Effects of Magnetic and Gravity forces on the Acceleration of Solar Filaments and Coronal Mass Ejections

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Prominence and filament eruptions are one of the origins of Coronal Mass Ejection (CME). There is a major class of CMEs characterized by a three-part structure, namely bright leading edge, dark cavity and high density core, when observed in white lightFisher and Poland,1981;Low et al.,1982;Illing and Hundhausen,1985,1986;Howard et al.,1985;Hundhausen,1987,1999;Dere et al.,1999). The eruptive filament/prominence is known to be a core of CME when viewed in the coronagraphs (Tandberg-Hanssen,1995;Low and Hundhausen,1995). Filament disappearances can be of thermal nature (Mouradian et al.,1986) or of dynamic nature (Demoulin & Vial,1992). In the latter case they are associated with catastrophic reconnection in the supporting magnetic field, and sometimes connected to other type of activity i.e. flares (Simon et al.,1984).

CMEs originating from active regions and with flares are characterized by a high constant speed already acquired low in the corona. In contrast, the prominence-associated CMEs erupting away from active regions tend to start with low speeds which detectably increase as the CMEs travel through the corona (MacQueen and Fisher,1983;St.Cyr et al.,1999;Dere et al.,1999;Sheeley,Jr. et al.,1999). This is also the case for prominence eruptions. Flare-associated prominence eruptions, which are often refered as flare-sprays(Warwick,1957), are shot out of the flare region at great speeds, and reaching high velocities (500-1200 km/sec) in a few minutes. Normal eruptive prominence starts to ascend slowly and are accelerated to great velocities after many minutes or hours (Valnicek,1964). These observational characteristics of CMEs and prominence eruptions show that magnetic field strength in the source region is the primary factor for their accelerations. We have, however, no results which shows their relations quantitively, yet. Moreover, no mechanisms other than magnetic forces are proposed as one of the drivers for CME and filament accelerations.

We have analized 35 solar disappearing filaments observed with Flare Monitor Telescope at Hida Observatory, Kyoto University. This telescope observes the solar full disk with not only in H alpha center but also in its line wings. The line wing data enables us to make use of Doppler method to measure the line-of-sight velocity of disappearing filaments, and hence their 3-D velocity fields. With the analysis above, we obtained the following results.

1) The time scales for filament acceleration coincide with Alfven transit time scale. 2) The direction of ejection can be well explained by gradient of nearby magnetic field strength.

3) We also found a evidence of gravity force affecting on the acceleration of filaments. 1) and 2) are the quantative results which relate the magnetic field strength and acceleration. Gravity is thought to be important for CMEs (e.g. Low, 2001), and our result is the first one which show its effect observationally.