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Falling Filament Material During Solar Eruptions

Mass drainage is frequently observed in solar filaments. During filament eruptions, falling material most likely flows along magnetic field lines, which may provide important clues for the magnetic structures of filaments. Here we study three filament eruptions exhibiting significant mass draining, often manifested as falling threads at a constant speed ranging between 50–300 km s^{-1}. We find that most of the falling material lands onto the hooked part of flare ribbons, only a small fraction lands inside the hooks, and almost none lands onto the straight part of ribbons. Based on these observations we conclude that initially most of the filament mass is entrained by field lines threading the quasi-separatrix layers (QSLs) that wraps around the filament field and dynamically evolves as the hooked ribbon, and that the magnetic reconnection involving these field lines is the major cause of the mass drainage during eruptions. In particular, the earlier QSL boundary is threaded by mass-loaded field lines, but the later QSL is threaded by mass-depleted field lines. Further, by assuming that the constant-speed motion is due to a drag force balancing the gravity, we propose a simplified model to estimate the density contrast of the falling material.

Primary author: WU, Yidian (University of Science and Technology of China)

Co-author: LIU, Rui

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