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Alfvén Eigenmode evolution in NBI-heated plasmas with dynamic magnetic configuration in the TJ-II stellarator

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Alfvén Eigenmodes (AEs) were studied in low magnetic shear flexible heliac TJ-II (B0=1 T, <R>=1.5 m, <a>=0.22 m). The modes were excited by hydrogen co-NBI in L-mode hydrogen plasmas (P_NBI=0.56 MW, E_NBI=32 keV), and diagnosed with Heavy Ion Beam Probe (HIBP) [1], Mirnov probes and bolometer arrays. An earlier published paper [2] shows that for any observed AE, its frequency fAE could be well described by a simple expression based on local AE dispersion relation including a linear iota dependence on plasma current Ipl in the k∥ term. Taking advantage of the unique TJ-II capabilities, a dynamic magnetic configuration experiment with iota ☒variation during discharge was performed via inducing net plasma current. This experiment has shown a strong effect of the iota value on the mode frequency. A drastic frequency change from ~50 to ~250 kHz was observed for some AEs when plasma current as low as ±2 kA was induced by small (≤10%) changes in the vertical field. It was also found that no AE exists with fAE < fmin ~50 kHz, which indicates the GAM/ EGAM effect on AEs at lowest frequency in TJ-II. On top of the conventional linear link between fAE and plasma current Ipl, which could explain via k∥ interplay why the local extrema of fAE coincide with the extrema of Ipl, a new type of fAE dependence on Ipl has been observed in TJ-II. In this new type cases, the local minima of fAE are seen not at extremum points of the current, but at certain Ipl values along linear evolution of the current. To describe this type of fAE behavior, the model [2] was modified by adding the fmin correction caused by the GAM/EGAM effect and a finite pressure gradient effect. It was found with the modified model, that when the iota evolving due to the temporal evolution of Ipl, passes values equal to the ratio of toroidal and poloidal mode numbers, iota = n/m for a specific AE, thus turning k∥ to zero, fAE reaches fmin then. With further Ipl evolution, the value of k∥ changes its sign, so that fAE changes the directivity of its evolution from the frequency decrease to the frequency increase.
It was also found that in some discharges the evolution of AE from a steady frequency mode to a chirping one and back takes place when the plasma current reaches certain values or changes its evolution from raise to decay. Amplitudes of the perturbations in the form of plasma potential and density, as well as the mode location were measured by HIBP.

[1] A.V. Melnikov et al, Nuclear Fusion 57 (2017) 072004
[2] A.V. Melnikov et al, Nuclear Fusion 54 (2014) 123002

Country or International Organization

Russia

Primary author: Prof. MELNIKOV, Alexander (National Research Centre "Kurchatov Institute")

Co-authors: Dr KOZACHEK, Alexander (KhIPT, Kharkov, Ukraine); HIDALGO, Carlos (CIEMAT); SPONG, Donald (Oak Ridge National Laboratory); ASCASIBAR, Enrique (CIEMAT); VARELA, Jacobo (National Institute for Fusion Science); Dr DEPABLOS, Jose Luis (CIEMAT, Madrid, Spain); ELISEEV, Leonid (NRC "Kurchatov Institute"); Dr LINIERS, Macarena (CIEMAT, Madrid, Spain); Dr OCHANDO, Marian (CIEMAT, Madrid, Spain); Mr DRABINSKIY, Mikhail (National Research Centre "Kurchatov Institute",); Dr KHARCHEV, Nickolai (National Research Centre "Kurchatov Institute"); Mr KHABANOV, Philipp (National Research Centre "Kurchatov Institute"); Dr LYSENKO, Sergei (National Research Centre "Kurchatov Institute"); SHARAPOV, Sergei (Culham Centre for Fusion Energy); CAPPA, Álvaro (Laboratorio Nacional de Fusión CIEMAT)

Presenter: Prof. MELNIKOV, Alexander (National Research Centre "Kurchatov Institute")

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