

P4.1070 Interpretation of suprathermal emission at deuteron cyclotron harmonics from deuterium NBI plasmas in KSTAR

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See full abstract here

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Intense suprathermal radiation, with spectral peaks at multiple harmonics of the deuteron cyclotron frequency, is detected from the outer midplane edge of KSTAR deuterium plasmas that are heated by tangential neutral beam injection (NBI) of 100keV deuterons. We identify how this deuterium ion cyclotron emission (ICE) is generated, and distinguish this signal from the ICE driven by fusion-born protons in KSTAR deuterium plasmas (B. Chapman et al., Nucl. Fusion 57, 124004 (2017) and 58, 096027 (2018)). We first combine particle orbit studies in approximate KSTAR magnetic field geometry with an analytical treatment of the magnetoacoustic cyclotron instability (MCI), to identify the sub-population of freshly ionised NBI deuterons that can excite deuterium ICE by the MCI. These deuterons are then represented as an energetic minority, together with the majority thermal deuteron population and electrons, in kinetic particle-in-cell (PIC) computational studies where all particle gyro-orbits are fully resolved. The PIC approach solves the Maxwell-Lorentz equations for many millions of interacting particles, with the self-consistently evolving electric and magnetic fields. It enables us to study the collective relaxation of the NBI deuterons through the linear phase of the MCI and deep into its saturated regime. The Fourier transform of the excited fields displays strong spectral peaks at multiple successive deuteron cyclotron harmonics, mapping well to the observed KSTAR deuterium ICE spectra. The time-evolution of the energy densities of the particle populations and field components in the PIC computations further supports our identification of the driving sub-population of NBI deuterons, whose relaxation through the MCI generates the observed deuterium ICE signal. We conclude that the physical origin of this signal in KSTAR is broadly the same as the NBI-driven ICE seen in TFTR tokamak and LHD stellarator plasmas. Its spatially localised character suggests that planned ion beam-plasma experiments in simpler magnetic geometries could also generate ICE of this kind.

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