# Relation Of Short Term Symmetric Cosmic Ray Decreases With Coronal Mass Ejections And Solar Flare

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*Abstract*
*We have analyzed asymmetric cosmic ray intensity decreases ≥4%, observed during the period of 1997 to 2013 with coronal mass ejections and X-Ray solar flares. We have found total numbers of symmetric cosmic ray intensity decreases are 47. We have the data of CMEs for 42 events out of these, 27 symmetric cosmic ray intensity decreases (Fds) have been found to be associated with coronal mass ejections. The association rate of halo and partial halo CMEs are 48.15% and 51.85 % respectively. Further we have observed that 42 symmetric cosmic ray intensity decreases, are associated with X ray solar flares of different categories and majority of the associated solar flares are C-Class X-ray solar flares. From the study of symmetric cosmic ray intensity decreases with speed of associated CMEs, we found that the magnitude of symmertic cosmic ray intensity decreases and speed of CMEs are positively correlated with correlation coefficient 0.19.*
*Keywords: Coronal mass ejections, X-ray Solar flares, symmetric cosmic ray intensity decreases.*

## 1- INTRODUCTION

The galactic cosmic-ray intensity recorded at Earth has an 11 year variation opposite to that of the sunspot number (Forbush 1954, 1958). The cosmic-ray intensity has its minimum at the maximum of the sunspot cycle. Generally, this variation is explained in terms of gradient and curvature particle drifts in the large-scale field of the heliosphere (Jokipii,Levy,and Hubbard1977) and diffusion/convection of cosmic rays (Morrison 1956;Burlaga et al 1984; Perko;&Burlaga 1992) in the solar wind (for recent reviews see McDonald 1998;Potgieter 1998Burger 2000) Coronal mass ejections (CMEs), large-scale eruptions of magnetized plasma from the Sun (Hundhausen 1993,1999), are related to very strong, short-lived (Forbush) decreases of cosmic-ray intensity at Earth and are considered to be the building blocks of global merged interaction regions (GMIRs) in the outer heliosphere (Burlaga, McDonald,& Ness 1993) which are associated with the extended Forbush-type decreases. There (Webber, Lockwood, & Jokipii 1986) Newkrik, Hundhausen, & Pizzo(1981) were among

the first to suggest that CMEs might play a role in long-term modulation of cosmic rays. At solar maximum, the CME rate, which tracks the sunspot number (Webb & Howard 1994), is high, and CMEs are observed at all latitudes, consistent with the closed shell of the GMIR picture (McDonald, Lal, & McGuire 1993), in which modulation proceeds as a series of steps. In so far as no one has championed the slow solar wind (which has the lowest average field strength of the three solar wind components;(Richardson et al.2000) as a modulation driver, downplaying the role of CMEs implies that intermediate- and long-term modulation originates primarily in coronal holes, the source of the open magnetic flux. This inference is supported by the correspondence between open flux increases and intermediate-term cosmic-ray decreases reported by Cane et al.(1999a,1999b).The relative importance of CMEs, which originate in closed-field regions on the Sun and the open magnetic flux for modulation has been discussed by Hundhausen 1993,1999. In this investigation we have short term cosmic ray decreases with coronal mass ejections

associated x-ray solar flares, to know relationship of short term cosmic ray decreases and these parameters.

## 2- SOURCES OF DATA

In this study short term cosmic ray intensity decreases with coronal mass ejections and solar flares have been studied during the period 1997- 2013. The data of cosmic ray intensity decreases adopted from Oulu super neutron monitor. The data of coronal mass ejections (CMEs) have been taken from SOHO – large angle spectrometric, coronagraph (SOHO / LASCO) and extreme ultraviolet imaging telescope (SOHO/EIT) data. The data of X-ray solar flares are taken from STP solar data (http://www.ngdc.noaa.gov/stp/solar/solardatas ervices.html).

## 3- ANALYSIS OF DATA AND RESULTS

From the data analysis we have found total numbers of 47 symmetric cosmic ray intensity decreases during the period1997-2013. Out of 47 symmetric cosmic ray intensity decreases we have no data of CMEs for 5 events for association .We have available data of CMEs are 42 events and out of these 42 events 27 (64.92%) symmetric cosmic ray intensity decreases have been found to be associated with coronal mass ejections .The association rate of H Type and P types CMEs have been found 48.15% and 51.85 % respectively shown in figure-1.

To see the dependence of magnitude of symmetric cosmic ray intensity decreases on speed of associated CMEs a scatter diagram has plotted between magnitude of symmetric cosmic ray intensity decreases and speed of associated CMEs .The scatter plot shown in Figure-2. From the observation of the trend line of the figure it is inferred that the magnitude of symmetric cosmic rays intensity decreases and speed of associated CMEs are positively correlated with correlation coefficient of 0.19.
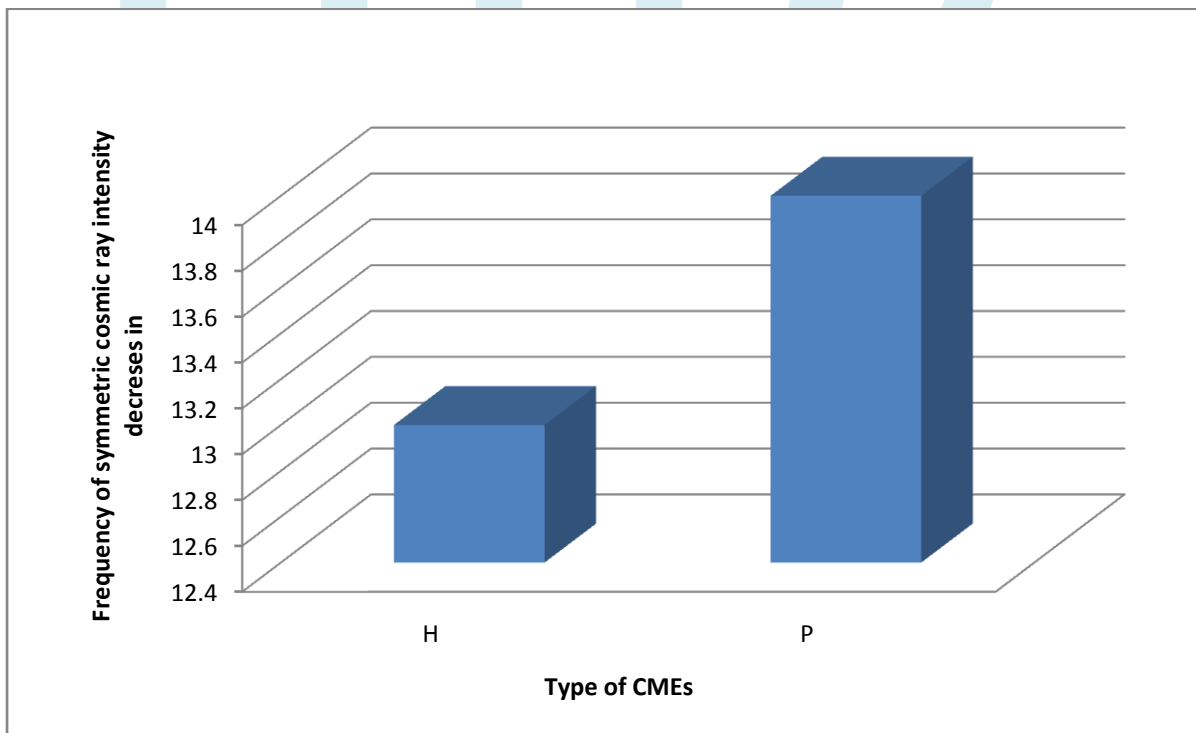


Figure 1- Bar diagram of symmetric cosmic ray decreases in cosmic ray intensity and types of associated CMEs for the period of 1997-2013.
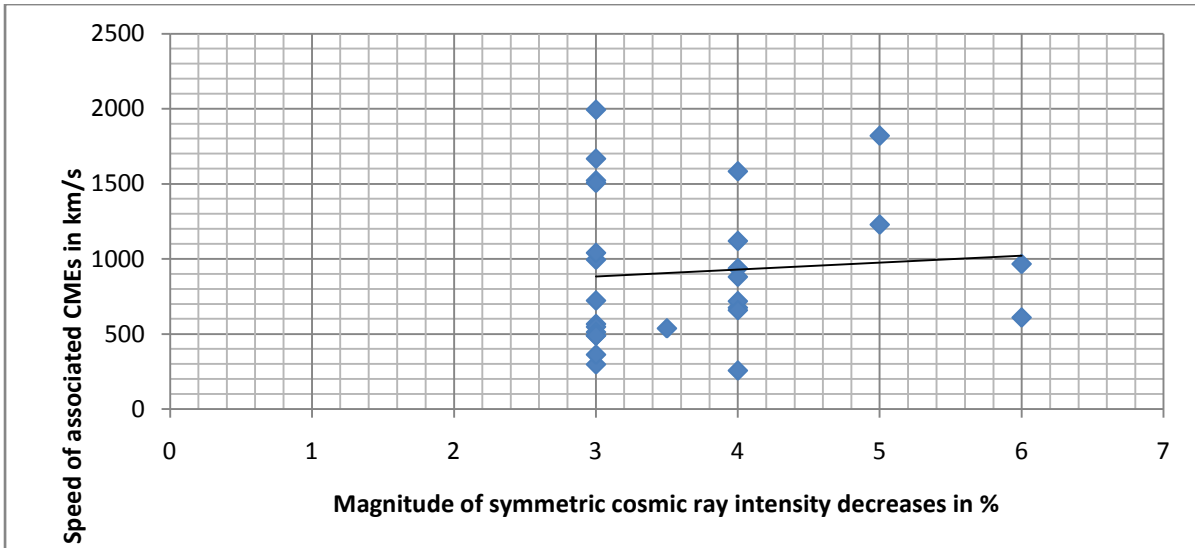
Figure 2- Scatter plot between magnitude of symmetric cosmic ray intensity decreases and speed of associated CMEs for the period of 1997-2013, showing positive correlation with correlation coefficient 0.19.

Further it is observed that 42(89.36%) cosmic ray intensity decreases associated with X ray solar flares of different categories. Out of 42 symmetric cosmic ray intensity decreases, 01(2.38%) symmetric cosmic ray intensity decreases are found to be associated with X class X-ray solar flares, 18(42.86%) are found to be associated with M class X-ray solar flares, 19(45.24%) are found to be associated with C class X-ray solar flares and 04(9.52%) are found to be associated with B class X-ray solar flares. From these results it is concluded that symmetric cosmic rays intensity decreases are closely related to solar flare. The bar diagram between different categories of solar flares and frequency of associated symmetric cosmic ray decreases in cosmic ray intensity is shown in Figure-3. From the data analysis it is concluded that majority of the symmetric cosmic ray intensity decreases are associated with X-ray solar flares and most of the symmetric cosmic ray decreases in cosmic ray intensity are associated with M class and C class solar flares.
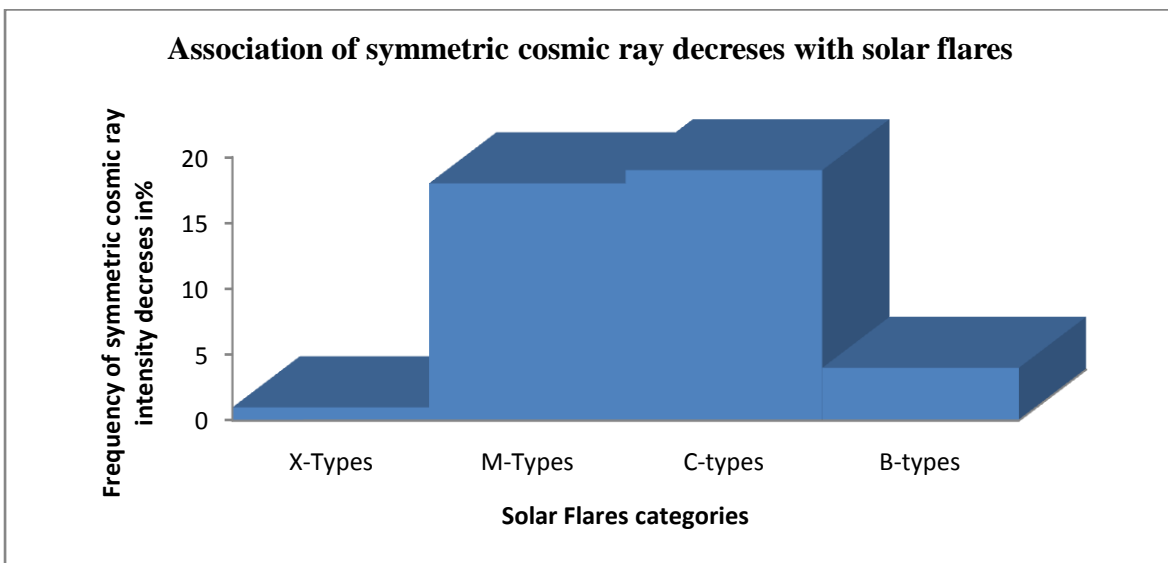


Figure 3- Bar Diagram between Different types of Solar flares and frequency of associated symmetric cosmic ray intensity decreases for the period of 1997-2013.

## 4- CONCLUSION

From our study we have found that 47 symmetric cosmic ray intensity decreases which are related to Coronal mass ejections and solar flares. Out of these 42 events are associated with CMEs, the majority of associated CMEs are partialhalo CMEs. Further it is concluded that these 42 events are also associated with X-ray solar flares.The majority of the associated solar flares are C-class X-ray solar flare. From the study of symmetric cosmic ray intensity decreases with speed of associated CMEs, we have determined positive correlation with correlation coefficient 0.19 between magnitudes of symmetric cosmic ray intensity decreases and speed of associated CMEs. It is concluded that symmetric cosmic ray intensity decreases are closely related with X-ray solar flares.

## 5- ACKNOWLEDGEMENT

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