GLOBAL FLUID SIMULATION OF PLASMA TURBULENCE IN A STELLARATOR WITH AN ISLAND DIVERTOR

An island divertor configuration consists of a chain of magnetic islands that surround the closed field region. The heat outflowing from the core is diverted along the field lines of the islands that strike the plasma-facing components. The interplay between the plasma fluxes from the core, the cross-field transport across the magnetic field lines and the losses to the walls determine the peak heat loads at the vessel targets. Boundary turbulence and plasma dynamics simulations and calculations are still not well developed in stellarators. GBS solves the drift-reduced Braginskii equations, valid in the high collisionality regime. The GBS code has been modified to simulate plasma turbulence in 3D magnetic configurations in stellarators and 3D perturbations in tokamaks. The dominating coherent low poloidal mode is studied using a non-linear local linear model and shows that the results are different from that of the tokamak simulation.

EQUATIONS

The drift-reduced Braginskii equations are solved. All quantities are evolved in time without separation between equilibrium and fluctuating parts. The Boussinesq approximation is applied considering the electrostatic limit, and the gyro viscous terms and the coupling to the neutral dynamics are neglected. The physical model in the GBS equations is discretised in a cylindrical grid (R, φ, Z), with R the radial coordinate, φ the toroidal angle and Z the vertical coordinate. The simulation domain is a torus of radius R0 with a rectangular cross-section of size LR × LZ. These are advanced in time with an explicit Runge–Kutta fourth-order scheme, while spatial derivatives are computed with a fourth-order finite difference scheme.

SOFTWARE

Simulations are performed using the GBS code.