Turbulent heat flux versus density gradient: an inter-machine study with the gyrokinetic code `stella`

H. Thienpondt[1], J. M. García-Regaña[1], I. Calvo[1], M. Barnes[2], F. Parra[2] and R. Davies[3]

[1]*Laboratorio Nacional de Fusión, CIEMAT, 28040 Madrid, Spain*

[2]*Rudolf Peierls Centre for Theoretical Physics, University of Oxford, Oxford OX1 3NP, UK*

[3]*York Plasma Institute, Department of Physics, University of York, York YO10 5DD, UK*

It has been experimentally observed in both tokamaks [1,2] and stellarators [3,4,5] that peaked density profiles lead to enhanced confinement regimes. The reduction in transport is believed to be related to the stabilization of ion-scale turbulence. In this conference contribution, we perform gyrokinetic simulations with the gyrokinetic code `stella` [6] focusing on the effect of the density gradient on nonlinear heat fluxes. The influence of the magnetic geometry is investigated by means of an inter-machine study that includes the W7-X, LHD, TJ-II and NCSX stellarators, as well as tokamak configurations. The simulations are collisionless and a vanishing electron temperature gradient is assumed.

We have computed the ion heat flux as a function of the normalized density gradient, scanned from a/L_n=0 up to a/L_n=4, for a fixed value of the normalized ion temperature gradient, a/L_{Ti}=3, by means of nonlinear `stella` simulations with kinetic electrons, performed on the Marconi HPC Cluster. We show that, in a broad range of the scanned a/L_n values, W7-X and NCSX exhibit a strong reduction of the ion heat flux with increasing a/L_n. In TJ-II the reduction is more modest and in LHD the ion heat flux has a weak dependence on a/L_n. Moreover, it is shown that in stellarator geometry, the behaviour of the linear growth rates as a function of a/L_n does not correlate with the behaviour of the ion heat flux. Finally, we will also discuss the effect on the ion heat flux of treating the electrons adiabatically or kinetically, as well as the effect of taking zero or finite a/L_{Ti}.

References

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