View metadata, citation and similar papers at core.ac.uk
brought to you by CORE
provided by National Institute for Fusion Science (NIFS-Repository)

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

Higaki, H., Kakimoto, S., Yamaguchi, Y., Ichimura, M. (Univ. Tsukuba),
Kumazawa, R., Watari, T., Mutoh, T., Seki, T., Saito, K.

When a magnetized plasma has an anisotropy in its velocity distribution function, various fluctuations (or waves) can be excited spontaneously. For examples, Alfven ion cyclotron waves are observed when high energy ions are confined in a mirror plasma [1] and ion cyclotron emissions can be observed in Tokamaks associated with the fusion products [2] and/or the high energy neutral beam injection (NBI) [3]. The production of high energy ions with Ion Cyclotron Heating (ICH) can also excite these fluctuations [4]. It is quite natural that these high frequency fluctuations to be observed in helical systems. Investigating these fluctuations is important because they are affected by the fusion reaction rate, high energy ions and edge localized modes.

To estimate if such a high frequency fluctuations around the ion cyclotron frequency can be excited in plasmas, the dispersion relation of an infinitely long uniform density plasma with a temperature anisotropy was considered as a first step. Shown in Fig.1 is the calculated contour plot of the growth rate for the slow and fast waves around the ion cyclotron higher harmonics. It is assumed in the calculation that a plasma has the density of 2×10^{13} cm^{-3} and the bulk electron and ion temperature of 1keV at B=1T. Also included are 25% high energy ion components (80keV in perpendicular to B field).

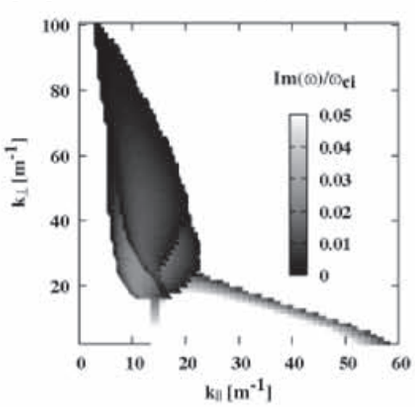

Fig. 1. A contour plot of the growth rate as a function of the parallel and perpendicular wave number.

For experiments in Large Helical Device (LHD), magnetic probes (MP) were employed to observe these high frequency fluctuations excited with NBI or high power ICH injection. Signals from MPs were recorded by an oscilloscope (250Ms/s) with the resolution $\Delta f \sim 15$kHz. Associated with the perpendicular injection of neutral beams (NBI#4), high frequency fluctuations were observed for the first time in LHD. An example is shown in Fig.2 when B = -2.71 T. Shown in Fig.2 (a) is the plasma density and stored energy as a function of time. In this example, NBI#4 was injected from 1.1 to 1.5 sec. In Fig.2 (b), the FFT power spectrum obtained by a MP signal before the injection of NBI#4 (t = 1.06 sec) is plotted. And the power spectrum during the injection of NBI#4 is shown in fig.2(c). It is seen that fluctuations are excited around 71 MHz during the injection of NBI#4. The frequency of 71MHz is near the second harmonic of the ion cyclotron frequency of protons (2fc ~ 82MHz).

Although a high frequency fluctuation near the second harmonic of ion cyclotron frequency was observed, the systematic data accumulation is still necessary to reveal the features of the high frequency fluctuations in helical systems.

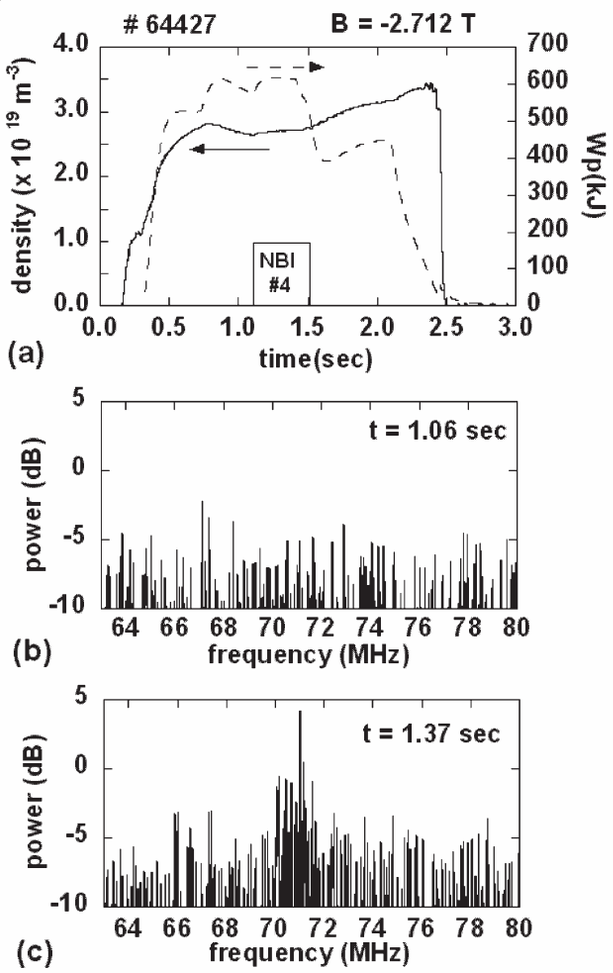

Fig. 2. (a) A plasma density and stored energy as a function of time. (b) A FFT power spectrum before the injection of NBI #4 (t = 1.06 sec). (c) A FFT power spectrum during the injection of NBI #4 (t = 1.37 sec).

References

1) M.Ichimura, M.Inutake, R.Katsumata, et.al., Phys. Rev. Lett. **70** (1993) 435
2) G.A.Cottrell and R.O.Dendy, Phys. Rev. Lett. **60** (1988) 33
3) M.Seki, M.Saigusa, M.Nemoto, et.al., Phys. Rev. Lett. **62** (1989) 1989
4) G.A.Cottrel, Phys. Rev. Lett. **84** (2000) 2397