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The Role of Drift in Long TermVariation of Cosmic Ray Intensity

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The long-term variation in cosmic ray intensity has been studied by using the pressure corrected cosmic ray intensity data during the period 1987-2004 (Which includes the solar activity cycles 22-23) recorded by Oulu Neutron monitor (cut off rigidity R_C =0.81 (GV). The observational results are compared with the past solar activity cycles 19, 20 and 21 which clearly indicate an even-odd cycle asymmetry which might be related to the polarity of the solar polar magnetic field configuration which are denoted by qA>O are qA<O in the drift notations.

1. Introduction

In the recent past, two ideas have motivates much to the modulation research. The first originally proposed by Lockwood (1960), is that the long-term variation of cosmic ray intensity i.e. 11 year variation result from pileup of individual intensity decreases caused by shock's and other disturbance in solar wind. The second major idea is that gradient end curvature drifts, long neglected in theories of modulation may be significant and in some cases even dominant in governing the modulation of the cosmic rays. This paper reports the results of an analysis of cosmic ray intensity data for current solar activity cycle 22 and 23 (incomplete) to observe the various features of long-term variation (i.e. 11-year/22 year) of cosmic ray intensity. The earlier observations for solar activity cycles 19, 20 and 21 (Lockwood et. al. 1988, Sharma et. al. 1994) are compared with the observations of current solar cycles, to observe the similarities/differences in the even and odd solar activity cycles.

2.Data Analysis

To observe the characteristic of long-term variation (11 year/22 year) of cosmic ray intensity, the pressure corrected data of Oulu, neutron monitor has been analysed during the period 1987-2004 which includes the solar activity cycles 22 and 23 (in complete). The counting rate has been arbitrarily normalized to 100 for the maximum cosmic ray intensity associated with the year 1965, the year of minimum solar activity**.**

3.Results and Discussion

Fig. 1 indicates the average time profile of the cosmic ray intensity data during 1987-2004, which including the solar activity cycles 22 and 23 (in complete) along with the polarity of the solar polar magnetic field. The polarity reversal in cycle 22 and 23 occurs in the years (1990-91) and 2000 respectively. The polarity becomes outward ± during the year 1992 onwards and it becomes inward during 2001 onwards. These polarity configurations are denoted by qA>O and qA<O in the drift rotation.

The purpose of this plot is to compare our observational results with previous solar activity cycles (19, 20 and 21) which help to identify the differences/similarities in nature of the cosmic ray intensity. In particular the shape of cosmic ray intensity maximum during solar activity cycle 22 and 23 (awaited). The comparison results are also summarized in Table 1.

The graphical and tabular presentation of our observational results clearly indicate that minimum or maximum cosmic ray intensity occurs after every-11 year but the time profiles of cosmic ray intensity is significantly different from are solar activity cycle to other. A flatter maximum is noted during 1994-97 (cycle 22; even) which is same as it was reported in solar cycle 20 (even) also the recovery of the cosmic ray intensity is fast of the order of 2 to 3 years in the even solar activity cycles 20 and 22 and it is slow in the odd solar activity cycle (i.e. ≈ 5 to 6 year) 19, 21 and 23. Our comparison results are also very useful to predict the shape of cosmic ray intensity maximum in solar activity cycle 23, which might be a sharp maximum followed by a slow recovery in odd solar cycle 23.

Our observational results clearly indicate the appearance of even and add cycle asymmetry which might be related with the sign of the particle charges and the polarity of the solar polar magnetic field of the sun. These observational results may be explained by the inclusion of a physical mechanism (i.e. drift along with the current sheet) which depend on the sign of the particle charge and the polarity of the solar polar magnetic field in the exiting modulation models. Our observational results presented in Table.1are in good agreement with theoretical result of Kota and Jokipii (1983).

According to drift current sheet model during solar activity minimum in 1965 (cycle 19) and 1987 (cycle-21), when the north polar magnetic field was inward (qA<0), positive particles drift along the equator from the outer boundary of the heliosphere. At this time current sheet plays on important role in the arrival of cosmic rays in the inner heliosphere and shaping the modulation peak during odd solar activity cycles. For the period 1972-77 (cycle 20) and 1994-97 (cycle 21) when the north polar field was outward (±; qA>O), positive particles drift to the inner heliosphere from the polar regions and then drifted outward along the current sheet. Therefore during these periods current sheet tilt is not important in modulating the cosmic ray intensity in the heliosphere. It is also possible to understand the slow and fast recoveries during odd and even solar activity cycles in terms of this model.

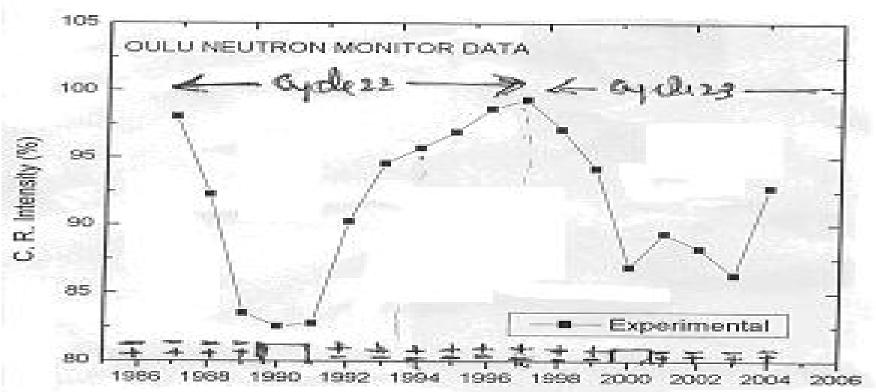

Fig.1 Average time profile of cosmic ray intensity during 1987-2004

4.Conclusions

1. The shape of maximum of cosmic ray intensity cycle 23, should be a sharp, maximum on the bans of previous observations.

2.An even-odd cycle asymmetry is observed which might be related with the sign of the particle charge and polarity of the suns magnetic field which enhance the importance of the role of the drift current sheet model in the modulation of the cosmic rays.

Table: 1 Observed feature of the 22 year variation of cosmic rays :

Period of solar activity minimum	Solar field polarity at solar activity minimum	Polar field changes over	Cosmic Ray intensity of solar activity minimum
1965 (cycle 19)	$N^{-} S_{+}$, $qA < 0$	1957-58 (± to ∓)	Peaked maximum intensity
1972-77 (cycle 20)	$N^{+} S_{-}$, $qA > o$	1969-71 (∓ to ±)	Flat maximum intensity
1987 (cycle 21)	$N^{-} S_{+}$, $qA < 0$	1980 (± to ∓)	Peaked maximum intensity
1994-97 (cycle 22)	$N^{+} S_{-}$, $qA > o$	1990-91 (∓ to ±)	Flat maximum intensity

References

[1] Lockwood, J.A., J-Gewphys. Res 65 (1960), 19
[2] Webber W.R. and Lockwood JA., (1988), Journal of Geophysical research, 93 (1988) 8735.
[3] Kata J & Jokipai J.R., Astrophysical Journal (USA), 265 (1983) 573.
[4] N.K. Sharma & R.S. Yadav, 1994, India Journal of Radio & Space physics 23 (1994) 165.