Effects of initial density fluctuations on linear and nonlinear evolution of parametric decay instabilities of circularly polarized Alfven waves

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The parametric decay instability [Goldstein, ApJ, 1978; Derby, ApJ, 1978] is regarded as an important process of damping of large amplitude, low-frequency Alfven waves in the solar wind. Since Alfvenic fluctuations and anisotropic spectra are widely observed in the solar wind, nonlinear evolution of decay instabilities can be related to the formation of the anisotropic spectra of magnetohydrodynamic turbulence in the solar wind. Recently, Shoda and Yokoyama[ApJL, 2018] discussed the relationship between the multi-dimensional decay instability and nonlinear processes such as the phase mixing and the perpendicular cascade.

In this presentation, we discuss roles of initial density fluctuations on the decay instabilities of Alfven waves. Since not only parallel propagating waves but also obliquely propagating waves are unstable to the decay instability [Vinas+Goldstein, JPP, 1991], oblique initial density fluctuations with finite amplitude can preferentially be excited, even if their linear growth rates are not large. In such a case, the growth of the parallel propagating mode is usually suppressed. Numerical results of three-dimensional MHD simulation also show an opposite case, in which the linear growth of the parallel propagating modes is promoted by the effects of the multi-dimensionality. Dependence of linear and nonlinear evolution on wave number spectra of initial waves will be demonstrated.

Keywords: Alfven wave, parametric instability, solar wind plasma

