Progress and plans for nonlinear wave-plasma interaction experiments

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An electromagnetic wave employed to introduce energy into plasma non-linearly exchanges energy via complex interactions with particles and plasma wave modes. Examples include Raman scattering where two electromagnetic waves are coupled via a Langmuir wave and Brillouin scattering where the coupling is via an ion-acoustic wave. One electromagnetic wave may be externally driven with the secondary electromagnetic wave growing naturally or both electromagnetic waves may be driven. Where beat-waves are coupled to the electron and ion cyclotron motions or hybrid oscillations, multi-wave interactions may be useful to drive current or heat the plasma in magnetically confined fusion.

The paper presents progress on the design, objectives and numerical simulations of a cylindrical plasma apparatus, 1 m diameter and 3 m length for multifrequency microwave interaction experiments in plasmas. An RF source driving a flat spiral antenna will be used to ionize either an unmagnetised plasma by inductive coupling or a magnetised plasma (T_e~ few eV, n_e in the range 10^{15} – 10^{18} m^{-3}) by helicon wave [1] injection. The magnetic field can reach up to 0.085 T. Diagnostics include line-integrated microwave interferometers and translatable probes to measure T_e, n_e, and fluctuations excited by the electromagnetic waves. Undertaking these experiments at microwave frequencies will grant enhanced active control of the injected waves and diagnostics. Combining measurement, simulation and theoretical analysis an enhanced understanding of the physics of these interactions for fusion relevant plasmas and for laser-plasma interactions is anticipated.

The project builds on previous research in magnetospheric cyclotron instabilities [2-4]. This authors gratefully acknowledge support from the UKEPSRC through grants EP/R004773/1 and EP/R034737/1.

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