Characterization of intrinsic rotation drive on DIII-D

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Abstract.

Recent experiments on DIII-D have focused on elucidating the drive mechanisms for intrinsic rotation in tokamak fusion plasmas. In H-mode plasmas, the effective torque at the edge ($\rho > 0.8$) associated with the intrinsic rotation shows a dependence on the pedestal pressure gradient ∇P_{ped}, which is qualitatively consistent with models describing $E \times B$ shear as a means of creating "residual stress" and driving intrinsic rotation. However, direct measurement of the turbulent Reynolds stress using probes suggests that this is not the full picture. Specifically, there is a significant mismatch between the plasma spin up and the inferred torque from the Reynolds stress at the edge, indicating that additional mechanisms are necessary to completely understand edge intrinsic rotation generation. A narrow rotation layer is observed near the separatrix, which can qualitatively be explained using a model of thermal ion orbit loss. Parametrically, the torque from such a process is expected to vary with $\sqrt{T_i}$. A good predictor of the edge intrinsic torque is obtained by including this dependence, together with with the previously observed ∇P_{ped} dependence, in a regression fit of a wide range of H-mode conditions. The intrinsic torque in the core ($\rho < 0.5$) of H-mode plasmas tends to be much smaller than observed at the edge, although some examples have been found where it is large enough to modify the rotation profile. For instance, in certain plasmas with electron cyclotron heating, a significant counter intrinsic torque has been observed in the inner region of the plasma.