

# Two-fluid kinetic Alfvén wave dispersion in particle-in-cell simulations

Kirit Makwana, Srinikitha Bhagvati

*Department of Physics, IIT Hyderabad, Kandi, Sangareddy,  
Telangana-502285, India*

The kinetic Alfvén wave (KAW) eigenvector relations between the various physical fields (electric, magnetic, density, and velocity fields) derived from a two-fluid model are used to set up KAW modes in a particle-in-cell (PIC) simulation. The propagation of this wave mode is observed in the simulation and its frequency is derived from its propagation speed. The frequency is also calculated by solving the dispersion relation derived from the two-fluid model, and also from a hot-plasma kinetic dispersion relation solver. We find that the simulation frequency matches closely with the kinetic dispersion relation for various plasma beta. The damping rate is also calculated from the simulation, and its behavior is qualitatively similar to the one obtained from kinetic dispersion solver. This shows that the two-fluid eigenvector works properly even in a fully kinetic PIC simulation. This can be useful for future studies of KAW properties.