3rd Asia-Pacific Conference on Plasma Physics, 4-8,11.2019, Hefei, China

Observation of High-frequency Chirping Modes Driven by Energetic Ions on HL-2A

L.M. Yu[1], W. Chen[1], P.W. Shi[1], X.Q. Ji[1], Z.B. Shi[1], Z.Y. Qiu[2], R.R. Ma[1], D.L. Yu[1], Y.B. Dong[1], W.J. Chen[1], X.X. He[1], Z.C. Yang[1], Y.G. Li[1], J.Y. Cao[1], B. Lu[1], X.M. Song[1], W.L. Zhong[1], X.T. Ding[1], YI Liu[1], L.W. Yan[1], Q.W. Yang[1], M. Xu[1] and HL-2A team

[1] Southwestern Institute of Physics, P.O.Box 432 Chengdu 610041, China, [2] Zhejiang University, Hangzhou 310063, China

e-mail: yulm@swip.ac.cn

Many branches of MHD instabilities, with its frequencies in the range of 35-150 kHz and chirping down rapidly, are found during high-power NBI heating on HL-2A. The

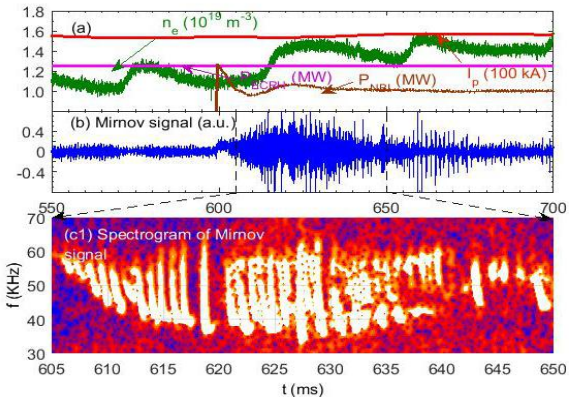

Fig.1 Low-frequency chirping mode

chirping range can reach to 30 kHz within 1 ms. The instabilities propagate in ion diamagnetic drift directions in poloidal. The global and large disturbance caused by the chirping mode can be found obviously by soft X-ray arrays, HCOOH laser Polarimeter- Interferometer and electron cyclotron emission diagnostic systems. The modes all propagate in ion diamagnetic directions in poloidal.

The toroidal mode number (n) is confirmed as n=1 for a low frequency branch mode (35-60 kHz), as shown in Fig.1. But, the poloidal mode number (m) changes from m=2 to 3 and 4 within the chirping down process. It is suggested that the mode moves from the core to the edge of plasma, and also indicated that the energetic ions are expelled from the core to the edge. The toroidal mode numbers of the modes with frequencies in the range of 60-90 kHz and 80-120 kHz are confirmed as n=2 and 3, respectively. Sometimes, the mode is identified as a energetic-particle continuum mode, which is called energetic particle mode (EPM), since the mode locates between the frequencies of toroidal Alfvén eigenmode and continue accumulation point of Beta induced Alfvén eigenmode. The chirping modes also locate on BAE and TAE gap, so we call them BAE-EPM and TAE-EPM.

The nonlinear interaction between EPM and tearing mode (TM)/Long-lived mode (LLM) are found on HL-2A for the first time. When the strong low frequency tearing mode (TM) appears, the single EPM becomes two branches (called EPM1 and EPM2). The value of EPMs and TM frequencies satisfies the relationship fEPM1-f EPM2=2fTM. The mode numbers of the two EPMs are m/n=2/1 and -2/-1, and that of the TM are m/n=-2/-1.