ION BERNSTEIN WAVE EXPERIMENTS ON THE ALCATOR C TOKAMAK

by

John Douglas Moody

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Abstract

Ion Bernstein wave experiments are carried out on the Alcator C tokamak to study wave excitation, propagation, absorption, and plasma heating due to wave power absorption. It is shown that ion Bernstein wave power is coupled into the plasma and follows the expected dispersion relation. The antenna loading is maximised when the hydrogen second harmonic layer is positioned just behind (to the low field side of) the antenna. Plasma heating results at three values of the toroidal magnetic field are presented. Central ion temperature increases of $\Delta T_i/T_i \gtrsim 0.1$ and density increases $\Delta n/n < 1$ are observed during rf power injection of up to 180 kW at a frequency of $183.6 \times 10^6$ s$^{-1}$ for plasmas within the density range $0.6 \times 10^{20}$ m$^{-3} \leq n_e \leq 4 \times 10^{20}$ m$^{-3}$ and magnetic fields $2.4 \geq \omega/\Omega$ $\geq 1.1$. The density increase is usually accompanied by an improvement in the global particle confinement time relative to the Ohmic value. The ion heating rate is measured to be $\Delta T_i/P_{rf} \approx 2-4.5$ eV/kW at low densities $\sim 1 \times 10^{20}$ m$^{-3}$. At higher densities $n_e \geq 1.5 \times 10^{20}$ m$^{-3}$ the ion heating rate dramatically decreases. It is shown that the decrease in the ion heating rate can be explained by the combined effects of wave scattering through the edge turbulence and the decreasing ion energy confinement of these discharges with density. The effect of observed edge turbulence is shown to cause a broadening of the rf power deposition profile with increasing density. It is shown that the inferred value of the Ohmic ion thermal conduction, when compared to the Chang–Hinton neoclassical prediction, exhibits an increasing anomaly with increasing plasma density. This increasing anomaly, which may result from the presence of the ion temperature gradient driven instability, can essentially account for the observed ion heating rate behavior.

Thesis Supervisor: Dr. Miklos Porkolab
Title: Professor of Physics