§20. Ideal MHD Analysis in LHD Plasma at Peripheral Region

Narushima, Y., Watanabe, K.Y., Sakakibara, S., Yamazaki, K.,
Cooper, A. (CRPP Lausanne, Switzerland)

The low-n ideal MHD analysis is performed to the LHD plasma using TERPSICHORE code[1]. TERPSICHORE code calculates the stability of low-n ideal MHD mode with 3-D equilibrium. Here, the behavior in a peripheral region of the LHD plasma is discussed.

Figure.1 contains the calculated result(circle) and experiment data(triangle). The opened and closed circles indicate the stable and unstable points respectively. The solid line and the dotted line show the Mercier criterion D_I=0 and the reference domain of low-n instability respectively.

The gradient of $d\beta/d\rho$ is the value in a certain fixed radial position, because it is easy to compare the calculated result to experimental result. In Fig.1(a) and (b), the position are ρ=0.7 and ρ=0.9 respectively. In LHD plasma, these positions correspond to the resonance surface of $\iota/2\pi$=0.67 (n/m=2/3) and $\iota/2\pi$=1.0 (n/m=1/1).

In case of ρ=0.7 (Fig.1(a)), the region of $d\beta/d\rho$>0.02 is the Mercier unstable region. The low-n unstable domain lies in the region around $\langle\beta\rangle$>2.0%. The experimental data of mostly half is contained in the Mercier unstable domain. However, these do not enter the low-n unstable region.

In case of ρ=0.9 (Fig.1(b)), there is the Mercier unstable region around $\langle\beta\rangle$>2% and $d\beta/d\rho$>0.04. The low-n unstable domain lies in the region around $\langle\beta\rangle$>2.0%. The calculated data around $\langle\beta\rangle$>2.0% and 0.03<$d\beta/d\rho$<0.04 are unstable for low-n mode. These unstable modes appear in the situation of the free boundary condition and more detailed study is needed.

Almost experimental data stay within the Mercier stable domain. However, these do not enter the low-n unstable region. As the beta goes up, the pressure gradient of experimental data linearly increases.

As beta goes up, the resonant surface $\iota/2\pi$=1.0 moves outward and disappears finally. At this situation, TERPSICHORE code produces the result of the existence of the external mode. However, this external mode without the resonance surface calculated by TERPSICHORE is ignored because its characteristic is different from the internal mode.

In case of peripheral region, low beta and low gradient region is stable to low-n mode. The low-n unstable appears in the high beta region. It is thought that if the beta increases, with a pressure form maintained, the LHD plasma will be in the unstable region to both of Mercier and low-n mode, and this is a different behavior from the core (ρ=0.5) region. It is necessary to control the pressure profile in a peripheral area for higher beta LHD plasma.

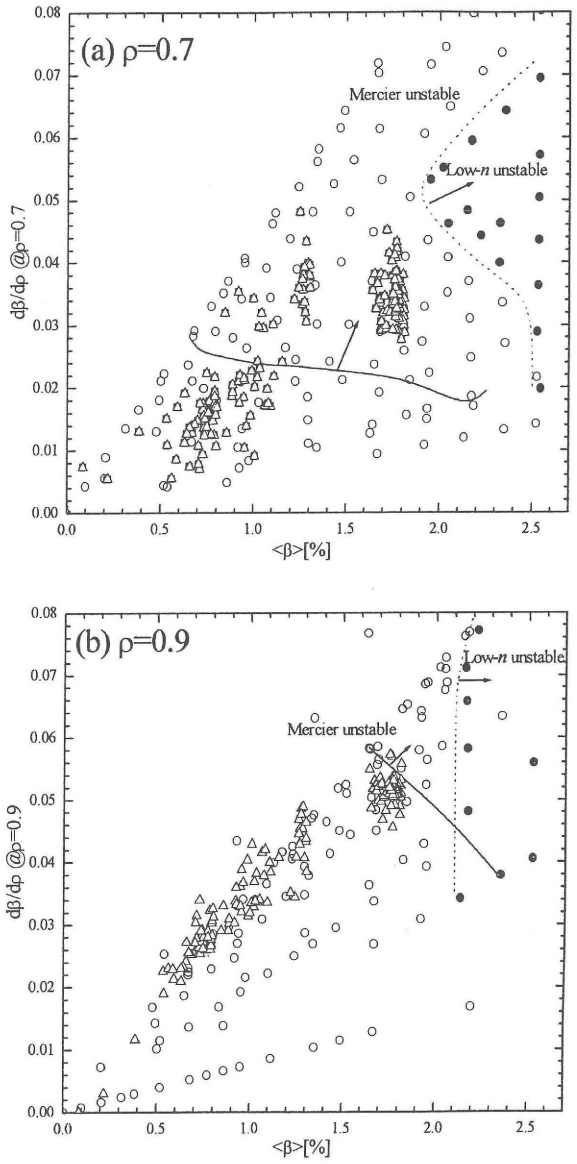

Fig. 1: Relation between the volume averaged beta and the pressure gradient at ρ =(a)0.7 and (b)0.9

Reference

1) W. A. Cooper, Plasma phys. and Controlled Fusion 34, (1992) 1011