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Theoretical explanation for strong poloidal impurity asymmetry in tokamak pedestals[1]

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Stronger impurity density in-out poloidal asymmetries than predicted by the most comprehensive neoclassical models have been measured in H-mode tokamak pedestals during the last decade. However, these pioneering theories[2] neglect the impurity diamagnetic drift, while recent measurements indicate that it can be of the same order as the ExB drift that is retained[3]. In order to keep both drifts self-consistently, stronger radial gradients of the impurity density must be allowed. As a result, radial impurity flow effects need to be included for the first time. These effects substantially alter the parallel impurity flow. The resulting modification in the impurity friction with the banana regime background ions then allows stronger poloidal variation of the impurity density, temperature and potential. Even the six-fold high field side accumulation of boron density measured on Alcator C-Mod[4] can be explained without invoking anomalous transport. Moreover, the potential can no longer be assumed to be a flux function since the impurity density variation gives a poloidally varying potential that results in strong poloidal variation of the radial electric field. The fact that the magnitude of the negative radial electric field and the impurity temperature are both larger on the low field side is also correctly predicted. Finally, this pedestal neoclassical model with radial flows may provide insight on how to control impurity accumulation in JET.

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[2]P. Helander, Phys. Plasmas 5, 3999 (1998)
[3]C.Theiler et al.,Nucl Fusion 54,083017 (2014)
[4]R.M.Churchill et al.,Phys Plasmas 22,056104 (2015)