Double Layer Formation in Expanding Helicon Plasmas: Recent Results

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The Ar and Xe ion velocity distribution functions (ivdfs), determined by laser induced fluorescence (LIF), in the expansion region of a helicon plasma have been measured as a function of ratio of Xe to Ar gas flow rates for a constant total gas flow rate and as a function of source RF frequency. In the magnetic field gradient region (~ 5cm upstream from the helicon source-expansion chamber junction) and at low pressure (≤ 2 mTorr) the Ar ivdf is bimodal with a fast group at a speed of ~ 7 km/s and a slow group at ~ 3.5 km/s. The bimodal structure persists for a wide range of Ar/Xe gas flow ratios, disappearing (due to the lack of LIF signal) at 25% Xe. Increasing Xe partial pressure does not affect the Ar ion flow velocities, but does decrease the Ar LIF amplitude. Conversely, the Xe ivdf is unimodal with a bulk ion flow of 0.85 km/s. These results are interpreted as evidence of a spontaneously forming electric double layer. Surprisingly, the source RF frequency has a significant effect on the strength and stability of the double layer. Higher RF frequencies yield double layers that are more stable and yield larger final ion velocities.