EXPERIMENTAL STUDY OF THE EFFECT OF ION FLOW SHEAR ON ELECTROSTATIC ION CYCLOTRON WAVES

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Magnetic field-aligned currents have traditionally been invoked to explain satellite observations of plasma waves near the ion gyrofrequency in the Earths auroral region. EIC waves provided an explanation for the transverse (to the geomagnetic field) energization of cold ionospheric ions, which eventually are driven upward by the magnetic mirror force, forming ion beams and conics. These ions ultimately find their way into the magnetosphere, where they account for a significant population of hot magnetospheric ions. One problem with this scenario has been that often the waves were observed in association with currents that were subcritical. Also, while the wave spectrum was expected to be narrowband and structured around cyclotron harmonics, a broadband frequency spectrum was often reported. The need for alternate or additional excitation mechanisms seemed obvious. Ganguli and his associates (Phys. Plasmas 9, 2321, 2002) suggested that transverse gradients in the ion flow along the magnetic field (for simplicity, ion flow shear) could provide a mechanism for EIC wave generation, either in addition to the field-aligned currents, or in the absence of field-aligned currents. They showed further, that since the critical shear required to excite EIC waves was approximately independent of the cyclotron wave harmonic number, ion flow shear could generate higher cyclotron harmonics, a common signature of the auroral observations.

In this work, the effect of ion flow shear on the excitation of electrostatic ion cyclotron (EIC) waves was studied experimentally in a double-ended Q-machine. An annular region of ion flow shear was produced by using a ring + disk configuration, as described by Kim et al. (Phys. Plasmas 11, 4501, 2004). Waves with frequencies near the ion gyrofrequency and multiple harmonics were launched from an antenna into a plasma with no field-aligned electron current. As the EIC waves propagated across the magnetic field through a region with ion flow shear, the waves were observed to grow in amplitude. The simultaneous excitation of a multi-harmonic EIC spectrum was also observed when a broadband signal from a white noise source was applied to the antenna.

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