Quantum Physics

Time Dependent Variational Principle and Coherent State Orbits for a Trapped Ion

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Spectral properties of the Hamiltonian function which characterizes a trapped ion are investigated. In order to study semiclassical dynamics of trapped ions, coherent state orbits are introduced as sub-manifolds of the quantum state space, with the K\"ahler structure induced by the transition probability. The time dependent variational principle (TDVP) is applied on coherent states' orbits. The Hamilton equations of motion on K\"ahler manifolds of the type of classical phase spaces naturally arise. The associated classical Hamiltonian is obtained from the expected values on symplectic coherent states of the quantum Hamiltonian. Spectral information is thus coded within the phase portrait. We deal with the bosonic realization of the Lie algebra of the SU(1,1) group, which we particularize for the case of an ion confined in a combined, Paul and Penning trap. This formalism can be applied to Hamiltonians which are nonlinear in the infinitesimal generators of a dynamical symmetry group, such as the case of ions confined in electrodynamic traps. Discrete quasienergy spectra are obtained and the corresponding quasienergy states are explicitly realized as coherent states parameterized by the stable solutions of the corresponding classical equations of motion. A correspondence between quantum and classical stability domains is thus established, using the Husimi representation.

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