Experimental Validation of Electromagnetic Electron-Ion Hybrid Instability Theory

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Strong gradients in plasma flows perpendicular to the magnetic field (such as can arise in the plasma sheet of the Earth's magnetosphere) can drive electromagnetic waves in the whistler branch. Theory predicts that when the wave vector normalized to the electron skin depth is much larger than 1, the waves are predominantly electrostatic in character and electromagnetic otherwise. We have observed this transition experimentally in the Naval Research Laboratory's Space Simulation Chamber where we have produced sheared flows by creating a high (>1 kV/m) electric field localized to a region whose radial dimension is less than one ion gyrodiameter but much greater than an electron gyrodiameter. In the electromagnetic regime, we observe a well-defined shear velocity threshold above which large-amplitude oscillations appear as bursts with clearly evident frequency chirping.

This project was supported by the Naval Research Laboratory Base Program.