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Towards entangled pairs of free-electrons and photons

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Abstract

Photons play a unique role as carriers of quantum information. They are essentially the only candidate on any scale: from linking neighboring qubits in quantum computers to a satellite-based quantum-key distribution [1].

My talk considers a different fundamental particle as a carrier of quantized information – the free-electron [2]. Although the electron mass renders energy and momentum exchanges between electrons and photons inefficient in free space, I propose a roadmap for reaching strong coupling between them by confining the photons to whispering-gallery-mode (WGM) microresonators. I describe possible quantum entanglements between the two entities, explain how it could be measured, and show experimentally the merits of WGM for controlling the electron state [3].

Aside from bringing free-electrons into the realm of quantum optics, the tight focusing of electron beams may allow for versatile access to individual quantum systems at the nanoscale. More generally, detailed control of electron-light interactions could enhance the capabilities of electron microscopy, which is already at the forefront of scientific research of the nanoworld.

- [1] J. Yin, et al., Satellite-Based Entanglement Distribution over 1200 Kilometers, Science 356, 1140 (2017).
- [2] O. Kfir, Entanglements of Electrons and Cavity Photons in the Strong-Coupling Regime, Phys. Rev. Lett. 123, 103602 (2019).
- [3] O. Kfir, et al., Controlling Free Electrons with Optical Whispering-Gallery Modes, Nature 582, 7810 (2020).

ההרצאה תתקיים ביום רביעי, ה-9.12.20 בשעה 12:30

דרך זום [קישור](#)

The lecture will take place on Wednesday 9.12.20 at 12:30

Via zoom : [link](#)

Host: Professor Oren Cohen