Magnetic Reconnection in Colliding Laser-produced Plasmas

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Magnetic reconnection enables the explosive conversion of magnetic field energy to plasma kinetic energy plasmas ranging from laboratory to astrophysical environments. The rate of magnetic reconnection can be greatly increased by the action of secondary instabilities, such as the tearing instability, breaking a long current sheet into a hierarchy of shorter reconnection layers, and the contraction and interaction of multiple flux ropes thus produced are efficient accelerators of particles. Here we show experiments with colliding magnetized laser-produced plasmas obtaining long extended current sheets ($L/d_i \sim 100$) and high Lundquist number far beyond previously obtained in dedicated laboratory reconnection experiments. The current sheet breaks up into a chain of a large number of magnetic islands. Proton radiography observations directly observe size and temporal growth of island structures, which merge into larger structures over the course of the interaction. The secondary instability leads to a turbulent magnetic reconnection, verifying processes recently proposed to drive particle acceleration in high-Mach number magnetized shocks.