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P2.1074 Hierarchical approach to first principle based reduced transport models

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A framework to validate reduced particle and energy transport models based on the theoretical framework introduced in [1, 2] is proposed. The motivation of the present work is two-fold: (i) extending first-principle-based gyrokinetic simulations to long time scales is extremely demanding from a computational resource point of view; and (ii), the relevant physics processes can be illuminated and extracted from complex simulations by means of reduced models. In this context, the theoretical framework reviewed in Ref. [3] provides our starting point allowing to describe plasma dynamics with a level of simplification appropriate in regimes not correctly described by the quasi-linear approach. Consequently, in our work, particle and energy transport equations are formulated first, and then solved within three levels of increasing simplification based respectively on: the weak-amplitude expansion, i.e. |B|/B0 1; the assumption that the parallel mode structure is set by linear theory, i.e. NL L-1 ||-1; and, finally, the quasi-linear description. The systematic comparison of these levels of approximation against nonlinear gyrokinetic simulation results yield a verified reduced description retaining only the essential physics ingredients. Although completely general, this framework is particularly relevant for energetic particle (EP) transport and nonlinear dynamics in fusion plasmas. In particular, the hierarchy of verified reduced descriptions, discussed in this work, may be adopted for systematic analyses of the role of EPs as mediators of cross-scale couplings [3]. Accordingly, simplifying assumptions in their governing equations must be strictly and systematically validated in realistic scenarios. Experiments with a set of dimensionless parameters relevant for burning plasma studies such as the Divertor Tokamak Test facility (DTT) [4], are the ideal testbed for the further validation process.

References

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