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# Study of cosmic ray intensity variation during quiet interplanetary periods

Pankaj K. Shrivastava and Ravindra P. Shukla

*Department of Physics, Govt. New Science College, Rewa 486 001 (M.P.), India*

**Abstract.** Various solar controlled disturbances in interplanetary medium represented by solar flares, coronal holes, solar wind streams, generally produced significant decreases in cosmic ray intensity as well as enhancement in geomagnetic field. The continuous occurrence of low values of the geomagnetic field disturbance index Ap is known to be a good indicator of undisturbed conditions prevailing in the interplanetary medium. Selecting such events of continuous days of low Ap values (Ap $\leq$ 6, for atleast 5 days), we have analysed daily values of the cosmic ray intensity for a number of events for the intervals, before during and after the events, for the period 1976 to 86. The results show that the cosmic ray intensity is maximum during event period. As expected, the associated interplanetary medium features V, B, Bz and also show minimum fluctuation during the event periods. Hormonic analysis for the representative years 1977, 1981 and 1986, provides conclusive evidence of observing relatively smaller amplitudes of the diurnal variation during quiet periods.

*Key words* : cosmic rays — quiet periods — interplanetary features

## 1. Introduction

It is known that geomagnetic disturbances, index Ap is one of the fundamental parameters which indicates geomagnetic field variations as well as quiet or disturbed condition of interplanetary medium. Various solar processes effecting the interplanetary medium, in turn produce variations in the geomagnetic field as well as modulate the cosmic ray intensity both on long and short term basis (Agrawal *et al.* 1995, Snyder *et al.* 1993; Shrivastava *et al.* 1993). Southward component (Bz) of the Interplanetary magnetic field has been found to be catalystic parameter to produce large disturbances in the geomagnetic field (Kane 1974). Recently it has been found that the flare-generated high speed solar wind streams identified during the period of maximum fluctuation in the interplanetary magnetic field, generally produce significant fluctuation disturbances in the geomagnetic field, as well as significant decreases in cosmic ray intensity (Shrivastava *et al.* 1993, 94). In fact, it is now well

understood that the low values of Kp or Ap indices indicate quiet periods, which signify quiet conditions in the interplanetary medium. However, to choose sustained long durations of quiet periods in the interplanetary medium, it is necessary to choose a series of continuous days of low values of the geomagnetic disturbance index (such as Ap index). Such selection will ensure sustained quiet conditions in the interplanetary medium. We have made systematic study of the time-variation of cosmic rays along with several interplanetary indices for extended length of time during which the geomagnetic field shows quiet conditions during the interval 1976 to 1986, covering the complete solar cycle 21.

## 2. Data analysis

To choose the extended periods of continuous days of low Ap values signifying quiet conditions of geomagnetic field disturbances during the interval 1976 to 1986, the condition is that the daily geomagnetic field disturbance index (Ap) should remain low (< 6) continuously at least 5 days. Having selected the events as above, signifying quiet periods, the daily mean cosmic ray intensity for the duration of the event period, as well as for 5 days earlier and also later, have been analysed. For this purpose the pressure corrected mean values for five days earlier to the event, and five days after the event, have been averaged using the data from the Deep River neutron monitoring station. We have also done harmonic analysis to derive amplitude and phase of diurnal variation of cosmic ray intensity for the representative years of 1977, 1981 and 1986. Those extended periods which produce ≥ 2% decrease in cosmic ray intensity are excluded from the study.

## 3. Results and discussion

In earlier studies, Svalgard (1977) indicated that there is significant correlation between Ap and solar wind velocity which justifies the use of Ap - index for statistical analysis in solar - terrestrial relationships. In this report our object is to study the isotropic and anisotropic variations of cosmic ray intensity during the prolonged quiet periods of interplanetary medium. For this purpose, the cosmic ray intensity for each event, has been calculated for the duration of the event, as well as for five days earlier and later to the event. The average cosmic ray intensity for the event period has been taken to be 100%, in respect of which the average for the duration of the pe–, as well as for the post event period have been calculated. Figure 1 shows the liniar diagram of average cosmic ray percent deviations (from the 100% level, for each event, in each case) for the pre-event period as well as for the post event period for each year starting from 1976 to 86. Similarly mean values of solar wind speed, B, Bz component of Interplanetary magnetic field, as well as Ap index have also been plotted alongwith the cosmic ray percent deviations. The figure clearly shows that the average cosmic ray intensity is generally higher during the event period indicating larger intensities during the event period of quiet days. A significant decrease in all the interplanetary parameters, V.B. and Bz are very easily distinguishable from the same figure for each event period. Daily variation of cosmic ray intensity is also an important factor in time-variation studies of cosmic rays, which depends on the 24 hour spin motion of earth. The daily variations of cosmic ray intensity at neutron monitor energies is usually composed of first three harmonic with significant

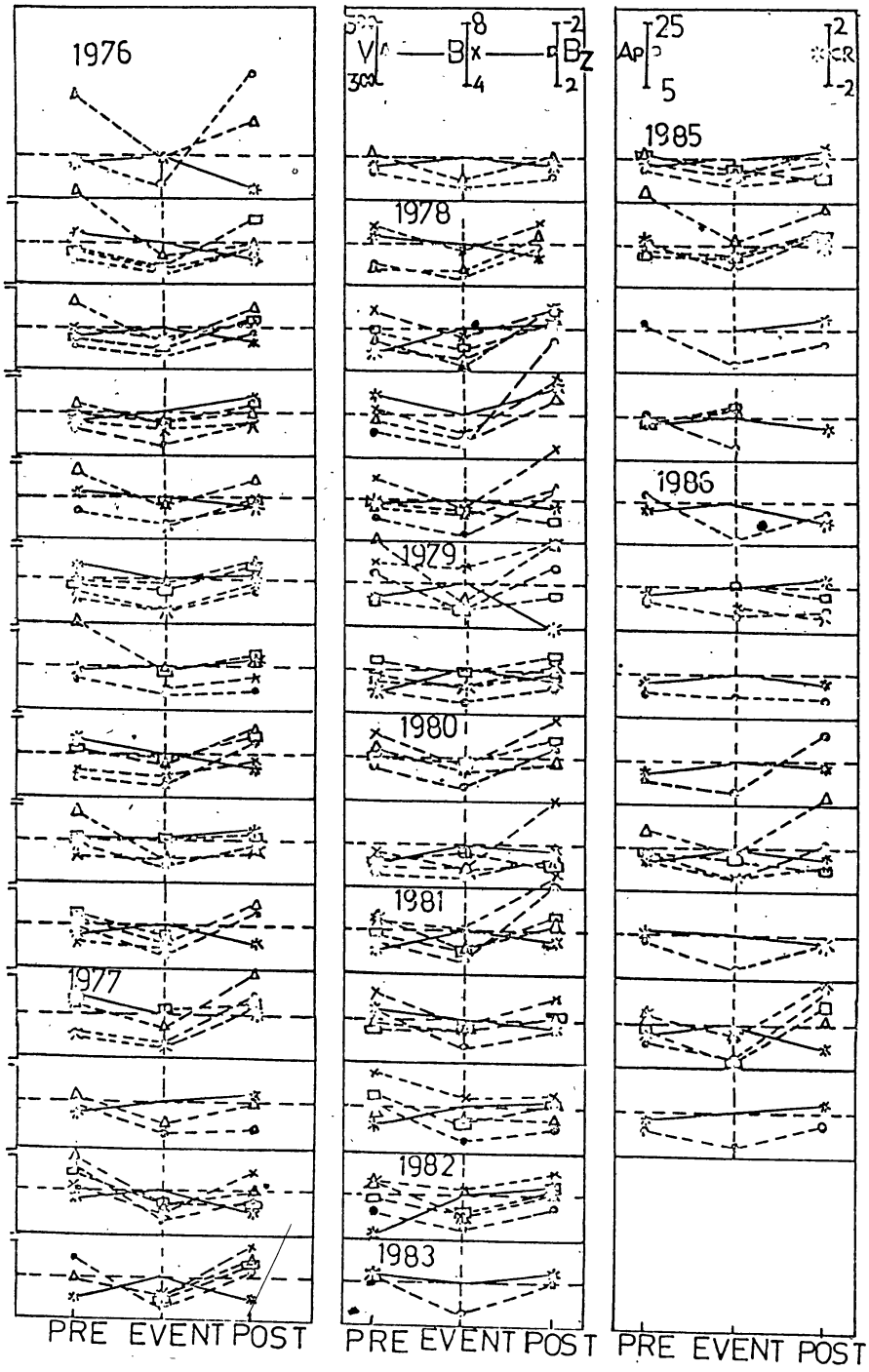


**Figure 1.** Shows the cosmic ray intensity deviations (in percent) for each event for the interval 1976 to 1986. The points associated with each event is the average cosmic ray intensity deviations for Deep River neutron monitoring station. The values for the event as well as pre and post values are plotted. V.B. and Bz are also plotted and are shown by different symbols.

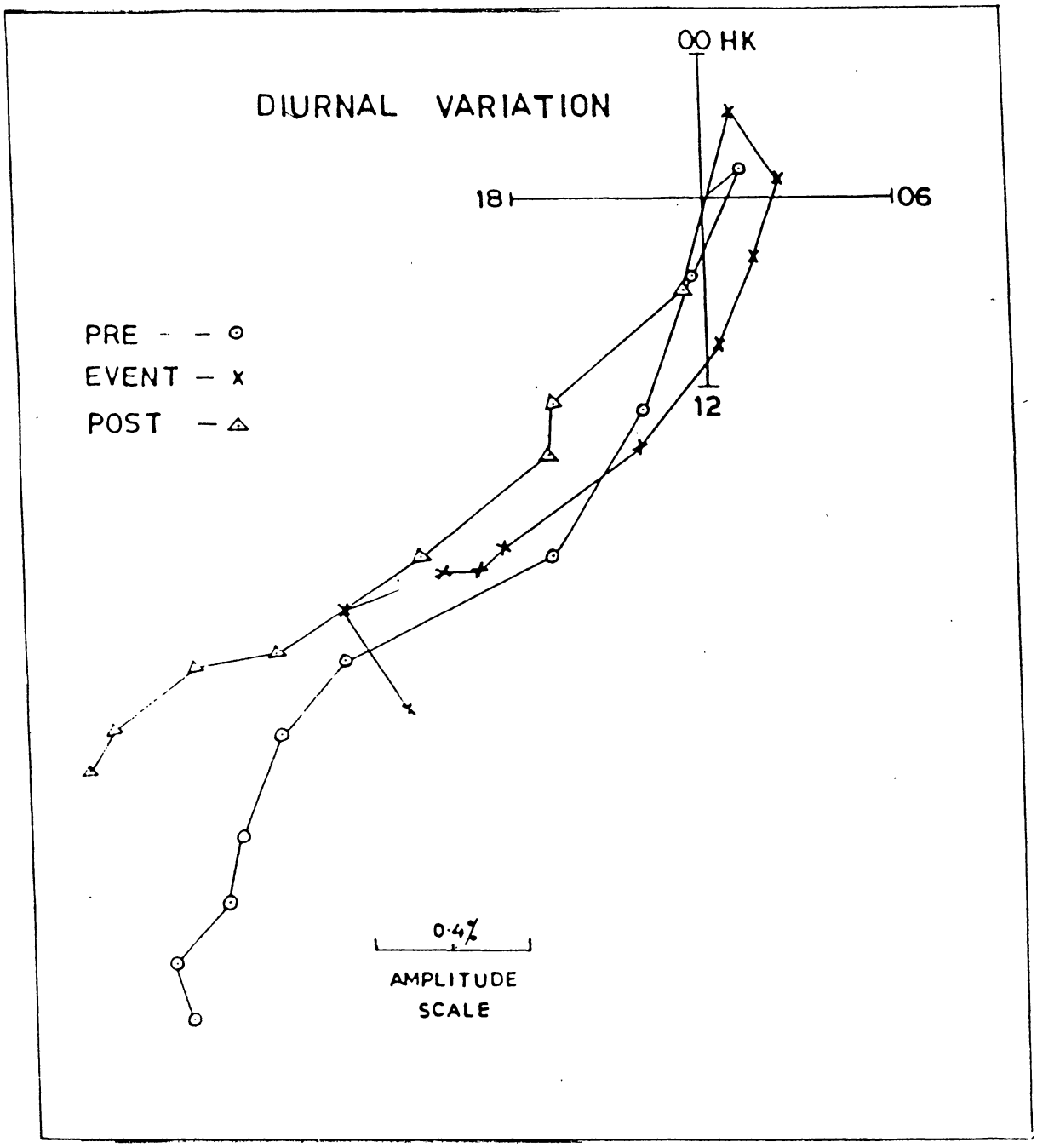


**Figure 2.** Shows the vector addition diagram of diurnal component of cosmic ray daily variation for the years 1977, 1981 and 1986. The pre event and post periods are represented by different symbols.

amplitudes. In this work, we have derived amplitudes and phase for diurnal variation of cosmic ray intensity. Figure 2 shows the vector addition diagram for diurnal variation events of cosmic ray intensity for the years 1977, 81 (2 events each) 1986 (6 events). In this figure the point of 1977 is taken as starting point of 1981 and the same method followed for 1986. It is seen that the amplitudes of diurnal variation of cosmic ray intensity for quiet period is significantly smaller than the average amplitudes of pre-and post periods. However dispersion in phases among all the three categories are similar and quite small.

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