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# Effect of energetic-particle induced n=0 instabilities to bulk-ions on LHD
LHDにおける高速イオン励起されたn=0モードとそのバルクイオンに対する影響

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A bursting up-chirping instability which associates an enhancement of low energy neutral particle flux, is 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.　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 toroidal mode number of the instability is identified to be zero, while the poloidal mode number is two, i.e., n=0/m=1.　The ion temperature behavior with the mode-activity indicates either the existence of additional ion-heating or enhanced radial-transport of bulk ions by the mode activity.

1. Introduction

Excitation of energetic-particle induced instabilities is the one of the great concerns on the magnetically confined fusion devices since it might degrade the confinement of fusion-born energetic alpha particles and might damage the first wall of the vacuum chamber with the loss of the energtic-particles.

The excitation of Alfvenic Eigen mode by energetic particles and its influence on the energetic particle confinement are extensively studied in the past decade and several reviews can be found on this issue [1,2].　On the other hand, the excitation of Geodesic Acoustic Mode (GAM) by energetic particles are observed and reported recently in several magnetically confined plasma devices, such as JET[3], DIIID[4,5] and LHD[6].　This mode becomes more attractive since the mode might enhance the efficiency of ion heating by alpha-particles through the channeling effect [7,8].

On LHD, excitation of the GAM by energetic particles were already reported in [6].　In this manuscript, we will report a energetic particle induced n=0 instability which associates an enhancement of low energy neutral particle flux.

2. Experimental observations

In Fig.1, a typical discharge wave forms are shown.　As shown here, an enhancement of low energy neutral particle flux is observed with the bursting mode activities.　This mode is observed for low density plasmas ($n_e(0)<1.0x10^{18}[m^{-3}]$) on LHD with the Bt=1.375~1.5T and Rax=3.75m configuration.　It 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 toroidal mode number of the instability is identified to be zero, while the poloidal mode number is two, i.e., n=0/m=1.　The initial frequencies of the modes are ranging from 40 to 100kHz.　The chirping-up of the mode frequencies is clearly observed, while the chirping down are not. 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 amounts of neutral flux increase are changing with the mode amplitudes and the energy ranges of the influenced particles are also expanded as the increase of the mode amplitudes.

In Fig.2, a typical variation of neutral energy spectra, which are measured by tangential Neutral

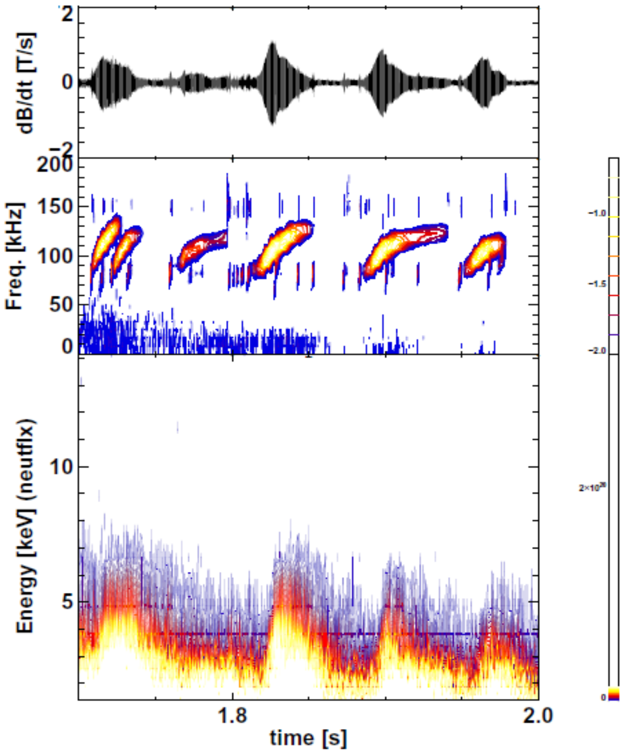

Fig.1 Magnetic-probe (Mirnov-coil) signal signal (top), Contour plot for the spectrogram of magnetic probe(middle) and that for neutral flux spectra(bottom) are shown.

Particle Analyzer, during a mode activity is shown with temporal behavior of the mode amplitudes and frequencies. The ion temperatures being evaluated from the slope of the spectra are also shown. As shown in the figure, the mode glows quickly at its initial phase. When the mode amplitude reaches a certain level (~2x10^{-2}), the ion temperature starts to increase and the effective growth rate of the mode decreases, simultaneously. This behavior indicates either the additional ion-heating or enhanced radial transport of bulk-ions by the mode activities. In the presentation, detailed analysis on this phenomenon will be presented

Acknowledgments

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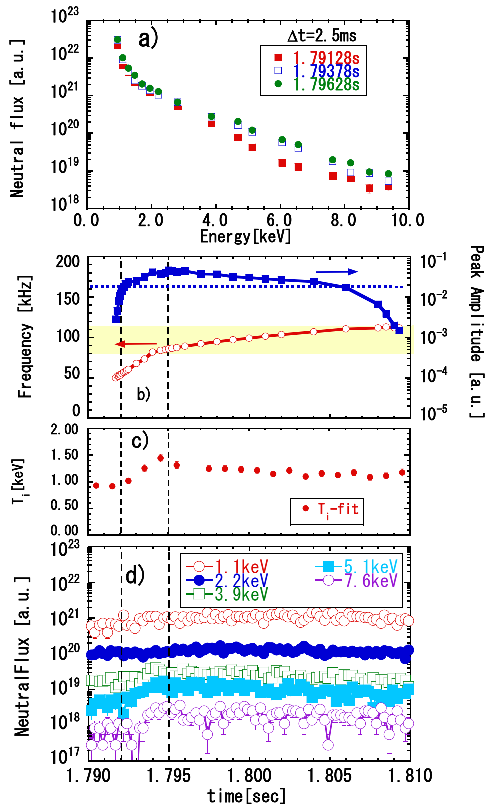

Fig.2 Change of (a)neutral energy spectra , (b) mode amplitude(blue) and frequency(red), (c)ion-temperature and (d) temporal behavior of neutral flux during the mode activity are shown

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