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Parametric Study of Linear Stability of Toroidal Alfvén Eigenmode in KSTAR and JET

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Toroidal Alfvén Eigenmodes (TAEs) driven by energetic ions play a critical role in the transport of the resonant energetic ions by relaxing their pressure gradient. It is important to predict the linear stability of TAE in various conditions for optimizing burning plasma scenarios. However, it requires considerable computational resources for MHD/gyrokinetic simulations to explore the diverse conditions and find the stability conditions. In this work, we performed parametric studies using analytic formulae for the linear growth rate derived from the eigenmode equation with suitable assumptions. First, we calculated the criteria of TAE destabilization by beam ions. We found that the beam damping becomes dominant when the beam-ion orbit width becomes narrower. This shows good agreement with KSTAR experiments. Second, we modelled the TAE resonance with ICRH-heated ions using a bi-Maxwellian for the fast ion distribution, in order to apply this stability analysis to RF-driven TAEs in JET. Then we checked the time-varying linear stability of TAE in a JET discharge using the analytic formulae. We could see that TAE is excited by ICRH, and damped as beam beta increases and the plasma density exceeds the critical value for the resonance. The strong interaction of TAE with the beam occurs only in plasmas with rather high density so that v_A is low enough for the resonance condition $v_b = v_A/3$. In JET plasmas with densities lower than the one required for such resonance, the interaction of TAE with the beam is small. Finally, we predicted the alpha particle contribution to TAE destabilization for a future DT campaign in JET. This fast modelling tool can be used for extensive parametric studies in order to optimize TAE scenarios in JET and ITER.

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