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Simulation of Space Plasmas with Kappa Distributions

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Abstract content
 (Max 300 words)

Plasma simulation provides a useful and cost effective tool to model the non-linear evolution of a variety of space plasma phenomena. The ready availability of fast modern workstations and supercomputers have provided the means for conducting research using large scale simulations. The particle-in-cell (PIC) simulation technique models the plasma as being composed of superparticles which typically have a larger charge and mass than real plasmas and are a necessity when using a spatial grid. The simulation follows the trajectory of each of these particles. The advantage of this is that kinetic effects such as wave damping and growth may be examined. It allows for the investigation of the non-linear regime of plasma instabilities including their eventual saturation, which is difficult to accomplish analytically. One of the major benefits of this simulation technique is the ability to produce velocity phase space plots for the particles. These plots graphically show the evolution of the instability, growth and saturation, and particle trapping which is a phenomenon caused by wave-particle interactions.

A brief overview of the technique of plasma simulation using a one dimensional electrostatic PIC code will be described as well as the application of this code to two plasma wave modes. First, results from a simulation of the ion acoustic instability will be shown. Second, results from a simulation of electrostatic Bernstein waves, propagating perpendicular to a static ambient magnetic field, will be presented. Whereas it is customary to load the particles in PIC simulations with Maxwellian distributions, we employ instead a kappa distribution loading. The kappa distribution, with its power law tail, more accurately reproduces observed particle velocity distributions in space plasmas, motivating our investigation. The significance of the results will be discussed briefly.

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