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Beta induced Alfven eigenmode excitation in the strongly shaped H-1NF stellarator[1]

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Recent advances in the modelling, analysis, and measurement of fluctuations in strongly shaped 3D magnetic configurations have significantly improved the diagnosis and understanding of Alfven eigenmodes in the H1 heliac. Visible light emissions from H1 reveal low frequency (10-40 kHz) electron density fluctuations correlated with magnetic measurements indicative of Alfven eigenmodes. Full 3D tomographic inversion of the emission was accomplished using a novel synchronous imaging technique, which achieves high SNR and aliases high frequency modes to frequencies that can be easily imaged. Excellent agreement is found between both the frequency and spatial structure of the mode and ideal MHD calculations of Beta-induced Alfven Eigenmodes using the CAS3D code. The resulting measurements and modelling demonstrates that the dominant low frequency Alfven eigenmodes in H1 are principally the axi-symmetric variety, similar to the modes in tokamaks. These results show experimentally that Alfven eigenmodes can exist in the acoustic range of frequencies even at low beta (approx. 10^{-4}) due to strong shaping in stellarators such as H1, unlike in tokamaks where significantly higher beta is required. Importantly, these modes are observed in the absence of confined ions near the Alfven velocity (V_A). Typical ion temperatures of 20 eV correspond to ion velocities several orders of magnitude below V_A. However, similar temperature thermal electrons closely match V_A and provide a potential mechanism for mode excitation. Additionally, there is evidence that the complex harmonic structure of the H1 magnetic field may allow mode excitation by ion energies corresponding to velocities which are a small fraction of V_A.

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