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Pellet Charge Exchange Measurements Of Confined Alphas In DT Plasmas*

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Alpha particle confinement is essential to achieving ignition, and measuring the energy and spatial distributions of fusion alphas is one of the most challenging tasks in plasma diagnostics research. Confined trapped-alpha energy spectra and differential radial density profiles in TFTR DT plasmas have been obtained with the Pellet Charge-eXchange (PCX) diagnostic, which measures high energy (E_α = 0.5–3.5 MeV), trapped alphas ($|v_\parallel/v|$ = 0.048) at a single time slice ($\Delta t \sim$ 1 ms) with a spatial resolution of $\Delta r \sim$ 5 cm. PCX measures the energy spectrum of energetic helium neutrals resulting from charge exchange interactions of alphas incident on the ablation cloud surrounding small boron and lithium pellets injected radially into TFTR.

The success of PCX has led to a number of important results on the behavior of alphas in TFTR. The measured alpha energy spectrum in the plasma core of MHD-quiescent discharges is consistent with the alphas being well-confined and slowing down classically. Outside the plasma core, the trapped alphas show the effects of stochastic diffusion due to the toroidal magnetic field ripple, with the PCX measured profiles consistent with the functional dependence of the stochastic ripple diffusion on the alpha energy and the *q*-profile. Large sawtooth instabilities result in radial redistribution of the trapped alphas to well outside the q = 1 radius and beyond the stochastic ripple loss boundary. Broadening of the radial profiles of trapped alphas is also observed in sawtooth-free reversed and reduced shear discharges on TFTR, with potential implications for reactor designs based on optimized shear configurations. Finally, radial redistribution of trapped alpha particles in the presence of core localized TAE activity is also observed.

Application of PCX measurements to future experiments, including ITER, will also be discussed.

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