Decay and persistence of spatial coherence in various spatial configurations of two quantum dots

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Abstract

Systems consisting of two semiconductor quantum dots (QDs) have richer physical properties than an individual QD. Some experiments show that collective emission effects [1] play a role in the optical response of such systems, which suggests that they cannot be treated as ensembles of independent emitters. One of the interesting features observed in the experiment [2] is the difference between the time resolved emission under quasi-resonant (optical transition to higher confined shells) and non-resonant (transition to wetting layer or bulk states) excitation. This suggests that spatial coherence, which is lost during carrier capture to the QDs, must be to some extent conserved during relaxation between confined states.

In this contribution, we present the results of modeling of the evolution of spatial coherence during intraband relaxation of carriers in a pair of spatially separated semiconductor QDs.

In the first scenario, the system consists of two vertically stacked QDs, including the coupling to acoustic phonons. We present results of theoretical study, in particular, we show that such coherence can be transferred from optically excited higher states to the QD ground states [3]. The phonon-assisted mechanism of coherence transfer leads to a dependence of the amount of the resulting coherence on the inter-dot distance and temperature. We also show the impact of carrier-phonon dynamics on a coupled system, where spatial coherence is present in the delocalized ground state.

In the second scenario, we take into consideration the horizontally placed QDs, coupled not only to the acoustic phonon reservoir, but also to optical phonons. Using the method of collective modes, we study theoretically the relaxation of polarons in the system. In particular, we investigate the impact of polaron effects into the evolution of spatial coherence. Our results may contribute towards the full uderstanding of the optical emission from double QDs, in particular collective effects.

References

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