Nonlinear Coupling of Alfvén Waves With Widely Different Cross-field Wavelengths

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A popular approach to study the evolution and damping of MHD perturbations assumes gradual evolution of wave energy to small dissipative length scales. This can be done by local nonlinear interactions among MHD waves with comparable wavelengths resulting in turbulent cascades, or by the phase mixing and resonant absorption. However, the gradual scenario is inapplicable where fast dissipation times are required. Therefore, we investigate the ability of the large-scale MHD Alfvén waves (MHD AWs) to excite directly the small-scale (kinetic) Alfvén waves (KAWs), which have sufficiently short wavelengths across the magnetic field for the dissipative effects to become significant. We find that in rarified plasmas, where the gas/magnetic pressure ration is less than the electron/ion mass ratio, the presence of finite-amplitude MHD AWs gives rise to the efficient excitation of KAWs via three-wave resonant interaction. This process results in a jump-like transport of MHD AW energy directly in the dissipation range and can be responsible for the plasma energization in the solar corona and in the auroral zones of the terrestrial magnetosphere.