Controlled coherent coupling in a quantum dot molecule measured with nonlinear spectroscopy

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Semiconductor quantum dot molecules are considered as promising candidates for quantum technological applications due to their wide tunability of optical properties and coverage of different energy scales associated with charge and spin physics. While previous works have studied the tunnel-coupling of the different excitonic charge complexes shared by the two quantum dots by conventional optical spectroscopy, we here report on the first demonstration of a coherently controlled inter-dot tunnel-coupling focusing on the quantum coherence of the optically active trion transitions. We employ ultrafast four-wave mixing spectroscopy to resonantly generate a quantum coherence in one trion complex, transfer it to and probe it in another trion configuration. With the help of theoretical modelling on different levels of complexity we give an instructive explanation of the underlying coupling mechanism and dynamical processes.