Low-Frequency Alfvén Eigenmodes during the Sawtooth Cycle at ASDEX Upgrade

D. Curran, Ph. Lauber, P.J. Mc Carthy, S. da Graça, V. Igochine and the ASDEX Upgrade Team

1 Department of Physics, University College Cork, EURATOM-Association DCU, Cork, Ireland
2 Max-Planck-Institut für Plasmaphysik, EURATOM-Association, Garching, Germany
3 Associação EURATOM/IST, Instituto de Plasmas e Fusão Nuclear - Laboratório Associado, Instituto Superior Técnico, 1049-001 Lisboa, Portugal

The confinement of fast particles, present in tokamak plasmas as nuclear fusion products and through external heating, will be essential for any future reactor. Foremost among the processes which can expel these fast particles is their interaction with Alfvén eigenmode instabilities. Under certain conditions, gaps in the Alfvén continuum can be opened as a result of certain properties of the plasma. Discrete Alfvén eigenmodes can exist in these gaps, and through interactions with fast particles can lead to a radial re-distribution of the population. In ASDEX Upgrade, low frequency modes in the Alfvén-acoustic frequency regime, known as beta-induced Alfvén eigenmodes (BAEs), have been observed. They exist in gaps in the Alfvén continuum opened up by geodesic curvature and finite plasma compressibility. In this paper, a kinetic ballooning mode dispersion relation [1] is solved numerically to investigate the evolution of BAEs with varying plasma parameters, as well as a potential variation on these modes which chirp significantly upwards in frequency towards the end of the sawtooth cycle. This equation is extended to include the effects of trapped particles [2] on the frequency continuum. The frequency evolution of these modes during the sawtooth cycle is investigated and the change in the mode frequency due to diamagnetism, which can act as a potential source of free energy through gradients in density and temperature, is considered. Realistic background plasma profiles are obtained through equilibrium reconstructions using the CLISTE code [3]. Using information gained from Mirnov coil, reflectometry and SXR measurements on the location and mode numbers of modes, the q-profile reconstruction is constrained using MHD-spectroscopy. These results for the mode frequency evolution are then compared with experimental results from ASDEX Upgrade.

References

