ENHANCEMENT OF ION THERMAL ANISOTROPY IN HELICON PLASMAS

Jacob W. McLaughlin, Andrew Jemiolo, Derek S. Thomson, and Earl E. Scime
Department of Physics and Astronomy, West Virginia University

ABSTRACT

Energetic ion temperature anisotropies provide a source of fast energy transport that is essential for the stability of many plasma systems. We use a new microwave antenna to simultaneously drive waves in the plasma to the cold plume and the hottest plasmas. The wave-induced heating and consequent anisotropic heating was measured using fluorescence imaging and ion temperature anisotropy measurements. A new, simple scaling law is developed to predict the heating efficiency of this antenna system.

THERMAL ANISOTROPY DRIVES INSTABILITIES

In magnetized, weakly collisional and collisionless plasmas, warm plasmas are found at the edge of the plasma and are driven by RF heating. These instabilities can be used to measure the density and temperature profiles of the plasma. The RF-driven instabilities are found to be highly anisotropic, with the highest temperatures occurring at the plasma edge.

ION CYCLotron RESONANT HEATING (ICRH)

Powerful experiments at WVU have demonstrated significant levels of ion heating by driving electromagnetic ion cyclotron waves at the cyclotron frequency (Kline et al., 2000). In this experiment, we use a new microwave antenna to drive waves at the cyclotron frequency, and we find that the heating efficiency is highly anisotropic, with the highest temperatures occurring at the plasma edge.

Laser Induced Fluorescence

Fluorescence is a technique used to measure the temperature and density of plasma. In this experiment, we use laser-induced fluorescence to measure the ion temperature anisotropy in the plasma.

MODULATION OF RF ANTENNA

Initial attempts at heating focused on modulating the RF antennas in the ion cyclotron range of frequencies to couple some of the RF energy into the ions. RF antennas in helicon source systems typically drive bounded by the waves and those that are driven by the waves are driven by the waves. The cold plasma parameters are used to optimize the RF source antenna frequencies to improve the heating efficiency.

TRANSVERSE HEATING ANTENNA RESULTS

The heating efficiency is highly anisotropic, with the highest temperatures occurring at the plasma edge.

LASER INDUCED FLUORESCENCE

Fluorescence is a technique used to measure the temperature and density of plasma. In this experiment, we use laser-induced fluorescence to measure the ion temperature anisotropy in the plasma.

CONCLUSIONS

- Modulation of RF antennas provided enhanced heating
- Transverse antennas showed enhanced heating at neutral pressure 7.2 mTorr
- Transverse antennas showed enhanced heating at neutral pressure 1.06 mTorr but are most likely driven by dust
- Heating similar to low power coupling to antenna
- Antennas have not yet been determined
- Possible plan includes providing a larger amplifier for heating antennas, adding a cold side of the plasma chamber, and measuring parallel and perpendicular polarization and calculated anisotropy.

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