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TH/6-3: Multi-Scale Drift Turbulence Dynamics in Ohmic Discharge as Measured at the FT-2 Tokamak and Modeled by Full-f Gyrokinetic ELMFIRE-code

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The complex interaction between large-scale mean flows, meso-scale zonal flows and fine-scale micro-turbulence excited due to specific profiles of plasma parameters and leading to anomalous transport is an important area of experimental and theoretical research in magnetically confined plasmas. Recent progress in massively parallelized simulations of the electron and ion gyrokinetic particle distribution function and the electromagnetic field has paved the way for several global gyrokinetic code development projects making first principal based investigations of this complex interplay possible, as all the above mentioned processes are simultaneously incorporated into one simulation.
In the present paper direct measurements of micro, meso, and macro-scale transport phenomena in the FT-2 tokamak are shown to be quantitatively reproduced by Elmfire global full f nonlinear gyrokinetic particle-in-cell simulation predictions. A detailed agreement with mean equilibrium flows, oscillating fine-scale zonal flows and turbulence spectra observed by a set of sophisticated microwave back-scattering techniques as well as a good fit of the thermal diffusivity data are demonstrated. Both the shift and the broadening of the power spectrum of synthetic and experimental Doppler reflectometry diagnostics have been found to overlap perfectly at various radial positions, indicating similar rotation and spreading of the selected density fluctuations. At the same time similar radial electric field dynamics have been observed by comparisons of the probability distribution function, the standard deviation and the dominant frequency of the simulated and experimentally measured radial electric field fluctuations, identifying the turbulent driven geodesic acoustic mode as a key contributor to the observed burstiness of the radial electric field. A clear influence of the impurity ions on the fluctuating radial electric field is observed.

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