Researchers discover triple-layered leading-edge of solar coronal mass ejections

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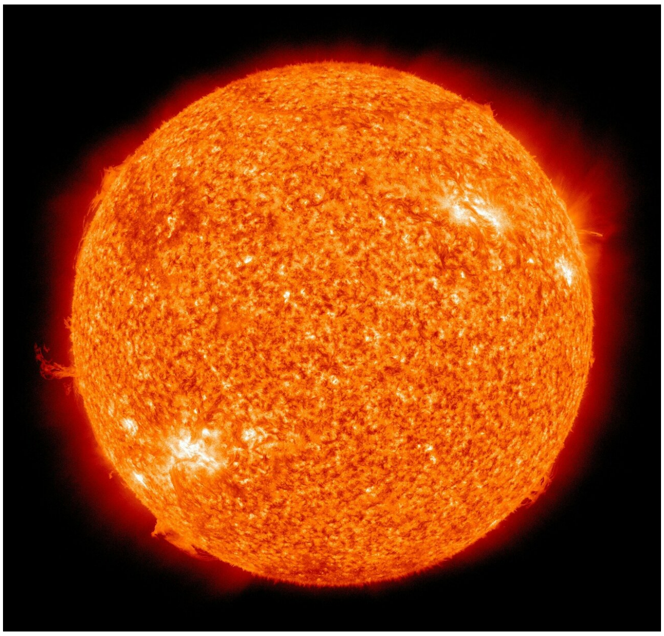

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In a study published in *The Astrophysical Journal*, Dr. MEI Zhixing in Yunnan Observatories of the Chinese Academy of Sciences and his colleagues reported a Magnetohydrodynamical (MHD) numerical study on the coronal mass ejection (CME). They presented a high-resolution 3-D resistive MHD simulation to investigate the large-scale structure of the CME due to the eruptive solar prominence/filament, and discovered the triple-layered leading-edge of solar coronal mass ejections.

Coronal mass ejections (CMEs) usually result from rapidly erupting magnetic flux ropes (MFRs). Observations from white-light coronagraphs and extreme-ultraviolet (EUV) passbands demonstrated that 30% of CMEs have three components, a bright leading front enclosing a dark cavity, which contains a bright core.

At present, it still remains an open question as to how these erupting MFRs evolve into the typical CMEs with three components. For the CME front/leading edges, early theory regarded the CME front as a fast-mode MHD wave. Later, the CME front was interpreted as coronal plasma pileup in front of the eruptive MFR. Recently, researcher relates the non-wave components of EUV disturbances with the expanding CME leading edges.

The researchers in this study carried out a 3-D resistive MHD numerical simulation based on the flux-rope model of the prominence/filament eruption, and put emphasis on the detailed 3-D magnetic structure of a coronal mass ejection.

The results showed that there exists a helical current ribbon/boundary (HCB) that wraps around the CME bubble. This HCB results from the interaction between the CME bubble and the ambient magnetic field, where it represents a tangential discontinuity in the magnetic topology. Its helical shape is ultimately caused by the kinking of the MFR that resides within the CME bubble.

In synthetic image of Solar Dynamics Observatory/Atmospheric Imaging Assembly (SDO / AIA) of the numerical results, processed to logarithmic scale to enhance otherwise unobservable features, the researchers showed a clear triple-layered leading edge, i.e., a bright fast shock front, followed by a bright HCB, and within it a bright MFR. These are arranged in sequence and expand outward continuously.

In the end, for kink unstable eruptions, they suggested that the HCB is a possible explanation for the bright leading edges seen near CME bubbles and also for the non-wave component of global EUV disturbances.

More information: Z. X. Mei et al. The Triple-layered Leading Edge of Solar Coronal Mass

Ejections, *The Astrophysical Journal* (2020). DOI: 10.3847/2041-8213/aba2ce