

Role of the multiple mode interaction on the excitation of 2/1 tearing mode by resonant magnetic perturbations on J-TEXT

F.Y. Mao¹, N.C. Wang¹, Q. Zhang¹, Z. Huang², Z.K. Ren¹, R. Jia¹, Y. He¹, Y.B. Li¹, C.X. Zhao¹, B. Hu¹, X.C. Yao¹, Z.R. Hou¹, S. Zhou¹, D. Li¹, Y.H. Ding¹, Z.J. Yang¹, Z.Y. Chen¹ and the J-TEXT team

¹International Joint Research Laboratory of Magnetic Confinement Fusion and Plasma Physics, State Key Laboratory of Advanced Electromagnetic Engineering and Technology, School of Electrical and Electronic Engineering, Huazhong University of Science and Technology, Wuhan 430074, People's Republic of China

²College of Computer Science, South-Central Minzu University, Wuhan, 430074, People's Republic of China

e-mail (speaker): fy_mao@hust.edu.cn

The excitation of $m/n = 2/1$ tearing mode (TM) by external non-axisymmetric magnetic perturbations, known as field penetration, is a significant concern in tokamak research as it leads to confinement degradation and disruption^[1]. The threshold for external field exciting 2/1 TM serves as an important reference for error field correction^[2] and edge localized mode suppression^[3]. Recent research on J-TEXT has discovered that the threshold of 2/1 TM excitation is significantly reduced by the interaction of multiple modes.

In experiments with various static resonant magnetic perturbations (RMPs), the 3/1 and 2/1 TMs were excited individually and successively, and it was observed that the threshold of 2/1 TM excitation was substantially reduced with pre-excited 3/1 TM^[4]. This phenomenon suggests that the interaction between 3/1 and 2/1 TMs has an effect on the field penetration threshold. To better understand the threshold reduction, the MARS-F code^[5,6] was used to investigate the effect of a 3/1 locked tearing mode on 2/1 plasma response, revealing that the 2/1 plasma response was significantly enhanced with a locked 3/1 TM, which may be the reason for the threshold reduction in the experiments.

In static RMPs penetration experiments, the 3/1 and 2/1 TMs were born locked, making it difficult to analyze their behavior separately. As a result, a series of rotating RMP penetration experiments were carried out using the unique high-frequency RMP system on J-TEXT. In these experiments, the helical and radial structure evolutions of the modes were obtained through magnetic probe arrays and local ECE measurements, allowing for analysis of

the interaction between 2/1 and 3/1 modes. Additionally, a 3/1 external kink mode (EKM) was excited by RMP with q_a slightly smaller than 3, and it was discovered that the 3/1 EKM also reduced the thresholds of 2/1 TM excitation^[7]. Further details will be presented at the conference.

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