2P57

Simulations of energetic particle driven instabilities in the quasi-axisymmetric stellarator

WANG Hao[1]，藤堂 泰[1]，HUANG Jie[1]，鈴木康浩[1]，清水昭博[1]，小川国大[1]，WANG Xianqu[2]，CFQS Team[1,2]
Hao WANG[1], Yasushi TODO[1], Jie HUANG[1], Yasuhiro SUZUKI[1], Akihiro SHIMIZU[1], Kunihiro OGAWA[1], Xianqu WANG[2], CFQS Team[1,2]

核融合研[1]，西南交通大学（中国）[2]
NIFS[1], SWJTU(China)[2]

The simulations of energetic particle (EP) driven instabilities in a quasi-axisymmetric (QA) device named CFQS are conducted using MEGA code for the first time. Based on the three-dimensional CFQS equilibrium, $m/n = 3/1$ global Alfvén eigenmode (GAE) is excited in the case with islands, and $m/n = 5/2$ toroidal Alfvén eigenmode (TAE) is excited in the case without island. Strong mode coupling is found because of very low number of field periods N_{fp}.

In the present work, the major radius is $1m$ on average, the magnetic field strength on the magnetic axis is $1T$ on average, N_{fp} is 2, the plasma beta value is 1%, the plasma density on the axis is $1.0 \times 10^{19}/m^3$, the energy of neutral beam is $40keV$, and a slowing-down distribution of EP is assumed. Two different equilibria with and without magnetic islands are considered. All the above parameters are the same as CFQS physics design parameters. An instability is excited in the case with islands. The $m/n = 3/1$ harmonics is dominant, and the mode is global. The mode frequency is close to GAE frequency $(n - m\iota) \times \omega_A/(2\pi) = 78kHz$, where $\omega_A = 6.147 \times 10^6 rad/s$, $n = 1$, $m = 3$, $\iota = 0.36$. The mode growth rate increases with EP pressure, but mode frequency does not depend on the EP pressure or EP velocity, that means the mode is eigenmode. Based on the above properties, the mode is identified as GAE. Some other components $n = n_0 + iN_{fp}$ (where $n = -1$ and 3) are also strong as shown in Fig. 1, where $n_0 = 1$, i is an arbitrary integer ($i = -1$ and 1). Strong mode coupling happens because of very small N_{fp} value, which is consistent with theoretical prediction. Another instability is excited in the case without island. The $m/n = 5/2$ harmonics is dominant. The mode frequency $125kHz$ is very close to the TAE gap constituted by $m/n = 5/2$ and $6/2$ harmonics. The mode growth rate increases with EP pressure, but mode frequency does not depend on it. Then, the mode is identified as TAE. Some other components $n = n_0 + iN_{fp}$ (where $n = -2$, 0, and 4) are also strong as shown in Fig. 2, where $n_0 = 2$, i is an arbitrary integer ($i = -2$, -1, and 1). Strong mode coupling happens because of very small N_{fp} value, which is consistent with theoretical prediction.

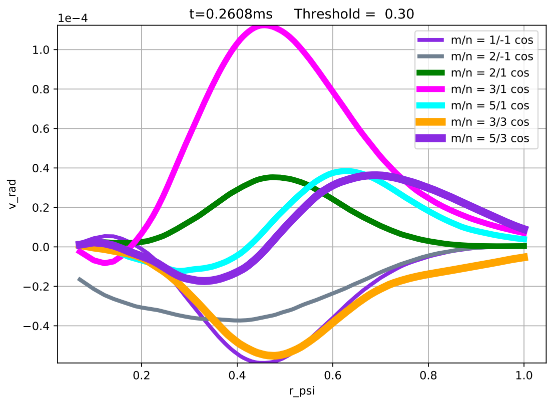

Fig. 1: Mode profile of GAE.

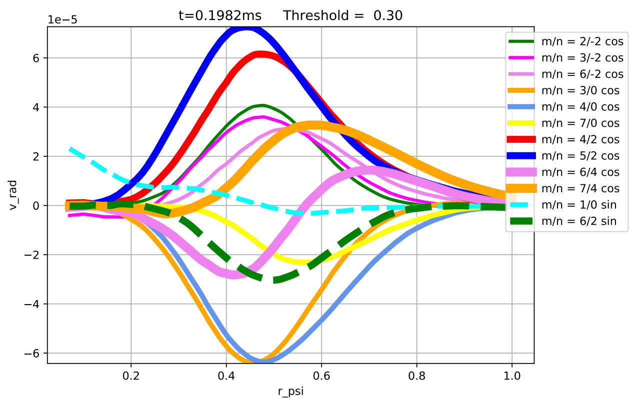

Fig. 2: Mode profile of TAE.