Quantum Solitons and Localized Modes in a One-Dimensional Lattice Chain with Nonlinear Substrate Potential

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Abstract: In the classical lattice theory, solitons and localized modes can exist in many one-dimensional nonlinear lattice chains, however, in the quantum lattice theory, whether quantum solitons and localized modes can exist or not in the one-dimensional lattice chains is an interesting problem. By using the number state method and the Hartree approximation combined with the method of multiple scales, we investigate quantum solitons and localized modes in a one-dimensional lattice chain with the nonlinear substrate potential. It is shown that quantum solitons do exist in this nonlinear lattice chain, and at the boundary of the phonon Brillouin zone, quantum solitons become quantum localized modes, phonons are pinned to the lattice of the vicinity at the central position $j=j_0$.

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