§3. Heavy Ion Beam Diagnostic of MHD Instabilities in the Compact Helical System

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In the Compact Helical System (CHS), magnetic fluctuations have been studied by the use of poloidal and toroidal arrays of magnetic probes. It has been found that the fluctuation modes depend on magnetic configuration, beta value, direction of beam induced current during NBI heating (which can change the magnetic shear), and so on. Among these fluctuations, periodic, burst type m/n=2/1 (m: poloidal mode number, n: toroidal mode number) modes observed in a low-β, NBI (co-injected) plasma have shown the strongest activity.

The CHS HIBP has been applied to measure the local space potential fluctuation during burst-type MHD activities in a low beta NBI plasma[1]. However, beams passing through the plasma suffer various effects from plasma itself. It is called path integral effect. Plasma potential measurement is generally considered not to be influenced by the path integral effect because of its diagnostic principle. However, in the presence of MHD fluctuations, beam acceleration (or deceleration) may occur due to the magnetic field fluctuation and may change the beam energy. Actually fluctuations of vector potential **A** associated with low-m tearing modes have been observed as a toroidal displacement of the secondary beam at the detector position in the TEXT tokamak. In tokamaks, beam trajectories are basically in the poloidal plane and the fluctuating part of the vector potential is dominated by the toroidal component. Then the path integral term is negligible. Unfortunately in HIBP for helical devices, the beam travels a certain distance in the toroidal direction and the path integral term should not necessarily be neglected.

In order to calculate the path integral term, it is necessary to know the detailed spatial structure of the vector potential, both on inside and outside of the plasma. It is not easy to measure it directly by HIBP in the real CHS configuration because of its non-axis-symmetry of the torus. In this study, a model vector potential for a cylindrical plasma column is assumed through theoretical and experimental approaches. Firstly, a simple spatial structure of the vector potential in the plasma is assumed based on an interchange mode theory and the contribution of the path integral term is evaluated for it. Here we take a fixed boundary plasma model and the vector potential outside the plasma is neglected. Next we have estimated the vector potential outside plasma from the magnetic probe data. For plasma inside we assume a simple but reasonable profile compatible with m=2 mode structure, where the vector potentail has a peak at q=2 surface with monotonically decreasing toward the plasma center and smoothly connecting to the profile of plasma outside. Then based on these model calculations and experimental results of the spatial profile of the normalized top-bottom difference signal, we have estimated again the path integral term inside plasma more realistically.

Taking those effects into account, the radial structures of space potential fluctuations during the m/n = 2/1 burst type MHD oscillation in a low beta NBI plasma has been clarified(Fig. 1).

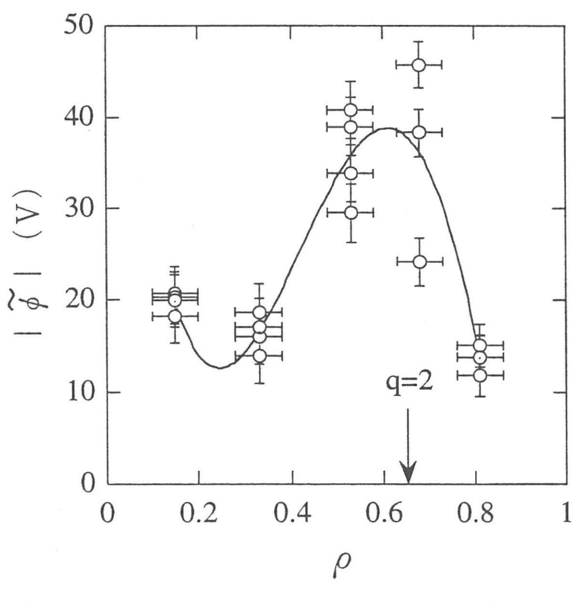

Fig. 1. Radial structure of potential fluctuations during the m/n=2/1 MHD burst mode.

Reference

[1] Crowley, T. P. et al., Annual Report of National Institute for Fusion Science, (1995-1996)235.