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Quantum dots in photonic crystals: from quantum information processing to single photon nonlinear optics

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Quantum dots in photonic crystals are interesting both as a testbed for fundamental cavity quantum electrodynamics (QED) experiments, as well as a platform for quantum and classical information processing. Quantum dot-photonic crystal cavity QED has been probed both in photoluminescence and coherently, by resonant light scattering from such a system [1]. In the latter case, both intensity and photon statistics of the reflected beam have been analyzed as a function of wavelength, leading to observation of effects such as photon blockade and photon induced tunneling - for the first time in solid state [2]. The system has also been employed to achieve a controlled phase and amplitude modulation between two modes of light at the single photon level [3] - nonlinearity observed so far only in atomic physics systems. These demonstrations lie at the core of a number of proposals for quantum information processing, and could also be employed to build novel devices, such as optical switches controlled at a single photon level.

[1] Dirk Englund, Andrei Faraon, Ilya Fushman, Nick Stoltz, Pierre Petroff, and Jelena Vuckovic, "Controlling cavity reflectivity with a single quantum dot," *Nature* , vol. 450, No. 7171, pp. 857-861, December 2007
[2] Andrei Faraon, Ilya Fushman, Dirk Englund, Nick Stoltz, Pierre Petroff, and Jelena Vuckovic, "Coherent generation of nonclassical light on a chip via photon-induced tunneling and blockade," *Nature Physics* , Vol. 4, pp. 859 - 863 (2008)
[3] Ilya Fushman, Dirk Englund, Andrei Faraon, Nick Stoltz, Pierre Petroff, and Jelena Vuckovic, "Controlled phase shift with a single quantum dot," *Science* , vol. 320, number 5877, pp. 769-772 (2008)

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