



Informal Seminar:

Thursday, April 11, 2019, at 2:00 p.m. ;

— all are invited to meet at around 1:40 for a chat and coffee —

Prof. Dr. Markus B. Raschke Nano-Optics Group,
Department of Physics,
University of Colorado, Boulder, CO.

Tip-enhanced strong coupling: room temperature cavity nano-optics with single emitter

PC Seminar Room **G2.06**, Building G, Faradayweg 4.

R. Ernstorfer

Abstract:

Optical cavities can enhance and control the light-matter interaction by modifying the local electromagnetic environment of a quantum emitter. However, large cavity mode volumes have prevented strong coupling between dielectric cavities and single emitters under ambient conditions. We demonstrate tip-enhanced strong coupling (TESC) spectroscopy, imaging, and control based on scanning probe microscopy using plasmonic antenna-tips forming a nano-cavity with the emitter [1]. With single quantum dots we observe room temperature mode splitting up to 160 meV and anti-crossing in the energy spectra with detuning, with nanometer scale mode confinement [2]. In the extension to the infrared we achieve strong coupling of molecular vibrations through configurable optical interactions of a nanotip with an infrared resonant nanowire with hybridization and mode splitting. We observe nanotip-induced quantum interference of vibrational excitation pathways in spectroscopic nanoimaging, which we model classically as plasmonic electro-magnetically induced scattering as the phase-controlled extension of the classical analogue of electromagnetically induced transparency and absorption [3]. Manipulating these interaction in the non-perturbative strong coupling regime opens new pathways from opto-electronic and chemical sensing to quantum information science..

References

- [1] K-D Park et al, Radiative control of dark excitons at room temperature by nano-optical antenna-tip Purcell effect, *Nat. Nanotechnol.* 13, 59 (2018).
- [2] K.-D. Park, M. A. May, H. Leng, J. Wang, J. A. Kropp, T. Gougousi, M. Pelton, and M. B. Raschke, Tip-enhanced strong coupling spectroscopy and control of a single quantum emitter. (arXiv:1902.103314).
- [3] E. A. Muller, B. Pollard, H. A. Bechtel, R. Adato, D. Etezadi, H. Altug, and M. B. Raschke, Nanoimaging and control of molecular vibrations through electromagnetically induced scattering reaching the strong coupling regime. *ACS Photonics* 5, 3594 (2018).