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Increase of rabi oscillations and excited state decay under resonant condition

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Abstract

The system of two electronic levels coupled to a single vibrational mode interacting with a heat bath has been studied theoretically. On the basis of the numerically calculated time dependences of electronic occupation probability we have shown that the rate of electronic excited state increases simultaneously with the increase of Rabi oscillations for resonant conditions. Namely, for integer ratio of electronic energy and vibrational quantum we observe a significant amplifying of the effect which is also controlled by the electronic inter-state coupling, Huang-Rhys factor and system-bath coupling.

***Key words**: Excited state decay, Resonant energy transfer, Electron-vibrational coupling, Rabi oscillations*

1. Introduction

Energy transfer processes in inorganic, organic and hybrid systems have attracted attention in the last several decades. Among them, the semiconductor- or organic-based quantum dots (QD) have much in common. It was calculated that within GaAs QDs the rate of electronic population transfer resonantly increases for the integer ratio of electronic excitation energy and energy quantum of longitudinal-optical (LO) phonons (Král and Khás, 2001). The effect can be attributed to the multi-phonon electronic scattering (Král and Khás, 1998). In a similar way, the resonant amplifying of the electronic energy decay was predicted in a molecular physics, where the interacting vibrational manifold was separated into the single (active) mode and heat bath (passive modes) (Menšík *et al.*, 2005). The latter model is a standard model of the energy and charge transfer in chemical physics. In our work we utilize the same model and we show that simultaneously with resonantly amplified excited decay there is also a significant increase of Rabi oscillations of the excited state population. The latter effect corresponds to the so called adiabatic limit, where a strong coherent coupling between the excited and ground electronic states is found.

2. Theoretical model

In the following, we will assume first that two electronic states both ground and excited or two excited ones, will be interacting strongly with a single vibrational mode. Next, we assume that the coupling of the rest of the vibrational manifold to electronic states can be neglected, but that it is coupled to the single vibrational

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