Fast Ion Tails during Radio Frequency Heating
on the Alcator C-Mod Tokamak

by

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Abstract

Observations of ion tails in the plasma edge during radio frequency heating on the Alcator C-Mod tokamak have been made using a toroidally and poloidally scanning charge-exchange neutral particle analyzer. The ion tails create a large flux of charge-exchange neutrals (hydrogen and deuterium) at suprathermal energies. The neutral particle flux is characterized by: fast rise and decay times, much faster than the time for changes in the bulk plasma; dependence on plasma conditions and magnetic field in the scrape-off layer; a threshold in electric field near the antenna; and no correlation with bulk plasma parameters. During hydrogen minority heating, edge ion heating may occur at power levels above approximately 500 kW. When the heating frequency is at an ion cyclotron harmonic in the edge, edge heating occurs at power levels lower than 10 kW. Dedicated experiments showed that edge ion heating does not generate impurities or cause loss of heating efficiency. Using the pitch-angle dependence of the fast particles, the total parasitic power loss to the edge is estimated at less than 0.1% during standard heating schemes, but up to 5% with a cyclotron resonance in the edge.

Evidence of Parametric Decay Instability (PDI) into an ion Bernstein wave and an ion cyclotron quasimode has been found on C-Mod using RF probes. Calculations of convective thresholds for PDI have been made for a range of edge parameters and magnetic fields. Calculated theoretical thresholds for PDI in the antenna near field are consistent with experimentally observed thresholds for edge heating, and observed dependence on toroidal field and changes at H-mode transitions.

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