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Continuum Damping of Toroidal Alfvén Eigenmodes Due to Magnetic Island Chains

M.R.Thomas[1], Z. Qu[2], M.J Hole[1]
[1] Mathematical Sciences Institute, The Australian National University,
[2] School of Physical and Mathematical Sciences, Nanyang Technological University
e-mail (speaker): matthew.thomas1@anu.edu.au

Energetic particles inside fusion plasmas have speeds comparable to the Alfvén velocity, making them able to excite shear Alfvén waves. Most shear Alfvén waves exist in a continuous spectrum and experience strong continuum damping, negating this excitation. However, discrete eigenmodes, such as the Toroidal Alfvén Eigenmode (TAE), exist outside the continuum, experiencing minimal damping.

Magnetic island chains are a common perturbation found in fusion plasmas. Recent work [1] has investigated the effect of magnetic islands on the shear Alfvén continuum in large aspect ratio tokomaks using ideal MHD theory. By creating new flux based magnetic island coordinates, it was shown that the magnetic island chain reduces the width of the TAE gap in the shear Alfvén continuum. The first image shows the Alfvén continuum without a magnetic island chain and the second with, taken from [1].

This raises the possibility that TAE's inside the gap, vulnerable to being driven unstable by energetic particles, may now experience strong continuum damping. We verify this claim, showing that TAE's experience a much larger damping rate in the presence of a magnetic island chain and compute the rate of damping for different island chains.

References

[1] Z. S. Qu, M. J. Hole, Plasma Physics and Controlled Fusion 2023, 65, 025002.

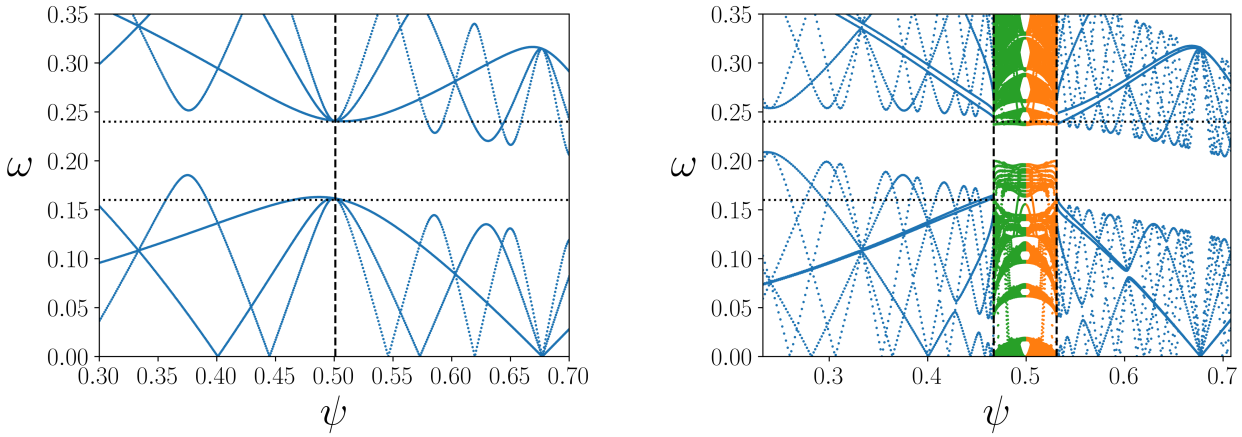

Figure 1. Shear Alfvén continuum without magnetic island chain (left) and with magnetic island chain (right). Presence of magnetic island reduces the frequency gap where a TAE resides.