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Bow shock formation in a asymmetric relativistic electron driven magnetic reconnection geometry

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Laser-driven magnetic reconnection experiments have been performed to explore a range of plasma and field conditions, including asymmetric conditions and relativistic electron driven reconnection. Laboratory studies of magnetic field dynamics and reconnection provide an important platform for testing theories and characterizing different regimes. Observations of laboratory scale plasmas can provide insight on the microphysical processes that are participating in much larger astrophysical plasmas. Presented here is a highly asymmetric geometry - a nanosecond laser interaction creates an azimuthal magnetic field through the Biermann battery effect, and a second magnetic field is driven by a high-intensity picosecond duration laser pulse creating conditions where the magnetic energy density exceeds the rest mass energy density of the plasma electrons. The relativistic electron current rapidly expands to form a large azimuthal magnetic field that impacts the more slowly evolving system. Experimental measurements using proton imaging observe the formation of a bow-shock type feature. Using scaled three-dimensional particle-in-cell simulations (OSIRIS) the interaction is explored in more detail. As the relativistic electrons encounter the long pulse plasma and embedded magnetic field, instabilities form both in-plane and out-of-plane. These instabilities impact the magnetic field dynamics.