Long-range correlation of fluctuations during edge sheared flows development in the TJ-II stellarator

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The importance of the *ExB* sheared flows as a stabilizing mechanism to control plasma fluctuations in magnetically confined plasmas has been widely established. First and second-order phase transition models, with *ExB* sheared flow as a key ingredient, have been invoked to explain the transition to improved confinement regimes. The correlation length and relaxation time divergence at the critical point of a phase transition are universal characteristics.

TJ-II stellarator has shown up to be an ideal laboratory to unravel the physics of shear flow development and momentum transport in fusion plasmas. Edge sheared flows can be easily driven and damped at the plasma edge of TJ-II changing the plasma density or during biasing experiments. Measurements of the relaxation time of externally induced electric fields show an increase above the threshold gradient to trigger the development of sheared flows in TJ-II. Due to the recent development of two sets of Langmuir probes located at two different positions, approximately 160º toroidally apart, TJ-II has been positioned as an excellent laboratory for investigating also long-distance correlations.

Different edge plasma parameters were simultaneously characterized in two different toroidal positions using two similar multi-Langmuir probes, installed on fast reciprocating drives. The correlation between edge density and potential fluctuations measured toroidally apart has been investigated during edge sheared flows development. Results have shown the existence of long-range correlations in potential fluctuations, whereas there is no correlation between ion saturation current (i.e. density) signals, being the effect amplified during the transition to improved confinement regimes (in biasing experiments). These findings show the important role of long-distance correlation as a first step in the transition to improved confinement regimes and the key of electric fields to amplify them, providing a critical test for L-H transition mechanisms (role of ion orbit losses and second order phase transitions based on turbulence driven flows).

Present findings point out the important role of edge diagnostic development to characterize simultaneously at different plasma locations the structure of sheared flows and fluctuations to unravel of physics of sheared flows.