Gyrokinetic and quasi-linear simulations of JET plasmas in view of DT operation.

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In view of JET DT operation, an extensive modelling effort has been carried out at JET, to increase the predictive capabilities of existing numerical models. Predictions of heat and particle transport have been tested in conditions that will be present in DT plasmas, as well as in future reactors. A particular attention has been given to the study of the effect of changing the main ion isotope from H to D and T, to the evaluation of the electromagnetic effects (finite-β effects), and to the ion-electron multi-scale turbulent transport. The authors addressed many aspects of these topics in the recent years, comparing the results of gyrokinetic simulations and quasi-linear models with dedicated JET experiments. A selection of relevant results, which required an intensive use of HPC, is given in this work. Electromagnetic effects and isotope dependence have been studied for a high-β hybrid D discharge in [1], also extrapolating to T, comparing GENE [2] simulations with quasilinear models, showing the dependence of the results on the collision frequency, impurities, $E \times B$ shearing, geometry, β. Additional evidence of such dependencies is found in [3]. In [4], the outcome of a dimensionless isotope mass scaling experiment in L-mode conditions is shown, where gyrokinetic and quasilinear estimates of the isotope scaling of the heat and particle transport were compared with the experiment, to single out the direct effect of the isotope mass. Numerically expensive nonlinear flux-tube multi-scale gyrokinetic simulations have been carried out in [5, 6] for a JET plasma, showing that simple quasi-linear estimates of the impact of electron scales on the transport are not valid for the considered case, and nonlinear multi-scale gyrokinetic simulations are needed instead.

References

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