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Magnetic Reconnection in the High-Energy-Density Regime[1]

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Motivated by an improved understanding of reconnection theory and its application to extreme astrophysical environments and controlled thermonuclear fusion, much attention has been given to the development of techniques for studying magnetic reconnection in the laboratory. Important open questions concern the multiscale processes that lead to reconnection onset, magnetic connectivity changes, and the conversion of magnetic energy into other forms. Recreating and studying these processes in the laboratory, particularly under conditions of extreme energy density, provides an opportunity for testing the fundamental physics that underpin reconnection-model predictions. In this work, magnetic reconnection is demonstrated between two laser-produced plasmas that are generated one laser-spot diameter apart. The closer spot separation minimizes the time for plasma expansion before the interaction occurs and allows, for the first time, the Biermann fields at the edge of each laser spot to interact and reconnect. The significant new result is the clear and complete change in magnetic connectivity that occurs close to the laser focal regions. The importance of plasma accumulation and heat-flow effects on the transport of magnetic fields into the region where reconnection occurs will be discussed in the context of experimental data, theory, and numerical simulations.

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