DPP14-2014-001028

Abstract for an Invited Paper
for the DPP14 Meeting of
the American Physical Society

Observation of ionization-mediated transition from collisionless interpenetration to collisional stagnation during merging of two supersonic plasmas[1]

AUNA MOSER, Los Alamos National Laboratory

Colliding plasmas appear in systems ranging from inertial confinement fusion hohlraum plasmas to astrophysical plasmas such as supernova remnants. These interactions can be in a regime that is neither purely collisional nor purely collisionless, which complicates modeling, and the nature of many colliding plasmas makes their detailed characterization difficult. Experiments studying the head-on collision of two supersonic plasma jets were performed on the Plasma Liner Experiment (PLX) [1] at LANL. We present experimental measurements demonstrating a transition from an initially collisionless interaction to a collisional one, due to a rising mean ionization level $\bar{Z}$ [2]. Jets of an argon/impurity mixture are launched from opposing ports of a 3-m-diameter spherical vacuum chamber, and when they meet have density $n \approx 10^{14}$ cm^{-3}, temperature $T \approx 2.4$ eV, $\bar{Z} \approx 1.2$, velocity $v \approx 45$ km/s, and diameter $d \approx 30$ cm. Laser interferometer measurements show that the two jet fronts interpenetrate as they arrive at chamber center, consistent with calculated inter-jet ion collision lengths, which are long. As they interpenetrate, a rising $\bar{Z}$, attributable to frictional heating of electrons by counterstreaming ions, causes a rapid decrease in the inter-jet ion collision length ($\sim \bar{Z}^{-4}$). As the inter-jet ion collision length drops to the scale of the interaction region, the interaction becomes collisional and the jets stagnate, eventually producing collisional shock waves. These measurements offer an opportunity to validate plasma collisionality models for plasmas with complex equation of state.

[1] S. C. Hsu et al., Phys. Plasmas **19**, 123514 (2012).
[2] A. L. Moser and S. C. Hsu, submitted (2014); http://arxiv.org/abs/1405.2286

[1]Supported by the LANL LDRD Program; PLX facility construction supported by OFES.