Stuttgarter Physikalisches Kolloquium

Fachbereich Physik, Universität Stuttgart
Max-Planck-Institut für Festkörperforschung
Max-Planck-Institut für Intelligente Systeme*

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Dienstag, 22. November 2011	17:15 Uhr	Hörsaal V 57.01

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Quantum Electrodynamics with Quantum Dots in Photonic Nanostructures

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Abstract

2D photonic crystal membranes fabricated in GaAs containing InGaAs quantum dots have in recent years proven to be a very successful platform for all-solid-state quantum optics experiments. In a photonic crystal, the light-matter interaction strength can be tailored, i.e. either enhanced or suppressed by controlling the lattice constant of the structure. We will present experimental results on how highly efficient single-photon sources can be constructed by coupling single quantum dots to a photonic crystal waveguide exploring slow light [1]. The role of disorder in the form of fabrication imperfections is explored and found to lead to Anderson localization of light enabling cavity quantum electrodynamics by exploiting disorder as a way to enhance light-matter interactions [2]. We finally demonstrate that the mesoscopic character of quantum dot emitters implies that the traditional point-dipole description of light-matter interaction may break down in plasmonic nanostructures [3] providing a new way to strongly interface photons with matter.

[1] T. Lund-Hansen, S. Stobbe, B. Julsgaard, T. Sunner, M. Kamp, A. Forchel, and P. Lodahl, Phys. Rev. Lett. 101, 113903 (2008).
[2] L. Sapienza, H. Thyrrestrup, S. Stobbe, P.D. Garcia, S. Smolka, and P. Lodahl, Science 327, 1352 (2010).
[3] M. Lykke Andersen, S. Stobbe, A.S. Sørensen, and P. Lodahl, Nature Physics 7, 215 (2011).

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