Superthermal Particle Effects On Solitons In A Symmetric Four-species Electron-Positron Plasma

Tamirat G. Gogo and Manfred A. Hellberg
School of Chemistry and Physics, University of KwaZulu-Natal, Durban, 4000, South Africa

Because of the high symmetry of a simple EP plasma, it cannot support acoustic waves. We have investigated acoustic solitons in a symmetric four-species EP plasma, consisting of equal densities (N_h) of hot kappa-distributed electrons and positrons at temperature T_h, and cold fluid electrons and positrons (density N_c) at temperature T_c. Such a plasma models the mixing of two, separately created, EP-pair plasmas, on a timescale short enough that full thermalization has not yet taken place. The kappa-distributed hot components enable one to investigate the effects of excess superthermal particles present in many nonthermal distributions.

Using the fully nonlinear Sagdeev pseudopotential approach, arbitrary amplitude nonlinear waves have been studied. Upper and lower limits on the Mach number, as well as other conditions of the model, lead to conditions that define existence domains in parameter space for solitons. The dependence of the soliton amplitude on different plasma parameters has also been investigated. It is found that solitons in low-kappa plasmas are supported over a wider range of the relative density ratio, N_c/N_h, than in the Maxwellian case studied by Verheest et al. [1]. Soliton amplitudes are relatively small in general. In fact, for fixed true Mach number, solitons in a low-kappa plasma have amplitudes smaller those reported earlier [1]. However, for fixed absolute soliton speed, soliton amplitudes decrease as the excess superthermal component is decreased (kappa is increased).

[1] F.Verheest, M.A. Hellberg, G.J. Gray and R.L. Mace, *Astrophys. Space Sci.* **239**, 125 (1996)