Exact conservation laws for truncated gyrokinetic Vlasov-Poisson equations.

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The turbulent plasma behavior inside a fusion device is generally associated with transport of energy and momentum. Therefore, a better understanding of turbulent transport phenomena is an important issue for investigating of confinement improvement in magnetized plasmas. In particular, momentum transport is believed to generate intrinsic plasma rotation, which has a stabilizing influence on the turbulence and macroscopic instabilities.

A particular interest represents treatment of the momentum transport within the gyrokinetic framework, when the non-relevant fast gyro- scale motion is removed from the dynamical description. Generally, the momentum transport equation is derived from moment equations of the nonlinear gyrokinetic Vlasov equation.

Our previous work [1] was concerned with an alternative derivation of the momentum and angular momentum conservation laws for the nonlinear gyrokinetic Vlasov-Poisson equations by the Noether method, which associates a conservation law with each symmetry of the gyrokinetic Lagrangian density with respect to infinitesimal space-time translations and rotations.

From the gyrokinetic canonical-momentum equation derived by the Noether method, the gyrokinetic parallel momentum equation and other gyrokinetic Vlasov-moment equations are obtained. In addition, an exact gyrokinetic toroidal angular-momentum conservation law is derived in axisymmetric tokamak geometry, where the transport of parallel-toroidal momentum is related to the radial gyrocenter polarization, which includes contributions from the guiding-center and gyrocenter transformations.

In particular, new guiding-center contributions to the polarization are presented, which may provide an additional contributions to the intrinsic rotation. There are associated with the grad B and curvature drifts, provided by the toroidal magnetic field geometry.

A Lagrangian formalism for momentum transport investigation has been employed in [2], but these geometrical contributions have been omitted.

The purpose of the current work is adapting the results of the Noether method derivation of momentum transport equations for the gyrokinetic Vlasov-Poisson system to numerical implementations. In particular, we are considering the delta-f truncated Gyrokinetic Vlasov-Poisson system and we derive the exact momentum conservation laws via the Noether method.

[1] A.J. Brizard, N.Tronko, PHYSICS OF PLASMAS 18, 082307 (2011)

[2] B. Scott and J. Smirnov, PHYSICS OF PLASMAS , 17 (2010), 112302