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Overtaking collisions of small-amplitude supersolitons in a plasma with cold ions and two-temperature Boltzmann electrons

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Solitons are spatially localized solitary waves that propagate without changing shape or velocity, and arise as bipolar structures in the electric field. A special class of solitons have recently been reported, namely supersolitons [1]. Supersolitons are deformed solitons with additional local minima and maxima in the electric field, giving rise to so-called “wiggles in the tails”. Supersolitons have been predicted theoretically in many different plasma models. It was also shown to be stable via fluid simulations [2]. However, the collision properties have not been considered. In this paper, we use a reductive perturbation analysis to study supersolitons in a plasma consisting of cold ions and two-temperature Boltzmann electrons. A Korteweg-deVries-type equation is derived that governs small-amplitude supersolitons. This equation is used to simulate supersoliton collisions, in order to determine the properties of overtaking soliton-supersoliton and supersoliton-supersoliton collisions.

[1] A. E. Dubinov and D. Yu. Kolotkov, Interpretation of ion-acoustic solitons of unusual form in experiments in SF_6-Ar plasma, High Energy Chem. 46, 349—353 (2012).

[2] A. Kakad, A. Lotekar and B. Kakad, First-ever model simulation of the new subclass of solitons “Supersolitons” in plasma, Phys. Plasmas 23, 110702 (2016)

Summary

We use a reductive perturbation analysis to study supersolitons in a plasma consisting of cold ions and two-temperature Boltzmann electrons. A Korteweg-deVries-type equation is derived that governs small-amplitude supersolitons. This equation is used to simulate supersoliton collisions, in order to determine the properties of overtaking soliton-supersoliton and supersoliton-supersoliton collisions.

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