DPP05-2005-000671

Abstract for an Invited Paper
for the DPP05 Meeting of
the American Physical Society

Advances in measurement and modeling of the H-mode pedestal on Alcator C-Mod[1]

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Edge transport barriers (ETBs) forming pedestals are crucial in determining H-mode plasma confinement. ETB studies on Alcator C-Mod have improved understanding in several areas, including pedestal scalings, edge stability, and radial transport of both plasma and neutrals. Results depend on the H-mode type, two examples of which are typically observed on C-Mod: ELM-free and enhanced D_α(EDA). Pedestal profiles from edge Thomson scattering show clear trends with plasma operational parameters, particularly in EDA operation. Notably, a ballooning-like I_p^2 dependence is seen in ∇p_e, despite calculated stability to ideal ballooning modes. A similar scaling is seen in near scrape-off-layer probe data for both L- and H-mode discharges, possibly due to electromagnetic fluid drift turbulence setting transport at the pedestal foot. Neutral density diagnosis at the ETB has allowed examination of fueling by atomic D^0 in typical H-modes, and has yielded profiles of an effective diffusivity well in the ETB, the depth of which varies between ELM-free and EDA operation. This experimental work is supplemented with a 1D semi-analytic model for neutral transport in the edge, in order to understand how changes in source D^0 impact the n_e pedestal. By coupling a fluid analysis to a kinetic computation of neutral distribution functions, the thermal equilibration between ions and neutrals is considered. Rapid equilibration at typical C-Mod densities can explain the invariance of n_e pedestal width and gradient with source rate, a result that contrasts with those of lower-density tokamaks. Incorporating neutral kinetics may resolve these apparently contradictory results, as well as dimensionless comparisons between C-Mod and larger tokamaks such as DIII-D and JET.

[1]Supported by U.S. D.o.E. Coop. Agreement DE-FC02-99ER54512

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