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Nonlinear Quantum Dust Acoustic Waves

Wael Farouk Hamed El-Taibany
Department of Physics, Graduate School of Science, University of Tokyo

The quantum hydrodynamic model (QHD) for plasmas is employed to study the dynamics of the nonlinear quantum dust acoustic (QDA) wave in a nonuniform quantum dusty plasma (QDP). Through the reductive perturbation technique, it is shown that the quantum hydrodynamical basic equations describing the nonlinear QDA waves yield a modified Korteweg-de Veries (MKdV) equation with slowly varying coefficients in the system inhomogeneity. Applying generalized expansion method (GEM), it is found that the system admits only rarefactive solitons. The properties of the solitons such as the velocity, the amplitude and the width of the nonlinear QDA waves are analyzed using appropriate choice for initial ion and electron density numbers. For the homogeneous QDP, no critical value is found. Because of the system inhomogeneity, a new criticality is found forcing with the usage of a new stretching coordinates. A higher evolution equation with third-order nonlinearity is derived at the critical values. The solution of the latter equation admits rarefactive shock wave attached with an amplitude factor. The present investigations should be useful for researchers on astrophysical plasmas as well as for ultrasmall micro- and nano- electronic devices.