Collisionality Scaling of Main-ion Toroidal and Poloidal Rotation in Low Torque DIII-D Plasmas

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Abstract. In tokamak plasmas with low levels of toroidal rotation, the radial electric field E_r is a combination of pressure gradient and toroidal and poloidal rotation components, all having similar magnitudes. In order to assess the validity of neoclassical poloidal rotation theory for determining the poloidal rotation contribution to E_r, D_α emission from neutral beam heated tokamak discharges in DIII-D [J.L. Luxon, Nucl. Fusion **42**, 614 (2002)] has been evaluated in a sequence of low torque (electron cyclotron resonance heating and balanced diagnostic neutral beam pulse) discharges to determine the local deuterium toroidal rotation velocity. By invoking the radial force balance relation the deuterium poloidal rotation can be inferred. It is found that the deuterium poloidal flow exceeds the neoclassical value in plasmas with collisionality $\nu_i^* < 0.1$, being more ion diamagnetic, and with a stronger dependence on collisionality than neoclassical theory predicts. At low toroidal rotation, the poloidal rotation contribution to the radial electric field and its shear is significant. The effect of anomalous levels of poloidal rotation on the radial electric field and cross-field heat transport is investigated for ITER parameters.

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