§14. Study of MHD Fluctuation with Tearing-Like Mode Structure in LHD

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The fundamental physics understanding of magnetohydrodynamic (MHD) stability behavior is important in the toroidal magnetic confinement devices. In the Large Helical Device (LHD), various MHD activities have been reported[1, 2]. For example, the interchange mode is appeared 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 is measured by electron cyclotron emission (ECE) diagnostics like Fig.1[3]. It is suggested that the fluctuation is caused by m/n= 2/1 tearing mode. However, in the calculation for stability analysis, it is found that the tearing mode becomes unstable if the plasma current is higher than above experiment. In this study, we investigate the relation between current profile and linear growth rate at appearance of electron temperature fluctuation by using MHD equations described in cylindrical coordinates.

Figure 1 shows the temporal evolution of the electorn 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 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] without plasma current. The current density profile is used 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. Figure 2 shows the growth rate of the first and second eigenfunction. The first and second eigenfunction correspond to the largest and second largest growth rates. From Fig.2, the growth rate is decreased with the increasing of peaking factor p because the magnetic shear around the resonant surface becomes large. 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. 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 when the perturbed steam function has odd structure[5]. Therefore, it is considered that the electron temperature fluctuation is caused by the second eigenfunction.

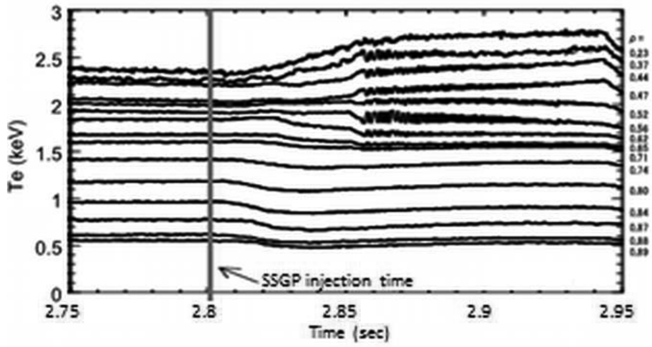

Fig. 1. Temporal evolution of electron temperature around SSGP injection time in #94655.

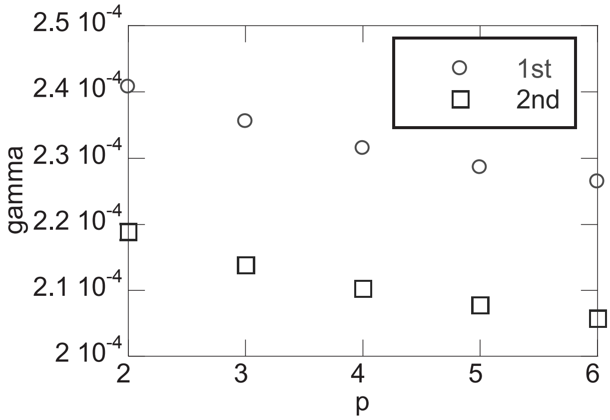

Fig. 2. Relation between current density profile and linear growth rates of first and second eigenfunction at t = 2.866 sec in # 94655.

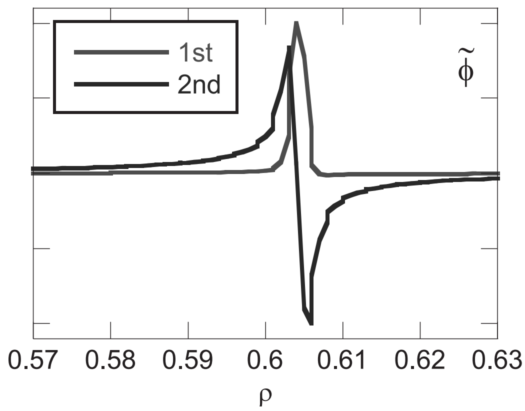

Fig. 3. Perturbation profiles of stream function ϕ of first and second eigenfunction at p = 2.

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