Measurement of the phase relationship of coupled $n = 1$ tearing modes in J-TEXT

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Tearing modes (TM) is a common magnetohydrodynamics instability in tokamaks. Coupled tearing modes with the same toroidal mode number and rotation frequency is observed by a poloidal array of Mirnov coils in J-TEXT. The poloidal variation of the perturbed magnetic field depends on the amplitudes and phase difference of coupled modes. Phase difference may lead to different evolutions of the coupled modes. This work develops a model for the phase relationship of the coupled modes in J-TEXT.

Based on the model for ASDEX-U [1, 2], a fitting model of magnetic measurements on J-TEXT is developed to determine the phase difference of 2/1 and 3/1 modes. The perturbed magnetic fields are considered to be generated by the force-free surface currents on the resonant surfaces. The surface currents are represented as filaments. The amplitude and phase of the perturbed surface currents at $q = 2$ and $q = 3$ surfaces can be obtained by least squares fitting.

The time evolutions of the amplitude and phase difference of the two modes are then obtained. The coupling of 2/1 and 3/1 modes is often observed to be in phase in the low field side (LFS) midplane. However, with the application of ECRH, the 2/1 and 3/1 modes are observed to be off phase in the LFS midplane. And the phase difference jumps from 180° to 0° once the ECRH is turned off, meanwhile the amplitudes of the two modes increase.

Reference

[1] M. Schittenhelm, H. Zohm and ASDEX Upgrade Team, Nucl. Fusion 37, 1255 (1997)

[2] A Gude et al, Plasma Phys. Control. Fusion 63, 045018 (2021)