UNIVERSITÄT DUISBURG ESSEN

PHYSIK E=

Physikalisches Kolloquium

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The semiconductor spin qubit

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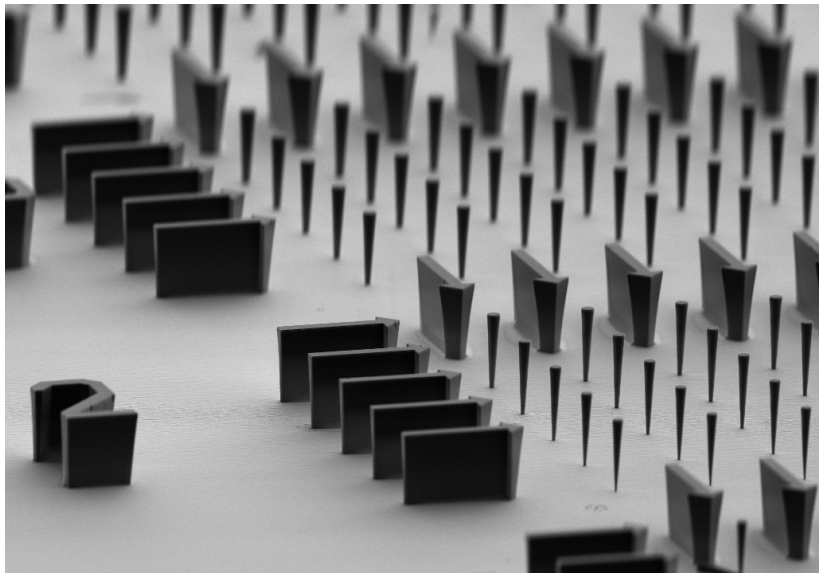

Image: GaAs “trumpets” for enhanced photon extraction efficiency from single quantum dots [Mathieu Munsch, Nitin S. Malik, Emmanuel Dupuy, Adrien Delga, Joël Bleuse, Jean-Michel Gérard, Julien Claudon, Niels Gregersen, and Jesper Mørk, Phys. Rev. Lett. 110, 177402 (2013); Mathieu Munsch, Andreas V. Kuhlmann, Davide Cadeddu, Jean-Michel Gérard, Julien Claudon, Martino Poggio, and Richard J. Warburton, arXiv:1608.03082 (2016)]

What will the quantum computer of the future be made from? Classical computers use semiconductors. Will quantum computers use semiconductors too? A powerful concept is to use an array of localized spins: each spin is a small and fast qubit. Implementation in a semiconductor benefits from advanced heterostructures and nano-fabrication. There are clear advantages in making the host structure small: size quantization is strong and this helps to decouple the spin from excitations in the bulk semiconductor. A self-assembled quantum dot represents an ideal test structure: the “bottom up” process results in very small structures, just 20 nm in diameter. In addition, self-assembled quantum dots in GaAs, the cleanest and most versatile semiconductor, have a strong optical transition across the energy gap. A quantum dot spin can be initialized, manipulated and read-out with optical techniques. Furthermore, the photons are emitted one by one, the basis of a single photon source.

The talk will address the performance of a semiconductor quantum dot as spin qubit and single photon source. The key concepts are noise and spin engineering, the design of structures which are robust against noise.