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Predicting the Toroidal Rotation Profile for ITER

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Toroidal rotation in ITER is predicted with a combination of intrinsic and NBI sources and gyrofluid modeling of momentum transport, and it is found to play a significant role in enhancing D-T fusion performance. In a large tokamak such as ITER, intrinsic sources of rotation as well as rotation drive from applied 3D fields will become more significant due to a relatively low amount of neutral beam torque. The predicted intrinsic rotation at the top of the pedestal in ITER is 10 krad/s, and the core rotation driven by NBI is predicted to be ˜20 krad/s. The predicted rotation for ITER is large enough that the TGLF transport model predicts significant turbulence stabilization, leading to improved confinement and an increase in the predicted fusion gain (Q) from 5 to 8 when rotation effects are included and the core density is assumed to be flat. Q is further increased to 11 when TGLF is also used to self consistently determine the core density. The predicted intrinsic rotation is derived from dimensionless parameter scan experiments that measured the dependence of intrinsic torque on ρ\. *Confidence in this prediction has been increased with experiments that investigated important uncertainties in the intrinsic torque measurements: the role of fast-ions on the measurement of intrinsic torque, and the effect of neutrals on momentum transport in the pedestal. Intrinsic rotation measured in a ρ* scan yielded a consistent dependence on ρ\, *and intrinsic rotation was not found to be affected by significant changes in divertor closure when other important parameters were held constant. In addition, it was found that intrinsic rotation undergoes no significant change at the onset of detachment. These results increase confidence in the prediction of the intrinsic rotation in ITER. The dependence of intrinsic rotation on ρ* found in this work appear to be inconsistent with completely independent database studies of intrinsic rotation. However, careful analysis shows a common dependency on ion temperature that underlies the similar predictions from these different methods.

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