§25. Study of MHD Activity Driven by Plasma Current in LHD

Okamoto, M. (Ishikawa National College of Technology),
Watanabe, K.Y.

The magnetohydrodynamic (MHD) stability behavior of toroidal magnetic confinement devices is important to maintain the steady state discharge. In the Large Helical Device (LHD), various MHD phenomena have been reported[1, 2]. For example, the interchange mode of m/n = 1/1 is observed in the weak magnetic shear configuration. Furthermore, when the plasma current of the opposite direction to the toroidal magnetic field is induced by NB injection, the electron temperature fluctuations are appeared in the core region by injection of supersonic gas puffing (SSGP) and the tearing-like mode structure of m/n= 2/1 is measured by electron cyclotron emission (ECE) diagnostics like Fig.1[3]. However, in the calculation for MHD stability analysis, it is found that the tearing mode becomes unstable if the plasma current is higher than above experiment condition. In this study, we investigate the linear growth rate by using MHD equations described in cylindrical coordinates to clarify the appearance condition of electron temperature fluctuation.

Figure 1 shows the temporal evolution of the electron temperature measured by ECE diagnostics with SSGP injection. The injection time of SSGP is t = 2.8 sec and the electron temperature fluctuation is observed after at t = 2.85 sec. In order to calculate the liner growth rate of m/n= 2/1 mode, we use the electron density and temperature profile measured by Thomson scattering system at t = 2.866 sec and the rotational transform profile $\iota/2\pi$ evaluated by VMEC code[4]. In Fig.2, solid line shows the profile of $\iota/2\pi$ calculated by VMEC and the liner growth late is estimated by using $\iota/2\pi$ profile of dashed line. When $\iota/2\pi$ profile is calculated, the current density profile is assumed by following equation,

$$j(\rho) = (j_0 - j_v) \times (1-\rho^2)^p + j_v$$

where j_0 and j_v are current density at the center and vacuum region and p is peaking factor of current profile. The perturbed component profiles of stream function of first and second eigenfunction around $\iota/2\pi = 0.5$ resonant surface is shown in Fig. 3. We define that the first and second eigenfunction correspond to the largest and second largest growth rates. The profile of first eigenfunction has even structure and the second eigenfunction has odd structure. It was reported that the magnetic island is formed at resonant surface by tearing instability when the perturbed steam function has odd structure[5]. Therefore, it is considered that the electron temperature fluctuation is caused by the second eigenfunction.

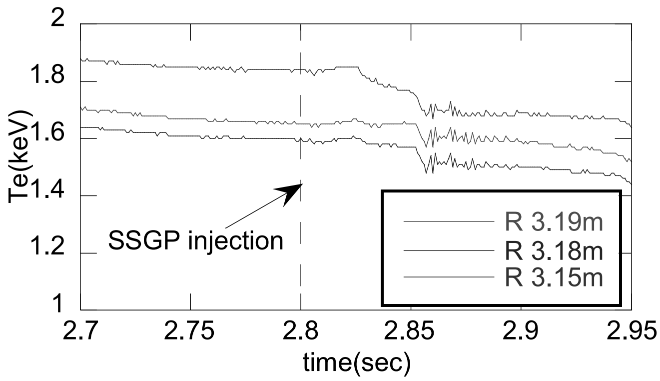

Fig. 1. Temporal evolution of electron temperature measured by ECE around SSGP injection time in #94655.

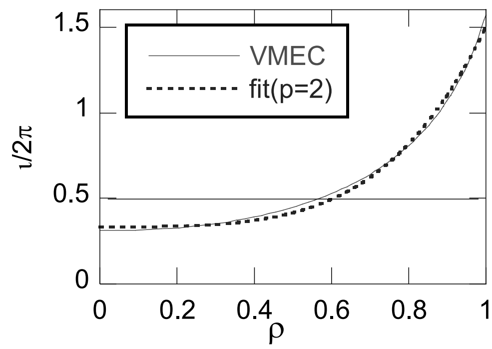

Fig. 2. The rotational transform profile at t = 2.866 sec in # 94655.

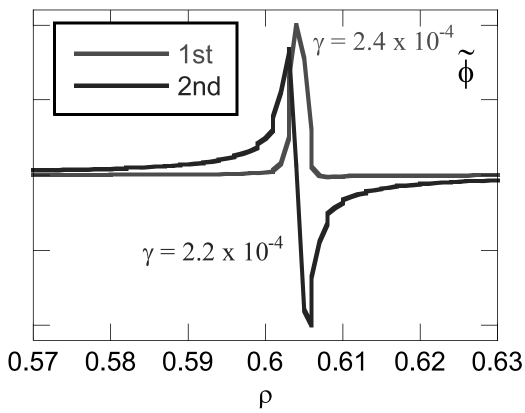

Fig. 3. Perturbation profiles of stream function ϕ of first and second eigenfunction at p = 2.

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3) Murakami, A. et al.: Plasma Fusion Res. **6** (2011) 1402135.
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