Signatures of Förster and Dexter Couplings between Quantum dots in 2D Spectroscopy

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Two major types of coupling mechanism lead to excitation energy transfer between nanostructures: Dexter- and Förster coupling. We show theoretically, that both couplings between two quantum dots can be distinguished by the double quantum coherence spectroscopy technique.

There are two major Coulomb coupling for exciton transfer between two nanostructures Förster and Dexter coupling. In this contribution, we focus on the coupling between two semiconductor quantum dots. Förster coupling is a pure dipole-dipole coupling and can in quantum dots either preserve the spin state or flip the spin state of excited electrons depending on the quantum dot orientation [3].
However Dexter coupling relies on an exchange of electrons and thus on an electronic wave function overlap and preserves always the spin of the excited electron. Nevertheless both mechanism can lead to a hybridization of the excitons of the coupled system and can therefore lead to a delocalization of the exciton wave function.

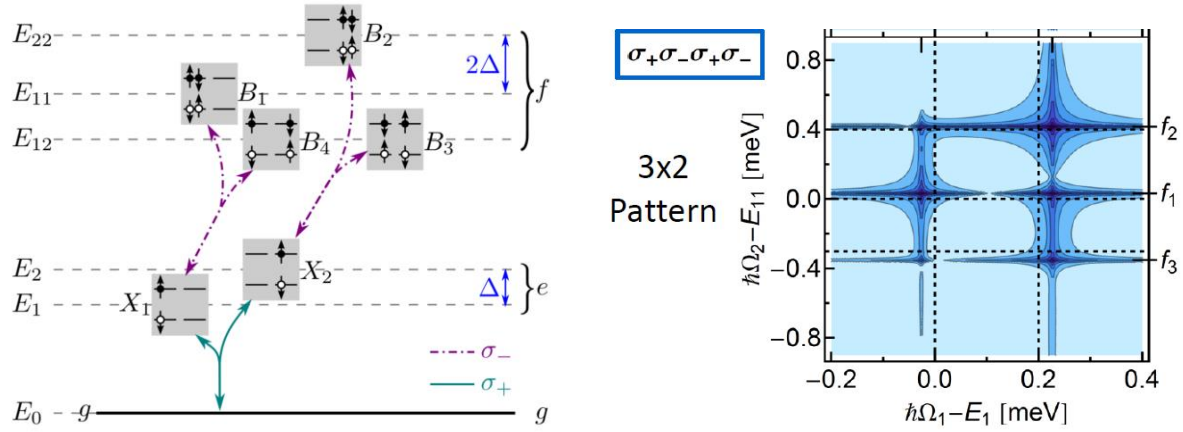

Fig.1 (left) Level scheme of the single and two exciton basis elements of two coupled semiconductor quantum dots and their selection rules for spin-preserving Förster coupling [1]. (right) Example of a double quantum coherence spectrum for alternating circular polarizations for spin-preserving Förster coupling[1].

Furthermore we show theoretically, that the polarization of the exciting laser pulses of the double quantum coherence allows to control the different excitation pathways. Depending if Förster or Dexter coupling dominates the selection rules and number of the formed bright exciton and two exciton states varies and allows to distinguish the different regimes using the pattern of the double quantum coherence spectroscopy.
In order to show this we will give an in depth discussion of the optical selection rules and their dependence on the different coupling mechanisms.
Overall we conclude that 2D spectroscopy allows to determine the dominating coupling process for two coupled quantum dots.

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[2] J. F. Specht, M.Richter; Proc. SPIE 9361, Ultrafast Phenomena and Nanophotonics XIX, 93610A (2015).
[3] G.D. Scholes and D.L. Andrews, Phys. Rev. B **72**, 125331 (2005)