§49. Effect of Energetic-particle Induced n=0 Instabilities to Bulk-ions on LHD

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Excitation of energetic-particle induced instabilities and its influence on the fast-ion and bulk ion confinement properties are the one of the great concerns on the magnetically confined fusion devices.

Recently, bursting instabilities which associate enhancements of low energy neutral particle flux, are observed for low density plasmas ($n_e(0)<1.0x10^{18}[m^{-3}]$) on LHD with the Bt=-1.5T and Rax=3.75m configuration (Fig.1). This mode is only observed when the Electron Cyclotron resonance Heating (ECH) is intensively applied to LHD plasmas and the energetic particles are produced by tangentially injected Neutral Beam (NB), simultaneously. The initial frequencies of the modes are ranging from 30 to 100kHz and the mode frequency chirps up during the bursting activity. The toroidal mode number of the instability is identified to be zero, while the poloidal mode number is two, i.e., n=0/m=1. Since this type of up-chirping and bursting instabilities was never observed without tangential NB injection, the mode is considered to be driven by energetic particles. The increase of low energy neutral flux is also observed with the burst. This indicates the mode influences the behavior of bulk ions.

In Fig.2(a), the variation of initial frequencies of the mode is shown. As shown in the figure, the mode can be divided into two groups at the initial frequency of 60kHz. The neutral flux increase is mostly observed for the mode whose initial frequency is greater than 60kHz. In Fig.2(b), the dependence of the initial frequencies on the central electron temperatures is shown. The lower frequency mode shows an dependence of $Te(0)^{0.5}$ and is thought to be the Geodesic Acoustic Mode(GAM)[1]. The other mode does not show the dependence on the temperature and its initial frequency is almost constant frequency at around 80kHz, which coincides with the orbital frequencies ($\iota v_0/R$) for the NB produced ions (~180keV) at the central iota value (ι_0) of 0.3. The identification of the mode is under progress. The energetic-particle-induced GAM proposed by G.Y.Fu[2] is the one of the candidate.

[1] Ido, T., *et.al.*, Plasma Phys. Control. Fusion, **52**(2010)124025
[2] Fu, G.Y., Phys. Rev. Lett., **101**(2008)185002

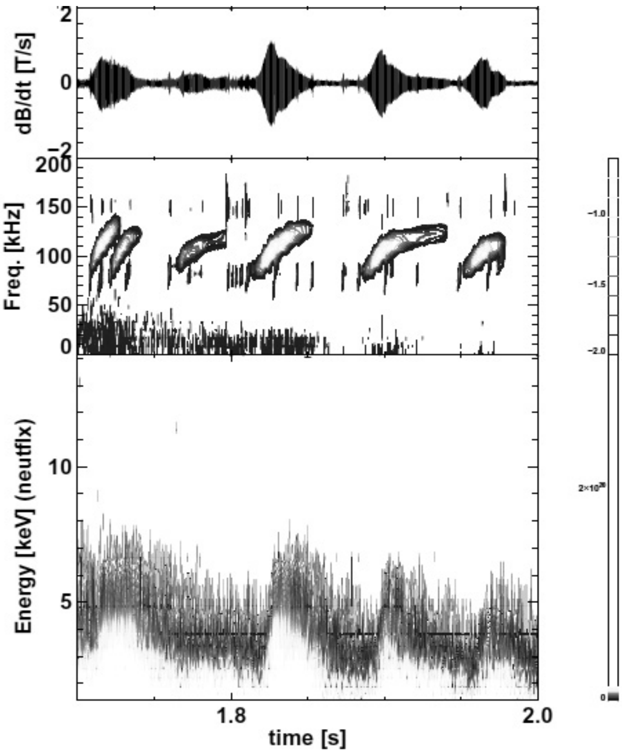

Fig.1 (a) Magnetic-probe (Mirnov-coil) signal signal. Contour plot for (b)the spectrogram of magnetic probe and (c) neutral flux spectra

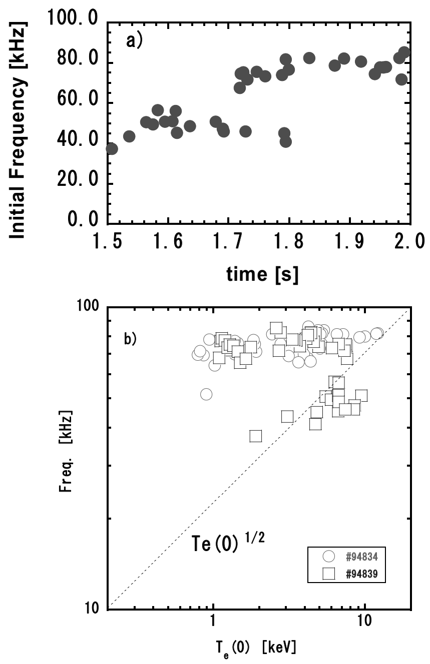

Fig.2(a) Time variation of initial frequency of the n=0/m=1 mode. (b) electron temperature dependence of the mode frequency.