Wave Growth in an Inhomogeneous Medium

R. E. Ergun and D. M. Malaspina

LASP and The Department of Astrophysical and Planetary Sciences, University of Colorado, Boulder, CO

Standard theories of wave growth and evolution describe complex, nonlinear interactions that form the basis of interpreting many emissions from space plasmas including auroral kilometric radiation, solar type II and type III radiation, radiation from shocks, and planetary radio emissions. Many of these theories, however, are built on the assumption that the background medium is uniform even though observations have shown quite the opposite. In almost every important source region, ambient density fluctuations are large enough to invalidate the "uniform background" assumption. Furthermore, observations show that waves invariably are highly localized. For example, the narrow-band source emissions of solar type III radio bursts are a set of widely-scattered, strongly localized packets. Auroral kilometric radiation displays highly modulated wave packets and discrete, drifting, frequency tones. Motivated by observations, we investigate a hypothesis that the spatial- and frequency-domain structure in waves observed in space plasmas is due to ambient density fluctuations. We compare waveform captures from STEREO, FAST, and sounding rockets to eigenmode solutions and find that, in most cases, ambient density perturbations are a plausible explanation for the packet shapes. Under this hypothesis, the ambient density perturbations then can regulate wave growth. Interestingly, eigenmode-dominated waves would be susceptible to nonlinear behavior allowing for electromagnetic emissions to efficiently escape. We also discuss the possibility that eigenmode growth can form the basis for the stochastic wave growth theory that describes the solar type III emissions.