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Using projection imaging to study ultracold plasmas XIANLI ZHANG, ROBERT FLETCHER, STEVEN ROLSTON, University of Maryland-College Park — We have developed a time-of-flight projection imaging technique to study ultracold plasma dynamics, such as plasma expansion and instabilities. We image the charged particle (electrons or ions) distribution by extracting them with a high-voltage pulse and accelerating them onto a position-sensitive detector. Measuring the 2-D Gaussian width of the ion images, we can extract the final asymptotic expansion velocity of the ultracold plasma. The plasma expansion velocities at different initial electron temperatures match earlier results obtained by measuring the plasma oscillation frequency, providing further support for this method as a means to extract ultracold plasma densities. We observe that the transverse expansion velocity in a uniform longitudinal magnetic field scales as $B^{-1/2}$, explained by a nonlinear ambipolar diffusion model that involves anisotropic diffusion in two directions. We also observe that the electron projection images split into two or three lobes with ExB field configuration, coincident with the observation of large oscillations in the electron emission signals. We identify the electron images as a signature of plasma instabilities due to electrons drifting relative to ions across the magnetic field. This work is supported by the NSF.

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