Electrostatic Supersolitons At The Acoustic Speed In Nonthermal Plasmas

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The concept of acoustic supersolitons was recently introduced for a very specific plasma with five constituents, and discussed only for a single set of plasma parameters. Supersolitons are characterized by having subsidiary extrema on the wings of a typical bipolar electric field signature, or by association with a root beyond double layers in the fully nonlinear Sagdeev pseudopotential description. It was subsequently found that supersolitons could exist in several plasma models having three constituent species, rather than four or five. It is worth pointing out that supersolitons cannot be described by weakly nonlinear theories such as reductive perturbation analysis, no matter how small their amplitudes.

Another recent aspect of Sagdeev pseudopotentential theory is that in certain plasma models and parameter regimes there can exist solitons and/or double layers at the acoustic speed, which also have no reductive perturbation counterparts. Importantly, they signal coexistence between solitons having positive and negative polarity, with the implicit understanding that only one solution can be realized at a time, depending on the infinitesimal perturbations from the equilibrium state.

Weaving the two strands together, one can even find finite-amplitude double layers and supersolitons at the acoustic speed. This will be illustrated using the model of cold positive and negative ions, in the presence of nonthermal electrons following a Cairns distribution. Some properties of this model have been discussed in the literature [1], but the existence of supersolitons at the acoustic speed was not yet established at the time of publication.

[1] F.Verheest, M. A. Hellberg and I. Kourakis, *Electrostatic supersolitons in three-species plasmas*, Phys. Plasmas **20**, 012302 (2013).