We investigate the existence of envelope soliton solutions in a collisionless quantum plasmas, using the quantum-corrected Zakharov set of equations in the kinetic case, which describes the interaction between high frequency Langmuir waves and low frequency plasma density variations. We show the role played by quantum effects in the nonlinearity/dispersion balance leading to the formation of soliton solutions and the stability of quantum nonlinear Schrödinger (QNLS) equation.

Keywords: quantum Zakharov equations; quantum plasma; Schrödinger equation; soliton

Quantum effects are expected to play a central role in the performance of today’s microelectronic devices, for which classical transport models are not always adequate in view of the increasing miniaturisation level. Hence, the topic of quantum plasmas has recently attracted considerable attention [1-3] and it is desirable to achieve a good understanding of the basic properties of quantum transport models.

At the classical level, a set of coupled nonlinear wave equations describing the interaction between high-frequency Langmuir waves with low frequency plasma density variations was first derived by Zakharov [4]. For the classical model, one can find many kinds of solitons by various methods. In this work, we focus on the solutions to the quantum-corrected Zakharov equations. The purpose of this study is to investigate the role played by quantum effects in the quantum-corrected Zakharov system; these effects modify the dispersion-nonlinearity equilibrium, which is the ultimate factor responsible for the existence of solitons. Numerical we also study the stability of the soliton solutions of the QNLS equation.

Figure 1: The soliton profile is stable (solid line) (remains localized) for $H = 0$ and spatially unstable (dashed line) (spreads) for $H = 0.3$.