§18. Determination of Mode Numbers of TAE with Movable Magnetic Probe Array

Takechi M., Matsunaga G.,
(Dep. Energy Eng. Science, Nagoya Univ.)
Toi K., CHS Group

We observed relatively high frequency magnetic fluctuations with high coherence in co-injected NBI heated plasmas in CHS. The observed frequencies change in proportion to the Alfven velocity. The mode amplitude obviously increases with the increase in NBI power. Therefore these observed magnetic fluctuations are thought to be the TAE driven by energetic ions of NBI[1]. In order to study these magnetic fluctuations more in detail, the movable magnetic probe array was inserted into the plasma up to the radial position of $\langle r\rangle/\langle a\rangle \sim 0.8$[2].

Figure 1 shows an typical example of the power spectral density of the TAE magnetic fluctuations. Usual Mirnov probes show that the poloidal and toroidal modes of these two fluctuations are different,that is, n=1 for the lower frequency component and n=2 for the higher one. However, we cannot distinguish the toroidal number n from the number which 8 added to n makes, that is, n+8, because four probes are arranged in the toroidal direction every 45 degrees. On the other hand, the poloidal mode numbers for the lower and higher frequency components are determined to be $m\sim2$ and $m\sim4$, respectively, from the poloidal array of Mirnov probes, where it is assumed to be $m<20$.

We have calculated the Alfven continua in a cylindrical plasma for this experimental condition. If the lower frequency component has the toroidal mode number n=1 and poloidal mode number $m\sim2$, this component corresponds to the TAE excited around the gap generated through m=2 and m=3 mode coupling,. On the other hand, if this component has toroidal mode number n=9, the TAE will be produced through poloidal mode coupling of modes with higher mode number of $m>20$.

The poloidal magnetic fluctuations having the poloidal mode number m exhibit the following radial variation outside the LCFS where it is assumed to be current-free,

$$B\theta m = mA_m r^{-(m+1)}[1+(r/b)^{2m}],$$

where b is the radius of a conducting wall. The radial profile of the observed magnetic fluctuations is shown in Fig.2, together with the predicted radial variations for m=2, 4 and 22. In the region outside LCFS the profile of lower frequency component fits well with the calculated variations of m=2 mode and higher one does for m=4. Radial variations of both fluctuations, however, deviate considerably from the variations of m=22 mode. Taken into account mode coupling in TAE as discussed above, the toroidal mode numbers of the lower and higher components are identified to be 1 and 2, respectively.

The mode numbers of the observed TAE are successfully determined by combination of the radial profiles of fluctuations obtained with the movable probe array and a set of poloidal and toroidal array of Mirnov probes.

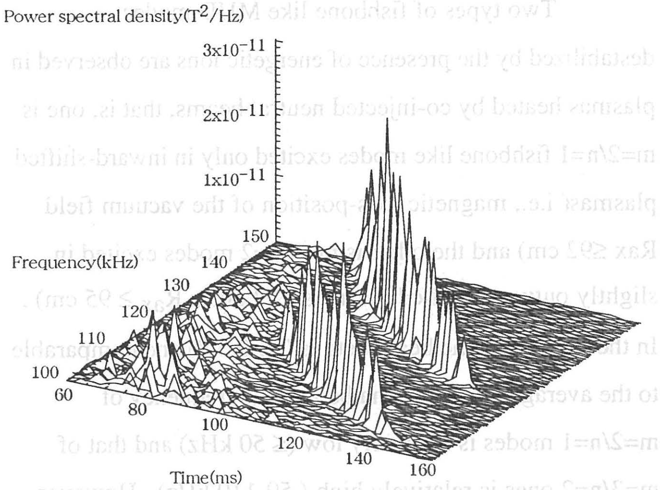

Fig. 1 An example of the power spectral density of the TAE magnetic fluctuations,.

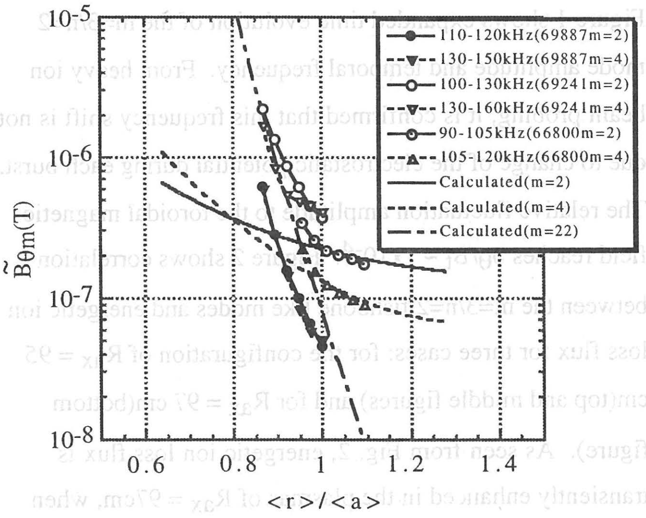

Fig. 2 Radial variations of the TAE magnetic fluctuations. The curves without data points indicate the calculated radial variations for m=2, 4 and 22, respectively.

Reference

[1] Takechi M., Toi K., et. all, Journal of Plasma and Fusion Reserch Vol.1 (1998) 270

[2] Takechi M., Toi K., et. all, to be published in RSI