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# Intensity of cosmic rays in relation to geomagnetic activity parameter Ap and Kp Index

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**Abstract:**

*We studied the relation between monthly average count rate of cosmic ray intensity (CRI) observed at Kiel super neutron monitor during the period of solar cycle 22 and 23 with monthly average values of Geomagnetic Activity (GA) parameter Ap index and Kp index .It is seen that monthly average count rate of cosmic ray intensity is well correlated with monthly average values of Ap index and Kp index. We have found negative correlation with correlation coefficient -0.58 between monthly average values of cosmic ray intensity (CRI) and monthly average values of geomagnetic activity parameter Ap index for the period of 1986-1996. Large negative correlation with correlation coefficient -0.63 has been found between monthly average values of cosmic ray intensity (CRI) and monthly average values of geomagnetic activity parameter Ap index for the period of 1997-2007.Negative correlation with correlation coefficient -0.58 has been found between monthly average values of cosmic ray intensity (CRI) and monthly average values of geomagnetic activity parameter Ap index for the period of 1986-2007. Inverse correlation has been found between monthly average values of cosmic ray intensity (CRI) and monthly average values of Kp index. Negative correlation with correlation coefficient -0.56 has been found between monthly average values of cosmic ray intensity (CRI) and monthly average values of geomagnetic activity parameter Kp index for the period of 1986-1996. Large* *negative correlation with correlation coefficient -0.70 has been found between monthly average values of cosmic ray intensity (CRI) and monthly average values of geomagnetic activity parameter Kp index for the period of 1997-2007. Negative correlation with correlation coefficient -0.58 has been found between monthly average values of cosmic ray intensity (CRI) and monthly average values of geomagnetic activity parameter Kp index for the period of 1986-2007.*

**Key words:** Cosmic ray intensity, Geomagnetic Activity parameter Ap and Kp Index.

## 1-Introduction

The cosmic-ray intensity, as is observed from Earth and in Earth's orbit, exhibits an approximate 11-year variation anti correlated with solar activity, with perhaps some time lag, a fact that was firstly studied by Forbush (1958) and by many subsequent researchers (Pomerantz and Dugal, 1974; Perko and Fisk, 1983). Many research groups have tried to express this long-term variation of the galactic CR intensity through means of appropriate solar indices and geophysical parameters, such as the sunspot number by Nagashima and Morishita (1980a), solar flares by Hatton (1980), and the geomagnetic index by Chirkov and Kuzmin (1979). Other authors such as Nagashima and Morishita (1980b) took into account the contribution of more than one parameter (solar or geophysical) in the modulation process. Mavromichalaki and Petropoulos (1984) found an empirical relation between the modulated CR intensity during the 20th solar cycle and a combination of the relative sunspot number, the number of proton events and the geomagnetic index Ap, that was later improved by Mavromichalaki and Petropoulos (1987) by including the number of co rotating solar wind streams. Usoskin et. al. (2002), using a reconstruction of the open solar magnetic flux from sunspot data as an input to a spherically symmetric quasisteady state model of the heliosphere, calculated the expected intensity of galactic cosmic rays at Earth's orbit. This calculated cosmic-ray intensity is in good agreement with the neutron monitor measurements during the past 50 years. More recently, an effort has begun to find a relation between the CR modulation and the interplanetary magnetic field (IMF), with which it has been suggested to be highly associated (Belov, 2000). A relationship between cosmic-ray intensity variations and IMF intensity exists for short time intervals during Forbush effects (Cane, 1993) and in the distant heliosphere (Burlaga, McDonald, and Ness, 1993). Kudela et al. (2000) distinguish the IMF configurations that can produce Forbush decreases in three categories and show that we cannot ignore the importance of the IMF, as it is also strongly related to cosmic-ray fluctuations. From this point of view we can use the IMF instead of, or coexisting with, geomagnetic index values. Belov et al.(2001) have shown that the tilt of the heliospheric current sheet and other solar heliospheric parameters successfully describe the long-term variations of cosmic rays in the past two solar cycles, especially in the epochs of solar maxima. Thus, Cane (2000) suggests that CMEs "do not appear to play a major role in long term modulation", whereas others such as Newirk, Hundhausen, and Pizzo (1981) and Cliver and Ling (2001) suggest that CMEs do play a role in long-term cosmic-ray modulation. Particular consideration of cosmic ray modulation is given to the correlation of long-term cosmic-ray variations with different solar-heliospheric parameters and to existing empirical models of cosmic-ray intensity, as is described in the review paper by Belov (2000). In the present study monthly average values has been analyzed with monthly average values of geomagnetic activity parameter Ap and Kp index to get possible relation between monthly average values of cosmic ray intensity and geomagnetic activity parameter Ap,Kp index.

## 2-Data and method of Analysis

In the present work, Ap and Kp geomagnetic activity parameters has been used to study the cosmic ray intensity (CRI) for the period of solar cycle 22 and 23. To study the monthly average behavior of cosmic ray intensity, monthly average values of Kiel neutron monitor station has been used. The correlation coefficient between cosmic ray intensity and Ap, Kp, geomagnetic activity parameters has been calculated for the said period. The data of geomagnetic activity parameter has been taken from Omni web data (http;//omniweb.gsfc.nasa.gov/form/dxi.html).

## 3-Data Analysis and Results

In this study, we have performed correlative analysis of monthly average values of cosmic ray intensity (CRI) and monthly average values of Ap index, for the period of 1986-1996, 1997-2007 and 1986-2007. To see how the monthly average values of cosmic ray intensity is correlated with geomagnetic activity parameters Ap,Kp index we have plotted a liner graph between monthly average values of cosmic rays intensity (CRI) and monthly average values of Ap index, and the graph so obtained is shown in fig. [1, 2, 3]. From the figures it is observed monthly average values of cosmic ray intensity (CRI) and monthly average values of Ap index are inversely correlated. Further we have calculated correlation coefficient between monthly average values of cosmic ray intensity and monthly average values of geomagnetic activity Ap, Kp index using statistical formula of correlation coefficient. Using the formula, we have obtained negative correlation with correlation coefficient -0.58 between monthly average values of cosmic ray intensity (CRI) and monthly average values of Ap index for the period of 1986-1996 .Large negative correlation with correlation coefficient -0.63 has been determined between monthly average values of cosmic ray intensity (CRI) and monthly average values of geomagnetic activity parameter Ap index for the period of 1997-2007 and negative correlation with correlation coefficient -0.58 has been obtained between monthly average values of cosmic ray intensity (CRI) and monthly average values of geomagnetic activity parameter Ap index for the period of 1986-2007.

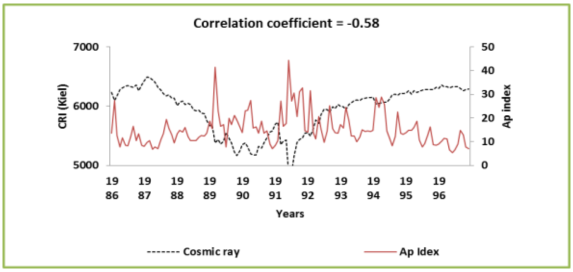


**Figure-1-Shows the relationship between monthly average value of CRI (Kiel) and Ap index, for the period of 1986-1996.**

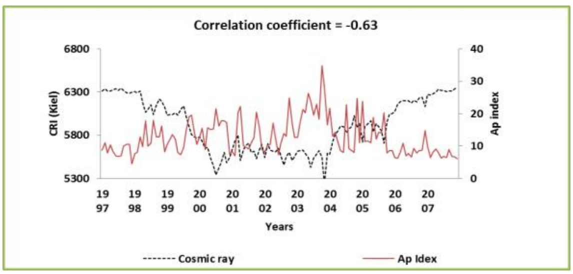


**Figure-2-Shows the relationship between monthly average value of CRI (Kiel) and Ap index, for the period of 1997-2007.**

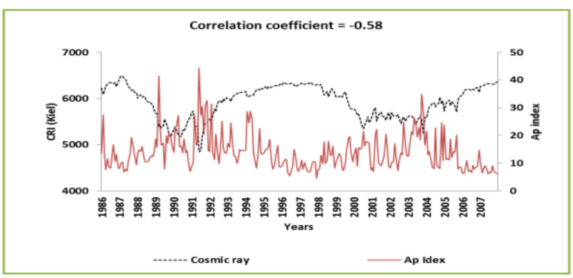


**Figure-3-Shows the relationship between monthly average value of CRI (Kiel) and Ap index, for the period of 1986-2007.**

We have also performed correlative analysis between monthly average values of cosmic ray intensity (CRI) and monthly average values of geomagnetic activity parameter Kp index, for the period of 1986-1996, 1997-2007 and 1986-2007. We have plotted a liner graph between monthly average values of cosmic rays intensity (CRI) and monthly average values of Kp index and the graph so obtained are shown in fig. [4, 5,6]. From the figures it is observed that monthly average values of cosmic ray intensity (CRI) and monthly average value of Kp index are inversely correlated .Negative correlation with correlation coefficient -0.56 has been found between monthly average values of cosmic ray intensity (CRI) and monthly average values of geomagnetic activity parameter Kp index for the period of 1986-1996 using statistical formula of correlation coefficient. Large negative correlation with correlation coefficient -0.70 has been found obtained between monthly average values of cosmic ray intensity (CRI) and monthly average values of geomagnetic activity parameter Kp index for the period of 1997-2007 and negative correlation with correlation coefficient -0.58 has been found between monthly average values of cosmic ray intensity (CRI) and geomagnetic activity parameter Kp index for the period of 1986-2007.

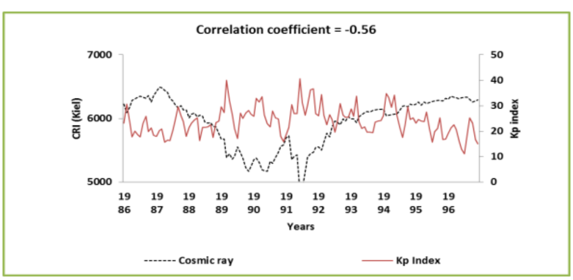


**Figure-4-Shows the relationship between monthly average value of CRI (Kiel) and Kp index, for the period of 1986-1996.**

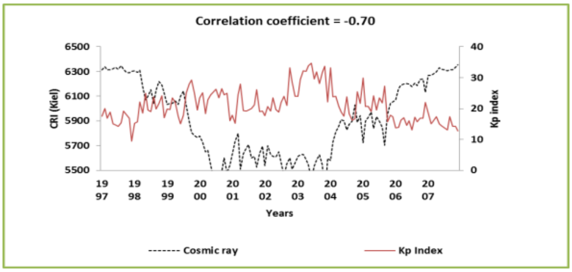


**Figure-5-Shows the relationship between monthly average value of CRI (Kiel) and Kp index, for the period of 1997-2007.**

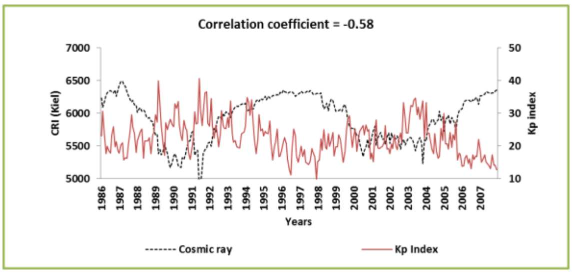


**Figure-6-Shows the relationship between monthly average value of CRI (Kiel) and Kp index, for the period of 1986-2007.**

## 4-Main Results and conclusion

Negative correlation with correlation coefficient -0.58 between monthly average values of cosmic ray intensity (CRI) and monthly average values of geomagnetic activity parameter Ap index for the period of 1986-1996.

Large negative correlation with correlation coefficient -0.63 has been found between monthly average values of cosmic ray intensity (CRI) and monthly average values of geomagnetic activity parameter Ap index for the period of 1997-2007.

Negative correlation with correlation coefficient -0.58 has been found between monthly average values of cosmic ray intensity (CRI) and monthly average values of geomagnetic activity parameter Ap index for the period of 1986-2007.

Negative correlation with correlation coefficient -0.56 has been found between monthly average values of cosmic ray intensity (CRI) and monthly average values of geomagnetic activity parameter Kp index for the period of 1986-1996.

Large negative correlation with correlation coefficient -0.70 has been found between monthly average values of cosmic ray intensity (CRI) and monthly average values of geomagnetic activity parameter Kp index for the period of 1997-2007.

Negative correlation with correlation coefficient -0.58 has been found between monthly average values of cosmic ray intensity (CRI) and monthly average values of geomagnetic activity parameter Kp index for the period of 1986-2007.

From our study of monthly average values of cosmic ray intensity observed during the period of solar cycle 22 and 23 and monthly average values of Ap,Kp ,it is seen that monthly average values of cosmic ray intensity is well correlated with monthly average values of geomagnetic activity parameters Ap, Kp. Negative correlations has been found between monthly average values of cosmic ray intensity and monthly average values of geomagnetic activity parameters Ap, and Kp. index.

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