Intrinsic Rotation in DIII-D*

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In the absence of any auxiliary torque input the DIII-D plasma is observed to have nonzero toroidal angular momentum. In Ohmic H-mode discharges the toroidal rotation profile is relatively flat, consistent with early C-Mod observations. In electron cyclotron heating (ECH) H-modes the velocity profile is hollow, directed in the direction of the plasma current on the outside and depressed, or actually directed counter to the plasma current near the plasma center, depending upon the ECH deposition profile. Such "intrinsic" rotation has been observed on other tokamaks. Understanding this effect is important for making projections toward burning plasma performance, and design considerations, where neutral beam injection torque will be relatively small, or nonexistent. Theoretical treatments of intrinsic rotation based upon neoclassical off-diagonal transport coefficients, and upon turbulence-induced momentum transport have been done. A detailed match with theory is yet to emerge. An empirical scaling is being developed, relating the intrinsic rotation velocity to the ratio of stored energy to plasma current. It appears possible that some aspects of intrinsic rotation will be elucidated through cross-machine experiments using similarity in the dimensionless plasma parameters, allowing a projection to a burning plasma. Velocity is an important parameter since sufficient toroidal rotation tends to stabilize deleterious MHD modes and velocity shear promotes thermal confinement. We will describe measured intrinsic rotation profiles from a variety of DIII-D L- and H-mode conditions, scalings, and comparisons with applicable theories, where they exist. Cross-machine experiments along paths of dimensionless similarity will be described. The DIII-D results will also be compared with experimental results from other tokamaks.

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