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Poloidal variation of high-Z impurity density in Alcator C-Mod ICRF-heated plasmas¹

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The poloidal variation of molybdenum density is measured in the core of ICRF-heated Alcator C-Mod plasmas and found to exhibit strong in/out asymmetries. Existing neoclassical parallel impurity transport theory is extended to include the effects of fast-ions and is shown to agree quantitatively with C-Mod measurements. The flux-surface variation of molybdenum is well described by $n_z(\theta)/\langle n_z \rangle = 1 + n_{z,c} \cos(\theta) + n_{z,s} \sin(\theta)$, where $-0.2 < n_{z,c}/\langle n_z \rangle < 0.3$ and $-0.1 < n_{z,s}/\langle n_z \rangle < 0.1$ are observed over a wide range of Ohmic, L/I-mode and EDA H-mode plasmas for $r/a < 0.9$. The in/out asymmetry, $n_{z,c}/\langle n_z \rangle$, is determined by a combination of centrifugal force due to toroidal rotation, leading to low-field side (LFS) accumulation, and poloidal electric fields sustained by magnetic trapping of cyclotron heated minority ions, leading to high field side (HFS) accumulation. While LFS accumulation due to centrifugal effects has been seen on other tokamaks, this represents the first observation of the effect driven entirely by intrinsic rotation. Scans of the D(H) resonance layer are shown to modify the in/out asymmetry by altering the fast-ion temperature anisotropy, T_{\perp}/T_{\parallel} , and changing the ICRF power density, P_{RF}/n_e , either by ramping down the input power or increasing the density is found to reduce HFS accumulation. Observations of up/down asymmetries $n_{z,s}/\langle n_z \rangle$, of molybdenum density are found to disagree with existing theories in the trace limit, $n_z Z^2/n_i \ll 1$, in the collisionless main-ion regime. The link between $n_z(\theta)$ and poloidal rotation, v_{θ} , is emphasized, as both are assumed to be determined by neoclassical parallel impurity transport, and a more rigorous test of theory which includes matching asymmetries and v_{θ} is discussed. The use of the poloidal variation in n_z as a diagnostic for E_{θ} and T_{\perp}/T_{\parallel} as well as the impact of $n_{z,c}/\langle n_z \rangle$ on radial transport are also discussed.

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