Unveiling the Initiation Route of Coronal Mass Ejections through Their Slow Rise Phase

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Coronal mass ejections are the impulsive ejections of plasmas from the solar corona to the interplanetary space. They could cause damages to human activities when they arrive at the Earth. Therefore, understanding and forecasting the CMEs is always a key topic in the field of solar physics and space physics.

The CMEs originate from their pre-eruptive structures. Some pre-eruptive structures appear as the hot channels, which are high-temperature structures with a mass density a little higher than the coronal density. In addition, some pre-eruptive structures are represented by the filaments/prominences, which are cold and dense plasmas in the corona.

The initiation of CMEs refers to the transition process from the quasi-static evolution of pre-eruptive structures to the erupting state of CMEs. In kinematics, the CME initiation is characterized by a slow rise of the pre-eruptive structures (e.g., hot channels and filaments) shortly before the impulsive eruption. A full understanding of the mechanisms of CME initiation is the key to forecasting solar eruptions, but it remains elusive so far.

In this talk, I will present our recent advancements in determining the complete initiation routes of CMEs, which are obtained by performing the state-of-the-art observationally-inspired magnetohydrodynamics (MHD) simulations of CMEs with the code MPI-AMRVAC[1]. Our findings show that the moderate hyperbolic flux tube (HFT) reconnection occurring below the pre-eruptive structures[2,3] and the drainage of the filament mass within the pre-eruptive structures[3] play an important role in triggering and driving the slow rise (CME initiation). In addition, the torus instability occurring during the slow rise also contributes to driving the slow rise (CME initiation)[2,3].

Consequently, we propose that the enhanced drainage of filament mass and various features related to the HFT reconnection, such as, the split of pre-eruptive structures and the pre-flare loops and X-ray emissions, can serve as the precursors of CME initiation in observations, which will be useful for better forecasting the solar eruptions.

References
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