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Thomson scattering measurements of ion interpenetration in cylindrically converging, supersonic magnetized plasma flows[1]

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Ion interpenetration driven by high velocity plasma collisions is an important phenomenon in high energy density environments such as the interiors of ICF vacuum hohlraums and fast z-pinches. The presence of magnetic fields frozen into these colliding flows further complicates the interaction dynamics. This talk focuses on an experimental investigation of ion interpenetration in collisions between cylindrically convergent, supersonic, magnetized flows (M≈10, V_{flow} ≈100km/s, n_i ≈10^{17}cm^{-3}). The flows used in this study were plasma ablation streams produced by tungsten wire array z-pinches, driven by the 1.4MA, 240ns Magpie facility at Imperial College, and diagnosed using a combination of optical Thomson scattering, Faraday rotation and interferometry. Optical Thomson scattering (TS) provides time-resolved measurements of local flow velocity and plasma temperature across multiple (7 to 14) spatial positions. TS spectra are recorded simultaneously from multiple directions with respect to the probing beam, resulting in separate measurements of the rates of transverse diffusion and slowing-down of the ion velocity distribution. The measurements demonstrate flow interpenetration through the array axis at early time, and also show an axial deflection of the ions towards the anode. This deflection is induced by a toroidal magnetic field (∼ 10T), frozen into the plasma that accumulates near the axis. Measurements obtained later in time show a change in the dynamics of the stream interactions, transitioning towards a collisional, shock-like interaction of the streams, and rapid radial collapse of the magnetized plasma column. The quantitative nature of the spatial profiles of the density, flow velocities and ion temperatures measured in these experiments will allow detailed verification of MHD and PIC codes used by the HEDP community.

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