§23. Dynamic Response of H-mode Transport Barrier and Giant ELMs

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The structure of the transport barrier was studied. The essential role of the shear viscosity to determine the radial extent of strong E_r was pointed out in the model of small and Frequent ELMs [1]. The model equation is formulated in a form of the time-dependent Ginzburg-Landau equation, such as

$$\frac{\partial Y_j}{\partial t} = N_j + \nabla D_j \nabla Y_j + S_j \qquad (1)$$

where Y_j stands for the plasma parameters (such as n, T or E_r), N_j stands for the nonlinear term which causes the bifurcation as is discussed in Ref.[1], D_j is the corresponding diffusion terms (such as viscosity, thermal conductivity) and S_j is the source term. The terms N and D are functional of Y. Equation (1) describes the dynamical structure of the transport barrier in the H-mode. The region, in which the transport coefficient takes intermediate value between those in L and H limits, appears. A simple estimate for the transport barrier thickness $\Delta_{barrier}$ is

$$\Delta_{barrier} \approx \sqrt{\hat{\rho}_p^2 + f_{tb}\frac{\mu_\perp}{v_i}} \qquad (2)$$

where $\hat{\rho}_p$ is the poloidal gyro radius modified by E_r', f_{tb} is a numerical coefficient of $O(1)$ and $\mu_\perp$ is the anomalous viscosity.

In addition to the spatial structure, the time scales of the events are discussed [2]: Three time scales are presented, i.e., the transition time, the cycle period, and the slow development time.

The limit cycle solution is predicted from Eq.(1). The cyclic behaviour is analyzed in connection with the dithering ELMs which appear near the threshold condition of the L-H transition [1]. A giant ELM is caused as a response of the pulsative increase of diffusivity D inside part of the transport barrier [2]. In Fig.1, the local enhancement of D is made in the region of -2 < x < -1, during the period of 5 < t < 6 where the length and time are normalized to ρ_p and ρ_p^2/D(in L-phase). The barrier width $\Delta_{barrier}$ is $\sqrt{2}$. Bird's eye view of the density profile development shows the local flattening inside the barrier (a). A giant pulsative outflux at the edge is shown as a function of time (b).
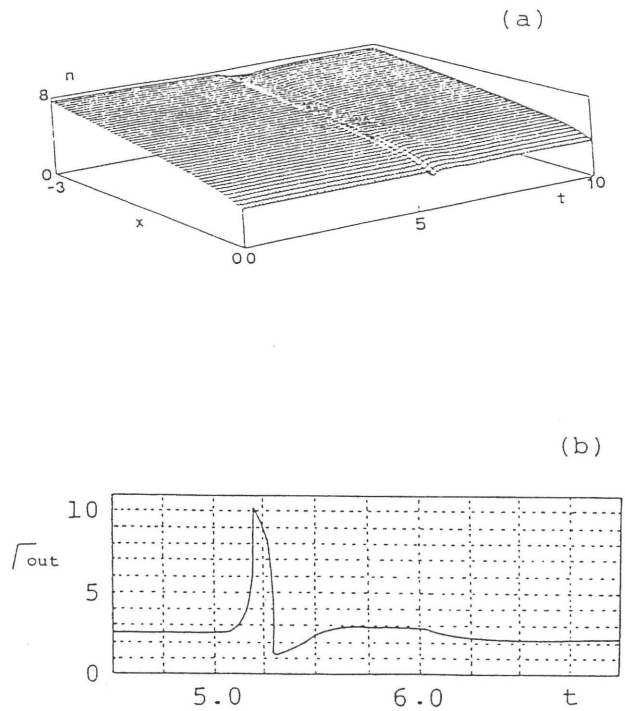

Fig.1 Model of Giant ELM. Evolutions of density (a) and outflux (b).

References

[1] Itoh S-I, Itoh K, Fukuyama A, Miura Y, et al. *Phys. Rev. Lett.* **67** (1991) 2485.
[2] Itoh S-I et al Nucl. Fusion 33 (1993) 1445.