Observation of Compressional Alfvén Modes during Neutral Beam Heating on the National Spherical Torus Experiment

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With the first injection of neutral beams into the National Spherical Torus Experiment (NSTX) a broad spectrum of nearly equally spaced peaks in the frequency range from ≈ 0.2 to ≈ 1.2 ω_{ci} was observed. The frequencies have a scaling with toroidal field and plasma density consistent with Alfvén waves. From these and other observations, the modes have been identified as Compressional Alfvén Eigenmodes. Recent theoretical studies have proposed that CAE activity may contribute significantly to the heating of the solar corona. The CAE in NSTX may play a similar role in transferring energy directly from the beam ions to the thermal ions, a first experimental realization of alpha channeling.

I. INTRODUCTION

The practical realization of a fusion reactor based on magnetic confinement of a plasma will rely on the heating of the thermal plasma by super-Alfvénic ions (the 4.5 MeV alpha particles from the D-T fusion reaction). In such a reactor, the alphas slow down on and heat primarily the electrons. Collisions transfer energy from the electrons to the ions, supporting the fusion reaction. The energetic ions may also excite, through resonant interactions, a variety of mode activity such as Toroidal Alfvén Eigenmodes (TAE), Energetic Particle Modes (EPM), the fishbone instability and others. In some cases, the interaction of the alphas with these instabilities can induce loss or redistribution of energetic ions [1-8].

The EPM and TAE family of modes in the shear Alfven branch have been extensively studied in experiments on TFTR, JET, JT-60U and DIII-D. For the most part, these modes have been relatively benign, although the localized losses associated with the TAE driven by ICRF tail ions were considered responsible for minor damage to the TFTR vacuum vessel. The EPM were also, indirectly, implicated in affecting the performance of TFTR by inducing redistribution of the sawtooth stabilizing fast