Alfvén wave parametric instability in a laboratory plasma

S. Dorfman[1], T. Carter[2], S. Vincena[2], S.K. Tripathi[2], P. Pribyl[2], Y. Lin[3], X.R. Fu[4], F. Li[4]
[1] Space Science Institute, [2] University of California, Los Angeles,
[3]Auburn University, [4]New Mexico Consortium
e-mail (speaker): sethd at spacescience dot org

Alfvén waves, a fundamental mode of magnetized plasmas, are ubiquitous in space and fusion plasmas. The non-linear behavior of these modes is thought to play a key role in important problems such as solar wind turbulence, the heating of the solar corona, and the scattering of energetic particles in tokamaks. Theoretical predictions show that these Alfvén waves may be unstable to various parametric instabilities, but in-situ satellite measurements of these processes are limited. Results from the Large Plasma Device at UCLA have recorded the first observation of a sheer Alfvén wave parametric instability in the laboratory [1]. When a single finite ω/Ω_i, finite $k\perp$ Alfvén wave is launched above a threshold amplitude, three daughter waves are observed: two sideband Alfvén waves co-propagating with the pump and a low frequency nonresonant mode. The daughter modes are spatially localized on a gradient of the pump wave magnetic field amplitude in the plane perpendicular to the background field, suggesting that perpendicular nonlinear forces (and therefore $k\perp$ of the pump wave) play an important role in the instability process.

New scaling studies show that this perpendicular parametric modulational instability (PPMI) is most active at the boundary between the inertial and kinetic Alfvén wave regimes, a parameter space highly relevant to the lower part of the Corona. Normalized experimental parameters will be compared to those expected in this region. Comparison with related simulation work will also be presented.

[1] S. Dorfman and T. A. Carter, Observation of an Alfvén wave parametric instability in a Laboratory Plasma, Phys. Rev. Lett. 116, 195002 (2016).

[2] S. Dorfman and T. A. Carter, Nonlinear Excitation of Acoustic Modes by Large-Amplitude Alfvén Waves in a Laboratory Plasma, Phys. Rev. Lett. 110, 195001 (2013).

[3] S. Dorfman and T. A. Carter, Non-linear Alfvén wave interaction leading to resonant excitation of an acoustic mode in the laboratory, Phys. Plasmas 22, 055706 (2015).

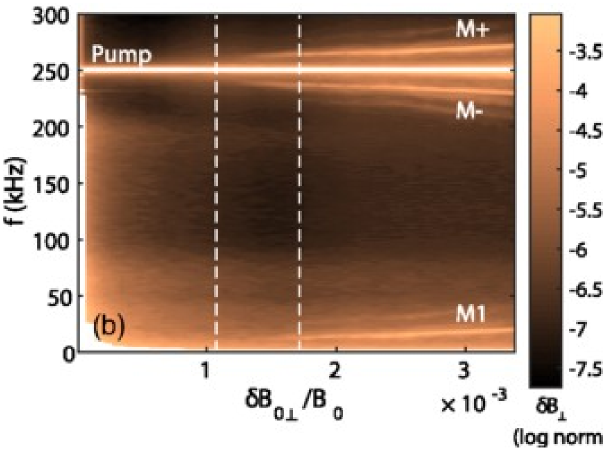

Figure 1: Frequency spectrum as a function of pump wave amplitude. When the pump amplitude is above the threshold for instability, three daughter modes are seen. The daughter mode frequencies show a parametric dependence on pump amplitude. From Ref. [1].