Observation of Doppler-Shifted Cyclotron Resonance of Fast Ions with Shear Alfvén Waves

Yang Zhang, W.W. Heidbrink, H. Boehmer, R. McWilliams
Department of Physics and Astronomy, University of California, Irvine, California 92697
S. Vincena, T. Carter, D. Leneman, P. Pribyl, W. Gekelman, B. Brugman
Department of Physics and Astronomy, University of California, Los Angeles, California 90095

Abstract

The Doppler-shifted cyclotron resonance ($\omega - k_z v_z = \Omega_f$) between fast ions and shear Alfvén waves is experimentally investigated. A test particle beam of fast ions is launched by a Li^+ source[1] in the helium plasma of the Large Plasma Device (LAPD) [W. Gekelman, H. Pfister, Z. Lucky, J. Bamber, D. Leneman, and J. Maggs, Rev. Sci. Instrum. 62, 2875 (1991)], with shear Alfvén waves (SAW) (amplitude $\delta B / B$ up to 1%) launched by a loop antenna. A collimated fast-ion energy analyzer measures the non-classical spreading of the beam, which is proportional to the effectiveness of the resonance. A resonance spectrum is recovered by launching SAW at frequencies from 0.3 – 0.8 Ω_{ci}. Both the magnitude and frequency dependence of the beam spreading are in agreement with the theoretical prediction using a Monte Carlo Lorentz code launching fast ions with initial spreading and random phases relative to the wave. Measured wave magnetic field data are used in the simulation. (ω: wave frequency; k_z: axial wavenumber; v_z: fast-ion axial speed; Ω_f: fast-ion cyclotron frequency.)

[1] Y. Zhang et al., Rev. Sci. Ins. **78**, 013302 (2007)