

Nusselt Number Scaling in Tokamak Plasma Turbulence

K. Takeda^{1,2}, S. Benkadda^{1,2}, S. Hamaguchi³ and M. Wakatani^{2*}

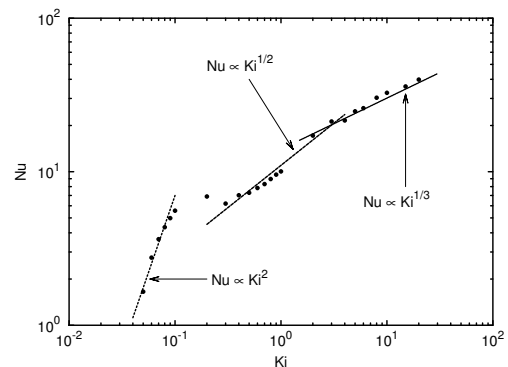
¹*Equipe Dynamique des Systèmes complexes, CNRS-Université de Provence, Marseille, France*

²*Kyoto University, Kyoto, Japan*

³*STAMIC/Osaka University, Osaka, Japan*

Anomalous heat transport caused by ion temperature gradient (ITG) driven turbulence in tokamak plasmas is evaluated from numerical simulations of the two dimensional (2D) partial-differential-equations (PDE) of the ITG model and of a reduced one-dimensional (1D) version derived from a quasilinear approximation. In the strongly turbulent state, intermittent bursts of thermal transport are observed in both cases. In the strongly turbulent regime, the reduced model as well as the direct numerical simulation (DNS) show that the Nusselt number Nu (normalized heat flux) scales with the normalized ion pressure gradient Ki as $Nu \propto Ki^{1/3}$ [1]. Since the Rayleigh number for ITG turbulence is proportional to Ki , the Nusselt number scaling for ITG turbulence is thus similar to the classical thermal transport scaling for Rayleigh-Bénard convections in neutral fluids.

The 18ODE low-degree-of freedom model for ITG modes[2], which contains only the most unstable mode and several low-order harmonics, can qualitatively accounts for the essential dynamics of nonlinear ITG driven turbulence also it fails to reproduce quantitatively correct anomalous transport, although the 1D model can reproduce the anomalous thermal transport scaling similar to that obtained from the full PDE model. These facts indicate that the generation of sheared mean flows due to the nonlinear evolution of toroidal ITG modes and suppression of the instabilities by such flows are largely determined by the dynamics and mode interactions in the radial direction.



References

- [1] K. Takeda, S. Benkadda, S. Hamaguchi and M. Wakatani, To be published in Phys. Plasmas **12**, (2005)
- [2] K. Takeda, S. Benkadda, S. Hamaguchi and M. Wakatani, Phys. Plasmas **11**, 3561 (2004)

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