Causality analysis of turbulent structures in the stellarator TJ-K.

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Convergent cross mapping [1] (CCM) as a causality inference technique is used to unveil causal coupling between variables measured in the same dynamical system. CCM measures how well the mapping – from a small region within a multidimensional phase space reconstruction of one variable (obtained from time-delay embedding) – compares to the actual representation of the second variable in its reconstructed phase space. Thus, CCM allows for the identification of causal links and direction of influence between variables. In this work, turbulent plasma fluctuations across different scales and positions are analyzed for magnetically confined plasmas of the stellarator TJ-K. To this end, conditional averaging and bandwidth filtering is used to isolate spatial and temporal scales in relation to turbulent phenomena such as blobs and zonal flows.

Langmuir-probe measurements of plasma potential and density fluctuations across TJ-K's whole poloidal cross-section are used as input for the CCM. This way, a two-dimensional mapping of the causal link existing between the fluctuations can be reconstructed. Recent studies revealed a distinct spatial region in which density perturbations appear to cause zonal potential structures. This is consistent with the localized tilt of vortices in the drift-wave – zonal-flow system previously observed as poloidally local Reynolds-stress maximum in this region [2].

References

[1] G. Sugihara et al, Science **338**, 496 (2012).

[2] B. Schmid et al, New J. Phys. **19**, 055003 (2017)