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ヘリカル・プラズマにおける乱流輸送のプラズマ・プロファイル依存性

Profile sensitivity of turbulent transport in helical plasmas

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The quantitative evaluation for the anomalous transport levels of heat and particle in magnetically confined plasmas is one of the most important issues in fusion researches. In order to design fusion reactors, especially, it is highly necessary to predict the turbulent transport level caused by microinstabilities such as the ion temperature gradient (ITG) mode. Furthermore, the turbulent transport fluxes are quite sensitive to the profiles for the plasma temperature and density.

In this work, the plasma profile sensitivities of the transport fluxes are discussed within the experimental error ranges of the temperature profiles in helical plasmas. The allowable range of the temperature gradients is obtained from re-generated radial functions for ion temperature profiles, which is obtained by random sampling from the redistributed temperature data within experimental error bars which can be regarded as the standard deviations of the distributions. We perform the gyrokinetic analyses for the ITG turbulent transport within the allowable range of the temperature gradients in the LHD plasmas. Figure 1 shows the ion heat diffusivities obtained by the ITG turbulence simulations and the LHD experiment. In outer radial region except for $\rho > 0.8$, the simulations within the experimental errors of the ion temperature (T_i) can cover the experimental heat flux, since the experimental T_i errors enhance the ranges of the simulation results. In the core region, on the other hand, the simulation results have larger ambiguity rather than outer region, due to the fact that the experimental errors are larger in the core region. Furthermore, up-shifts of the critical gradients from linear critical values are also observed and critical gradients go away from experimental values for more outer radial region. In the outer radial region, there exists large density gradients which may cause the TEM instability, while the density profile in core region is almost flat. Therefore, we discuss the effect of the TEM in the outer radial region within the errorbars of the experimental density profile.

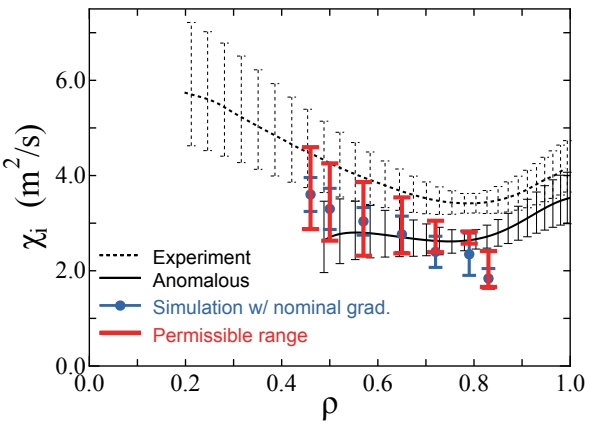

Fig. 1: Ion heat diffusivities obtained by the experiment (solid curve) and the gyrokinetic simulations (blue symbols) with nominal temperature gradients. The simulations within the errorbars of temperature profile enhance the ranges (red error bars) .