Gyrokinetic theory and simulation of angular momentum transport

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Abstract

A gyrokinetic theory of turbulent toroidal angular momentum transport as well as modifications to neoclassical poloidal rotation from turbulence is formulated starting from the fundamental six-dimensional kinetic equation. The gyroBohm scaled transport is evaluated from toroidal delta-f gyrokinetic simulations using the GYRO code [J. Candy and R.E. Waltz, J. Comput. Phys. **186**, 545 (2003)]. The simulations recover two pinch mechanisms in the radial transport of toroidal angular momentum: the slab geometry $E \times B$ shear pinch [R.R. Dominguez and G.M. Staebler, Phys. Fluids **B5**, 387 (1993)] and the toroidal geometry "coriolis" pinch [A.G. Peeters, C. Angioni, and Strintzi, Phys. Rev. Lett. **98** (26), 26503 (2007)]. The pinches allow the steady state null stress (or angular momentum transport flow) condition required to understand intrinsic (or spontaneous) toroidal rotation in heated tokamak without an internal source of torque [G.M. Staebler, J.E. Kinsey, and R.E. Waltz, BAP **46** (2001), p221, LP1-17]. A predicted turbulent shift in the neoclassical poloidal rotation [G.M. Staebler, Phys. Plasmas **11**, 1064 (2004)] may be significant at the finite relative gyroradius (rho-star) in current experiments.

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