§6. Spontaneous Excitation of Ion Cyclotron Range of Frequency Waves in GAMMA 10

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In magnetically confined plasmas, fluctuations in the ion cyclotron range of frequency (ICRF) will be driven by the presence of non-thermal ion energy distribution. Also in the low frequency region, so-called Global Alfvén Eigenmodes (GAE) have been observed in many large tokamak experiments. Recently, higher frequency Alfvén Eigenmodes (0.5 ~ 2.5 MHz) have been reported in LHD [1]. In a typical discharge on the GAMMA 10 tandem mirror, Alfvén-ion-cyclotron (AIC) modes are spontaneously excited due to strong temperature anisotropy. And also, low frequency magnetic fluctuations have been observed at the same time. In 2006, we refocused on these low frequency modes.

On the other hand, in burning plasma experiments on JET and TFTR, fusion-product (FP) ions will form the non-thermal ion energy distribution in the bulk plasma and the ion cyclotron emissions (ICEs) have been observed. To study the relation among these high frequency fluctuations (AIC-modes, beam-driven electrostatic instabilities, ICEs, and GAEs) in the magnetically confined plasmas with non-thermal energy distribution is the main purpose of this work.

In GAMMA 10, low frequency fluctuations associated with excitation of AIC modes are sometimes observed in the range below 1 MHz. The frequency of the fluctuation is just the difference between frequencies of applied ICRF (6.36MHz) and AIC modes. Figure 1 shows FFT spectra of the magnetic probe signal in the low frequency region below 1 MHz. Fluctuations observed in the range of 600 ~ 800 kHz are identified to be fluctuations with differential frequencies. In Fig.2, the power of the excited waves is shown as a function of the diamagnetism. It is clearly seen that the low frequency waves are strongly excited when the diamagnetism exceeds a certain level of 8 x 10^{-5} Wb. The parametric decay process of the applied ICRF waves to AIC modes and these low frequency magnetic fluctuations is considered to be essential for these observations.

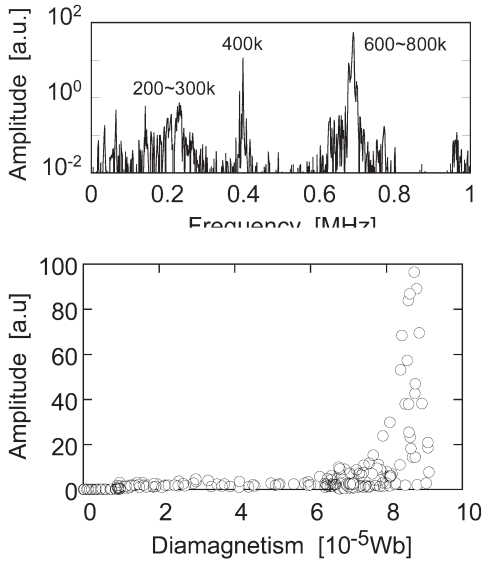

Fig.2 The amplitude of the low frequency fluctuations as a function of diamagnetism.

To study ICEs, the dispersion relation of the bulk plasma with a small fraction of FP-ions has been evaluated. Figure 3 shows the dispersion relations of deuterium plasmas with (a) ^{3}He and (b) T ions. As shown in Fig. 3(a), the fast wave branch of bulk D plasmas crosses the branch of Ion Bernstein Wave (IBW) due to ^{3}He-ions near the cyclotron frequency of ^{3}He-ions. The fast waves in deuterium plasmas are destabilized due to IBW coupled with high-energy fusion-product ^{3}He-ions. On the other hand, new cut-off and hybrid-resonance appear below the fundamental cyclotron frequency as shown in Fig. 3(b). The slow wave branch of bulk D plasmas couples with IBW due to T ions. The precise evaluation of effects of FP-ions to bulk plasma is now proceeding.

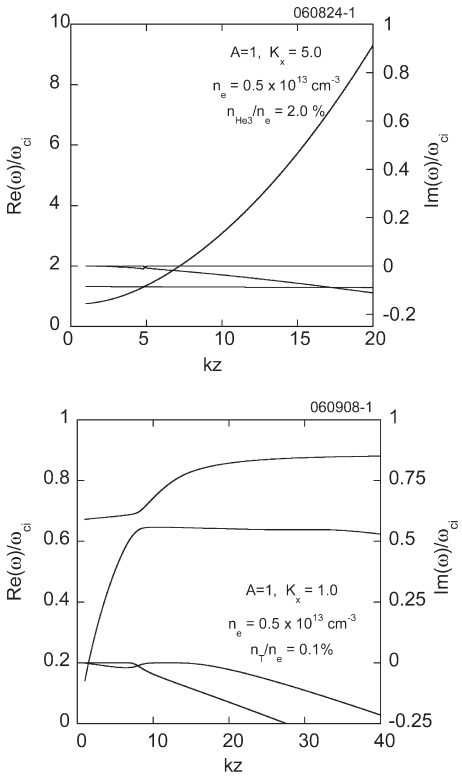

Fig.3 Dispersion relation of deuterium plasma with a small fraction of (a) ^{3}He and (b) T-ions.

REFERENCE

[1] Higaki, H., Plasma Fusion Res., 1, 034 (2006)