Investigation of the Electron-Ion Hybrid Instability in a Collisional Environment

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The linear Electron-Ion Hybrid (EIH) instability, a transverse velocity shear-driven instability with frequency near the lower hybrid frequency, was previously predicted theoretically to explain the observation of lower hybrid waves in applications from the plasma sheet boundary layer to laser produced plasmas. The linear EIH instability has also been observed in the laboratory in scaled magnetospheric plasma conditions and in laser produced plasma expansion experiments across magnetic fields. PIC simulations have shown that a key feature of the nonlinear evolution of the EIH mode is that it leads to the formation of coherent, closed potential contours in the fluctuating electrostatic potential.

In the work presented, we have expanded the theoretical framework of the linear instability to highly collisional plasmas and finite temperature effects for applications to the plasma region surrounding a hypersonic vehicle. In this collisional plasma layer, strongly sheared transverse flows can exist due to the relative motion of the vehicle and the surrounding atmosphere. If the scale size of these sheared flows are smaller than an ion gyroradius but much larger than an electron gyroradius, they can give rise to the EIH instability. We wish to study whether the resulting lower hybrid turbulence can impede communication to and from the hypersonic vehicle.

Experiments conducted in the Space Physics Simulation Chamber have demonstrated the existence of this instability in the linear phase in a collisional environment and have begun examining the nonlinear evolution of the instability.
Results from theory and a comparison from laboratory experiments on the generation of the EIH instability in a collisional plasma environment will be presented.