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First experimental studies of ion flow in 3 ion species plasmas at the presheath-sheath transition¹

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The Bohm sheath criterion is studied with laser-induced fluorescence (LIF) in three ion species plasmas using two tunable diode lasers. KrI or HeI is added to a low pressure unmagnetized dc hot filament discharge in a mixture of argon and xenon gas confined by surface multi-dipole magnetic fields. The argon and xenon ion velocity distribution functions are measured at the sheath-presheath boundary near a negatively biased boundary plate. The potential structures of the plasma sheath and presheath are measured by an emissive probe. Results are compared with previous experiments with Ar–Xe plasmas, where the two ion species were observed to reach the sheath edge at nearly the same speed. This speed was the ion sound speed of the system, which is consistent with the generalized Bohm criterion. In such two ion species plasmas instability enhanced collisional friction (IEF) was demonstrated [Yip et al. Phys. Plasmas, 2010] to exist which accounted for the observed results. When three ion species are present, it is demonstrated under most circumstances the ions do not fall out of the plasma at their individual Bohm velocities. It is also shown that under most circumstances the ions do not fall out of the plasma at the system sound speed. Results are consistent with the presence of instabilities.

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