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Control in boson-boson dynamics through long time scale discontinuities

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Abstract content
   (Max 300 words)

The quantum model for a damped harmonic oscillator, linearly coupled to a continuous distribution of field modes, has been exactly diagonalized in terms of the coupling function. For the Drude model, the formal solution provides oscillations of the time evolution of the expectation values of position, momentum and number of excitations, enveloped in exponential decays. We consider a class of spectral densities ranging from sub- to super-ohmic regimes at low frequencies, recovering the Drude form as a limiting case and we provide an exact description of the dynamics through Fox-H functions. Furthermore, the analysis of the long time scale dynamics is extended to spectral densities either sub- or super-ohmic near an arbitrary band-gap, with an arbitrary cut-off. The inverse power law long time evolution shows discontinuities and, especially, arbitrary slow relaxations of the expectation values in correspondence of critical frequencies of the main oscillator depending on the first negative moment of the spectral density. This effect allows to engineer environments that enhance arbitrarily the lifetime of the excitations. This condition is suitable for the study of the quantum domain of opto- and nano-mechanical resonators.

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