Category 1.Magnetic & Inertial Fusion Plasmas

Momentum transport in full-*f* gyrokinetic simulations

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Momentum transport induced by tokamak micro-turbulence is one of key issues in predicting the performance of ITER, and has been studied intensively based on gyrokinetic simulations. However, Parra and Catto [1] raised a question about the accuracy of momentum transport in gyrokinetic simulations, in particular, in so-called full-*f* gyrokinetic simulations, in which both momentum transport and rotation profiles develop self-consistently. On the other hand, a recent work [2] clearly showed that toroidal angular momentum is conserved even in the conventional lowest order gyrokinetic equations, provided that the system keeps an energetic consistency. In this work, we study the accuracy issues of momentum transport in a full-*f* gyrokinetic Eulerian code GT5D [3], which solves the lowest order gyrokientic equations based on so-called modern gyrokinetic theory. First, we check basic properties of axisymmetric plasmas such as an equilibrium distribution function given by the canonical angular momentum, the ambipolar condition of particle transport, and a neoclassical force balance relation for a given rotation profile. We then show the conservation law for toroidal angular momentum, and examine its accuracy in GT5D. Finally, we implement higher order Hamiltonian [4], and estimate influences of higher order corrections on heat and momentum fluxes. After discussing the accuracy issues, we present effects of momentum transport on ion turbulent transport by comparing simulations with and without adaptive momentum sources, which cancel development of rotation profiles induced by turbulent momentum transport. The results show that in the ion temperature gradient turbulence, momentum transport tends to suppress ion heat transport by forming rotation profiles, which enhance the radial electric field shear through a force balance relation. It is also found that finite momentum transport is induced with zero rotation profile, suggesting the existence of so-called residual stress.

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