DPP17-2017-000139

Abstract for an Invited Paper
for the DPP17 Meeting of
the American Physical Society

Characterization of the core poloidal flow at ASDEX Upgrade[1]

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An essential result from neoclassical (NC) theory is that the fluid poloidal rotation (u_{pol}) of the main ions is strongly damped by magnetic pumping and, therefore, expected to be small ($< 2\,\mathrm{km/s}$). Despite many previous investigations, the nature of the core u_{pol} remains an open question: studies at DIII-D show that at low collisionalities, u_{pol} is significantly higher in the plasma core than expected. At higher collisionalities, however, a rather good agreement between experiment and theory has been found at both DIII-D and TCV. This is qualitatively consistent with the edge results from both Alcator C-Mod and ASDEX Upgrade (AUG). At AUG thanks to an upgrade of the core charge exchange recombination spectroscopy (CXRS) diagnostics, the core u_{pol} can be evaluated through the inboard-outboard asymmetry of the toroidal rotation with an accuracy of 0.5-1 km/s. This measurement also provides the missing ingredient to evaluate the core $\vec{E}\times\vec{B}$ velocity ($u_{\vec{E}\times\vec{B}}$) via the radial force balance equation. At AUG the core u_{pol} ($0.35 < \rho_{\mathrm{tor}} < 0.65$) is found to be ion-diamagnetic directed in contradiction to NC predictions. However, the edge rotation is always found to be electron-directed and in good quantitative agreement with NC codes. Additionally, the intrinsic rotation has been measured in Ohmic L-mode plasmas. From the observed data, it is clear that the gradient of the toroidal rotation is flat to slightly negative at the critical density defining the transition from the linear to the saturated Ohmic confinement regime. Furthermore, the non-neoclassical u_{pol} observed in these plasma leads to a good agreement between the $u_{\vec{E}\times\vec{B}}$ determined from CXRS and the perpendicular velocity measured from turbulence propagation. The difference between these two quantities is the turbulent phase velocity. The gathered dataset indicates that the transition in the turbulence regime occurs after the saturation of the energy confinement time.

[1]The author thankfully acknowledges the financial support from the Helmholtz Association of German Research Centers through the Helmholtz Young Investigators Group program.