DS 43: Quantum Optics at the Nanoscale: From Fundamental Physics to Quantum Technologies (Joint Session HL, DS, O, and TT, organized by DS)

Time: Thursday 17:00–17:30 Location: CHE 91

DS 43.1 Thu 17:00 CHE 91

Sensing weak radio-frequency radiation by pulsed Autler-Townes spectroscopy — Timo Joas, Andreas M. Waeber, Georg Braunbeck, and •Friedemann Reinhard — TU München, Walter Schottky Institut and Physik-Department

Nano-emitters have shaped a new era of quantum optics, serving as convenient single photon sources, e.g. to launch surface plasmons [1,2] or to build long-distance entanglement [3]. So far, they have mostly been used in the optical (100THz) domain.

Here we employ a nano-emitter and a quantum-optical protocol to detect weak radiation in the radio-frequency (GHz) range. Our scheme is based on Autler-Townes spectroscopy [4]. We extend this technique to a pulsed protocol, which greatly improves spectral resolution, sensitivity and robustness to experimental fluctuations.

We demonstrate our approach on a NV center in diamond, where it might enable various applications. Specifically, we consider radio-astronomy, ultrasound detection and spin-phonon coupling.

[1] A.V. Akimov et al., Nature 450, 402 (2007)
[2] R. Kolesov et al., Nature Physics 5, 470 (2009)
[3] B. Hensen et al., Nature 526, 682 (2015)
[4] J.A. Gordon et al., Appl. Phys. Lett. 105, 024104 (2014)

DS 43.2 Thu 17:15 CHE 91

Free-electron quantum optics — •Katharina E. Priebe, Christopher Rathje, Armin Feist, Sergey V. Yalunin, Sascha Schäfer, and Claus Ropers — 4th Physical Institute - Solids and Nanostructures, University of Göttingen, Göttingen, Germany

Besides being a powerful tool for time-resolved measurements of nanoscale dynamics, ultrafast transmission electron microscopy (UTEM) serves as an ideal test bench for quantum optical experiments studying the interaction with free-electron beams. Specifically, inelastic scattering between the electrons and strong optical near-fields [1] allows for a coherent manipulation of the electron quantum state [2]. The optical near-field imprints a sinusoidal phase modulation on the electron wavefunction, which is manifest in a comb of sidebands in the electron kinetic energy distribution. In this contribution, we will demonstrate how multiple near-fields can be employed to coherently control the free-electron momentum superposition states [3,4]. Furthermore, dispersive propagation translates the phase modulation into a density modulation: the electron wavefunction is self-compressed into a train of attosecond bursts. This temporal structuring of free-electron beams may find applications in electron microscopy with attosecond resolution.

[1] B. Barwick *et al.*, Nature, **462**, 902 (2009).
[2] A. Feist *et al.*, Nature, **521**, 200-203 (2015).
[3] K. E. Echternkamp *et al.* Nat. Phys **12**, 1000-1004 (2016).
[4] K. E. Priebe *et al.* In preparation.