Exact conservation laws for full and truncated gyrokinetic Vlasov-Poisson equations.

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The turbulent plasma behavior inside the fusion device is generally accompanied by violent transport of energy and momentum and leads to creation of strong gradients and instabilities. Therefore, to get a better understanding of transport phenomena represents an important issue of plasma stabilization and confinement improvement.

In particular, momentum transport is believed to generate intrinsic plasma rotation, which stabilizing property was observed in many devices.

A particular interest represents its treatment within the gyrokinetic framework, when the non-relevant fast scale motion is removed from the dynamical description. Generally, momentum transport equation is derived as 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 to 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, identification of new guiding-center contributions, associated with magnetic field geometry to the polarization represents an especial interest as may be potentially interpreted as additional contributions to the intrinsic rotation. Lagrangian formalism for momentum transport investigation has been employed in [2], but these geometrical contributions have been omitted.

One of the purposes of the current work is adapting the results of the Noether method derivation of momentum transport equation 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.

References

[1] A. J. Brizard and N. Tronko, *Physics of Plasmas* **18**, 082307 (2011)

[2] B. Scott and J. Smirnov, *Physics of Plasmas* **17**, 112302 (2010)