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

Ichimura, M., Yamaguchi, Y., Sato, S.
(Univ. Tsukuba),
Kumazawa, R.

In magnetically confined plasmas, spontaneously excited waves in the ion cyclotron range of frequency (ICRF) will be driven due to the presence of non-thermal ion distribution and the temperature anisotropy. In a typical discharge on the GAMMA 10 tandem mirror, Alfvén-ion-cyclotron (AIC) modes are spontaneously excited due to the strong temperature anisotropy[1]. The waves including ICRF waves for plasma production and heating interact strongly with each other in the plasma. Low-frequency (LF) magnetic fluctuations with beat frequencies between the heating ICRF waves and discrete peaks of the AIC modes are clearly detected in GAMMA 10[2]. In this research, the parametric decay of the heating ICRF waves is discussed.

ICRF waves are used for the plasma production and heating in GAMMA 10. Ion temperature in the range of several keV has been achieved in the relatively low density plasmas around 2×10^{18} m^{-3}. In such high power ICRF experiments, plasmas with the strong temperature anisotropy are produced when the cyclotron resonance layer exists near the midplane of the central cell. Figure 1(a) shows the frequency spectrum of the magnetic probe signal in the range from 5.5 to 6.5MHz. Figure 1(b) is the intensity plot of the time evolution of frequency peaks. A frequency of 6.36MHz in the figure is an applied frequency of the heating ICRF wave and magnetic fluctuations with frequencies just below the heating wave are spontaneously excited AIC modes. The AIC modes have several discrete peaks as shown in Fig.1.

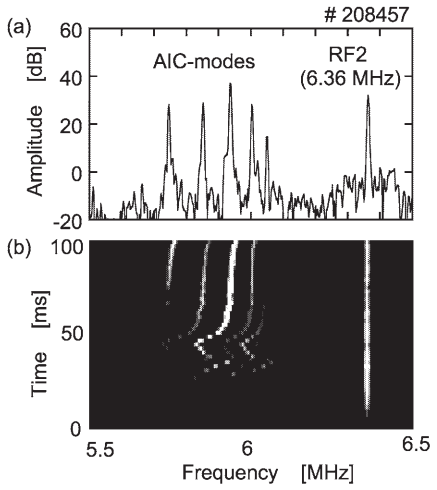

Fig.1 (a) Frequency spectrum of the signal of a magnetic probe and (b) intensity plot of the temporal evolution of the frequency spectrum. The intensity of the mode is represented by the shade of brightness.

In 2007, low-frequency (LF) waves which have differential frequencies between the heating ICRF waves and the AIC modes have been measured and the spatial structures (in the azimuthal direction) of these modes are evaluated for discussing the parametric decay of the heating ICRF waves to the AIC modes and the LF waves. In 2008, the spatial structure in the axial direction is discussed. A magnetic probe is located at the position of 0.78 m from the azimuthal probe array (z = 0.33 m). By using these two probes arrayed on the same magnetic field line, the axial structure of the excited modes is evaluated. Figure 2 shows frequencies of detected waves as a function of the phase difference between two probes. In Fig. 2(a), measured phase differences of RF2 and the AIC modes are indicated. It is noted that the phase difference of RF2 is almost π. Because the same frequency of 6.36 MHz is used to both east and west DHT antennas, fast waves which can propagate in the central cell have interference with each other and form the standing waves. The phase difference between two probes in the standing wave region is considered to be detected as π or 0. Then, the phase difference of π on RF2 is consistent with the standing wave formation. In the previous paper[3], it has been reported that the AIC modes are formed as standing waves near the midplane of the central cell and propagate outside the standing wave region. As shown in Fig. 2(a), the phase differences of the AIC modes are almost π or 0, except for a peak with the highest frequency. Figure 2(b) shows the phase differences for the LF waves. Now, the parameter dependences of the phase difference between two probes are under investigation.

1) Ichimura, M., *et al.*, Phys. Rev. Lett. **70**, 2734 (1993).
2) Ichimura, M., *et al.*, International Congress on Plasma Physics 2008, Fukuoka, 2008, Sep. 8-12, P2-132.
3) Katsumata, R., *et al.*, Phys. of Plasmas, **3**, 4489 (1996).

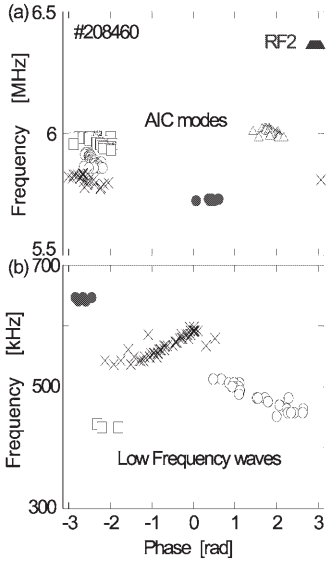

Fig.2 Axial mode structures of (a) RF2 and the AIC modes and (b) the LF waves. Symbols of AIC modes and LF waves in the figure indicate discrete peaks and correspond to each other.