Calculated HFS impurity density profiles on Alcator C-Mod via CXRS

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Through the use of beam-based CXRS at the low-field side (LFS) of the plasma and first-order neoclassical theory we are able to derive the expected velocity profile at the high-field side (HFS) midplane and compare it to the flow profile from CXRS measurements taken directly at the high-field side of the tokamak (using room-temperature injected neutrals). Currently Alcator C-Mod is the only tokamak employing high-field CXRS. First-order neoclassical theory states that flows on a flux surface can be decomposed into two parts; the first flowing along the magnetic field line and the second flowing strictly toroidally [1]. These flows are characterized by flux functions that may be derived through the analysis of the charge-exchange emission line of fully-stripped boron at 494.4nm. Two periscopes (one poloidal, one toroidal) view the low-field side plasma and one periscope views along the magnetic field at the high-field side. During L-mode the calculated and measured velocity profiles agree to within the error bars. During H-mode however, there is a region extending about one centimeter inside the LCFS with steep velocity gradients in the measured (LFS) profile which then map to the HFS and are not seen on the HFS measurements. This disparity could be explained if the impurity density is not constant on a flux surface from HFS to LFS. Including a poloidally-dependent density factor in the first-order theory allows us to calculate an expected B^{+5} density profile at the high-field side. The HFS impurity density profiles obtained in this manner have similar magnitudes (10^{16} - 10^{17} m^{-3}) to their counterparts at the plasma LFS. In an EDA H-mode the B^{+5} profiles at the high-field side appear to have a smaller pedestal height and width (but a steeper gradient) than the LFS, although it is sometimes unclear whether the measurement extends to the top of the pedestal. During ELM-free H-modes the HFS density profile height and gradient increases similar to the density at the LFS. These profiles can also be compared with those derived using the B^{+5} brightness profile and a neutral injection modeling code such as KN1D.

[1] Kim, Y., Diamond, P., Groebner, R. Neoclassical poloidal and toroidal rotation in tokamaks. *Phys. Fluids B.* **3** (8). August 1991.