6th Asia-Pacific Conference on Plasma Physics, 9-14 Oct, 2022, Remote e-conference

Observation of a bursting Alfvén instability driven by energetic electrons during EAST ohmic discharges

P. Su[1], L. Zeng[1], H. Lan[2], X.Zhu[3], S. Lin[2], T. Zhang[2], H. Liu[2], H. Zhao[2], Y. Sun[2], C. Luo[2], T. Tang[2], M. Wu[2], Z. Qiu[4], J. Wang[5], Y. Tan[1], Z. Gao[1]
[1] Department of Engineering Physics, Tsinghua University,
[2] Institute of Plasma Physics, Chinese Academy of Science,
[3] Advanced Energy Research Center, Shenzhen University,
[4] Institute for Fusion Theory and Simulation and Department of Physics, Zhejiang University,
[5] Department of Helical Plasma Research, National Institute for Fusion Science
e-mail (speaker): spj18@mails.tsinghua.edu.cn

Alfvén instabilities will affect the confinement of energetic particles, as well as the overall performance of future tokamak devices. In addition to energetic ions, energetic electrons can also drive Alfvén instabilities, with the normalized orbit width comparable to alpha particles in future reactors[1].

Bursting high-frequency (400 kHz ~ 1MHz) instabilities have been observed during ohmic discharges on EAST tokamak (Figure 2(f)). Toroidal field and electron density scans show that the mode frequencies scale linearly with the expected gap frequency for Alfvén eigenmodes (Figure 1), indicating that the mode is likely to be AEs since the frequencies closely match AE frequencies.

It is a bursting rather than a continuous pattern, in which the mode frequency mainly chirps downward at each burst. The bursting behavior of this instability is influenced by the plasma sawtooth events (Figure 2(g)), which laterally indicates that this mode is located in the plasma core. Alfvén continuum calculations (Figure 3(b)) also shows that the location of this mode is close to the core of the plasma. The toroidal number is mainly 2 ~ 4 and it propagates in the ion diamagnetic drift direction. This instability is stronger with a lower toroidal field, lower plasma density and higher plasma current, suggesting that this mode is driven by energetic electrons[1,2] accelerated by the toroidal electric field during the ohmic discharge. Besides, the application of rotating n = 1 RMP causes an interaction of this bursting mode with other Alfvén modes, including TAEs and BAE. The evolution of the mode frequency chirping suggests that there may be nonlinear physics involved. This will contribute to a better understanding of the physical mechanisms of the Alfvén instability driven by energetic particles.

References
[1] F. Zonca et al. Nucl. Fusion 47 1588 (2007)
[2] Jialei Wang et al. Nucl. Fusion 60 112012 (2020)

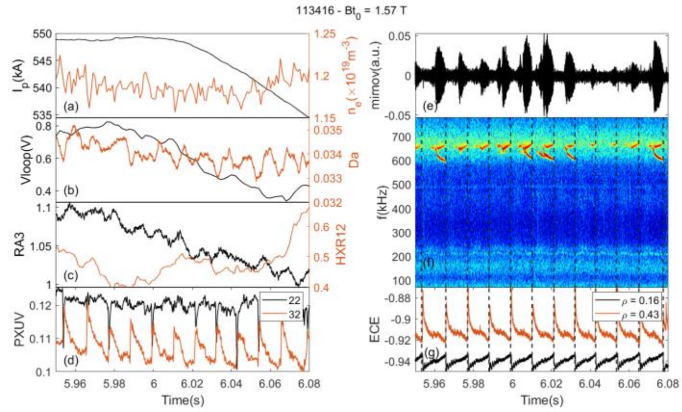

Figure 2. Main parameters of the discharge and the frequency spectrum of the mirnov signal.

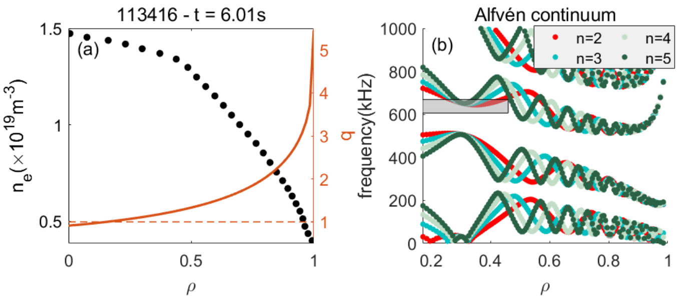

Figure 3. (a) The electron density profile and safety factor profile, (b) the Alfvén continuum.

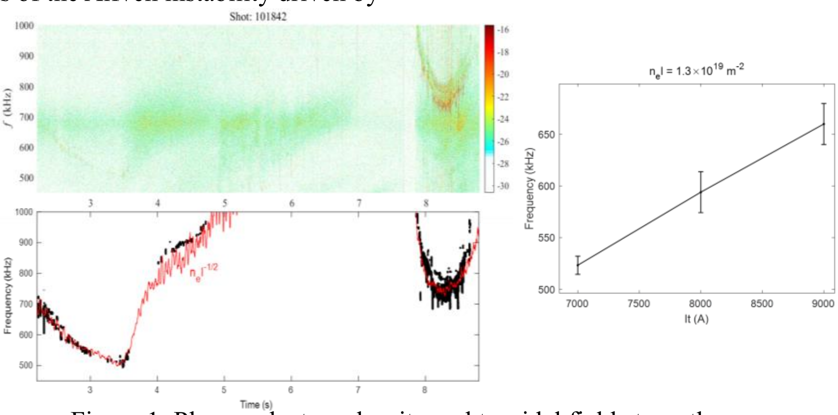

Figure 1. Plasma electron density and toroidal field strength scans.