Simulations of divertor plasma turbulence driven by the current-convective instability under DIII-D-like detached conditions

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Investigation of the physical processes determining dynamics of detached divertor plasmas is highly important for successful prediction of the operational limits of the present-day and future tokamaks. Recent observations at ASDEX Upgrade (AUG) [1] have demonstrated the presence of the new state of detachment, called the fluctuating state, characterized by strong fluctuations of the divertor plasma parameters in the vicinity of the machine X-point, which vanish once the transition to complete detachment occurs. One of the possible mechanisms responsible for these oscillations, recently suggested in Ref. 2, can be related to the onset of the current-convective instability (CCI). The first numerical simulations of plasma dynamics, driven by the CCI, have demonstrated the plausibility of this mechanism for formation of saturated turbulence with temporal characteristics akin to those observed at AUG [3].

In this contribution, we employ the model of Ref. 3 to simulate divertor plasma turbulence, formed by the CCI under the DIII-D-like detached conditions, characterized by the asymmetry in detachment of the tokamak inner and outer divertors. We demonstrate the frequency and spatial spectra of turbulence formed by the instability, and their dependence on the plasma and magnetic field parameters, such as the field line connection length between the target and the X-point, the magnitude of the electron temperature at the inner strike point, the magnitude of the electron temperature drop along the magnetic field line inside the inner divertor leg, etc. The simulation results are also used to reconstruct the fluctuations of the parallel current and magnetic field at the target near the inner strike point. Where possible, the results of the simulations are compared with the available experimental data.

References

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