Effect of magnetic field strength on Alfvén eigenmode stability

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Next-generation fusion experiments will attempt to reduce the size and cost of fusion power plants by increasing volumetric fusion power density, which increases strongly with magnetic field strength. Recently-presented designs use magnetic fields of 9 T and 12 T [1,2], in excess of the operating range of previous tokamak experiments. Developing theoretical and computational understanding of trends with increasing magnetic field strength is of critical importance for this new era of very-high-field machines. This work considers one area of particular significance to high-magnetic-field experiments which hope to demonstrate net energy: the stability behavior of Alfvén eigenmodes (AEs). In a tokamak, energetic particles, including alpha particles produced in D-T fusion reactions, can drive these modes unstable, leading to increased energetic particle transport, loss of alpha power needed to heat the plasma, and damage to device walls. AE physics is strongly sensitive to background magnetic field strength through the magnetic field dependence of AE resonances and alpha particle beta. This work describes the origin and effect of these dependences, and potential consequences for alpha particle transport. The trends identified are demonstrated computationally by using a workflow developed in [3] to study AE stability in a tokamak equilibrium which is scaled through magnetic field. Overall, the work suggests high-magnetic field machines could have some favorable AE stability properties.

[1] B.N. Sorbom, *et al.*, *Fusion Engineering and Design* **100** (2015): 378-405.

[2] M. Greenwald, *et al.*, *PSFC Report* **RR-18-2** (2018).

[3] P. Rodrigues, *et al.*, *Nuclear Fusion* **55.8** (2015): 083003.