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Plasma heating by nonlinear development of a finite amplitude whistler wave

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A two-dimensional, three-velocity (2D3V) particle-in-cell simulation has been done in order to study nonlinear development of a finite amplitude and long wavelength R-mode wave propagating parallel to the mean magnetic field, where the fluctuation energy is 10% of the mean magnetic field and the wavelength is about the ion inertial length. The simulation has shown that the bulk motion associated with the finite amplitude wave triggers the modified-two-stream instability that generates electrostatic field in the quasi-perpendicular direction. The electrostatic field scatters ions in the perpendicular direction and electrons in the parallel direction. About 70% of fluctuation energy of the initially imposed R-mode decreases in one gyro-period of ion. The dissipation through the modified-two-stream instability in the two-dimensional system is more effective than the parametric instability in the one-dimensional system. Further the simulation found that quasi-perpendicular-propagating electromagnetic fluctuations are enhanced through the nonlinear development of the R-mode. Discussion will focus on both the plasma heating and the nonlinearly enhanced fluctuations propagating quasi-perpendicular directions.

Keywords: Whistler wave, Solar wind, Nonlinear development, Plasma heating, Particle-in-cell simulation