§19. Experiment of Alfvén Eigenmodes Excitation by External Antennas

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

In a thermonuclear reactor, the fast ions such as fusion generated alpha particles can resonate with shear Alfvén waves. These modes are called Alfvén Eigenmodes (AEs). It is theoretically predicted that fusion alpha particles loss is enhanced if these AEs become unstable, and consequently prevent ignition. Typical AEs in a toroidal plasma are the global Alfvén Eigenmodes (GAEs) and the toroidicity-Induced Alfven Eigenmodes (TAEs), where the former is excited without the toroidal effect and the latter with the toroidal effect. It is necessary to clarify excitation and damping mechanisms of these modes experimentally. Experimental studies on these AEs have been carried out by using energetic particles generated by NBI or ICRF heating in tokamaks. But in this cases these mechanisms are complicated, because damping and driving effects by the bulk plasma and by the fast ions, respectively, are mixed. Accordingly, damping effects only must be evaluated.

For this reason, we preform the direct excitation of AEs using half-turn loop antennas in an ECH heated plasma without fast ions in the heliotron / torsatron device CHS. Four antennas are arranged in the toroidal direction to determine the toroidal mode number. The AC current in the range of 10~250kHz is fed to the antennas. Magnetic fluctuations are detected by fast magnetic probes distributed in the toroidal direction.

Experiments of AEs excitation have been carried out in two cases. In the first case, the excitation frequency is fixed at 150kHz. In the second case the frequency is swept from 250kHz to 50kHz, of which frequency range is chosen to be close to the predicted AEs. Figure 1 shows magnetic fluctuations in the first case. In a plasma shot, poloidal field fluctuations are enhanced as $\tilde{b}_r < \tilde{b}_\phi < \tilde{b}_\theta$, while $\tilde{b}_r < \tilde{b}_\phi \approx \tilde{b}_\theta$ without the plasma. These results show a possibility that shear Alfvén waves are excited. As shown in Figure 2, magnetic fluctuations exhibit two peaks when the frequency of the antennas current is swept from 250kHz to 50kHz. At around 32ms toroidal mode number is n=1,expect at this time n=2. If these magnetic fluctuations are concerned with the GAEs of n/m=1/3 and TAE of n/m,m+1=2/4,5 these might be excited. In future, these modes will be identified by poloidal mode analysis.

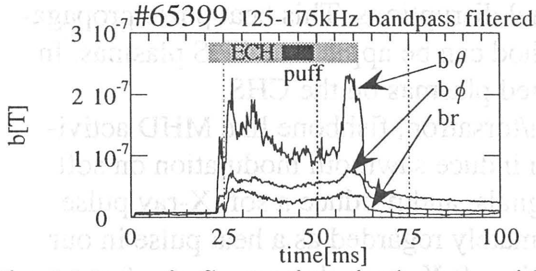

Fig. 1 Magnetic fluctuations in the case with fixed excitation frequency (150kHz), D_2, $Rax = 0.995m$, $B = 0.9T$ and $\bar{n}_e \approx 5\times10^{18} m^{-3}$.

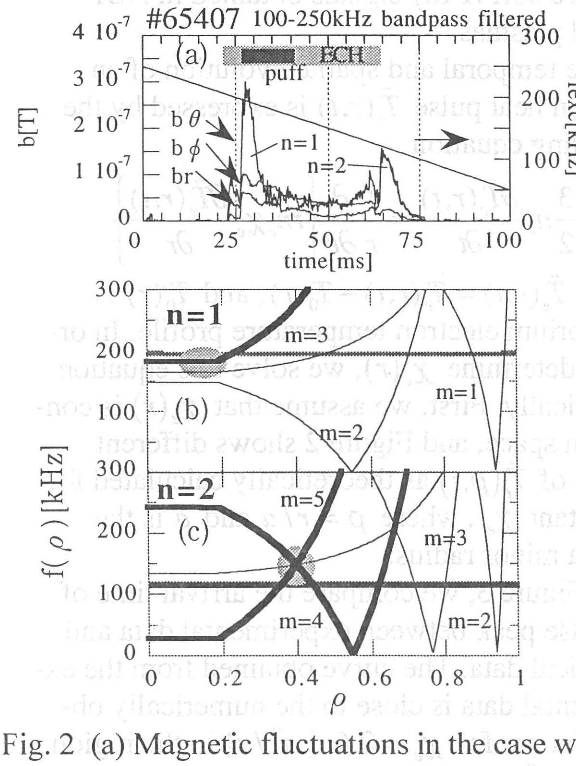

Fig. 2 (a) Magnetic fluctuations in the case when the frequency is swept from 250kHz to 50kHz, D_2, $Rax = 0.995m$, $B = 0.9T$. (b) Alfvén continuum of n=1 in a cylindrical geometry at $\bar{n}_e \approx 6\times10^{18} m^{-3}$. (c) Alfvén continuum of n=2 at $\bar{n}_e \approx 9\times10^{18} m^{-3}$.