Abstract Submitted
for the DPP16 Meeting of
The American Physical Society

Particle acceleration in laser-driven magnetic reconnection[1]

SAMUEL TOTORICA, TOM ABEL, Stanford U., KIPAC, SLAC, FREDERICO FIUZA, SLAC — Particle acceleration induced by magnetic reconnection is a promising candidate for producing the nonthermal emissions associated with explosive astrophysical phenomena. We have used two- and three-dimensional particle-in-cell simulations to explore the possibility of studying particle acceleration from reconnection in laser-driven plasma experiments. For current experimental conditions, we show that nonthermal electrons can be accelerated to energies up to two orders of magnitude larger than the initial thermal energy. The nonthermal electrons gain energy primarily by the reconnection electric field near the X-points, and particle injection into the reconnection layer and escape from the finite system establishes a distribution of energies resembling a power-law spectrum. Energetic electrons can also become trapped inside the plasmoids that form in the current layer and gain additional energy from the electric field arising from the motion of the plasmoid. Based on our findings, we provide an analytical estimate of the maximum electron energy and threshold condition for suprathermal electron acceleration in terms of experimentally tunable parameters [1]. Finally, we investigate future experiments with a more energetic laser drive and larger system size. We discuss the influence of plasmoids on the particle acceleration, and the use of proton radiography to probe plasmoids. [1] S. Totorica, T. Abel, and F. Fiuza, PRL 116, 095003, (2016).

[1]This work was supported by the DOE Office of Science, Fusion Energy Science (FWP 100182).

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Date submitted: 15 Jul 2016 Electronic form version 1.4