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Deciphering the evolution of pre-eruptive CMEs

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Coronal mass ejections (CMEs) are the largest scale eruptions of plasmas in the solar corona. Many observations show that pre-eruptive CMEs always appear as bright structures in EUV high-temperature bands and rise slowly when approaching the onset of their eruption. However, the mechanisms behind these phenomena are still puzzling. In this work, we aim to explore these by combining observations and numerical simulations. Based on the observation of an eruptive event, we find that a moderate magnetic reconnection, evidenced by the weak thermal-dominated hard X-ray emission, occurs at the center of an X-shaped plasma sheet before the eruption. This reconnection forms the hot M-shaped threads and cusp-shaped loops, the former of which merges with the pre-eruptive CME and contributes to its heating and slow rise. More details of the heating and the slow rise phenomena are revealed by performing a thermal 3D MHD simulation of a pre-eruptive CME by MPI-AMRVAC. It is shown that the Ohmic heating, which is related to a weak magnetic reconnection, mainly contributes to the heating in the hyperbolic flux tube (HFT) and quasi-separatrix layers wrapping around the pre-eruptive CME. The slow rise of the pre-eruptive CME is also mainly driven by the reconnection in the HFT. All of the above results give us a better understanding of how the pre-eruptive CME gradually transitions from the quasi-static state to the eruption.

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