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Simulations for understanding Alfven Eigenmode Mitigation physics in KSTAR Experiment

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Successful mitigations of Alfvén Eigenmodes (AEs) in H-mode plasmas have been achieved in KSTAR discharges through the control of electron cyclotron current drive while maintaining a fixed neutral beam power [1]. In this work, dedicated global gyrokinetic simulations with GTC code [2] and gyrofluid simulations with FAR3d code were performed to reveal underlying AE mitigation physics in KSTAR #21695.

In AE-active phase, linear gyrokinetic simulations have found the most unstable low-n modes with frequency near Beta-induced Alfvén Eigenmode (BAE) at outer core region while linear gyrofluid simulations have found those with higher frequency near Toroidal Alfvén Eigenmode (TAE) lower gap frequency at inner core region. Figure 1 shows the different mode location found in two simulations for n=3 and corresponding Alfven continuum spectra. Both BAE and TAE in the two simulations have similar frequencies considering doppler shift, which are well-consistent with experimentally observed frequencies as shown in Figure 2. It is obvious that the multiple type of AEs can exist in the discharge. In AE-mitigated phase, the safety factor becomes monotonic and the thermal pressure increases with enhanced fast ion pressure. Experimentally observed magnetic signals shows that AE activities are strongly mitigated with weakly sustaining n=1,2 mode, as shown in Figure 2. In contrast, it is notable that the linear simulations have found significant growth of AE activities in AE-mitigated phase, even stronger than those of AE-active phase in GTC gyrokinetic simulations as shown in Figure 3. With constant NBI heating during the whole discharge, the drive of AEs in AE-mitigated phase is still strong so that $\gamma/\omega > 0.6$ indicating it is far from marginal stability. It suggests that interpretations based solely on linear AE stability are insufficient to explain the sustaining AE mitigation with strong fast ion pressure gradient drive.

To reveal nonlinear mechanisms governing the AE-mitigated phase, gyrofluid nonlinear simulations with multiple AE activities have been conducted using FAR3D code. The results from these simulations will be addressed to identify the sustaining mechanisms of AE mitigation in KSTAR #21695 and its parameter dependences.

References
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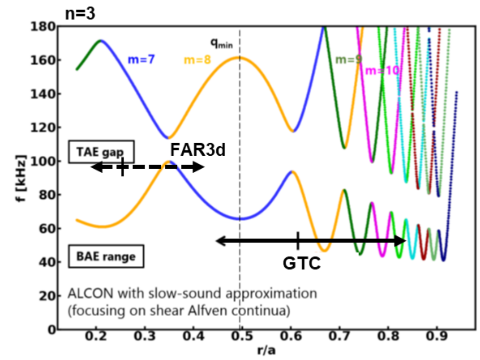

Figure 1. n=3 shear Alfven continuum spectra at AE-active phase in KSTAR #21695.

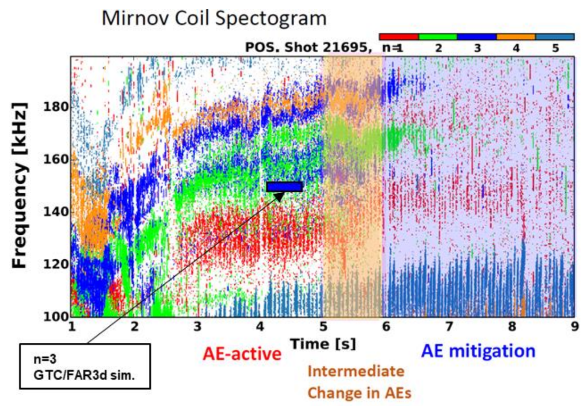

Figure 2. Mirnov Coil Spectrogram in KSTAR #21695.

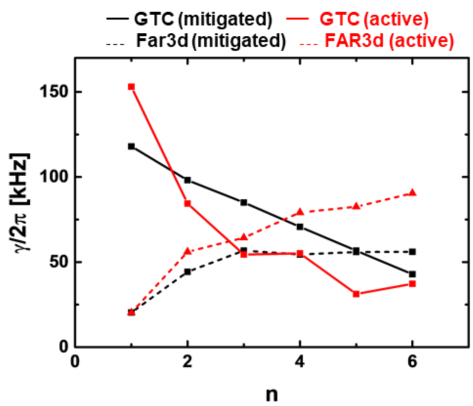

Figure 3. Linear gyrokinetic simulation with GTC and gyrofluid simulation with FAR3d in AE-active phase and AE-mitigated phase.