anisotropy during magnetically most quiet days. Here again the vectors are drawn for the diurnal amplitude and phase observed at the station Deep River.

The results show that, in general, magnetically most quiet days are slightly more effective by the polarity reversal as compared to all days. The significance of magnetically most quiet days comes from the fact that these are least affected days due to disturbances in the interplanetary medium and hence are best suited for understanding the anisotropy on long as well as short term basis. It has been visualised further that if the similar trend exists, one should observe a steady variation in the diurnal amplitude and phase on magnetically most quiet days during 1981 and onwards till the polarity of the solar magnetic field in the northern hemisphere remains negative.

References

1. Kumar, S. et al., 1981, Proc. 17th Int.Conf.Cosmic Rays., France (Paris). pp.226-229.
2. Yadav, R.S. and Badruddin, 1983, Proc. 18th Int.Conf. Cosmic Rays, Bangalore (India) pp.366-369.