Physical Chemistry Seminar

New Methods and Materials in Quantum Emitter Science

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Solid-state emitters of single photons serve as testbeds for studying fundamental condensed matter dynamics and are increasingly appealing for various applications. I highlight recent advances in both the materials science of single-photon emitters and the spectroscopic methods used for their characterization.

Lead-halide perovskite quantum dots (PQDs) exhibit highly coherent optical emission at low temperatures [1]. I outline the latest developments in perovskite quantum emitters, including our first demonstration of two-photon (Hong-Ou-Mandel) interference from sequentially emitted single photons. We achieved visibilities of up to 0.55, surpassing the threshold for genuine quantum interference, even without cavity acceleration of the emission. This indicates that entangled-photon generation is indeed feasible with perovskites [2].

Additionally, advancements in quantum defect spectroscopy using combined optical and electron-beam methods will be presented [3]. These developments include a novel all-optical super-resolution concept based on spatio-temporal time-frequency photon-correlation functions. This Spectral Fluctuation Super-Resolution (SFSR) technique is effective for non-blinking emitters and stochastic spectral fluctuations with arbitrary temporal statistics, suggesting its utility in super-resolution microscopy of quantum emitters at low temperatures, where spectral diffusion is often more prominent than emitter blinking, as used in alternative optical fluctuation microscopy.

[1] *Science,* **2019,** 363 (6431), 1068-1072.
[2] *Nat. Photon.,* **2023**, 17, 775–780.
[3] *PNAS,* **2024,** 121 (14) e2308247121.

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PURDUE UNIVERSITY | James Tarpo Jr. and Margaret Tarpo Department of Chemistry

Utzat Bio

- Assistant Professor, University of California at Berkeley, College of Chemistry (since 2022)
- Post-doc, Stanford University, Department of Materials Science and Engineering (2022)
- Ph.D. in Physical Chemistry, Massachusetts Institute of Technology (2019)
- M.Sc. in Chemistry, ETH Zurich (2013)
- B.Sc. in Chemistry, RWTH Aachen University (2008-2011)

Hendrik Utzat did his undergraduate studies at RWTH Aachen University. After brief stints at ETH Zurich and Imperial College London, he moved to Cambridge, MA for his Ph.D. work with Prof. Moungi Bawendi at the Massachusetts Institute of Technology (MIT). His graduate research focused on the development of advanced optical single-emitter spectroscopy and the study of optical coherences and quantum interference in single quantum dots and quantum defects in two-dimensional materials. After receiving his Ph.D. in 2019, Hendrik conducted postdoctoral work in nanophotonics with Prof. Jennifer Dionne in the Department of Materials Science and Engineering at Stanford University. From 2021-2022, he additionally served as the Associate Director of the Photonics at Thermodynamic Limits Energy Frontiers Research Center, a DOE-funded multi-university research effort combining materials development and photonic integration. Hendrik joined the UC Berkeley College of Chemistry as an Assistant Professor in July 2022. He was additionally appointed a Faculty Scientist at Lawrence Berkeley National Lab in the Materials Science Division in 2023. His current research lies at the nascent interface of nanophotonics and quantum optics with the chemical sciences