Relativistic magnetic reconnection driven by high intensity lasers

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Over the past decade, considerable experimental and computational work has been dedicated to the laser-driven magnetic reconnection geometry. Two laser pulses are fired side-by-side and self-generated magnetic fields are driven into the midplane where reconnection occurs. Much of the previous work has been carried out in the context of nanosecond-class, moderate intensity lasers, where magnetic fields (~1MG) are generated by the Biermann battery effect ($\nabla T_e \times \nabla n_e$), and are driven together with velocities near the sound speed ($v_B \approx c_s$). In recent experiments performed at the OMEGA EP laser system at LLE and the Vulcan laser at RAL, we have extended this experimental geometry by replacing the long pulse (ns) lasers with short pulse (ps) lasers focused to relativistic intensities. In this case, the self-generated magnetic fields are incredibly strong (~100MG) and are driven together by relativistic electrons with velocities near the speed of light ($v_B \approx c$). Indeed, the fields are so strong that the reconnection event enters the relativistic regime ($\sigma = B^2/\mu_0 n_e m_e c^2 > 1$). Experimental evidence of this relativistic reconnection will be presented, including Copper Kα imaging from OMEGA EP and proton radiography from Vulcan, as well as supporting 3D particle-in-cell simulation results.