# Phase-Space Dependence of Fast-Ion Transport by Alfvén eigenmodes*

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To manage fusion-product transport in future devices, control of phase-space gradients and flows will likely be required. Recent studies of neutral-beam driven Alfvén eigenmodes (AE) on DIII-D have begun to measure fast-ion flows in phase space using a newly developed beam modulation technique and a variety of fast-ion diagnostics that are sensitive to different parts of the distribution function. The beam modulation technique has much in common with thermal perturbative transport methods but the measured quantity is the divergence of the fast-ion flux from the phase-space volume interrogated by the diagnostic [1]. Interestingly, measurable net transport does *not* occur at the linear AE stability threshold but requires multiple unstable modes [2]. The transport threshold occurs when multiple modes cause stochastic transport in phase space [2-4]. Above threshold, the fast-ion transport is "stiff" with respect to phase-space variables. Such critical-gradient behavior is reminiscent of the simpler picture for thermal transport [5]. Flows in phase space are obtained through comparisons of measured neutron, solid-state neutral particle analyzer, and fast-ion D-alpha signals with the expected signals in the absence of wave-induced transport. Well above threshold, simulations that utilize the measured mode amplitudes and structures in the TRANSP code predict a hollow fast-ion profile that reproduces the experimental data [5]. A newly developed imaging neutral particle analyzer [6] provides detailed measurements of phase-space flows.

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