Discrete Compressional Alfven Eigenmode Spectrum in tokamaks

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Sub-cyclotron frequency instabilities of Compressional Alfvén Eigenmodes (CAE) have been observed in the similarity experiments on National Spherical Torus (NSTX) and DIII-D [W.W. Heidbrink, et.al. submitted to Nuclear Fusion]. Theoretical analysis of these instabilities predicts their localization in poloidal (at the low field side) and radial (toward the plasma edge) directions [N.N. Gorelenkov, et.al., Nucl. Fusion, **42** 977 (2002)]. In this work we apply a numerical ideal MHD code NOVA to study CAE properties in similarity experiments on NSTX and DIII-D. NOVA is applied using the numerical equilibrium and is able to recover main properties of these modes predicted by the theory. Among those are the discrete spectrum of CAEs, which are characterized by three quantum numbers (M, n, s), where M, n, and s are poloidal, toroidal, and radial mode numbers, respectively. In the example shown in the figure for DIII-D shot $\#122806$, we present one CAE mode structure, its magnetic field in the poloidal cross section, and the discrete spectrum versus M, for two branches $(M, 0, 1/2)$ and $(M, 0, 1)$. For better numerical convergence and to avoid interaction with the continuum, only $n = 0$ modes were analyzed. In the analyzed case of DIII-D plasma it was found that the observed mode frequency splitting between s and $s + 1$ branches is similar to the one numerically obtained. Poloidal mode number splitting, i.e. between M and $M + 1$ modes, is larger by a factor of two, which is possibly due to neglecting the Hall term. Obtained modes are used for the numerical stability analysis with the NOVA-K kinetic code. CAE properties and their implications are discussed.

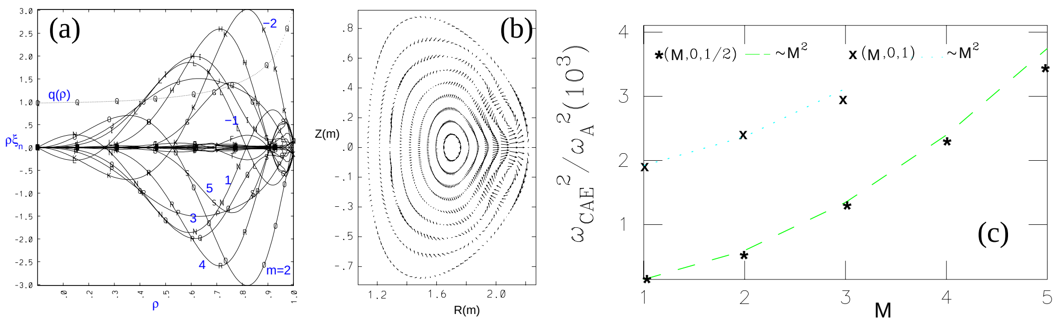

Figure 1: *Normal to the surface component of the plasma displacement of (4,0,1/2) CAE poloidal harmonics, m, is shown in Figure (a). Perpendicular magnetic field of CAE in the tokamak cross section is shown in Figure (b). CAEs discrete spectrum for (M,0,1/2) and (M,0,1) modes is shown versus the poloidal mode number. Here frequencies are normalized to* $\omega_A = v_{A0}/Rq_{edge}$, *so that* $\omega_A/2\pi = 36.64kHz$.