Vlasov simulation of finite amplitude magnetohydrodynamic waves in solar wind : Parametric instability of Alfven waves

Takashi Kumashiro[1]; Yasuhiro Nariyuki[2]; Tohru Hada[3]; Takayuki Umeda[4]

[1] ESST, Kyushu Univ.; [2] KNCT; [3] ESST, Kyushu Univ; [4] STEL, Nagoya Univ.

http://www.esst.kyushu-u.ac.jp/˜space/

Since the solar wind is a high beta plasma, ion kinetic effects in general cannot be neglected in discussions of magnetohydrodynamic (MHD) waves. Until now, hybrid code (super-particle ions + electron fluid) is the most commonly used to numerically study the kinetic effects in the solar wind MHD waves. However, use of the super-particles introduces rather large numerical noise. In order to overcome this difficulty, we have recently developed a Vlasov-Hall-MHD code, in which the Vlasov equation is solved along the main (longitudinal) axis, while the Hall MHD equations are solved for the transverse directions.

Our research interest is in the solar wind quasi-parallel Alfven waves. Since they are typically robust for linear ion-cyclotron damping (due to their small wave frequencies) and for linear Landau damping (due to their small propagation angle to the background magnetic field), parametric instabilities are believed to play important roles in dissipation of such quasi-parallel Alfven waves.

In this study we examine long time consequences of parametric instabilities of solar wind Alfven waves using the Vlasov-Hall-MHD simulations. Growth rate of the decay instability agrees well with analytical solutions and also with hybrid simulation runs using the same set of parameters. Evolution of ion distribution functions (heating and acceleration of ions) and ion temperature effect on the decay instability will be discussed.