Long Term Behavior Of Higher Harmonics Of Cosmic Ray Intensity On Quiet Days

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ABSTRACT

The cosmic ray intensity data recorded with Deep River Neutron Monitoring Station have been investigated on 60 Quiet Days (QD) in a year for studying the higher harmonics of daily variation during solar cycle 21 and 22. It has been observed that inspite of the abrupt change in the amplitude and the phase of the higher harmonics of daily variation in cosmic ray intensity, the amplitude of third harmonics is quite significant throughout the period of investigation with larger amplitude during the year 1980 and 1985 due to changing of threshold cutoff rigidity of the station. The tri-diurnal anisotropy of cosmic ray intensity shows clearly long-term variation, i.e. 11-year variation at mid latitude station.

1. INTRODUCTION

The spatial anisotropy of the galactic cosmic ray intensity in the interplanetary space manifests itself as daily variation with a period of 24 hours (and its higher harmonics) due to the rotation of the Earth in the course of a day. The Power Spectrum analysis as well as the Fourier analysis of the long term data of the 24-hour values of cosmic ray (CR) intensity observed by Earth based detectors have provided confirmatory existence alongwith the characteristics of the first three harmonics of daily variation of extra terrestrial origin [1,2]. However, the amplitude of the fourth harmonics is still controversial [3–7]. Moreover, it has been observed that the amplitude and phase of tridiurnal variation of CR intensity on quiet days also vary considerably from one period to another. On the long term behaviour of the first three harmonics showed that high degree of year to year variability exists, a trend with solar activity was evident.

2. ANALYSIS OF THE DATA

The pressure corrected hourly CR intensity data (corrected for meteorological effects) on geomagnetically five quietest days (QD) in evesy month for Deep River (Lat : 46.06N; cutoff rigidity: 1.02GV; Longitude 282.5^{0}E; Altitude 145m) neutron monitoring station and for the period 1978–94, have been used in

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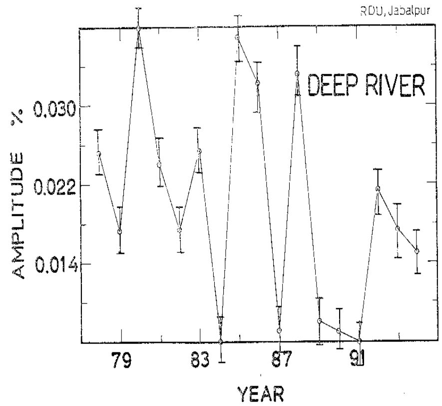

Fig. 1. Amplitude(%) of tri-diurnal anisotropy of CR intensity on QD during 1978–94.

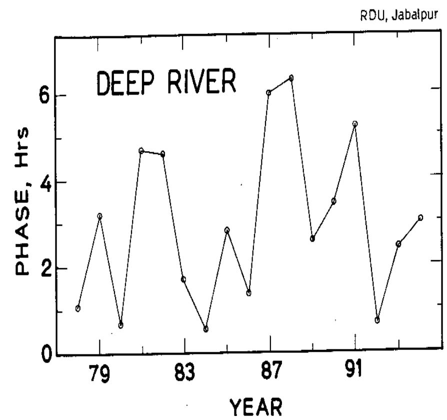

Fig. 2. Phase(Hrs in local time) of tri-diurnal anisotropy of CR intensity on QD during 1978–94.

Fourier analysis. After applying the trend corrections, such a set of data have been subjected to Harmonic analysis for each day [8]. According to solar geophysical data five quietest days are selected in a month; thus 60 quietest days are obtained in a year. These days are called international quit days (QD).

3. RESULTS AND DISCUSSION

The yearly average amplitude and phase of the third harmonics of daily variation for Deep River Neutron Monitoring Station have been plotted in Fig. 1 and 2 during the period 1978–94 on quiet days. It is quite apparent from Fig. 1 that the amplitude of third harmonics of daily variation has quite abruptly increased during the years 1980 and 1985. The likely cause for such type of variation could be the changing of geomagnetic threshold cut off rigidly from 1.02 GV to 1.15 and 1.12 in 1980 and 1985 respectively [9.11] as it has been discussed in the case of change of diurnal anisotropy of cosmic ray intensity on QD [12]. These type of variation in the amplitude of the tri- diurnal anisotropy on QD may be attributed to the change in the rigidity spectrum.

The amplitude of tri-diurnal anisotropy on QD has shown an exceptionally small value during 1987, which is a period of minimum solar activity [13]. The amplitude of third harmonics of daily variation on QD is observed to be significantly low during 1981 as well as in 1990, which coincides with phase reversal of the solar poloidal magnetic field [14].

It is observed from Fig. 2 that there is no systematic change in the phase of third harmonics of daily variation of cosmic ray intensity on quiet days. However, a slight change in the value of tri-diurnal phase is observed, when the solar polar magnetic field reversed its polarity during the periods 1979–80 and 1990–91 [14].

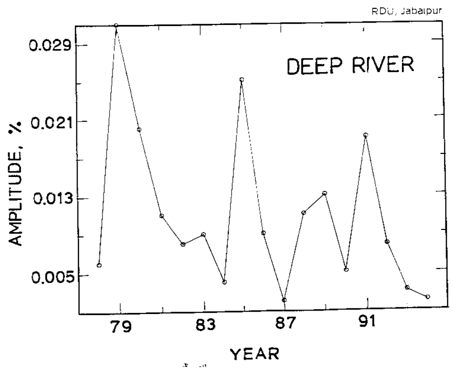

Fig. 3. Amplitude(%) of quart-diurnal anisotropy intensity on QD during 1978–94.

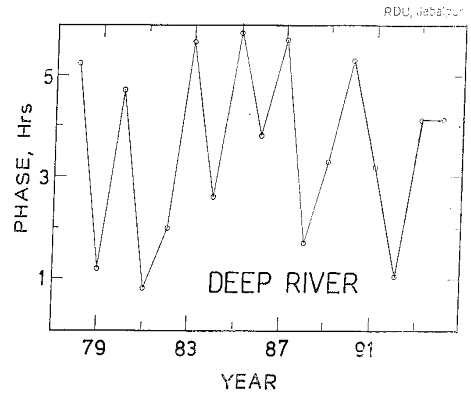

Fig. 4. Phase(Hrs in local time) of quart diurnal of CR anisotropy of CR intensity on QD during 1978–94.

It shows that the phase of tri-diurnal anisotropy on quiet days has nearly the same value at both sides of reversal period. Whereas in both the cases during the succeeding years, i.e., 1980–81 and 1991–92, the change in the phase of tri-diurnal anisotropy of CR intensity has been found quite significant [15]. This supports 11 year type variation in tri-diurnal anisotropy of CR intensity on quiet days [16–18].

It is quite apparent from the Fig. 3 that there is no systematic change in the amplitude in the fourth harmonics of daily variation on quiet days, the amplitude during the year 1979 and 1985 has quite abruptly increased. Further the year 1987, the amplitude has small value, which is a period of minimum solar activity. The amplitude during the years 1980 and 1991 has been observed same value, which is period of high solar activity in the solar cycle 21 and 22. This confirm the 11 year type variation also occur in the fourth harmonics of daily variation.

It is quite apparent from Fig. 4, that there is no systematic change in the phase of fourth harmonics, the phase in the year 1981 and 1992 has occurred in the same direction, which also indicate likely 11 year type variation [15].

4. CONCLUSIONS

Following conclusion may be drawn from the present investigation.

1. The amplitude of tri-diurnal anisotropy of CR intensity on QD has abruptly increased due to changing of threshold cutoff rigidity of the station.

2. The amplitude of tri-diurnal and quart diurnal anisotropy on QD having small value during the year 1987. i.e., which is the period of minimum solar activity.

3. The tri-diurnal and quart diurnal anisotropy of CR intensity on QD has shown long term variation .i.e., 11 year variations.

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