Decay dynamics in a periodically driven open quantum system

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The exponential and non-exponential decay processes of an open quantum system driven by an external oscillating field are investigated. We consider a system in which a discrete impurity is weakly coupled to a one-dimensional continuum and the energy of the impurity is driven by an oscillating field. The survival probability at the impurity is calculated in terms of the complex spectral analysis of the Floquet Hamiltonian. With this method we can unambiguously decompose the survival probability into the exponential decay component, the oscillating component, and the power law decay component. We discuss the effects of the driving field on the time evolution of these components.

The exponential component that dominates the survival probability in the intermediate time region is associated with the resonance state. The exponential decay rate given by the imaginary part of the eigenvalue is significantly modified by the driving field. In the small band case where the width of the continuum is small compared with the frequency of the driving field, the exponential decay is completely suppressed when the ratio between the amplitude and frequency of the driving field satisfies the zeroes of the Bessel function [1]. The oscillating component associated with bound states near the band edges does not decay because the eigenvalues are real. However, the amplitude of this component depends on the driving field and even vanishes when the corresponding eigenvalues move to the second Riemann sheet in the complex energy plane due to the influence of the driving field [2]. The power law decay component coming from the contribution of the continuum states dominates the survival probability in the long time region. During the intermediate time domain (long time near zone) the dynamics follows a t^{-1} decay, while in the asymptotic domain (long time far zone) it follows a t^{-3} decay [3]. The characteristic time scale dividing these two zones can be modified by the driving field [4].

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