Structure and Dynamics of Colliding Plasma Jets

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Monoenergetic-proton radiographs of laser-generated, high-Mach-number plasma jets colliding at various angles shed light on the structures and dynamics of these collisions [1]. The observations are compared favorably with results from 2D hydrodynamic simulations of multi-stream plasma jets with collisional electrons and also with results from an analytic treatment of azimuthal magnetic field advection using a plausible model for velocity distribution of the effective electron flow. For collisions of two noncollinear jets, the observed flow structure is similar to the analytic model’s prediction of a characteristic feature with a narrow structure pointing in one direction and a much thicker one pointing in the opposite direction. Spontaneous magnetic fields, largely azimuthal around the colliding jets and generated by the well-known \( \nabla T_e \times \nabla n_e \) Biermann battery effect near the periphery of the laser spots, are demonstrated to be “frozen in” the plasma (due to high magnetic Reynolds number \( R_M \approx 5 \times 10^4 \)) and advected along the jet streamlines of the electron flow. These studies provide novel insight into the interactions and dynamics of colliding plasma jets.