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Interaction of dust-ion acoustic solitons with cubic nonlinearity in a magnetized dusty plasma with (r, q) distributed electrons

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Dust ion acoustic waves (DIAWs) are analyzed in multi-component plasmas via reductive perturbation technique comprising inertial ions, (r, q) distributed electrons and stationary dust by using fluid theory of plasmas. The modified Kadomtsev-Petviashvili (MKP) equation is obtained for the critical condition at which the quadratic nonlinearity vanishes. Hirota's bilinear formalism

is employed, for the first time, to study the two-soliton solutions of MKP equation in the context of plasma physics. It is investigated how the flatness at low energy (represented by r) and superthermality at high energy (represented by q) of electrons in phase space affect the linear and nonlinear propagation of DIAWs. It is found that the amplitude of the nonlinear DIAW is highest for the flat-topped distribution whereas it is lowest for kappa distribution. Using the plasma parameters of Saturn's B-ring, we have given the estimates of the spatial scales over which the MKP solitons form for flat-topped, kappa and Maxwellian distributions, respectively. We have also discussed in detail how the presence of dust and non-Maxwellian electron distributions affect the interaction of MKP solitons in the Saturn's B ring.

In addition, the interaction of a compressive and rarefactive soliton is studied giving results not achievable for KdV and KP equations.

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