

Generalized Pechukas-Yukawa formalism for quantum systems with discrete energy spectra

Alexandre Zagoskin

Loughborough University, Epinal Way, Loughborough, United Kingdom

The success of a perturbation theory expansion is determined by the appropriate choice of the zero-order approximation. The Pechukas-Yukawa formalism provides a promising alternative approach to the description of perturbed quantum systems with discrete energy spectra. It implicitly uses the matrix elements of the Hamiltonian in the basis of exact instantaneous eigenstates rather than the eigenstates of the unperturbed Hamiltonian. In this formalism, the evolution of the energy spectrum due to the perturbation is reduced to the Hamiltonian dynamics of a 1D classical gas of particles with cubic repulsion (a modified Calogero-Sutherland model). We develop the kinetic theory of this gas (BBGKY chain of equations for the probability distribution functions), which serves as the basis for the equations for the density matrix of the underlying quantum system. The approach provides a good basis for a perturbative treatment of the evolution of the density matrix of a quantum system in the presence of a time-dependent perturbation, and gives an insight into the evolution of large quantum systems.

This work was supported by EU Horizon 2020 Research and Innovation Program under Grant Agreements No. 863313 (SUPERGALAX) and No. 101129663 (QRC-4-ESP), UKRI Horizon Guarantee programme, and EPSRC through the grant No.EP/M006581/1.