CORONAL MASS EJECTIONS AND THEIR IMPACT ON COSMIC RAY INTENSITY VARIATION DURING 23-CYCLE

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ABSTRACT: - Cosmic rays are falling all the times and everywhere on our earth surface probably from our milky way galaxy. The process of a cosmic ray particle colliding with particles in our atmosphere and disintegrating into smaller poins muons and the like is called a cosmic ray shower. These particles can be measured on the Earth's surface by neutron monitors. Coronal Mass Ejections are vast structures of plasma and magnetic fields that are expelled from the sun into the heliosphere. The present study deals with derived long–term relation between cosmic rays and solar activity. We have described the various characteristics of long term cosmic ray intensity variations. Long-term relationship between CME and cosmic rays are studied. Coronal Mass Ejections occurrence rates show good correlation with cosmic ray intensity on long-term basis. In our study, Correlation between Cosmic rays and CME rates show negative and for A> 0 epoch (1996 to 1999) of solar magnetic cycle. However negative and normal correlation is found during the period 2001 to 2008, which represent A < 0 epoch of solar magnetic field. The deviations in cosmic ray intensity are more pronounced in case for asymmetric and complex full halo CMEs compared to other CMEs.

KEYWORDS:- Cosmic ray; Coronal mass ejections.

INTRODUCTION:-

Cosmic ray intensity as it is observed on earth surface, exhibits an 11 year variation anti correlated with solar activity, with perhaps some time lag, firstly studied by Forbush in1954.Many research groups have tried to explain cosmic ray modulation through means of appropriate solar, interplanetary and geomagnetic parameters. The modulation of galactic cosmic rays in heliosphere using theoretical as well as empirical approaches is successful and advanced rapidly. (Potgieter, 1998). However, an adequate description of the effect of the heliosphere on cosmic ray still does not appear to be a simple task. Exarhouse and Mouses,1999;Morishita and Sakuibara,1999 tried to estimate the magnetic field at the heliospheric termination shocks and size of the heliosphere to study the effects of its temporal variation on the galactic long-term cosmic ray variation. Calculated cosmic intensity is in good agreement with the neutron monitor measurements during the last 50 years. Particular consideration of the cosmic ray modulation is given to the correlation of long-term cosmic ray variation with different solar-heliospheric parameters and to existing empirical models of cosmic ray intensity (Belov, 2000).
Solar cycle 23 was a cycle of great interest, as it was characterized by a lot of violent periods of extreme solar events mainly in descending phase and secondly, it had an extraordinary and extended minimum with duration more than three years. In this minimum, the cosmic ray intensity was much higher than previous cycles (Kane, 2011).

The first “Cosmic rays” gives the information’s about of primary, and secondary cosmic rays,. Time variation of cosmic rays is described with physical mechanism. Long-term and short-term, for bush decreases are also described in this research paper.

REVIEW OF LITERATURE:-

Bieber and Evenson (1998) noticed strong enhancements of the cosmic ray anisotropy before and during the January 1997 CME/magnetic cloud. From a multi-station analysis of neutron monitor data, they conclude that $B \times \Delta n$ drift is a primary source of CME-related anisotropies for 5 GeV cosmic rays.

Cane et al. (1996) reported a significant relationship between CMEs and cosmic ray variations. Evolution of the cosmic ray density and density gradients is closely linked to magnetic properties of the ejecta, and provides information on the magnetic cloud and related features as they approach and pass Earth. Strong enhancement of the field-aligned anisotropy was observed primarily during the 9 hours prior to shock arrival condition of Earth.

Shrivastava (2001) argued that the coronal mass ejections in association with B-type solar flare might be the reason for the enhancement of geomagnetic field variation and CMEs indicate its better role in cosmic ray modulation. The intensity of galactic cosmic rays measured on Earth is related to the Sun’s cycle of activity, which is well known by astronomers.

Cliver and Ling (2001) have discovered a quirk in this pattern - and they believe that coronal mass ejections could be responsible for it. The solar magnetic field flips every 11 years and the number of sunspots and ’coronal mass ejections’ rises and falls twice in each complete 22-year cycle. The cosmic ray intensity on Earth also peaks twice every 22 years in time with the solar cycle.

MATERIALS AND METHODS:-

“Detectors Method of analysis and geomagnetic indices” gives a sufficient information neutron regarding neutron monitors. Various analytic techniques, such as correlation, regression, chree etc. are well written in this chapter. Geomagnetic indices are also described in this chapter Cosmic rays, solar and geomagnetic data have been taken from the monthly publications of solar geophysical data books as well as various internet websites.

RESULTS AND DISCUSSION:-

Cosmic ray modulation on long-term as well as on short-term basis is still a interesting topic in interplanetary and space science studies. Identification of Coronal Mass Ejections since 1974 proved a new and key aspect in cosmic ray modulation. Propagation of large energy and mass from a CME event into interplanetary space casing geomagnetic field variation and large changes in cosmic ray intensity. Recent space craft observations of different categories of CMEs (i.e. Halo, partial halo, Bright loop etc.) enhance our information's regarding cosmic ray modulation process.

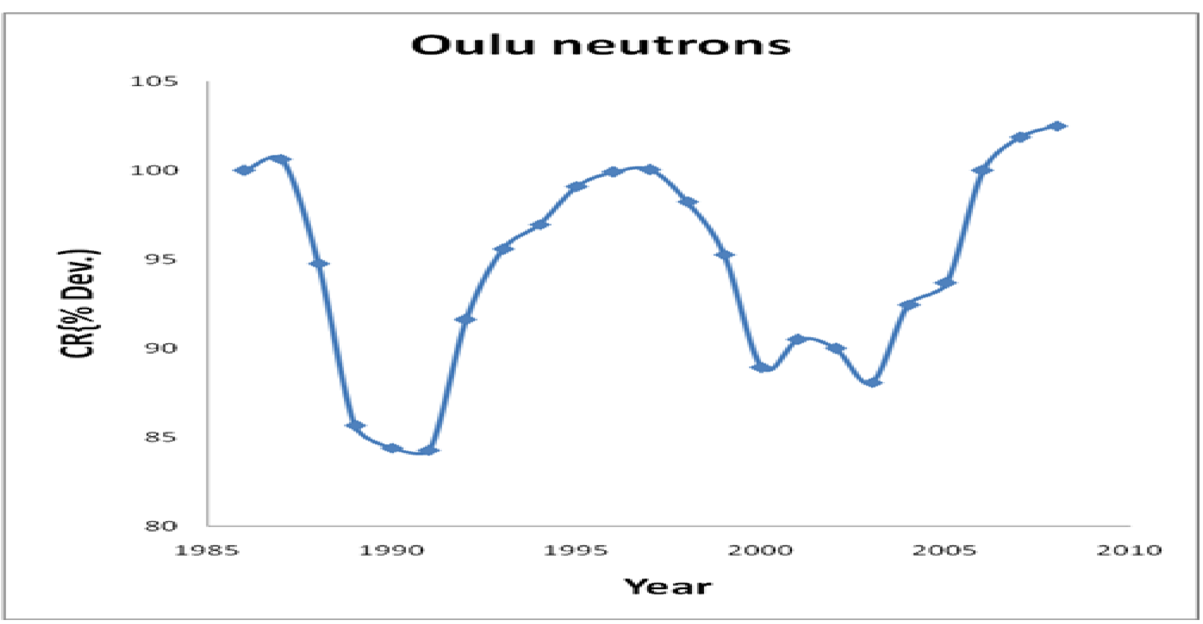

Fig.1. Long-term profile of Oulu NM station cosmic rays.

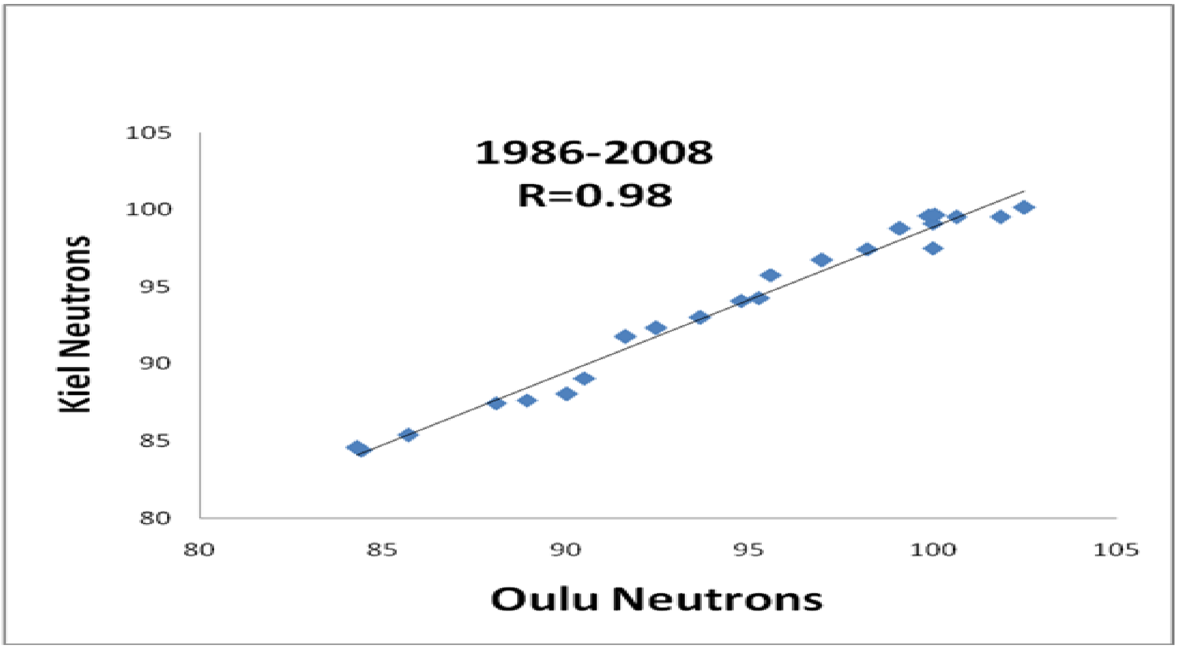

Fig. 2- Shows the correlation between annual mean CR deviations of Kiel and Oulu neutron

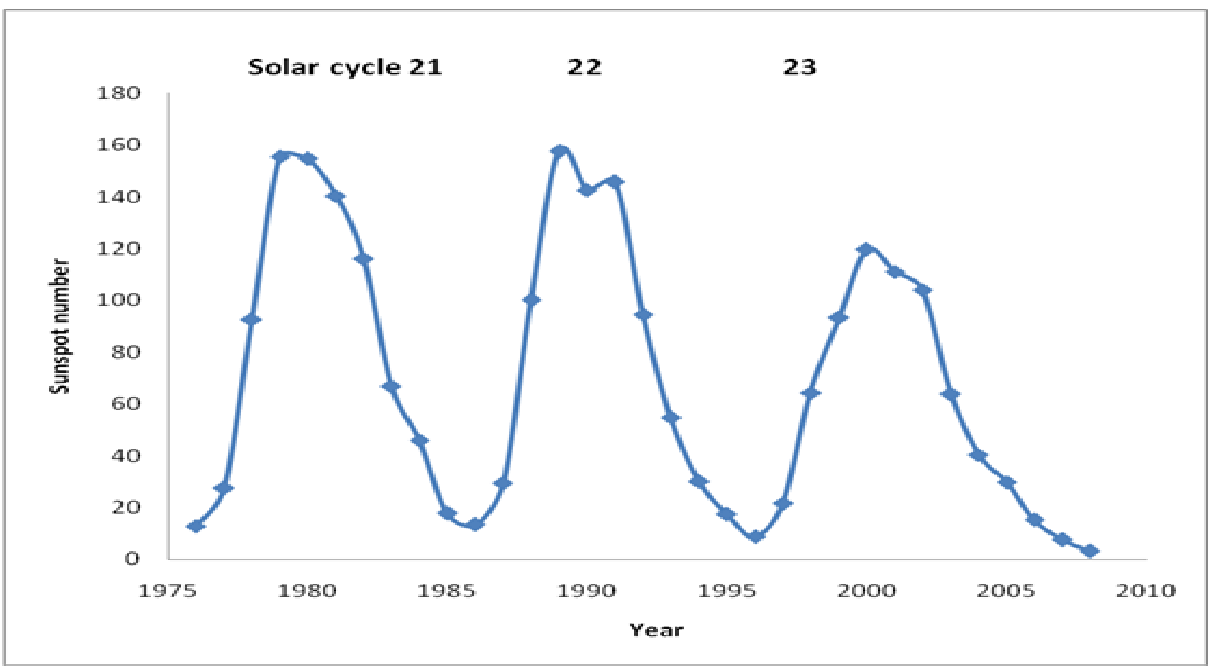

Fig.3. Shows the annual mean value of sunspot numbers for the period of 1976 to 2008 covering the solar cycles 21 to 23

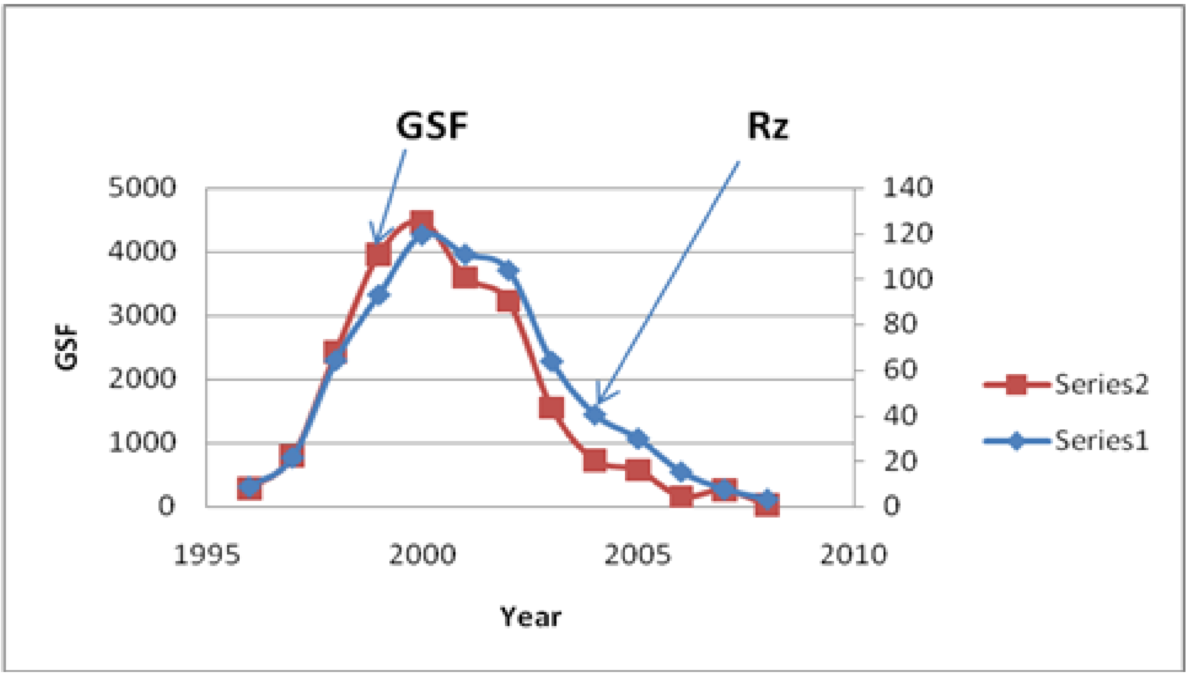

Fig.4- Shows the yearly mean values of Rz along with GSF for the period of 1996 to 2008

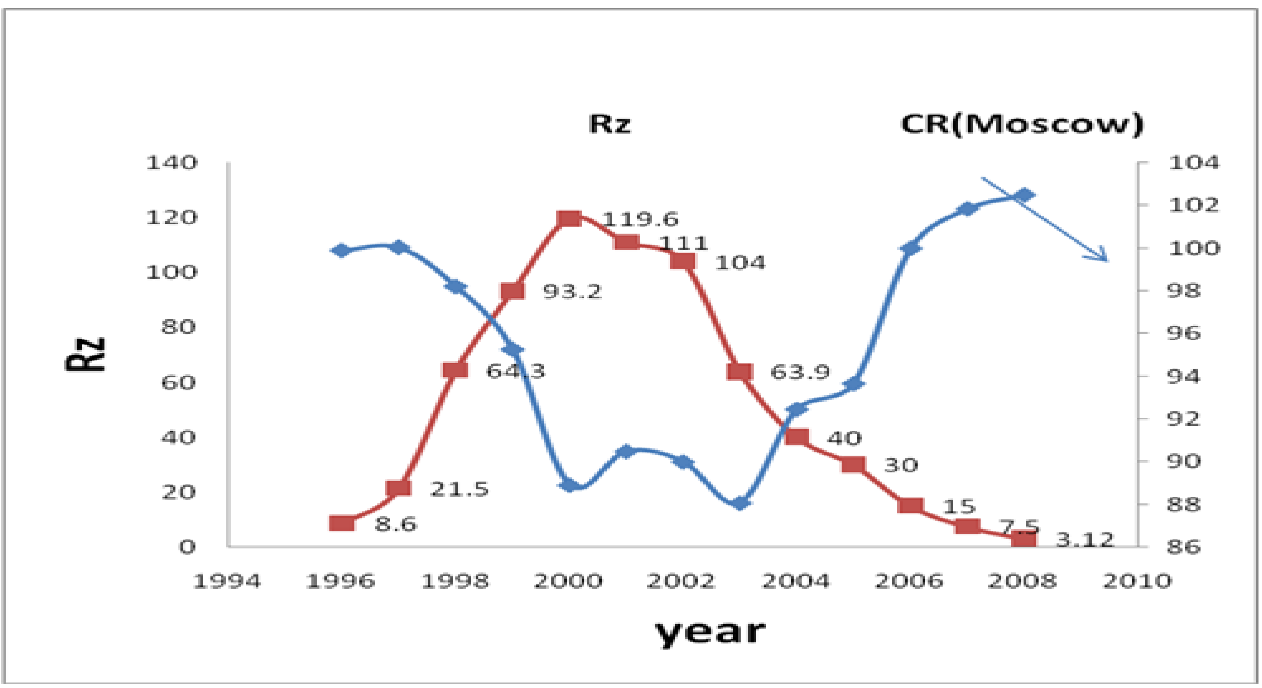

Fig.6- Shows yearly mean values of sunspot numbers along with cosmic rays for the Period of solar cycle 23.

We have derived long–term relation between cosmic rays and solar activity. We have described the various characteristics of long term cosmic ray intensity variations. Long-term relationship between CME and cosmic rays are studied. Coronal Mass Ejections occurrence rates show good correlation with cosmic ray intensity on long-term basis. Halo CMEs produce short-term a periodic decreases in cosmic ray intensity which are in agreement with earlier findings (Cane,2000). Halo CMEs also produce enhancement in geomagnetic activity. We have compared our findings with results reported by a number of research workers in the field (Forbus, 1954; Badruddin and venkatesan, 1990; Shrivastava et an ,1993;Belov,2000;Morishita et a1999).

In our study, Correlation between Cosmic rays and CME rates show negative and for A> 0 epoch (1996 to 1999) of solar magnetic cycle. However negative and normal correlation is found during the period 2001 to 2008, which represent A < 0 epoch of solar magnetic field.

CONCLUSION:-

The present investigation important finding conclusions are given below-

1. Cosmic ray intensity shows 11-year periodicity on long-term basis.
2. Cosmic ray count rates from two different stations show strong positive correlations.
3. All the solar indices i.e. sunspot numbers, group solar flares, solar flux show 11-year long-term variability.
4. Sunspot numbers show positive and high correlation with solar flux.
5. Sunspot numbers show negative and high correlation with cosmic ray intensity on long-term basis.
6. Cosmic ray intensity shows negative and high correlation with solar parameter.
7. We have derived CME rates for the period of 1996 to 2008 on monthly and yearly basis. CME rates show 11-year periodicity.

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