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Experimental studies on fast-ion transport by Alfvén waves on NSTX[1]

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Interaction of fast ions with Alfvén eigenmodes (AEs) may redistribute fast ions in phase and real space, and degrade fusion and current drive efficiencies in devices such as ITER. A plethora of AEs naturally occurs in beam-heated NSTX plasmas, making it a suitable environment for fast-ion studies. Space and energy resolved measurements of fast-ion dynamics during AE activity are presented. The effects of toroidicity-induced AEs (TAE), energetic-particle modes (EPM) and compressional AEs (CAE) are discussed. Modest changes in the fast-ion profile, n_f(R), correlate with TAEs for multiple, non-interacting modes. As the beam beta is increased above a critical threshold, TAEs interact non-linearly and disrupt in *avalanches*. n_f(R) decreases, but remains peaked at the magnetic axis. A depletion of the energy range >20keV, leading to drops of up to ∼20% in the neutron rate over <500us, is observed. Good agreement is found between the radial profile and frequency of TAEs, measured by reflectometers and Mirnov coils, and the eigenmode structures calculated by the NOVA-k code. The latter are combined with the measured amplitude and frequency evolution to simulate the effect of TAEs on fast ion transport. Prompt fast-ion losses are also observed during EPMs. Slower time-scales (∼10ms) are observed during CAE activity, which appears to be correlated with low-frequency kink modes. A depletion of the energy spectra above 20keV is observed for 100<R<130cm. Measurements of n_f(R,t) by Fast-Ion D-Alpha (FIDA) spectroscopy are complemented by data from neutral particle analyzers, a scintillator-based fast-ion loss diagnostic and neutron detectors. Data are validated from studies of MHD quiescent discharges, and benchmarked against the results of simulation codes.

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