Core toroidal rotation characteristics of pure ohmic plasmas in KSTAR

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Behaviors of the toroidal rotation of Ohmic plasmas without any external momentum source are investigated in the KSTAR tokamak. In general, the core impurity toroidal rotation is shown to rotate in the counter-current direction and its magnitude strongly depends on the global plasma parameters such as plasma current and the ion temperature. Since the intrinsic flow generated by collisions or turbulence is diamagnetic in nature, it scales as \( v_t \rho_{pi} / L \propto T_i / I_p \) where \( v_t \) is the ion thermal speed, \( \rho_{pi} \) is the ion poloidal gyro-radius and \( L \) is the radial scale length [1, 2]. In this study, we show that the measured toroidal rotation scales as \( T_i / I_p \) very well. Since the edge plasma rotates in the co-current direction, it is natural to think that there exist independent momentum sources in the core. The applied electric field is not large enough to explain the measured rotation [3]. Asymmetric magnetic fields, \( \frac{\delta B}{B} \sim 10^{-5} \), are too small to expect plasmas to get to the steady state flow caused by the neoclassical toroidal viscosity [4]. Thus, the residual stress [1] is the only known remaining candidate. Having that said, it does not necessarily mean that the residual stress is the only possible candidate because the scaling is the only supporting evidence.

References