# Parametric instabilities of whistler waves revisited

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Nonlinear wave-wave interactions such as parametric instabilities play an essential role in plasma turbulence. The existence of the spectrum anisotropy in solar wind turbulence near 1AU suggests that the damping of quasi-parallel propagating right-handed polarized magnetohydrodynamic (MHD) waves (whistler waves) may occurs in the interplanetary space. Although the parametric instabilities of whistler waves have been studied over for more than forty years, recent studies do not pay much attention to these. This may be because it is believed that the linear collisionless damping dominates the damping of these waves. However, the recent numerical simulation suggests that the parametric instabilities take place, even if the frequency of the parent wave is very close to the electron cyclotron frequency (Umeda, Saito, Nariyuki, submitted to ApJ). In the present study, we revisit the linear analysis of the parametric instabilities of parallel propagating whistler waves. We apply the Hall-MHD system including finite electron mass and collisionless damping to our analysis. The importance of the parametric instabilities to the ion and electron heating (the energy dissipation scale of the whistler waves) is discussed by comparison with the past theoretical analysis.