Observations of anomalous plasmoid ejection, plasma jets and electron diffusion regions of magnetic reconnections in laser-plasma experiments

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Abstract

The driving mechanism of the solar flares and coronal mass ejections is a topic of ongoing debates except the consensus that the magnetic reconnection plays key roles during the impulsive process. While present solar researches mostly depend on observations and theoretical models, laboratory experiments based on high energy density facilities provide the third method for quantitatively comparing astrophysical observations and models with data achieved in experimental settings. In this article, we show laboratory modelling of the solar flares and coronal mass ejections by constructing the magnetic reconnection system with two mutually approaching laser-produced plasmas circumfused of self-generated megagauss magnetic fields. Due to Euler similarity between laboratory and solar plasma systems, present experiments demonstrate the morphological reproduction of flares and coronal mass ejections in solar observations in a scaled sense, and confirm the theory and model predictions about the current-sheet-born anomalous plasmoid as the initial stage of coronal mass ejections, and the behavior of moving-away plasmoid stretching the primary reconnected field lines into a secondary current sheet conjoined with two bright ridges identified as the solar flares. On the other hand, the experimental results also present three elongated electron diffusion regions, which are similar to tens of magnetotail observations through last decades.