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# Development of a numerical code for analyzing the propagation characteristics of fluctuations in fusion edge plasmas

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

Plasma control, stability, and material durability are key to achieving a commercial reactor. Regarding durability, the heat load issue of fusion plasmas [1] is related to the amount of heat released to the divertor plate (plasma-facing component). A wider scrape-off layer (SOL), a thin layer surrounding the main plasma, is more advantageous for this purpose. Fusion reactors have two plasma confinement modes. In L-mode, where turbulence propagation is active, confinement performance is reduced, but the penetration of turbulence into the SOL [2] widens the SOL width, mitigating heat concentration [3]. On the other hand, in H-mode, where a strong transport barrier [4] is formed, confinement performance is improved, but the narrowing of the SOL width poses a challenge for heat concentration. Under these circumstances, H-mode operation, which prioritizes confinement performance, is essential, but the suppression of turbulence poses a new challenge: the narrowing of the SOL width. It is interesting to explore the role of turbulence in the heat load issue.

In this study, we focus on the heat flux generated when turbulence generated in the core plasma leaks through the transport barrier and examine the contribution of this heat flux to transport.

The propagation characteristics of turbulent pulses localized within the SOL are evaluated using a computational model as shown in the schematic diagram in Figure 1. Turbulence propagation is expressed as the relationship between pressure fluctuation $\delta p$ and the distance $r$ from the plasma boundary, and the propagation characteristics are analyzed by applying the one-dimensional Damped Burgers equation [5], which takes turbulent propagation into account. This equation is expressed as follows:

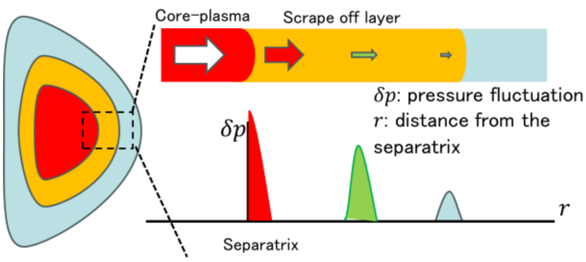


**Figure 1 Schematic of turbulence propagation in the SOL**

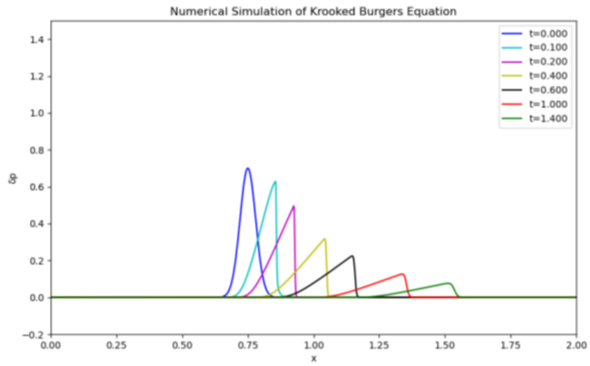


**Figure 2 Simulation result**

$$\frac{\partial}{\partial t}\delta p + v_D\frac{\partial}{\partial r}\delta p + \alpha\delta p\frac{\partial}{\partial r}\delta p - D_0\frac{\partial^2}{\partial r^2}\delta p + \frac{\delta p}{\tau} = 0 \qquad (1)$$

Here, $v_D$ is the magnetic drift velocity, $\alpha$ is a coefficient that determines the steepness of the pulse, $D_0$ is the diffusion coefficient, and $\tau$ is the damping coefficient.

In the case shown in Figure 2, the pulse becomes steeper during propagation, forming a shock wave. We are currently investigating the parameters that contribute to shock wave formation. Finally, we plan to determine the main parameters for shock wave formation and summarize them from the perspective of turbulence control.

References

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