Fast particles, flows and confinement in the TJ-II stellarator

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Operation with Li coated wall has been in the basis for a significant improvement in the performance of TJ-II stellarator[i], and lies behind the most relevant findings reported in this overview, including L-H transition.

Li-coating experiments and particle control. Different experiments concerning the specific features of plasma–lithium interactions have been addressed in TJ-II, showing evidence of self-screening by strong localized radiation, in agreement with the short ionization mean free path of the evaporated lithium into the local plasma deduced form the attenuation analysis[ii]. Recently a liquid lithium limiter (LLL) based on the Capillary Porous System (CPS) has been installed in TJ-II and first results will be reported.

Fast particles and Alfvén waves. Fast ions coming from NBI have been observed to destabilise Alfvén waves (AEs) in TJ-II[iii], which gives us the opportunity of studying such an instability, showing its dependence with rotational transform[iv] and a way to mitigate them[v].

Large-scale flow dynamics and transport. Although TJ-II presents a strong flow damping, the presence of an ambipolar radial electric field[vi] as well as turbulence driven flows provide driving mechanisms for mean and fluctuating flows, which will provide long range toroidal correlation whose typical frequencies are in agreement with the obtained in the simulations[vii]. The transitions to improved confinement regimes provoked by biasing are accompanied by an amplification of long-range correlation in the plasma potential, which is a footprint of zonal flows (ZFs). ZFs are seen to provide a global transport modulation, thus strongly modifying the confinement[viii]. Superthermal electrons and as well as MHD phenomena are also seen to play a role in the flow properties[ix]. The dynamics of ZFs has consequences on isotope effect since the structure of ZFs is observed to change when the plasma species are changed in TEXTOR[x], differently to what happens in TJ-II.

Spatio-temporal dynamics of the L-H transition. Flow dynamics also plays an important role during L-H transitions in Li-coated walls in TJ-II, since an oscillating low frequency non-damped sheared flow appears in the edge prior to the change to H mode[xi], which presents a predator-pray relation with the turbulence, and a pattern propagation from the shear layer.

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