Overview of spreading of turbulence in magnetized fusion

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Abstract

Turbulence is believed to be responsible for the anomolous transport in most types of magnetized fusion devices. A basic, ubiquitous feature of the turbulent dynamics is its ability to spread itself. This tendency of the turbulence to homogenize, is indeed coupled (and in a certain sense in opposition to) its tendency to form meso scale flow patterns, such as zonal flows, geodesic acoustic modes (GAMs) or convective cells. Such structures may either block or in some cases "help" spreading depending on their anisotropy and whether or not they have an associated group velocity. Turbulence spreading is basically a meso-scale phenomenon (i.e. $\gamma_{lin}^{-1} < \tau_{spr} < \tau_{transp}$) that has traditionally been ignored in transport modelling due to the inconvenience of including the effects of the "dynamics" of turbulent quantities in the description of profile evolution. It is suggested that turbulence spreading may play an important role in momentum transport, a process believed to play a key role in the formation of transport barriers. As of today, little is actually known about the coupling of turbulence spreading to neoclassical phenomena and thus its quantitative implications for a stellarator or a large ripple tokamak. However, recent experimental observations in ASDEX-UG, TJ-II, TJ-K and CSDX provide experimental indications (if not evidence) for the predator prey dynamics of flows and fluctuations in various different kinds of fusion and basic plasma devices. In TJ-II and CSDX, it was further observed that the formation of a shear layer was accompanied by radial propagation of fluctuations of potential and vorticity, respectively. These recent observations and their implications, along with recent developments in the theory of turbulence spreading will be discussed.

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