A model of GAM intermittency near critical gradient in toroidal plasmas

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The transport near critical gradient is of great interest in understanding various transition dynamics such as L-H transition and the formation of internal transport barriers (ITBs) in magnetic fusion plasmas. Nonlinear up-shift of critical gradient of ion temperature gradient (ITG) mode, referred to the *Dimits shift*, due to the quench of turbulent fluctuation by self-generated zonal flows is one of typical examples [1]. Recently, the geodesic acoustic mode (GAM) has been extensively studied since it significantly changes the characteristics of zonal flows and then the transport [2]. In the Dimits shift regime, we have found a new type of transport intermittency through performing global Landau-fluid ITG turbulence simulations, which is originated from the emission and propagation of GAMs [3].

In this work, to qualitatively understand the GAM intermittency observed in the simulations, we have developed a minimum model to analyze the nonlinear interaction among the turbulent fluctuations, zonal flows, GAM dynamics, and ion sound wave. These physical quantities are represented by fluctuation energy *N*, zonal flow velocity *U*, anisotropic pressure perturbation $< p\sin\theta >$ and ion parallel sound velocity $< \upsilon_{//i}\cos\theta >$ in the model, respectively. Here $< \cdot >$ denotes the average over flux surface. This model has extended the conventional turbulence-zonal flow predator-prey system [4] to include the GAM and ion sound wave dynamics. It describes the same physical processes as those in the simulations, in terms of typical phases of the intermittency, *i.e*. the trigger, damping, and recursion. It is found that the model can well reproduce the accumulating process of zonal flow with residual mechanism. The trigger time scale of intermittency can be estimated as geometrical mean value between GAM damping rate and the linear growth rate. The recursion time scale is determined by GAM damping rate. Furthermore, we have examined comprehensive property of the model by investigating the behavior of solution trajectories around fixed points in four-dimensional phase space.

[1] A. M. Dimits et al., Phys. Plasmas **7**, 969 (2000).

[2] N. Miyato et al., Phys. Plasmas **11**, 5557 (2004).

[3] Y. Kishimoto and K. Miki et al., Proc. of the 21st IAEA Conference, IAEA-CN-149-PD-2, (2006).

[4] M. A. Malkov et al., Phys. Plasmas **8**, 5073 (2001).