Laboratory investigation of nonlinear whistler wave processes*

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Nonlinear interactions involving whistler wave turbulence result from processes, including wave-particle interactions and instabilities in sharp boundary layers. Given sufficient whistler energy density, nonlinear scattering off thermal electrons substantially changes the wave vector direction and energy flux, while inducing a small frequency shift (see *Crabtree*, *Phys. Plasmas* **19**, 032903 (2012)). In the magnetosphere, boundary layers often have highly sheared plasma flows and lower hybrid turbulence. Such nonlinear processes are being investigated in the NRL Space Physics Simulation Chamber (SPSC) in conditions scaled to match the respective environments. The specific nonlinear process being examined is the scattering of the transversely propagating, primarily electrostatic, lower hybrid wave into a more parallel propagating electromagnetic whistler mode. Two techniques are being applied to generate the lower hybrid waves for these experiments. The first uses an electrostatic antenna consisting of four conductors driven alternately at phases of 0 and 180 degrees, with spacing between the conductors setting the perpendicular wavelength of the lower hybrid wave. The second uses a previous experimental configuration in the SPSC designed to study the physics of the plasma sheet boundary layer (PSBL). By creating boundary layers with controllable density gradient and transverse electric fields and scale length much smaller than an ion gyroradius, lower hybrid waves consistent with the Electron-Ion Hybrid Instability (first described theoretically in *Ganguli*, *Phys. Fluids* **31**, 2753 (1988)) were observed in the laboratory (see *Amatucci*, *Phys. Plasmas* **10**, 1963 (2003)). This instability mechanism is applied to produce lower hybrid waves for the nonlinear scattering experiments in addition to the antenna launched technique. Sufficiently large amplitude lower hybrid waves have been observed to scatter into whistler modes by scattering from thermal electrons. The plasma response as a function of transmitted lower hybrid wave amplitude is monitored with magnetic antennas. Details of the observed wave spectra and mode characteristics will be presented.

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