Modification of Alfvén eigenmodes in tokamaks by pellet injection

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Alfvén eigenmodes driven unstable by energetic particles are routinely observed in tokamak plasmas. The most frequently observed Alfvén eigenmodes are gap modes, where two poloidal harmonics are coupled by geometric effects. Further coupling of harmonics can transiently result from the injection of frozen deuterium pellets. Once injected, pellets break down on timescales of several milliseconds. In JET, we observe a significant change in the Alfvén eigenmode spectrum during this short period. This phenomenon may be explained by the transient breaking of the toroidal and poloidal symmetry of the density profile by the material deposited by the pellet. These inhomogeneities couple additional poloidal and toroidal harmonics, modifying the Alfvén continuum and eigenmode spectrum.

We have generalised the 3D MHD codes Stellgap [1] and AE3D [2], which characterise Alfvén waves in stellarators, to incorporate 3D density profiles generated from analytical expressions for pellet deposition profiles. We thereby obtain the Alfvén mode spectrum and structure in tokamak plasmas with pellet injection. We compare these calculations with analytical predictions of mode coupling due to density inhomogeneities.

These results complement the ongoing efforts to use Alfvén eigenmodes for MHD spectroscopy [3]. From changes in the mode frequency and amplitude – both of which are affected by the density-related coupling of harmonics – information can be inferred about the pellet deposition dynamics and fast particle response to pellet injection.

This work has received funding from the U.S. Department of Energy under Grant No. DE-FG02-04ER54742 (IFS) and DE-AC05-00OR22725 (ORNL).

References

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