§35. Double Hysteresis in L/H Transition and Compound Dithers

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The bifurcation theory of the radial electric field was presented for the L/H transition [1]. This model predicts the self-generated oscillation near the threshold condition for the transition [2], which was attributed to the model of dithering ELM. We have compared the impacts from the mechanisms of the bipolar losses, i.e., the loss cone loss, collisional bulk viscosity loss of ions and the anomalous loss, and found that these three could cause compound Dithers.

The model of bipolar flux driven by the three mechanisms is constructed. Both the radial electric field E_r and its shear E_r' are important for the H-mode physics. We represent E_r' as $E_r' = E_r/\ell$ and employ the constant-ℓ approximation for the analytic insight. The Poisson equation is rewritten as

$$\varepsilon_0 \varepsilon_\perp E_r = e\left(\Gamma^a_{e-i} - \Gamma^{lc}_i - \Gamma^{bv}_i\right) \qquad (1)$$

where Γ^a_{e-i} is the excess electron flux due to anomalous loss, Γ^{lc}_i is the ion loss cone loss, and Γ^{bv}_i is the bulk viscosity loss of ions. The details are shown in [3].

Equation (1) predicts the double hysteresis in the L/H transition. Figure 1 shows the dependence of the normalized particle flux on the thermodynamical force (gradient parameter $\lambda_p = -\rho_p(\nabla n/n + C\nabla T/T)$). The multiple bifurcation is demonstrated. If the anomalous loss is small, the contribution of the third term increases; the new hysteresis is generated combined with the other hysteresis.

The double hysteresis causes the compound dithers. Evolution of the plasma parameter and electric field is solved as in [2]. Figure 2 shows the time evolution of the loss flux. The periodic solution is obtained, and the two kinds of bursts are found to be put together. The compound dither is predicted theoretically.

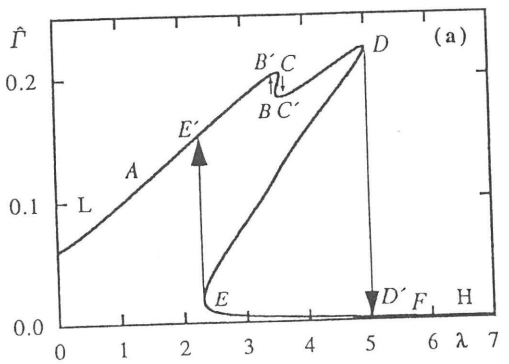

Fig.1 Double hysteresis is predicted for the gradient-flux relation and

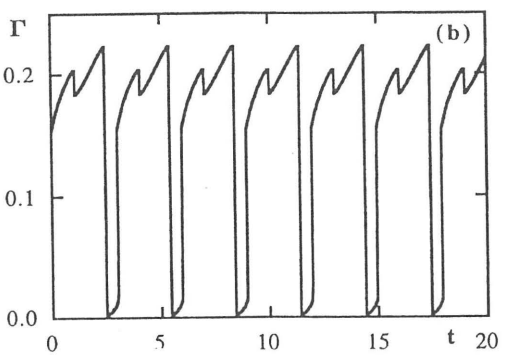

Fig.2 Time evolution of flux. Compound dither is predicted to appear.

1) S.-I. Itoh , et al., Phys. Rev. Lett. 60 (1988) 2276.
2) S.-I. Itoh, et al., Phys. Rev. Lett. 67 (1991) 2485.
3) S. Toda, et al., Research Report FURKU 95-09 (1995).