Fast-ion transport by Alfv´en eigenmodes above a critical gradient threshold

W.W. Heidbrink,[1] C.S. Collins,[2] M. Podest`a,[3] G.J. Kramer,[3] D.C. Pace,[2]
C.C. Petty,[2] L. Stagner,[1], M.A. Van Zeeland,[2] R.B. White,[3], and Y.B. Zhu[1]

[1]University of California Irvine, Irvine, California, USA
[2]General Atomics, San Diego, California, USA
[3]Princeton Plasma Physics Laboratory, Princeton, New Jersey, USA
(Dated: November 21, 2016)

Abstract

Experiments on the DIII-D tokamak have identified how multiple simultaneous Alfv´en eigenmodes (AEs) lead to overlapping wave-particle resonances and stochastic fast-ion transport in fusion grade plasmas [C.S. Collins et al., Phys. Rev. Lett. 116, 095001 (2016)]. The behavior results in a sudden increase in fast-ion transport at a threshold that is well above the linear stability threshold for Alfv´en instability. A novel beam modulation technique [W.W. Heidbrink et al., Nucl. Fusion 56, 112011 (2016)] in conjunction with an array of fast-ion diagnostics probes the transport by measuring the fast-ion flux in different phase-space volumes. Well above threshold, simulations that utilize measured mode amplitudes and structures predict a hollow fast-ion profile that resembles the profile measured by fast-ion D (FIDA) spectroscopy; the modelling also successfully reproduces the temporal response of neutral-particle signals to beam modulation. The use of different modulated sources probes the details of phase-space transport by populating different regions in phase space and by altering the amplitude of the AEs. Both effects modulate the phase-space flows.