Launching Process of Coronal Mass Ejections and its Observability

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Coronal mass ejections (CMEs) are one the most spectacular explosive phenomena, in which large amount of mass and magnetic flux are ejected to the interplanetary space, as a result of a disruption of coronal magnetic field. It is very important for space weather science to understand the whole process of CMEs because of their close relation with geoeffective events. However, the relation between CMEs and flares has been argued for a few decades, but still remains unclear. Although eruptions of coronal magnetic field may cause CMEs and solar flares, many observations show nevertheless that all flares are not necessarily associated with CMEs. The fact implies that there are some kinds of criteria. For example, the interactions between an eruption and the global scale magnetic field, such as confinement and reconnection, are candidates.

In order to examine the condition whether the eruption of coronal field can be launched as a CME, we performed a three-dimensional MHD simulation of a twisted flux rope ejected from a small and strong magnetic field active region surrounded by a global coronal magnetic field. We carried out the simulations for various configurations aiming to systematically reveal the condition for the capability of CME formation. As a result, we found, for example, that a flux rope cannot be ejected as a CME due to magnetic tension force of anchored field under weak surrounding field, while it can under moderately strong surrounding field. In this paper, we summarize the relationship between the key parameters for the ejection; the amount of magnetic flux and field directions.

The ejected flux rope shows tilting rotation in the direction perpendicular to the ejection line in the case where the CME is successfully formed. The tilting motion, which results from a relaxation of complex field structure, is much important for the determination of the field structure inside a propagating CME as well as for forecasting the orientation of magnetic field at the orbit of the Earth. In order to examine the observability of some signatures related to the tilting motion with the instruments onboard SOHO and STEREO satellites, we produced synthetic coronagraph images with some angles using the simulation results.