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Centrifugal Effects on Gyro-Kinetic Stability and Transport*

G.M. Staebler and R.E. Waltz

General Atomics, PO Box 85608, San Diego, California 92186-5608, USA

Data from tokamaks shows that measured carbon toroidal rotation velocities can be comparable to the carbon thermal velocity in many discharges with unbalanced neutral beam injection. Impurity ions do not usually make a very significant contribution to energy or particle transport because of the small impurity density. However, the toroidal momentum transport from impurities can be important even at small density since it scales with the ion mass times the density. The parallel velocity shear threshold for the Kelvin-Helmholtz mode is also lowest for the heaviest ion species. These considerations lead to the conclusion that it is essential to include kinetic impurities ions in order to predict momentum transport in tokamaks and that the ion mach number must not be assumed to be small. Gyro-kinetic theory has already been extended to toroidal velocities of order the ion thermal velocity [1]. The GKV gyro-kinetic turbulence code has implemented the extended equations [2,3]. In this work the gyro-fluid theory is extended to this same ordering. The most challenging and interesting aspect of the gyro-fluid theory is the inclusion of the particles that are trapped by the poloidal variation of the electric potential induced by the centrifugal effects on the density. These E-trapped particles exist below a boundary kinetic energy. Unlike the magnetic mirror trapped (B-trapped) particles the E-trapping boundary does not depend upon pitch angle. The E-trapped particles cannot be collisionally detrapped by pitch angle scattering but can be detrapped by scattering to higher energy. The E-trapped particle can bounce average the Landau resonance like B-trapped particles. The unique character of the E-trapped particles can be included in a gyro-fluid model by introducing a new fluid sub-species. The gyro-fluid equations for the three sub-species (E-trapped, B-trapped-E-untrapped, B-untrapped-E-untrapped) will be presented. The linear stability and quasi-linear prediction of the transport for this extended gyro-fluid theory will be explored.

[1] H. Sugama and W. Horton, Phys. Plasmas **5** (1998) 2560.
[2] A.G. Peeters, D. Stinitz, Y. Camenen, et al., Phys. Plasmas **16** (2009) 042310.
[3] F.J. Casson, A.G. Peeters, C. Angioni, et al., Phys. Plasmas **17** (2010) 102305.

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