Consequences of finite ion temperature effects on parametric instabilities of circularly polarized Alfven waves

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Parametric instabilities of finite amplitude, circularly polarized parallel propagating Alfven waves in homogeneous plasma is discussed analytically, taking into account the ion Landau damping and ion Finite Larmor Radius (FLR) effects. A hybrid kinetic-fluid model is systematically derived from one-dimensional Vlasov equation for ion motion in longitudinal direction and the FLR-Hall Magnetohydrodynamic (MHD) equations for transverse directions. The longitudinal kinetic effects are retained in the model, whereas transverse kinetic effects such as ion cyclotron damping is neglected. Validity of the model is justified as far as the collisionless damping is concerned, since the ion cyclotron damping for typical quasi-parallel Alfven waves in the solar wind is considered to be extremely small.

As already shown in a number of past studies, inclusion of the kinetic effects let some new instabilities emerge, while that reduces the growth rates of fluid instabilities in general. Furthermore, as a consequence of the FLR effects, the growth rates of the fluid instabilities of the LH- (RH-) mode are reduced more strongly (weakly) in the FLR-Hall-MHD model than in the Hall-MHD model. Numerical results of the present model and those of the models using collision-like (local) damping terms do not agree well, suggesting the importance of using the exact Landau-type interactions. The models and results demonstrated here can be applied to the parametric instabilities of Alfven waves in the solar wind near the earth, in which finite ion temperature effects are eminent.