Numerical Simulation of Ion Waves in Dusty Plasmas

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(ABSTRACT)

There has been a great deal of interest in investigating numerious unique types of electrostatic and electromagnetic waves and instabilities in dusty plasmas. Dusty plasmas are characterized by the presence of micrometer or submicrometer size dust grains immersed in a partially or fully ionized plasma. In this study, a two-dimensional numerical model is presented to study waves and instabilities in dusty plasmas. Fundamental differences exist between dusty plasmas and electron-ion plasmas because of dust charging processes. Therefore, a primary goal of this study is to consider the unique effects of dust charging on collective effects in dusty plasmas. The background plasma electrons and ions here are treated as two interpenerating fluids whose densities vary by dust charging. The dust is treated with a Particle-In-Cell PIC model in which the dust charge varies with time according to the standard dust charging model. Fourier spectral methods with a predictor-corrector time advance are used to temporally evolve the background plasma electron and ion equations. The dust charge fluctuation mode and the damping of lower hybrid oscillations due to dust charging, as well as plasma instabilities associated with dust expansion into a magnetized background plasma are investigated using our numerical model. Also, an ion acoustic streaming instability in unmagnetized dusty plasmas due to dust charging is investigated. The numerical simulation results show good agreement with theoretical predictions and provide further insight into dust charging effects on wave modes and instabilities in dusty plasmas.

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Contents

List of figures