Combined effects of the electron-hole exchange and Förster energy transfer interactions in self-assembled quantum-dot pairs

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At present, semiconductor quantum dots (QDs) are of great interest due to their potential usefulness in the advance of different optoelectronic technologies, including emitters for photon-based quantum information [1-3]. However, the optimization of such devices for applications at the industrial level, requires comprehensive understanding of the optical response of single emitters under different influences such as the optical Stark effect, electric/magnetic fields, asymmetric stress fields, and non-negligible electron-hole exchange [4,5]. Besides that, if neighboring dots are close enough, resonant tunneling and Förster energy transfer may play a substantial role on the photon-emission dynamics.

Particularly, the electron-hole exchange and the Förster energy transfer, both usually modeled in terms of dipole-dipole interactions, are phenomena that exhibit similar spatial ranges and consequently alike energy scales, in despite of the interdot character of the former as compared to the intradot character of the latter [6,7].

In this work, we study the spin evolution of an optically-generated bright exciton confined in a pair of self-assembled quantum dots, that simultaneously undergo both intra and interdot interactions. On the one hand, each radiative dipole is subject to electron-hole exchange, while on the other hand, they are subject to exciton-exciton interaction due to the near presence of a second excited dot, as illustrated in figure 1.

By means of numerically solving the corresponding Lindblad master equation, we simulate the interplay of these two interactions on the time dependent polarization of the exciton spin. The simulation results suggest that under particular conditions, the composed effect of both decoherence channels, favors preservation of the spin direction, which represents a very convenient scenario for the extended use of quantum dots as reliable on-demand sources of polarized photons.

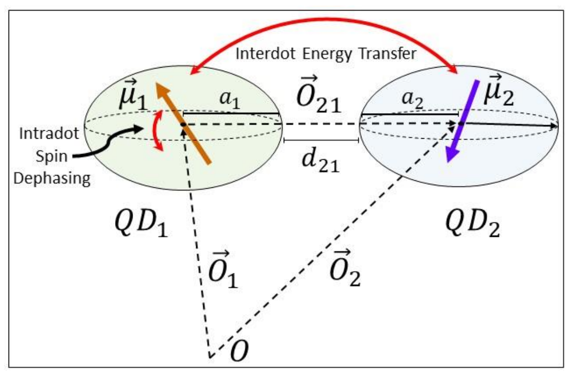

Fig.1. Schematics of the theoretical model. The exciton dipoles interact through electron-hole exchange and near field Forster-type energy transfer.

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