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**Spatial Studies of Ion Beams in an Expanding Plasma** EVAN AGUIRRE, West Virginia University, TIMOTHY GOOD, Gettysburg College, EARL SCIME, DEREK THOMPSON, West Virginia University — We report spatially resolved perpendicular and parallel ion velocity distribution function (IVDF) measurements in an expanding argon helicon plasma. The parallel IVDFs, obtained through laser induced fluorescence (LIF), show an ion beam with v  8 km/s flowing downstream that is confined to the center of the discharge. The ion beam is confined to within a few centimeters radially and is measurable for tens of centimeters axially before the LIF signal fades, likely a result of metastable quenching of the beam ions. The axial ion beam velocity slows in agreement with collisional processes. The perpendicular IVDFs show an ion population with a radially outward flow that increases with radial location. The DC electric field, electron temperature, and the plasma density in the double layer plume are all consistent with magnetic field aligned structures. The upstream and downstream electric field measurements show clear evidence of an ion hole that maps along the magnetic field at the edge of the plasma. Current theories and simulations of double layers, which are one-dimensional, completely miss these critically important two-dimensional features.

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