Three-wave interaction of fast ion driven modes in NSTX*

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Fast ions generated in fusion plasmas by heating techniques, and alpha particles in burning plasmas, can excite global modes that degrade fast ion confinement. While the mode dynamics have been well studied, nonlinear three-wave interactions between modes have received little attention. Such interactions can transfer energy, leading to damping and excitation. Using core localized reflectometry and edge magnetic measurements, we observe three-wave interactions between two distinct types of such modes in NBI-heated plasmas: energetic particle modes (EPMs), consisting of harmonics in frequency (f) and toroidal mode number (n), peaking at the $f \sim 17$ kHz, $n = 1$ fundamental, and higher frequency modes (HFMs) that peak at larger f and n and have a uniform f and n spacing of $\Delta f \sim 17$ kHz and $\Delta n = 1$. This spacing suggests three-wave interactions are occurring [see EJ Strait, Plas. Phys. & Cont. Fus. (1994)], which we verify by calculating the bicoherence. Analysis also indicates these interactions organize the HFMs into a toroidally localized wave-packet whose envelope is stationary in the EPM toroidal rotation frame.

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