PHONON-INDUCED QUALITY ENHANCEMENT OF QUANTUM DOT-BASED PHOTONIC SOURCES

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Semiconductor quantum dot-cavity systems are widely discussed as sources of highly nonclassical photonic states, such as single photons and pairs of polarization-entangled photons. Since the pure-dephasing type coupling to longitudinal acoustic phonons has been identified as the key decoherence mechanism for quantum dot excitons one would naively expect the phononic influence on the quality of the target photonic states to be of a similar detrimental nature. But, quite unexpectedly, we were able to theoretically identify situations leading to a phonon-enhancement of single-photon purity [1] and photon entanglement [2].

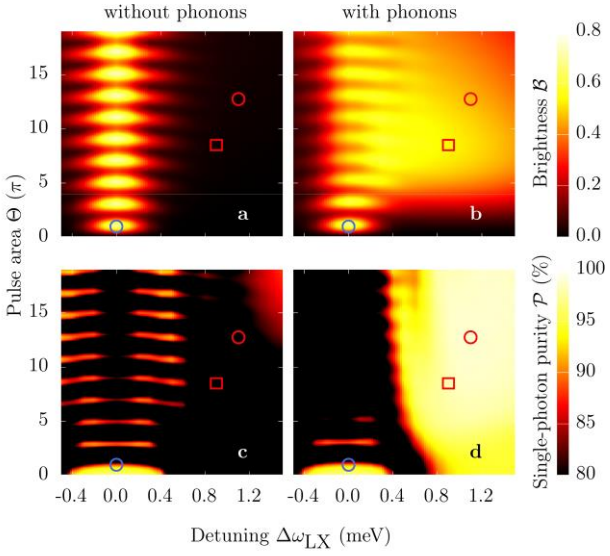

Fig. 1. Source brightness (a,b) and single-photon purity (c,d) as a function of the laser-exciton detuning and the pulse area. Image taken from Ref. [1].

Comparing the standard resonant π-pulse excitation with off-resonant phonon-assisted schemes in terms of source brightness and single-photon purity reveals a wide parameter regime, where the single-photon purity is close to or beyond the value obtained in the resonant scheme for otherwise identical parameters [1] (cf. Fig. 1 d) and the brightness does not drop significantly (cf. Fig. 1 b). Besides numerous experimental advantages, off-resonant schemes ultimately pave the way to excite two or more spatially separated dots with the same laser, which is a crucial step towards complex quantum networks.

Furthermore, we predict a phonon-induced enhancement of photon entanglement in the biexciton-exciton cascade in a certain parameter range caused by a combination of phonon-induced dephasing and renormalization of the cavity coupling strength.

References

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