

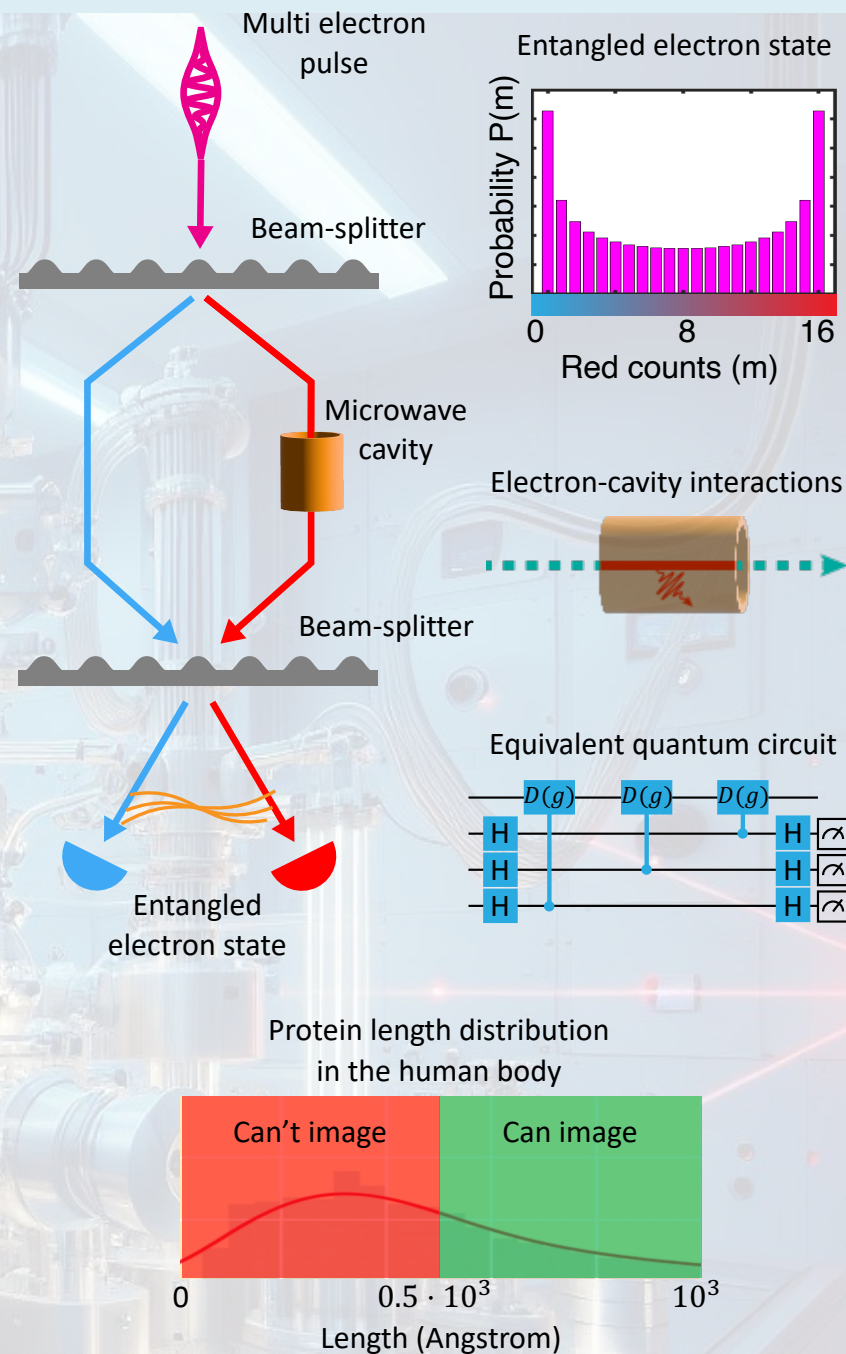
Joint PhD position proposal:

Electron-Cavity Interactions for Quantum Electron Microscopy

We propose a joint Jülich E-RC/Technion position for a PhD student to investigate how quantum interactions inside an electron microscope could lead to entangled electron states which can be used for quantum electron microscopy. Entanglement of free-electrons has never been demonstrated before, which could alter their interaction with light and matter in ways never anticipated. One application of such entangled states is for imaging dose-sensitive samples beyond the standard quantum limit.

Our project relies on creating entanglement between the path of the electrons and other quantum objects such as a cooled-down cavity (see the figure). The project is extremely challenging from both theoretical and practical aspects.

High-resolution transmission electron microscopy (HRTEM) is to date the most powerful microscopy imaging technique for atomic resolution. Yet, for imaging of biological structures such as cells and proteins, the resolution is limited by the number of electrons that can be used before the sample is damaged. To date, the majority of the proteins in the human body cannot be imaged (see bottom figure). This requires the development of the next generation of electron microscopes.



The Ernst Ruska-Centre for Microscopy (ER-C) in Jülich is the German national center of excellence for high-end electron microscopy and it is the world's largest and most advanced electron microscopy center.

The AdQuanta group at the Technion is one of the world leaders in ultrafast electron microscopy. The group develops unique theoretical capabilities for exploring the physics of novel kinds of electron-photon interactions.

Research highlights:

- Measurement of quantum coherence using free electrons [[Phys. Rev. Lett. 126, 233404 \(2021\)](#)]
- Generation of quantum light with free electrons [[Phys. Rev. X 13, 031001 \(2023\)](#)]
- Many-body entanglement using “which-path” information [[Phys. Rev. Research 5, 043271\(2023\)](#)]

Seize this opportunity to be a part of an enriching PhD program. This position comes with substantial support for regular international travel between Germany and Israel, and housing allowance, all on top of a full PhD fellowship. You will have the invaluable experience of working in top laboratories in both Israel and Germany. To apply, kindly forward your CV and a cover letter to kaminer@technion.ac.il and r.dunin-borkowski@fz-juelich.de.

Please note: acceptance to the program necessitates successful interviews at both Technion and the Jülich Research Center.