Structure, Dynamics and Bifurcations of Discrete Solitons in Trapped Ion Crystals

We study discrete solitons (kinks) [1] accessible in state of the art trapped ion experiments, considering zigzag crystals and quasi-3D configurations, both theoretically and experimentally [2, 3]. We first extend the theoretical understanding of different phenomena predicted and recently experimentally observed in the structure and dynamics of these topological excitations. Employing tools from topological degree theory, we analyze bifurcations of crystal configurations in dependence on the trapping parameters, and investigate the formation of kink configurations and the transformations of kinks between different structures [4]. We calculate the effective potential experienced by solitons within the Coulomb crystal from basic principles, and study how this (so-called Peierls-Nabbaro) potential can get modified to a nonperiodic globally trapping potential in certain parameter regimes. The kinks' rest mass (energy) and spectrum of excitations are computed and the dynamics of linear and nonlinear oscillations of kink modes are analyzed. We also present novel configurations realized experimentally, of kinks with an embedded molecular ion representing a large-mass defect, and of stable pairs of interacting kinks, and study theoretically their energy of interaction.

References

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