Numerical modelling of edge tokamak plasma: impact of collisionality on turbulence properties

Tatali[1] & *et al.*[2]

[1] M2P2, UMR7340 Centrale Marseille Plot 6, 38 rue Joliot-Curie 13451 Marseille, France
[2] IRFM CEA Cadarache, F-13108 St. Paul-lez-Durance, France
raffaele.tatali@univ-amu.fr

Turbulence developing in the edge plasma of tokamaks is nowadays accepted to play a major role in determining the transport of particles and energy from the hot centre towards the peripheral region. This transport eventually affects the characteristic gradients appearing in the system. Hence, the consequences of turbulent transport are two-fold. First of all, a reduction of turbulent transport would lead to steeper pressure gradients and a better global confinement of plasma, with beneficial consequences on the fusion reaction rates. Turbulence is also involved both in the formation of transport barriers in the closed flux surfaces region, and in the transition from Low to High confinement mode.The latter key feature affected by turbulence in edge plasma is the high heat load exhausted in the region where magnetic field-lines hits on solid components. For ITER, this is an issue of major concern, and the power deposited on the divertor tungsten mono-blocks will have to be maintained below a certain threshold, in order not to compromise the integrity of the material.

The understanding of turbulence and of the related transport is still full of open questions. The aim of turbulence numerical modelling is to fill the gaps in the current understanding of turbulence and experiments, and ultimately reach the ability to be predictive on edge plasma dynamics. In this framework, the TOKAM3X 3D fluid turbulence code that has been developed through a long-term collaboration between the IRFM/CEA institute and the M2P2 laboratory of Marseille as well as the PIIM laboratory[1].

In this contribution, we focus on the impact of collisionality on edge turbulence properties. Among many parameters that can modify the behavior of turbulent transport, the collisionality plays a key role, as shown both from a theoretical [2] and experimental [3] point of view. An initial linear study has been done on a 2D model which has shown that a decreasing resistivity should lead to a shrink of the filamentary structures characteristic of turbulent transport in the border region of the device. This trend has been partially recovered in the 3D fully turbulent simulations showing how the non-linear terms can be mainly responsible to determine the behaviour of the system.Furthermore the main property of plasma turbulence have been recovered related to the change of resistivity and heat conducvity which both depend on collisionality.

References

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