Superthermal effects on the two-dimensional dynamics of electrostatic solitons in laser plasmas

G. Williams*, S. Sultan and I. Kourakis
Centre for Plasma Physics, School of Mathematics and Physics, Queen's University Belfast, BT7 1NN, Northern Ireland, UK

Ion-acoustic solitons can be generated during the nonlinear evolution of a plasma fluid. Motivated by recent experimental observations, in which electrostatic solitary structures were detected in laser-plasma experiments [1], we have undertaken an investigation of the nonlinear dynamics of plasma evolving in two dimensions, in the presence of excess superthermal background electrons.

The effect of a magnetic field on weakly nonlinear ion acoustic waves is investigated. Nonlinear propagation of the ion-acoustic (IA) shock waves in a non-thermal magnetised plasma is shown to be governed by a hybrid Zakharov-Kuznetsov/Burgers-type equation, where dissipation is modelled via an ad hoc damping term. A reductive perturbation technique (RPT) is used to derive the KdVB-ZK equation. Different types of shock solutions are obtained, depending on the relation between the system parameters. Excess superthermality of the electrons is considered via a kappa-type distribution, and the effect of excess superthermality on electrostatic shock structures is investigated numerically. A parametric investigation is conducted into the role of plasma non-thermality and magnetic field strength.

[1] Marco Borghesi, Gianluca Sarri and collaborators, Queen’s University Belfast.

* Email: gwilliams06@qub.ac.uk