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Global features of gyrokinetic simulations with sources

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Gyrokinetic simulations of turbulence are now routinely used for various physics studies. Gyrokinetic theory as such can be considered as based on first principles. However, virtually all codes add some elements which are, strictly speaking, not first-principle based. Examples of these are the source terms, which are introduced in global gradient-driven or flux-driven simulations, typically in order to avoid the system to relax their gradients to the marginal state. The simulations can thus reach a quasisteady-state, with average gradients above marginality and finite fluxes of heat, particles or momentum.

The main objective of this paper is to examine in more detail, and from a pragmatic point of view, the consequences on the transport level and turbulent structures of the application of different types of source terms. Source terms have been designed [1] to conserve selected momenta of the distribution function in a flux-averaged sense: density, parallel flows, kinetic energy or Zonal Flow (ZF) residuals.

Using the ORB5 code [2], ITG turbulence properties with various choices of source terms are shown to depend crucially on the type of conservation, respectively non-conservation, imposed on the sources. The effect is particularly marked in the vicinity of the critical gradient, where a Krook source not flow-conserving is shown to lead to the destruction of radially coherent regularly repetitive avalanches, in which ZFs play an essential role, and which have been observed in the TCV experiment near or below the GAM frequency [3]. Furthermore, the time- and radially averaged heat transport is overestimated as compared to a source term with appropriate conservations. The flow structures are also affected.

This speaks in favour of a more systematic assessment of how sources are applied to gyrokinetic codes, with the goal of designing source terms that have a 'benign' effect on the physics.

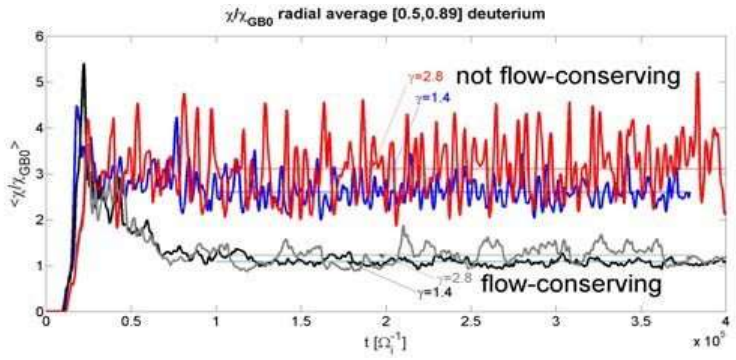

Figure 1: *Ion heat effective diffusivity for flow-conserving (black, grey) and non-conserving (blue, red) sources, for two values of the Krook relaxation rate, in global, gradient-driven ITG simulations.*

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References

[1] B. F. McMillan, et al., Phys. Plasmas 15, 052308 (2008)
[2] S. Jolliet, et al., Comput. Phys. Commun. 177, 409 (2007); T.M. Tran, et al., Varenna (1999)
[3] C.A. de Meijeire, et al., Plasma Phys. Control. Fusion 56, 072001 (2014); G. Merlo, EPFL Thesis No.7065 (2016); Z. Huang, EPFL Thesis No. 7715 (2017)