Abstract for an Invited Paper
for the MAR10 Meeting of
The American Physical Society

Ultrafast quantum optics with solid-state nanosystems

RUDOLF BRATSCHITSCH, University of Konstanz and Center for Applied Photonics

Semiconductor quantum dots and color centers in diamond are promising solid-state systems for fundamental quantum optical experiments and robust quantum information processing. In quantum dots, ultrafast sequences of coherent quantum operations may be envisioned with femtosecond light pulses. We present the first femtosecond pump-probe experiment on a single CdSe quantum dot. In this few-fermion system, Coulomb renormalization and single-photon gain are observed on an ultrafast timescale. The ability to add or remove single photons to and from photon bunches is explored [1]. To not only reach single-electron but also single-photon sensitivity, we present two ideas to efficiently couple light from the far field into nanometer sized objects: metal nanoantennas [2] and dielectric microresonators [3]. Color centers in diamond allow for single spin initialization, manipulation and readout at ambient conditions. We present imaging magnetometry on the nanoscale with a single diamond color center [4]. Furthermore, new concepts to fabricate diamond nanophotonic elements are demonstrated.

[1] F. Sotier et al., Nature Physics 5, 352 (2009).
[2] J. Merlein et al., Nature Photonics 2, 230 (2008).
[3] M. Kahl et al., Nano Lett. 7, 2897 (2007).
[4] G. Balasubramanian et al., Nature 455, 648 (2008).