§2. Nonlinear Dynamics of LHD Plasma with RMP

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Nonlinear dynamics of the LHD plasma including resonant magnetic perturbation (RMP) is examined numerically¹⁾. The HINT2 code²⁾ and the MIPS code³⁾ are utilized for the equilibrium and the stability calculations, respectively. We employ the magnetic configuration with $R_a x = 3.6$ m and $\gamma_c = 1.13$. The equilibrium without any RMPs is unstable for the interchange mode resonant at the $\epsilon = 1$ surface.

Here we impose the horizontally uniform magnetic perturbation. This magnetic perturbation is resonant at the $\ell = 1$ surface and generates an m = 1/n = 1 magnetic island in the equilibrium magnetic surfaces. The equilibrium pressure profile is locally flat at the O-point of the magnetic island while the profile is still steep at the X-point. Because of this deformation of the pressure profile, the pressure driven mode localized around the X-point dominantly grows. In the nonlinear phase, the pressure collapse starts at the X-point and spreads to the core region, as shown in Fig.1. The magnetic surfaces are also destroyed from the X-point.

Since the mode is destabilized at the X-point, the spatial phase of the collapse should be fixed to that of the island geometry. The confirmation of this property is shown in Fig.2. We employ the initial perturbations \tilde{X} which has the ϕ -dependence as $\tilde{X} = \text{Rnd}(\phi) \cos(\phi - \phi_0)$, where $\text{Rnd}(\phi)$ means a random function of ϕ and ϕ_0 is an initial toroidal phase. The pressure contours at the cross sections and the constant pressure surface show the same phase for the different initial phases of $\phi_0 = 0$ and $\phi_0 = \pi/2$. These results indicate that the collapse phase is independent of the initial phase. The fixed phase of the collapse corresponding to this result is observed in the LHD experiments ⁴.

- K. Ichiguchi, et al., Proc. IAEA-FEC 2014, St.Petersburg, Russia, TH/6-2.
- 2) Y. Suzuki, et al., 2006 Nucl. Fusion 46 L19.
- 3) Y. Todo, et al., 2010 Plasma and Fusion Res. 5 S2062.
- 4) S. Sakakibara, et al., 2013 Nucl. Fusion 53 043010.





Fig.1 Nonlinear evolution of the total pressure (left) and the magnetic field (right).



Fig.2 Pressure surface of $\beta = 3.0\%$ and pressure contour at the cross section in the half torus at $t = 900\tau_A$ in the case with the RMP for the initial angles of $\phi_0 = 0$ (left) and $\phi_0 = \pi/2$ (right). The cross sections are enlarged into twice.