Experimental investigation of Alfvén wave saturation by microturbulence induced fast ion scattering in DIII-D

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Recent experiments at the DIII-D tokamak in the ongoing Energetic Particle (EP) Turbulence thrust have acquired data documenting the impact of varied effective pitch-angle scattering rate (ν_{eff}) on the saturation level of fast-ion-driven instabilities. These experiments, focused on the current ramp, aimed to change microturbulence induced pitch-angle scattering in the presence of a single marginally unstable Toroidal Alfvén Eigenmode (TAE) driven principally by a 2 MW, 81 kV neutral beam. Three distinct methods were used in experiment to modify drift-wave microturbulence while keeping Alfvén Eigenmode drive as fixed as possible (as diagnosed by Electron Cyclotron Emission, CO2 interferometry, and fast magnetics spectroscopy): injection of low-voltage (45 kV) neutral beams, suppression of microturbulence via L-H transition, and modification of Ion Temperature Gradient (ITG) turbulence by carbon impurity seeding. An L-H transition was induced by changing the plasma shape from Upper Single Null (USN) to Lower Single Null (LSN), and the injection of carbon impurities was performed using the DIII-D Impurity Powder Dropper (IPD) system. The shape modifications induced Limit Cycle Oscillations (LCOs), dithers between L-mode and H-mode, resulting in weaker drift-wave turbulence, as seen by Beam Emission Spectroscopy (BES). Likewise, carbon impurity seeding is observed to suppress ITG turbulence. Initial experimental evidence confirms drift-wave turbulence modification, alongside changes in Alfvén Eigenmode amplitude, as anticipated based on the the $\delta B/B\sim\nu_{eff}^2$ regime scaling [Berk, Breizman, PRL (1992)] for AE saturation. Ongoing work seeks to validate and test these observations using reduced models for AE saturation, such as TGLF-EP and linear CGYRO.

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