A relation between Coronal Mass Ejections and Solar activity for solar cycle 23

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Abstract

We studied the relationship among CME rates, speed of full halo and partial halo CMEs for solar cycle 23. It is investigated Based on SOHO/LASCO catalogue and solar geophysical data book, we studied the relationship from the analysis that the average speed of full halo CMEs is almost faster than the annual average speed of partial halo CMEs. The maximum average speed of halo CMEs is found to be as large as1400 km/sec whereas minimum speed of halo CMEs is some time of the order of 350 km/sec. CMEs are predominantly from sunspot regions(except for some CMEs associated with low latitude quiescent prominces). Frequency varies according to the solar sunspot cycle. It is inferred that the correlation between them is positive and also found two peaks in CME and only one peak in sunspot line. {keywords coronal mass ejections;solar activity;sunspot number.

1 Introduction

CMEs are the explosions in the sun's corona. Coronal Mass Ejections from the solar corona are the most spectacular phenomena of solar activity . CMEs occur in regions of closed magnetic fields that Overlie magnetic inversion lines [?]. A study on CMEs is an important topic that relates directly to space environments . Within CMEs we have also Halo CMEs , appear as enhancement surrounding the entire occulting disk looks like a roughly circular "Halo" surrounding the sun. The Halo CMEs are more likely to impact the earth those of which are right angles to the earth - sun line [?]. Population of Halo CMEs and their average speeds increases during solar maximum and their occurrence generally fallow the phase of solar cycle. During solar minima, one CME occurs every other day. The rate goes up to several per day during solar maximum. On one day during solar maximum 13 CMEs were recorded by SOHO. There were several days with more than 10 CMEs. The rate of CMEs and the minimum to maximum variability, originally thought to be inadequate [3, 4]. The CME activity should fallow rather closely to the Sunspot cycle, but the correlation in exact counts may not be precise. This is probably because CMEs happen in layers of the sun that are much higher above the solar surface than the Sunspots. In this work, we have derived the relationship between Comes and sunspot numbers for the solar cycle 23.

2 Data analysis

The data used in this study was obtained by the Large Angle Spectroscopic Coronagraph (LASCO) in structure aboard the solar and Helosheric Observatory (SOHO) Mauna Loa coronagraphs and Solar Geophysical data. In the present study, we have analyzed the speed of all Full Halo CMEs and Partial Halo CMEs for 23 solar cycles. Angular width only 360 0 consider a Full Halo CMEs and angular width¿/120 0 has been consider as Partial Halo CMEs.

3 Results and discussion

Mass motion is the basic characteristic of CMEs, quantified by the speed coronagraph obtain image with a certain time cadence, so when a CME occurs, the leading edge progressively appears at a greater heliocentric distance. By tracingCME feature in successive frames. One can drive the speed of the feature for the studying the variation of speed one has to use higher order fits. It is noted that the average speed of halo CMEs is roughly twice that the general population of CMEs.We have observed total 11658 CMEs during the period of solar cycle 23.Out of 11658 CMEs, 375 are full halo and 805 are partial halo. CMEs will become more and more frequent as we near solar maximum. A rate of 0.5 CMEs /day was derived from the OSO-7 corona graph data[5,6] . According to Probhas Raychaudhuri[2] the occurrence of average CME rate is 121.51 per month during June 1999 to June 2003 (Sunspot maximum range) where as the occurrence of average CME rate is 41.24 during January 1996 to May 1999(Sunspot minimum range), although during the year 1996(when the average Sunspot number is 8.6 per month) occurrence of average CME rate is 18.16 per month. We find out that in Sunspot minimum phase 1996 the occurrence rate is minimum of 23 solar cycle , that is 0.56 Comes per day where as in Sunspot maximum phase 2002, the occurrence rate is maximum for 23 solar cycle that is 4.63 CMEs per day. The average CMEs occurrence rate for 23 solar cycle is 2.9 CMEs per day. . Fig .1 Shows the occurrence rate of CMEs per year for 23 solar cycle. The occurrence rate of CMEs is slightly increases towards Sunspots maxima and slightly decreases towards Sunspots minima. CME feature in successive frames. One can drive the speed of the feature for the studying the variation of speed one has to use higher order fits. It is noted that the average speed of halo CMEs is roughly twice that the general population of CMEs.We have observed total 11658 CMEs during the period of solar cycle 23.Out of 11658 CMEs, 375 are full halo and 805 are partial halo. CMEs will become more and more frequent as we near solar maximum. All the vales are given in table1: 1. A rate of 0.5 CMEs /day was derived from the OSO-7 corona graph data[5,6] . According to Probhas Raychaudhuri[2] the occurrence of average CME rate is 121.51 per month during June 1999 to June 2003 (Sunspot maximum range) where as the occurrence of average CME rate is 41.24 during January 1996 to May 1999(Sunspot minimum range), although during the year 1996(when the average Sunspot number is 8.6 per month) occurrence of average CME rate is 18.16 per month. We find out that in Sunspot minimum phase 1996 the occurrence rate is minimum of 23 solar cycle , that is 0.56 Comes per day where as in Sunspot maximum phase 2002, the occurrence rate is maximum for 23 solar cycle that is 4.63 CMEs per day. The average CMEs occurrence rate for 23 solar cycle is 2.9 CMEs per day. . Fig .1 Shows the occurrence rate of CMEs per year for 23 solar cycle. The occurrence rate of CMEs is slightly increases towards Sunspots maxima and slightly decreases towards Sunspots minima. Fig 1. shows that the two largest peak in the CME rate, where as only one largest peak in SSN . CME rate is multiplied by fraction 30 to fit the scale. CMEs can occur at any time during the solar activity but their occurrence rate increases with solar activity and peaks around solar maximum. In the graph, the largest difference between CMEs occurrence rate and Sunspot number seems to be due to the fact that CMEs originate not only from the sunspot regions but also from non Sunspot (quiescent filament) regions. Based on the 110 Skylab CMEs, Hildner et al. [5] found the CME rate (R) to be corrected with the Sunspots number (n) and obtained the relation, R=0.96+0.084N (based on 7 rotations). They suggested that this relation is independent of the phase of the solar activity cycle and predicted a rate 3.2 per day for solar maxima. With new observation from Solwind and SMM/cp coronagraph, this relation was essentially confirmed [7]. Webb [8] studied CMEs from 1973 to 1989 concluding that (1) The frequency occurrence tends to follow the solar activity cycle in both amplitude and phase. (2) Considering only long term average all solar activity indices are equally correlated with CME rate.In our study we find out that the regression line is (23.43x-0.67) and correlation coefficient (r=0. 5), which measure the degree linearly related. There is perfect relationship rate with positive slope between Sunspots number and CMEs occurrence rate ,as shown in correlation graph of Fig.2 . Where all points are near the linear -fitting line. Although a correlation between two variables does not mean that one of them causes the other, it can suggest a way of finding out what the true cause might be.

4 Conclusions

From the above, the following conclusions can be drawn:

1. Occurrence rate of CMEs shows almost similar variational patter for the solar cycle 23.However descending phase shows some deviation in their trends
2. Occurrence rates of CMEs and Sunspot numbers shows high and positive correlation for solar cycle 23.

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Coronal Mass Ejections (CMEs) are highly dynamic events originating in the solar atmosphere, that show a wide range of kinematic properties and are the major drivers of the space weather. The angular width of the CMEs is a crucial parameter in the study of their kinematics. The fact that whether slow and fast CMEs (as based on their relative speed to the average solar wind speed) are associated with different processes at the location of their ejection is still debatable. Thus, in this study, we investigate their angular width to understand the differences between the slow and fast CMEs. We st Coronal mass ejection (CME), large eruption of magnetized plasma from the Sunâ€™s outer atmosphere, or corona, that propagates outward into interplanetary space. The CME is one of the main transient features of the Sun. Although it is known to be formed by explosive reconfigurations of solar magnetic.Â Thank you for your feedback. Our editors will review what youâ€™ve submitted and determine whether to revise the article. Join Britannica's Publishing Partner Program and our community of experts to gain a global audience for your work! External Websites. NOAA Space Weather Detection Center - Coronal Mass Ejection. UCAR Center for Science Education - Coronal Mass Ejection. WRITTEN BY. Mark Moldwin. At the begining of the Solar cycle the Sun's magnetic field is pointed North-South as in the Earth. During the cycle the differential rotation makes the plasma interact with the magnetic field causing it to be displaced. This makes the first the Sun's spots appear near the poles. As the cycle advances the magnetic field get more and more scrambled, it's orientation changes to west-east and the spots appear closet to the equator. Finally the magnetic field can't hold the "pressure" and "breaks" like a rubber band creating the biggest spots and flares. The magnetic field stabilizes again but wit Coronal mass ejections (CMEs), as we know them today, were first detected in the coronagraph images obtained on 1971 December 14 by NASAâ€™s OSO-7 space-craft (Tousey, 1973). Typical coronagraphs have an occulting disk to artificially eclipse the bright photosphere, so the faint coronal structures outside the periphery of the occulting disk can be viewed in the photospheric light scattered off of these structures.Â Def-inite inferences on mass ejections in the solar atmosphere predated the white-light discovery by decades: prominence eruptions [Secchi and de la Rue in the late 1800s (see, e.g., Tandberg-Hanssen, 1995)], slow-drifting radio bursts (Payne-Scott et al., 1947), and moving type IV radio bursts (Boischot, 1957). We present a statistical analysis of solar coronal mass ejections (CMEs) based on 23 years of quasi-continuous observations with the LASCO coronagraph, thu.Â The correlations between the various physical parameters and between these parameters and the solar activity cycle are studied in Sects. 11 and 12. In Sect. 13, we consider halo and stealth CMEs. Section 14 extensively investigate the question of the physical relationship between CMEs and other manifestations of transient solar activityâ€”flares, eruptive prominences and filamentsâ€”as well as with active regions and streamers. We finally discuss and summarize our results in Sect. 15 and then conclude.