Characterization of the core poloidal flow structure at ASDEX Upgrade

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An essential result from neoclassical theory is that the fluid poloidal rotation ($u_{\text{pol}}$) of the main ions is strongly damped by magnetic pumping [1] and, therefore, expected to be small ($< 2 \text{ km/s}$). Experimental measurements of $u_{\text{pol}}$ enable us, therefore, to benchmark our understanding of basic transport processes in magnetically confined plasmas. Despite many previous investigations, the nature of the core poloidal rotation remains an open question: recent studies at DIII-D show that $u_{\text{pol}}$ is significantly higher in the plasma core than expected at low collisionalities [2]. At higher collisionalities, however, a rather good agreement between experiment and theory has been found for impurity ions at TCV [3], which is qualitatively in good agreement with previous observations at ASDEX Upgrade (AUG) for the plasma edge [4]. Due to an upgrade of the core charge exchange recombination spectroscopy systems at AUG, $u_{\text{pol}}$ can now be deduced also in the plasma core with an accuracy $< 1 \text{ km/s}$ [5] by evaluating the toroidal flow on the low-field side and the high-field side of the torus [6]. This measurement provides as well the missing ingredient to calculate the radial electric field in the plasma core via the radial force balance equation which is an important quantity to understand plasma transport [7].

This contribution will show core poloidal velocity measurements from AUG plasmas over a wide range of plasmas parameters and confinement regimes. In all cases, including very low collisionality plasmas, the measured values remain well within error bars of neoclassical values. For these comparisons, the neoclassical codes NEOART, NEO, and NCLASS have been used. Additionally, measurements of $u_{\text{pol}}$ and $E_{\text{r}}$ will be shown in interesting plasma scenarios like the reversal of the intrinsic rotation in low density L-mode discharges, during sawteeth crashes and during the formation of internal transport barriers.

References

[7] G. Dif-Pradalier et al, PRL \textbf{103} 065002