Toward quantum dot based quantum networks

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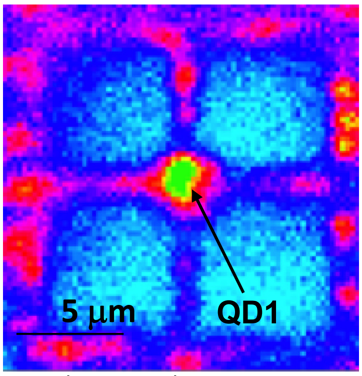
Semiconductor quantum dots (QDs) are very promising artificial atoms for quantum information processing; they can generate flying quantum bits in the form of single photons or polarization entangled photon pairs. They show single photon sensitivity, which can be used to implement quantum logic gates; and, last but not least, the spin of a carrier trapped in a QD can be used as a quantum memory. The scalability of a QD based quantum network requires having efficient interfaces between stationary and flying quantum bits. In the last few years, our group has made significant progresses in this direction using cavity quantum electrodynamics.



By deterministically positioning a single QD in a microcavity, we control its spontaneous emission at will [1]. With such a tool, we fabricate ultrabright sources of single photons and of entangled photon pairs, with brightnesses as high as 80% [2]. By controlling the charge environment of the QD in a gated structure [3], we demonstrate near unity indistinguishability of the emitted photons. Symmetrically, we have made important progresses in the development of an efficient interface between a flying quantum bit and a stationary one. We show that a single spin in a cavity can macroscopically rotate the polarization of photons [4] and reach the regime where coherent control of a quantum bit can be done with only few photon pulses.

References

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[3] A. Nowak. et al., Nature Communications 5, 3240 (2014)