Apparatus for investigating non-linear microwave interactions in magnetised plasma

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Electromagnetic wave injection plays a dominant role in the introduction of energy in laser plasma interactions and in the heating of magnetically confined fusion reactors. Nonlinear coupling enables energy to be transferred between one or more EM waves interacting in plasma. Coupling of injected EM waves to Langmuir and ion acoustic waves is of interest for a number of laser plasma interactions and in ionospheric physics experiments. Long (and short) pulse signals with normalised intensities approaching those used in some recent laser plasma interactions can be generated using flexible microwave amplifiers. Multi-wave microwave interactions can be directly relevant to the delivery of heating and current drive in future magnetic confinement fusion (MCF) reactors coupling to cyclotron motion of ions and electrons and to lower hybrid waves. Understanding of the nonlinear electrodynamics will benefit from employing microwave sources and amplifiers to precisely launch and electronically control multiple EM signals. The relatively long lived, benign and accessible plasma relevant to coupling of microwave frequency signals will enable the use of insertion diagnostics in addition to analysing the EM signals.

A linear plasma experiment is being designed, which will be magnetised at up to 0.8T. The plasma will be created by an RF helicon source, using a whistler wave injected from a high-field region to generate a dense, large, cool plasma with high ionisation fraction (an electron number density up to $10^{19}m^{-3}$ has been reported in other helicon experiments). A range of frequency-flexible microwave sources will provide beams to enable multi-wave coupling experiments. The paper will present the proposed apparatus and will outline the envisioned research programme.

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