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MHD spectroscopy of pellet injected plasmas

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In magnetic confinement devices, pellet injection is used to refuel the core of the plasma, control edge localised modes, and mitigate disruptions. These varied applications require drastically different pellets. As a result, the timescales of pellet assimilation can vary significantly depending on the experiment and machine. Diagnosing the effect of the pellet on the plasma represents an important but challenging task because of the short lifetime of the pellet and complexity of the pellet assimilation into the plasma. MHD spectroscopy provides information on the density of ions deposited by the pellet with excellent time resolution.
Alfvén eigenmodes driven unstable by energetic particles are ubiquitous in tokamak plasmas. The frequencies of Alfvén eigenmodes drop significantly during pellet injection, making them an attractive candidate for MHD spectroscopy [1]. We demonstrate how key pellet parameters can be inferred from the observed changes to the Alfvén eigenfrequencies. MHD spectroscopy of pellet injected plasmas was enabled by generalising the 3D MHD codes Stellgap [2] and AE3D [3] to incorporate 3D density profiles. 3D density profiles were generated using a model for the expansion of the pellet wake along a magnetic field line derived from the fluid equations. Thereby, we obtain the time evolution of the Alfvén eigenfrequencies. From the change in mode frequency, we estimate the density of the pellet wake and the timescale for poloidal homogenisation of the wake.

References
[1] S. E. Sharapov et al., Nucl. Fusion, 58, 082008 (2018)
[2] D. A. Spong et al., Phys. Plasmas, 10, 3217 (2003)
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