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3-D magnetic reconnection in colliding laser-produced plasmas[1]
JACKSON MATTEUCCI, Princeton University, WILL FOX, PPPL, CLEMENT MOISSARD, Ecole normale suprieure de Cachan, France, AMITAVA BHATTACHARJEE, Princeton University — Recent experiments have demonstrated magnetic reconnection between colliding plasma plumes, where the reconnecting magnetic fields were self-generated in the expanding laser-produced plasmas by the Biermann battery effect. Using fully kinetic 3-D particle in cell simulations, we conduct the first end-to-end simulations of these experiments, including self-consistent magnetic field generation via the Biermann effect through driven magnetic field reconnection. The simulations show rich, temporally and spatially dependent magnetic field reconnection. First, we find fast, vertically-localized Biermann-mediated reconnection, an inherently 3-D reconnection mechanism where the sign of the Biermann term reverses in the reconnection layer, destroying incoming flux and reconnecting flux downstream. Reconnection then transitions to fast, collisionless reconnection sustained by the non-gyrotropic pressure tensor. To separate out the role 3-D mechanisms, 2-D simulations are initialized based on reconnection-plane cuts of the 3-D simulations. These simulations demonstrate: (1) suppression of Biermann-mediated reconnection in 2-D; (2) similar efficacy of pressure tensor mechanisms in 2-D and 3-D; and (3) plasmoids develop in the reconnection layer in 2-D, where-as they are suppressed in 3-D.

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