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# Characteristics of CMEs with respect of their source region during 23rd sunspot cycle

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**Abstract:** Different properties of coronal mass ejection have been studied based on the observation form Large Angel and Spectormetric Coronagraph (LASCO) on board of the Solar and Heliospheric Observatory (SOHO) space craft during the period Jan 1996 – Apr 2006. Statistically, it is observed that the rate of occurrence of Class B CMEs is greater than class A CME's . The occurrence trend of both classes follows the trend of the phase of sunspot cycle and maximum number both type CME's have occurred during maximum activity of sunspot cycle. It is noticed that the maximum number of class A, Class B CMEs have speed range 0-500 km/sec. Statistically, it is observed that maximum number of Class A, Class B CME's occurred in apparent angular width ragne $0^0$-$90^0$. Further, it is found that the maximum number of class A and class B CME's have occurred in measurement position angle range $5^0$-$100^0$ and $250^0$-$300^0$ respectively.

## Introduction

Coronal mass ejection (CMEs) are large- scale magnetized plasma structure that erupt from the sun and are transported in the heliosphere [1]. They are found to correlate with the occurrence of strong, non recurrent disturbances in the interplanetary medium, and their interactions with Earth's magnetosphere cause severe geomagnetic storms [2,3]. CME's typically appear as loop like features that disrupt helmet streamers in the solar corona. There mass ejection carry a bulk of solar material in the range $10^{11}$ - $10^{14}$ Kg at the speeds of 10 – 4000 km/sec. The coronagraph/polarimeter on board the solar maximum mission (SMM) allowed identification of many properties of CME's [4]. The huge amount of energy involved in such election processes is beloved to be stored in the magnetic fields surrounding the mass ejection site. The solar and heliospheric observatory (SOHO) space craft has now extensively observed CME events from solar minimum in 1996 into the present solar cycle. Some of the properties of the SOHO/LASCO have been described by many workers [5-8]

In the recent years, many authors have investigated the CME's speeds at the near sun region, mainly from the space borne white light images and their implications at 1 A U [9,10,11]. In this paper various properties of coronal mass ejection classfied their source region (Measurement of position angle) are presented.

## Data and analysis

Our knowledge on coronal mass ejection comes from two spatial domains; the near sun (up to 30 solar radii) region remote sensed by coronagraph and the geospace and beyond where in site observations are made by space craft. In the present study, we have analyzed in detail all coronal mass ejectio occurred during in 1996 to Apr 2006 by using the datea of web; http://cdaw.gsfc.nasa.gov/CME list. Here we taken new aspect to clarify the properties of coronal mass ejection. We have classified CME's into two classes with respect to their position angle namely Class A and Class B respectively. Class A CME's are those which occur with position angle in the range (50-200) degree and class B CME's are those which occur with measurement position angle (MPA) in the range $200^0$- $360^0$.

## Results and Discussion

We have identified 5235 CMEs which ccurred in MPA range (0- 200)$^0$ and 5159 CME's which occurred in measurement position angle range (200-360)$^0$ during the period Jan. 1996- Apr. 2006. The number of class A CME are 5032 which occurred in MAP range (50- 200)$^0$. The 9, 22, 64, 93, 120, 111, 104, 64, 40, 30 sunspots have occurred during the years 1996, 1997, 1998, 1999, 2000, 2001, 2002, 2003, 2004, 2005, respectively. The histogram of two classes of CME's is depicted in Fig 1.

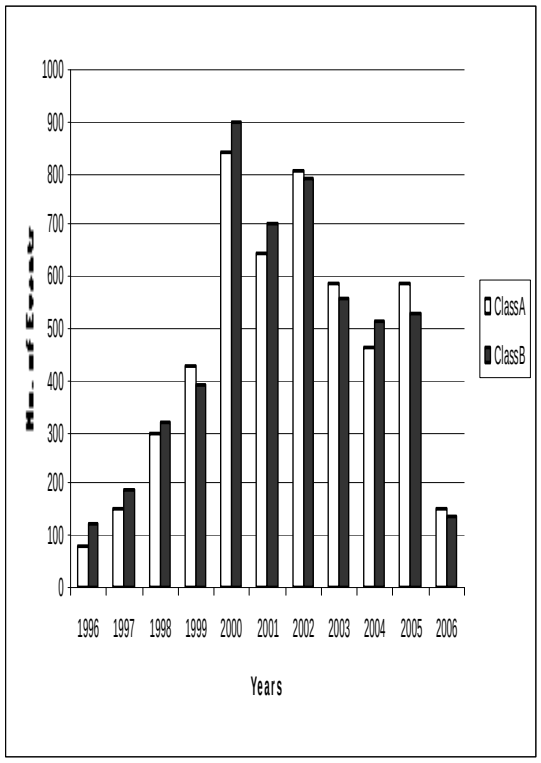


Fig 1 Variation of CME's during the year 1996-2006

Empty and black shaded histogram stands for A and B Class CME's respectively. It is apparent from fig1 that the occurrence rate of class B CME's is more than class A in the year 1996, which is the year of minimum solar activity. It is also observable from fig1 that the maximum number of both types of CME have occurred in year 2000 but the occurrence rate of class B CME is more in comparison to class A [12]. Thus, we conclude that maximum number of both types CME's have occurred during maximum activity of solar cycle. The CME speed is determine when at least two height measurements are available. Sometime data gap in our inability to measure the speeds of about 3% of the CME's.

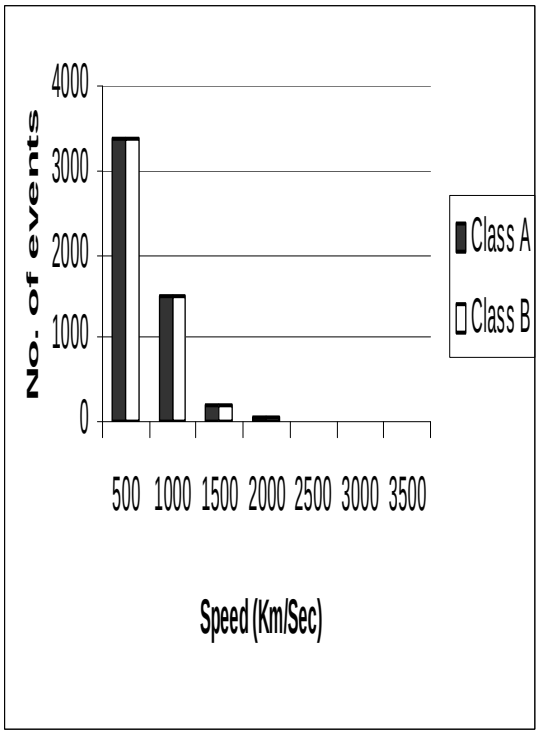


Fig 2 Histogram of Speed Distibution of CME's

We have taken the linear speed of CME's in km/sec. The number of events in both classes are almost same in each with speed distribution range as depleted in Fig-2. Where empty and black shaded histogram denotes A and B Class CME's respectively. Further, it is observed that maximum number of CME's of class A and B occurred in the range of 0-500 km/sec.

The histogram of position angle of CME's of class A and class B have been plotted in Fig 3. We have found that the maximum number of B class CME's occurred in the range $250^0$ - $300^0$, whereas minimum number of class B CME's occurred in the range $300^0$ -$360^0$. In case of A class CME's maximum number of CME's occurred in the range $50^0$-$100^0$ and minimum number of CME's

occurred in the range $(0\text{-}50)^0$. This result is simi-similar to earliest findings [13].

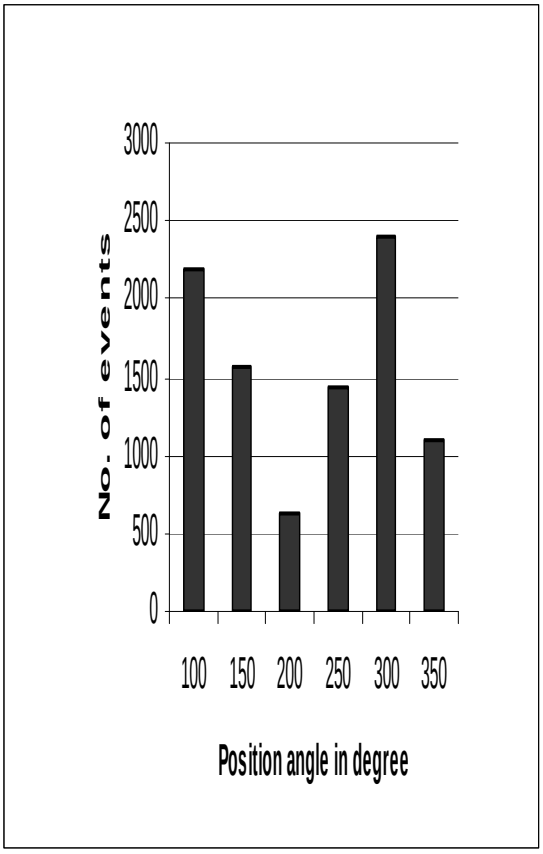


Fig 3 Histogram of Position angle distribution of CME's

Figure 4 shows the distribution of the apparent angular width of class A and class B from Jan 1996 to Apr 2006. In Fig 4 empty and black shaded histograms indicates Class A and B CME's respectively. In order to investigate the properties of CME's with angular width, we grouped CME's into four population : $(0\text{- }90)^0$, $(90\text{-}180)^0$, $(180\text{- }270)^0$ and $(270\text{ –}360)^0$. It is observed that in the width distribution, the maximum number of CME's have occurred range $(0\text{-}90)^0$ in both classes. It is also observed that in angular width distribution, the minimum number of CME's occurred in the range $180^0$-$270^0$ in both classes.

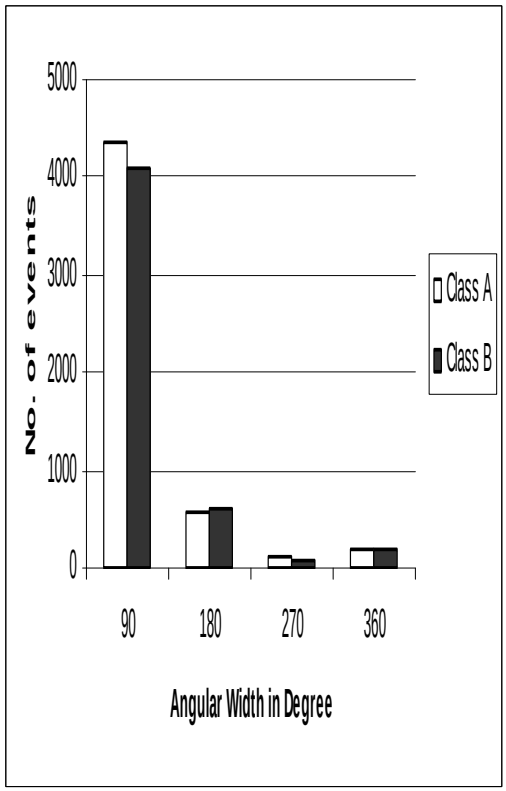


Fig 4 Histogram of apparent angular width distribution of CME's

## Conclusions

On the basis of above analysis following conclusions have been drawn:

[1] The occurrence trend of both classes follows the phase of solar cycle. Maximum number of A and B class CME's have occurred during maximum activity period of solar cycle.

[2] It is observed that the maximum number of class A and B CME's have occurred in the measurement position angle range $50^0$-$100^0$ and $200^0$-$250^0$ resepectively.

[3] It is noticed that the maximum number of class A and B CME's have occurred in the speed range 0-500 km/sec.

[4] Maximum number of class A and B CME's have occurred in apparent angular width range $(0\text{-}90)^0$ range .

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