Formation and propagation of turbulent structures in drift-wave turbulence

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Regardless of the specific magnetic field topology, edge turbulence in toroidal fusion devices is characterized by intermittent fluctuations of the density and potential resulting in intermittent transport events. This fluctuation-induced transport of plasma particles and energy across the confining magnetic field affects several key reactor issues, e.g., heat and particle fluxes to the first wall, recycling, the divertor concept and strongly determines the radial evolution of the plasma profiles. Experimental results and numerical simulations clearly show that the intermittent bursts in the scrape-off layer (SOL) can be ascribed to large-amplitude self-organized coherent structures, called 'blobs', which propagate radially outwards through the SOL with a velocity of less than one tenth of the ion sound speed typically. A detailed comparison of the statistical properties of the spatiotemporal fluctuation dynamics revealed that the formation and propagation of such turbulent structures can also be investigated in linearly magnetized laboratory experiments. Studies in the linear helicon discharge VINETA demonstrated that in weakly developed drift wave turbulence the formation of coherent turbulent structures is observed. The turbulent structures peel off quasi-coherent drift wave modes and propagate radially outwards across the confining magnetic field with a velocity of less than one tenth of the ion sound speed [1]. The radial propagation of the structures is explained as E×B-convection in the self-consistent potential perturbation, which is caused by the three dimensional dynamics of the drift wave. In this paper the experimental findings are quantitatively compared with numerical three-dimensional fluid simulations with appropriate geometry and boundary conditions usng the code CYTO [2]. Special attention is paid to the mechanism of radial structure propagation.

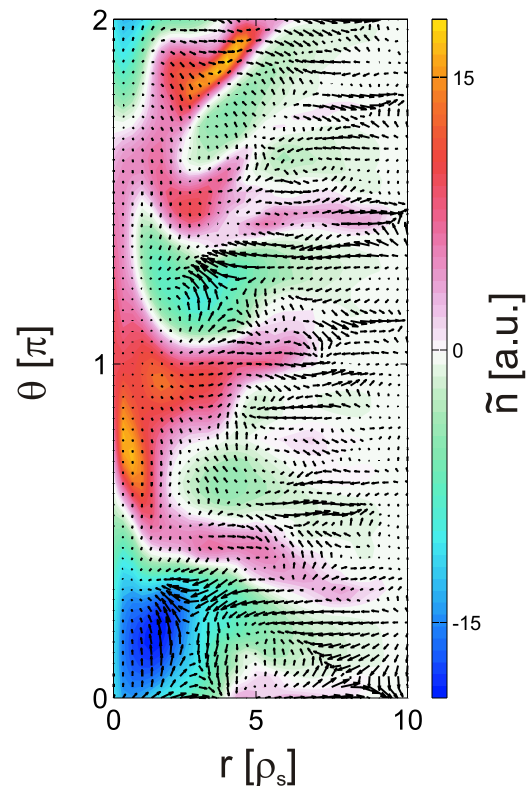

Figure 1: Simulated density fluctuations (colorcoded) in the azimuthal plane and superimposed $\boldsymbol{E} \times \boldsymbol{B}$-velocity.

[1] T. Windisch, O. Grulke, and T. Klinger, Phys. Plasmas, **13**, 122303 (2006)
[2] V. Naulin, T. Windisch, and O. Grulke, Phys. Plasmas, **15**, 012307 (2008)