DPP16-2016-000674

Abstract for an Invited Paper
for the DPP16 Meeting of
the American Physical Society

Predicting Rotation via Studies of Intrinsic Torque and Momentum Transport in DIII-D[1]

C. CHRYSTAL, GA

Experiments at DIII-D using dimensionless parameter scans to study momentum transport and intrinsic (self-generated) torque have yielded a predicted average toroidal rotation in ITER of 10 krad/s and shown that intrinsic torque is relevant for large tokamaks. Intrinsic torque can generate toroidal rotation via various mechanisms (residual stress, orbit loss, field ripple, etc.), and rotation is important for determining turbulence suppression, MHD stability, and high-Z impurity transport. The 10 krad/s prediction is 2x higher than when only neutral beam torque is accounted for, an increase that is predicted to benefit ITERs performance. This work employs scans of normalized gyroradius (ρ_*), normalized collision frequency (ν_*), T_e/T_i, and q. Intrinsic torque normalized by T_i has been found to scale as $\rho_*^{-1.5}$, yielding significant intrinsic torque in ITER. The measurements disagree with theoretical predictions and suggest that residual stress is not the primary source of intrinsic torque. These results are consistent with a companion scan in JET. The ν_* scaling of normalized intrinsic torque is smaller ($\nu_*^{0.3}$). Momentum confinement time was measured to have gyro-Bohm like scaling ($\rho_*^{-0.7}$, similar to ITB98(y,2) energy confinement time scaling), and weaker ν_* scaling ($\nu_*^{0.4}$). Intrinsic torque and momentum confinement time results are found by analyzing the time history of the angular momentum. The time variation of main-ion and impurity rotation were found to be the same, verifying a key assumption in the analysis. The same intrinsic torque was measured when canceling the intrinsic torque with neutral beam torque, suggesting that the Mach number is not an important parameter. The beneficial level of rotation in ITER implied by these results is encouraging.

[1]Work supported by US DOE under DE-FC02-04ER54698.