Evidence of turbulence spreading in the TJ-II stellarator

T. Estrada, C. Hidalgo, T. Happel and the TJ-II Team

Laboratorio Nacional de Fusión. Asociación Euratom-CIEMAT, 28040, Madrid, Spain

Turbulence spreading refers to the spatial propagation of turbulence from a region of the plasma where it is generated to another region where the turbulence drive is smaller or nonexistent. As a consequence, turbulent transport can exist where no turbulence drive exists [1]. Experimentally, a possible way to look for turbulence spreading is to explore the edge transport barrier formation or the barrier collapse. Turbulence spreading can penetrate transport barriers, invading regions where local analysis predicts low level of transport, with the subsequent impact on the transport barrier width.

In the TJ-II stellarator, spontaneous L-H transitions are achieved in NBI heated plasmas [2]. During the H-mode, impurity accumulation and the concomitant increase in the radiation losses often bring the plasma into the H-L back-transition conditions.

The spatio-temporal evolution of turbulence and plasma flows, studied experimentally by means of Doppler reflectometry [3], shows signatures of spatial spreading of the turbulence inside the radial position of the sheared *E*x*B* flow as the H-L back-transition is approached [4]. The experimental results may suggest the following scenario. Radial spreading of the turbulence, braked during the H-mode by the high E_r-shear, becomes noticeable as E_r-shear declines and produces a gradual increase in the turbulence level at the internal radial positions, reaching the E_r-shear location right before the H-L back-transition. The consequence is a gradual retreat of the transport barrier quantified as the width in the turbulence reduction region. These experimental results resemble the simulation studies reported in [5] -where the key quantity to the control of turbulence spreading was found to be the E_r-shearing rate- and point to the possible role of radial spreading of turbulence in determining the width of transport barriers.

[1] X. Garbet *et al.,* Nuclear Fusion **34**, 963 (1994)
[2] T. Estrada *et al.,* Plasma phys. Control. Fusion **51**, 124015 (2009)
[3] T. Happel *et al.,* Rev. Sci. Instrum. **80**,073502 (2009)
[4] T. Estrada *et al.,* Nuclear Fusion **51**, 032001 (2011)
[5] W.X. Wang *et al.,* Phys. Plasmas **14**, 072306 (2007)