§8. Observation of Global Alfvén Eigenmodes Destabilized in the CHS Plasmas with Finite Magnetic Shear

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We are studying toroidal Alfvén eigenmodes (TAEs) in the CHS heliotron/torsatron, focusing on the destabilization condition and internal structure of TAEs with low toroidal mode numbers, n=1 and 2. In CHS plasma, TAE gap can be formed due to its moderate magnetic shear. On the other hand global Alfvén eigenmodes (GAEs) are easily destabilized in the W7-AS stellarator with very low magnetic shear. Recently, two kinds of GAEs have been observed even in the CHS plasma. One is n=1 GAE generated by the transition from the n=1 TAE in a co-NBI heated plasma and the other the n=0 GAE in a counter-NBI heated plasma.

Figure 1 (a) shows the time evolution of the magnetic fluctuations in the CHS plasma heated with co-NBI where the magnetic axis position of the vacuum field is R_{ax} = 0.949 m and the toroidal field B_t = 0.9 T. The mode of the frequency f~180kHz is observed from t~30ms. This mode is the n=1 TAE related to the m=2 and m=3 coupling and disappears at t~65ms. Then, n=2 TAE split into multiple peaks is destabilized. The fluctuations of f>200kHz are higher harmonics of the TAE. The n=1 modes appear again from t~90ms in the frequency range of f<90kHz just below the n=2 TAE with multiple peaks and in the range of f~150kHz. Figure 1 (c) shows the TAE gap structure calculated by a simple dispersion relation for a large-aspect-ratio tokamak equilibrium at t=50ms. As seen from Fig. 1 (c) the observed frequency of n=1 mode (indicated by the horizontal line) lies near the lower bound of the n=1,m=2/3 TAE gap. Figure 1 (d) shows the TAE gap structure at t=120ms. The n=1,m=2/3 TAE gap does not exist at the time. As seen from this figure, the higher frequency of n=1 mode observed at t=120ms lies near the minimum of the n=1/m=3 Alfvén spectrum, and the lower frequency of n=1 mode lies near the maximum of n=1/m=2. These n=1 modes are thought to be n=1/m=3 and n=1/m=2 GAEs. The rotational transform increases with the increase in the plasma current. Therefore, the 1/q=0.4 surface of n=1, m=2/3 disappears in the plasma, and TAE cannot exist there. After that, GAE gap produced by the n=1/m=2 and n=1/m-3 continua is expanded due to the increase in the plasma current. The GAEs would be destabilized within the gap.

Figure 2 (a) shows the time evolution of the magnetic fluctuations in the CHS plasma heated with counter-NBI, where R_{ax} = 0.974 m and B_t = 0.9 T. Two n=0 modes are observed. The figure 2 (c) shows the TAE gap structure at t=100ms. Because n=0, no TAE gap is formed. The Figure shows the observed higher frequency of the mode lies near the minimum value of the n=0/m=1 Alfvén spectrum which is indicated as f_{MIN} in Fig. 2 (a). The value of f_{MIN} is calculated using $n_e(0)$, where the impurity effect is taken into account. The calculated frequency f_{MIN} agrees well with the observed frequency of the n=0 mode. Therefore the mod

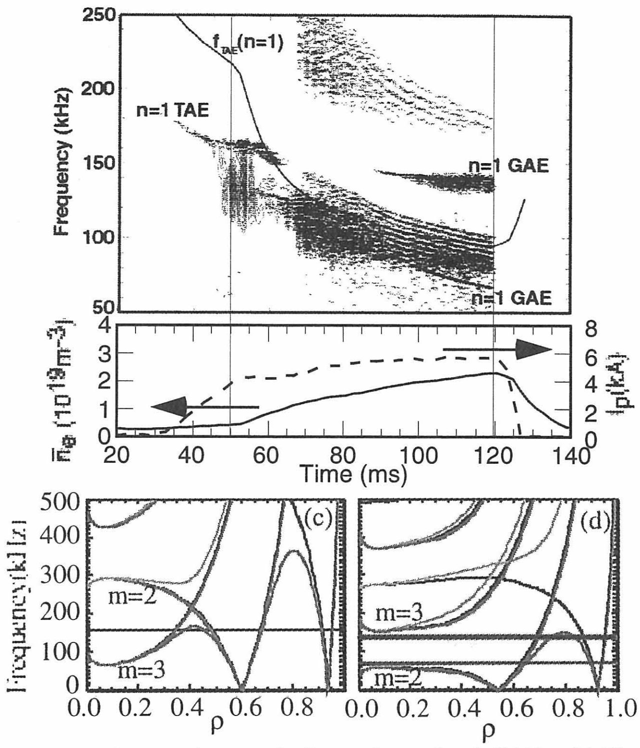
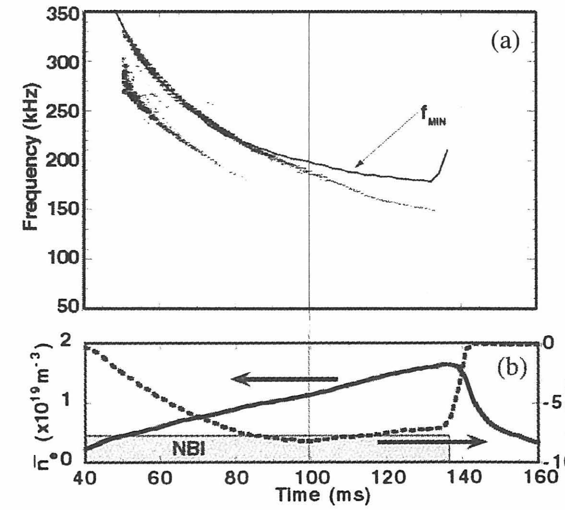


Fig.1 (a) Observed magnetic fluctuations of n=1 GAEs. (b) The electron density and the plasma current. (c)(d) Alfvén spectra for n=1 at t=50ms and t=120ms, respectively.



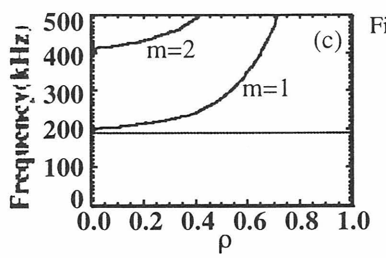


Fig.2 (a) Observed magnetic fluctuations of n=0 GAE. (b) The electron density and the plasma current. (c) Alfvén spectra for n=0 at t=100ms.