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Observational discovery of slip-running reconnection during a solar flare

Apparent slipping motions of reconnecting field lines are a prime signature of three-dimensional magnetic reconnection, the process powering flares and eruptions. The existence of slipping motions in the super-Alfvénic regime is a key prediction of 3D magnetohydrodynamic extensions to the standard flare model. Validating these predictions proved challenging as the detection of slipping motions, typically of flare loops and flare kernels, has been limited by the time resolution of space-borne solar imagery. We overcame this issue by utilizing high, 1.8 s cadence flare observations of a confined C4.2-class flare from 2022 September 25 of the Interface Region Imaging Spectrograph (IRIS). Flare ribbon kernels, composing one of the ribbons captured in the 1330 Å filter of the IRIS Slit Jaw Imager, exhibited apparent slipping motions at speeds of thousands of kilometers per second. These dynamics are consistent with the slip-running reconnection, aligning with model predictions. Signatures of kernel motions were further analyzed in observations with varying spatial and temporal resolution. By utilizing a computer vision algorithm we found that fast, super-Alfvénic dynamics can only be resolved in observations with a cadence of a few seconds at most. Preliminary analysis of selected IRIS flare datasets with high (< 2s) time resolution strengthens these results, confirming that the rapid kernel slippage was not limited to a single event.

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