CONFINEMENT OF MULTIPLY CHARGED IONS IN AN ECRH MIRROR PLASMA

by

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Abstract

This thesis is an experimental study of multiply charged ions in the Constance B mirror experiment. By measuring the ion densities, end loss fluxes and ion temperatures, the parallel confinement times for the first five charge states of oxygen and neon plasmas are determined. The parallel ion confinement times increase with charge state and peak on axis, both indications of an ion-confining potential dip created by the hot electrons. The radial profile of ion end loss is usually hollow due to large ion radial transport ($\tau_{ni} \approx \tau_{Li}$), with the peak fluxes occurring at the edge of the electron cyclotron resonance zone.

Several attempts are made to increase the end loss of selected ion species. Using minority ICRH, the end loss flux of resonant ions increases by 20% in cases when radial transport induced by ICRH is not too severe. A large antenna voltage can also extinguish the plasma. By adding helium to an oxygen plasma, the end loss of O$^{6+}$ increases by 80% due to decreased ion radial transport.

An ion model is developed to predict the ion densities, end loss fluxes and confinement times in the plasma center using the ion particle balance equations, the quasineutrality condition and theoretical confinement time formulas. The model generally agrees with the experimental data for oxygen and neon plasmas to within experimental error. Under certain conditions spatial diffusion appears to determine the parallel ion confinement time of the highest charge states. For oxygen plasmas during ICRH, the measured parallel confinement time of the resonant ions is much shorter than their theoretical value, probably due to rf diffusion of the ions into the loss cone.

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