Multiscales mechanisms of magnetic islands generation by drift interchange turbulence

A. Poyé[1], M. Muraglia[2], O. Agullo[1], N. Dubuit[1], S. Benkadda[1], X. Garbet[3] and A. Sen[4]

[1] Aix-Marseille Univ.,PIIM Laboratory, UMR 7345 CNRS, Marseille, France
[2] Aix-Marseille Univ., LISA Laboratory EA 4672, Marseille, France
[3] CEA, IRFM, 13108, St. Paul-Lez-Durance, France
[4] Institute for Plasma Research, Bhat, Gandhinagar 382428, India

Coronal loops in the sun or magnetic islands in fusion devices are well known examples of plasma instabilities that can give rise to coronal mass ejection and disruption phenomena in tokamaks respectively. Quite frequently these structures coexist with fine scale micro-structures associated with turbulent fluctuations arising from various microinstabilities such as the interchange instability. Until recently, considering magnetic fluctuations to be weak in fusion plasmas, microturbulence has been investigated from an electrostatic point of view. The origin of large scales magnetic structures was also exclusively attributed to mechanisms unlinked to the plasma turbulent nature. We show that, in fact, the whole dynamics of the system can be the result of a complex multiscale interaction processes. Thus a large scale magnetic island may result not only from a macroscopic tearing instability but may also be driven by small-scale microturbulence. Various works have investigated this multiscales problem [1, 2, 3]. However, the impact of small scales turbulence on islands generation is still an open question. Using MHD simulations, we address, here, the question of the connection between the level of turbulence and the island size dynamic in 2D, 3D and NTM contexts. In 2D, for a stable tearing mode, the nonlinear beating of the fastest growing interchange modes drives a magnetic island with an enhanced growth rate to a saturated size that is proportional to the turbulence generated anomalous diffusion [3]. In 3D, the turbulence and magnetic islands are not localized at the same rational surface, however, we found that turbulence spreads out to stable regions to trigger magnetic island by beating modes. Moreover, we add in the model anomalous diffusive parameters to generate zonal flow which participates actively to the nonlinear isalnd dynamics : it calms down the turbulence level and as a consequence, island size depends on the zonal flow activity. [4].

References

[1] M. Yagi et al, J. Plasma Fusion Res. **2**, 025 (2007),

[2] F. Waelbroeck et al, Plasma Phys. Controlled Fusion **51**, 015015 (2009), A. Ishizawa and N. Nakajima, Phys. of Plasmas **17**, 072308 (2010)

[3] M. Muraglia et al, Phys. Rev. Lett. **107**, 095003(2011)

[4] A. Poyé, PhD Thesis, Aix-Marseille Univ. (2012)