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Global 3D Two-Fluid Simulations of Turbulent Transport in the Tokamak Edge Region: Turbulence, Profile Evaluation and Spontaneous E $\times$ B rotation[1]

BEN ZHU, Dartmouth College

A new global 3D two-fluid code, GDBM, based on the drift-reduced Braginskii model[1] is developed to study the turbulent transport across the entire tokamak edge region: from plasma sources in the inner core to plasma sinks in the outer-most scrape-off layer (SOL). In this code, profiles of plasma density, electron and ion temperature, electric potential, magnetic flux and parallel flow are evolved self-consistentlty. As a first step, the current code implements a flux-driven source zone near the core and a limiter configuration with the volume penalization method on the edge. In the L-mode regime, simulations indicates the predominant driver of edge turbulence is the resistive ballooning instability. The simulations show that, in agreement with experimental observations, as the simulation moves towards density limit regime by ramping up the density profile, the turbulent transport is enhanced; on the other hand, as the simulation approaches to the H-mode regime by ramping up the temperature profile, the turbulent transport is suppressed. In all cases, spontaneous formation of the E $\times$ B drift in the opposite direction of the ion diamagnetic drift is observed. The E $\times$ B shear gets stronger as the temperature is increased. These findings seem largely consistent with previous local flux-tube simulation results[2]. Simulations also show that in L-mode plasma, the Boussinesq approximation has limited impact on the turbulence structure, fluctuation level and the global profile evolution. More detailed results will be presented at the meeting.

[1] A. Zeiler, J. F. Drake and B. N. Rogers, Phys. Plasmas, 4, 2134 (1997)
[2] B. N. Rogers, J. F. Drake and A. Zeiler, Phys. Rev. Lett., 81,4396 (1998)

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