TRR 142
Tailored Nonlinear Photonics

TRR Guest Scientist Lecture / Seminar

Date/Time: 04.09.2015 / 11am
Location: UPB / P8.409

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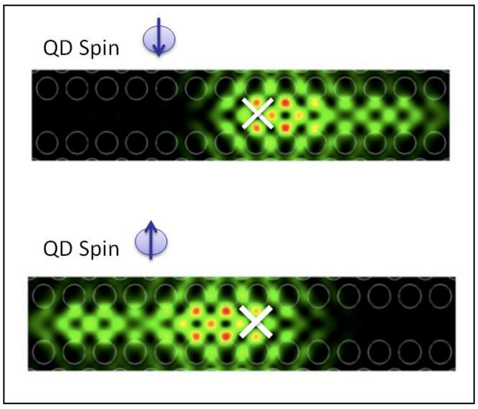
Coupling electron spin and light spin: the surprising results of doing cavity QED with artificial atoms

Abstract:

Quantum dots are semiconductor artificial atoms. They are nanoscale structures that trap single electrons and holes, and their quantized energy level structure results in atomic-like transitions and single photon emission. These quantum dots act as a solid-state interface that is useful for quantum information applications, and for the past decade, semiconductor physicists have been attempting to replicate atomic cavity quantum electrodynamics in a practical semiconductor form. One can embed quantum dot into micron-sized photonic structures to capture and control the light emission, in order to use the single photon emission in quantum communication and quantum circuits.



One of the most exciting applications of quantum dots is to use their electron spins as a quantum memory. This involves transferring spin information from an electron spin to the polarization of a photon. However, as I shall explain, the definition of "polarization" for nanophotonic structures is far more complex than for a beam of light. In fact, we find that point-like "spin" emitters couple to a photonic structure in surprising ways: unlike any phenomenon observed in bulk material, simply changing the position of an emitter or the spin direction controls completely in which direction photons propagate. Suddenly, a rich variety of behaviour has arisen in the semiconductor/photonic domain, which has no equivalent in atomic cavity QED, including a fundamental difference between how a classical dipole and a quantum dipole emitter interfere with incoming light. I will finally discuss progress on achieving deterministic photon-spin interactions. In particular, I will demonstrate a macroscopic spin-induced phase shift in a low Q-factor system. Thus, I show that when designing photonic QD systems, it is the "beta" factor, not the cavity quality (Q) factor that should be optimised to achieve deterministic interactions.

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