PHYSICS:
Genuine Quantum Interference of Single-Photons Emitted from Colloidal Lead-Halide Perovskite Quantum Dots

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About The Speaker:

Hendrik Utzat received his undergraduate degree from 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. His research demonstrated the first coherently-emitting colloidal quantum dot and a novel method for all-optical charge control in semiconductor nanostructures.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.

Date:
10/6/2023

Time:
10:30 – 11:50 AM

Location:
GRAN 135

Abstract:

Chemically prepared colloidal semiconductor quantum dots have long been proposed as scalable and color-tunable single emitters in quantum optics, but they have typically suffered from prohibitively incoherent emission. This changed in 2019, when individual lead-halide perovskite quantum dots (PQDs) at low temperatures were shown to display highly efficient single-photon emission with optical coherence approaching the radiative lifetimes. [1] In this talk, I highlight the latest developments of perovskite quantum emitters, including our first demonstration of two-photon (Hong-Ou-Mandel) interference of sequentially emitted single photons. We achieve visibilities of up to 0.55, above the limit for genuine quantum interference, even without cavity acceleration of the emission, indicating that entangled-photon generation is indeed possible with perovskites.[2] I further present a detailed temperature-dependent single-nanocrystal study of the optical dephasing mechanism in perovskite quantum dots indicating that ligand-engineering can increase the coherent fraction of the emitted photons by reducing inelastic phonon scattering. We show that the residual dephasing of the excited state is caused by thermally activated elastic phonon scattering of low energy (1-3meV) modes.[3] Our results indeed confirm the potential of perovskite quantum dots as scalable, colloidal sources of coherent, indistinguishable single photons, and that can be optimized by chemical means and integrated with nanophotonic cavities.

[1] Utzat et al. Science, 2019, 363 (6431), 1068-1072.
[2] (Utzat, Bawendi), Nat. Photon., 2023, 17, 775–780.
[3] (Utzat, Bawendi), Nano Lett. 2023, 23, 7, 2615–2622.

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