Condensed Matter Physics Institute Seminar

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Optical positioning of single-photon emitters within engineered quantum photonic devices

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Single solid-state quantum emitters are promising ingredients for quantum information protocols relying on the storage, manipulation, and transmission of the information encoded in single photons through optical cavities and waveguides. Epitaxially grown, self-assembled InAs/GaAs quantum dots are a particularly promising system. However, optimal operation of such devices requires precise positioning of the quantum dot within a photonic structure and such a task is challenging, due to the random spatial position of the emitters within a wafer, a result of the self-assembly process by which they are grown.

I will discuss a novel photoluminescence imaging technique applied to a sample containing InAs/GaAs quantum dots and demonstrate that its implementation enables the creation of simultaneously bright and pure on-demand single-photon sources [1]. By fabricating circular grating cavities [2] around positioned single quantum dots, we demonstrate bright and pure Purcell-enhanced single-photon emission on a chip. More generally, the positioning technique that we describe enables location of single emitters with nanometer-scale accuracy and to obtain wavelength and polarization information prior to device fabrication. Quantum photonic devices can thus be tailored to the specific quantum emitter: this represents an important step to controllably engineer the interaction of single quantum dots with highly confined optical or mechanical modes, very important for areas such as cavity quantum electrodynamics and optomechanics.

[1] L.Sapienza, M.Davanco, A.Badolato, K.Srinivasan, *Nanoscale optical positioning of single quantum dots for bright and pure single-photon emission*
Nature Communications **6,** 7833 (2015).

[2] S. Ates, L. Sapienza, M. Davanco, A. Badolato, K. Srinivasan, *Bright single photon emission from a quantum dot in a circular Bragg grating microcavity*
IEEE, Journal of selected topics in quantum electronics **18**, 1711 (2012).