Avalanches in magnetic fusion and their efficacy for the heat load problem

Y. Kosuga[1], R. Matsui[2], P. H. Diamond[3]
[1] Research Institute for Applied Mechanics, Kyushu University
[2] Interdisciplinary Graduate School of Engineering Sciences, Kyushu University
[3] University of California, San Diego
e-mail (speaker): kosuga@riam.kyushu-u.ac.jp

Self-organized criticality (SOC) is often observed in complex, non-equlirium systems. SOC is realized in a wide variety of contexts, including a sand pile, stock market, fluids and plasmas, etc[1]. In particular, the realization of SOC is reported in the context of magnetically confined plasmas[2], and its associated transport event, an avalanche, is thought to be a critical element to understand the confinement property of fusion plasmas. Avalanches in fusion plasmas are indeed observed in experiments, and their relation to the formation of an ExB staircase is also discussed[3]. Once triggered, avalanches propagate through the fusion plasma. Some of the events penetrate into the scrape off layer(SOL), a thin layer that surrounds the main plasma[4].

The fact that avalanches can penetrate into the SOL region poses several questions, in particular in relation to the heat load problem in fusion plasmas[5]. Here, the heat load problem is concerned with the amount of heat that is disposed of on a divertor plate (a plasma facing component). From an engineering point of view, this value needs to be lower than a typical value (it is usually 20 MW/m^2). While a broader SOL width is favorable for the heat load problem, a past study indicates that the SOL width would be too narrow in the future device such as ITER. However, more recently, it is found that turbulence may help the SOL width to broaden by penetrating into the SOL region[6]. In this context, it is of interest to seek for the role of avalanches in the heat load problem.

In this work, we report on the propagation feature of avalanches in magnetized plasmas. To do so, we have developed a simplified numerical code to solve 1D Burgers equation, including additional damping due to the parallel loss in the SOL region. As shown in Fig.1, a localized pulse is initiated plasmas, and its propagation is solved numerically. In the case shown

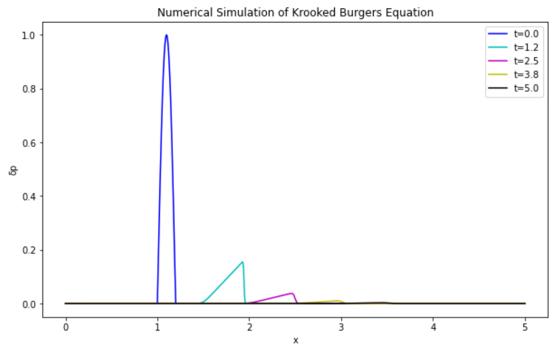

Fig1: Propagation of an avalanche pulse.

in Fig. 1, the pulse steepens to form a shock. Parameter survey on the shock formation is ongoing, and the results will be summarized in terms of the initial pulse parameters, including the strength and the width. These ultimately sets the spatial gradient of the initial pulse, a critical parameter for shock formation. Response to the stochastic boundary forcing will be discussed as well.

We thank F. Kin, S. Inagaki, T. Long, for stimulating discussion. This work is in part supported by Grants in Aids (KAKENHI) of JSPS, Japan (JP21H01066, JP23K200838), Joint Research Program of RIAM, Kyushu University.

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