On the Non-Equilibrium Distance from Thermal Equilibrium for Turbulent Plasmas

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Plasmas in nature and laboratories are often in the state, which is called far-from-thermal equilibrium. In employing the terminology 'far', one naively assumed that the 'distance' from thermal equilibrium is definable. The distance from thermal equilibrium, if it is quantified, is one of the essential parameters that specify the turbulent plasmas. In this research, efforts to identify the distance are discussed, by surveying the intensity of turbulence, transport properties, and dynamical relaxations.

In the history of study of turbulence, the parameters such as Reynolds number or Rayleigh number have played the central role that specifies the features of turbulence. These parameters are defined by the competition between the spatial inhomogeneity and dissipation due to microscopic processes. Similar argument holds for plasmas and an example of distance was discussed [1]. In plasmas, however, additional degrees of freedom in dynamics, i.e., the structure of velocity space must also be taken into account. The recent result on LHD clearly shows that the spatial inhomogeneities alone are insufficient [2]. The distance, which is defined in the parameters of velocity space, is introduced, and its relation with those in real space is also discussed [3].

The nonequilibrium feature is also described by the mixing of the time scales of macroscopic and microscopic dynamics. The Onsager's anstaz for the thermal equilibrium system is that the kinetic coefficients (e.g., viscosity, etc.) are independent of the scale of dynamics of interest. This naturally allows discriminating the micro- and macro- timescales. The cross-scale dynamics in multi-scale turbulence leads the mixing of time scales [4], and provides additional way to discuss the distance.

In this contribution, these aspects are explained with illumination of dynamics of turbulent transport of plasmas.

This work is partly supported by the Grant-in-Aids for Scientific Research (21224014, 23360414), and collaboration programmes of NIFS and RIAM Kyushu University. Discussions with Drs. S. Inagaki, Y. Kosuga, M. Lesur and A. Fujisawa are acknowledged.

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