CRC 1227
Designed Quantum States of Matter

GUEST LECTURE

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Leibniz Universität Hannover
DQ-mat Colloquium
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(via Zoom-Meeting)

"From Single Molecules to Many, Many Atoms"

Single molecules under cryogenic conditions can have outstanding optical properties [1] – due to the low temperatures, all broadening mechanisms can be frozen out. Subsequently, their optical emission can be Fourier-limited and accordingly spectrally narrow down to 12.5 MHz [2]. When the molecules are isolated, such that only a single molecule is in the observation space, they act as single photon emitters with an outstanding optical brightness. Only recently, we have observed up to 2.5 10 6 clicks per second on a single photon detector from a single molecule.

In the past, we have combined the outstanding properties of such an isolated single molecule in a solid-state sample with hot atomic sodium vapor. This comes handy in the form of an optical glass cylinder and operates at room temperature or slightly above. The atomic vapor is suitable for slowing down single photons in the vapor [3], but also for atomic filtering [4].

I will introduce into the general scope of our single photon experiments, and show that the hybridization with hot atomic vapors gives some crucial advantages [5,6].

References
[1] **Single organic molecules for photonic quantum technologies**
C. Toninelli, I. Gerhardt, A. S. Clark, A. Reserbat-Plantey, S. Götzinger, Z. Ristanovic, M. Colautti, P. Lobardi, K. D. Major, I. Deperasinska, W. H. Pernice, F. H. L. Koppens, B. Kozankiewicz, A. Gourdon, V. Sandoghdar, M. Orrit, Nature Materials, 2021, 1-14
[2] **An atomic spectrum recorded with a single molecule light source**
Wilhelm Kiefer, Mohammad Rezai, Jörg Wrachtrup, Ilja Gerhardt, Applied Physics B: Lasers and Optics, 2016, 122, 1-12
[3] **Molecular photons interfaced with alkali atoms**
Petr Siyushev, Guilherme Stein, Jörg Wrachtrup, Ilja Gerhardt, Nature, 2014, 509, 66-70
[4] **Na-Faraday rotation filtering: The optimal point**
Wilhelm Kiefer, Robert Löw, Jörg Wrachtrup, Ilja Gerhardt, Scientific Reports, 2014, 4, 6552
[5] **Coherence Properties of Molecular Single Photons for Quantum Networks**
Mohammad Rezai, Jörg Wrachtrup, Ilja Gerhardt, Phys. Rev. X, 2018, 8, 9
[6] **Polarization-entangled photon pairs from a single molecule**
Mohammad Rezai, Jörg Wrachtrup, Ilja Gerhardt, Optica, 2019, 6, 34-40

All DQ-mat members and all interested are cordially invited to attend.