§73. Excitation of High Frequency Fluctuations and Their Effects on High Energy Ions in LHD

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When a magnetized plasma has a temperature anisotropy, various fluctuations (or waves) can be excited spontaneously. For examples, Alfven ion cyclotron (AIC) waves are observed when high energy ions are confined in a mirror plasma and ion cyclotron emissions (ICE) can be observed in Tokamaks associated with the injection of high energy neutral beams (NB). Alfven eigen modes (AEs) are also observed with NB injection in many fusion oriented devices including LHD[1]. The production of high energy ions with ICH can also excite these fluctuations. Investigating these fluctuations is important because they affect the fusion reaction rate and as a result the neutron yield degrades.

Here, magnetic probes (MP) are employed to observe these high frequency fluctuations excited with NB injection or high power ICH injection in LHD. Signals from MPs were recorded by an oscilloscope (250Ms/s) with long memories in a sequence mode. So far, fluctuations were observed in NB sustained plasmas with various magnetic field strength ranging from 1.0 to 2.8 T. An example is shown in Fig.1 when B = 2.75 T. Shown in Fig.1 (a) is the plasma density as a function of time. A feature of the observed fluctuations is that they are observed at relatively low density (< 10^{19} m^{-3}). In Fig.1 (b), the time evolution of FFT power spectrum obtained from a MP signal is plotted. The darker tone has the higher power. An example of FFT power spectrum is plotted in Fig.1 (c) at t = 0.92 sec. It is clearly seen that fluctuations are excited much stronger than the noise level.

Accumulating these fluctuation signals at various field strengths B and plasma densities n_e, it was found that the frequencies of observed fluctuations are proportional to B and $n_e^{-1/2}$ as shown in Fig.1 (d). Since the Alfven velocity V_A is given by

$$V_A = 2\pi f_A / k = B / (\mu \, n_e \, m)^{1/2} \qquad (1)$$

and the observed fluctuations are discretely excited, it is suggested that these fluctuations are the AEs. Here, k is the unknown wave number, μ is the permeability and m denotes the ion mass. As far as the AEs in LHD are concerned, it was found that the AEs can be excited at much higher frequency and higher magnetic field than reported before.

Since AEs are related with the behavior of high energy ions in plasmas, the details should be investigated more in conjunction with other high frequency fluctuations.

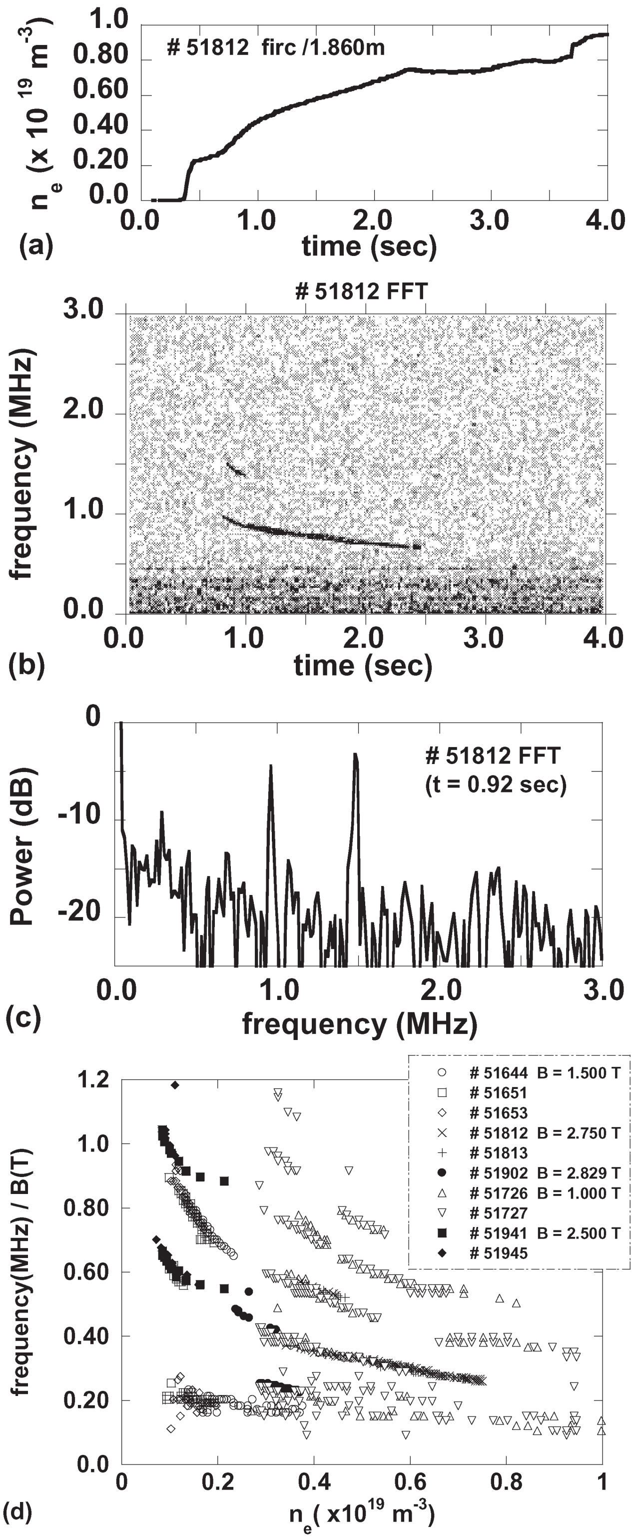

Fig. 1. (a) A plasma density as a function of time. (b) A time evolution of FFT power spectrum. (c) An example of FFT power spectrum at t = 0.92 sec. (d) Frequencies of the fluctuations normalized by the field strength are plotted as a function of plasma density.

Reference

1) S.Yamamoto, K.Toi, N.Nakajima, et.al., Phys. Rev. Lett. **91** (2003) 245001