

Abstract Submitted
for the MAR15 Meeting of
The American Physical Society

Interaction-Free Quantum Electron Microscope in Free-Space¹

YUJIA YANG, CHUNG-SOO KIM, RICHARD HOBBS, VITOR MANFRINATO, ORHAN CELIKER, Massachusetts Institute of Technology, PIETER KRUIT, TU Delft, KARL BERGGREN, Massachusetts Institute of Technology — We propose the design and theoretical analysis of a quantum electron microscope (QEM), which utilizes interaction-free quantum measurement with electrons for nanoscale imaging. The QEM can be used to image electron-irradiation-sensitive materials, such as biological samples, with a high resolution and low radiation damage. Our QEM scheme is an electron interferometer with a storage resonator. The incoming electron beam is asymmetrically split into a strong reference beam and a weak sample beam, both of which are stored in the resonator. Only the weak sample beam transmits through the sample for multiple times. We propose to build the QEM with free-space electron optics. We develop a scattering matrix method to theoretically analyze the contrast mechanism, radiation damage, and measurement accuracy. We propose an electron-mirror-based storage resonator and we have performed electron optics simulation of electron trajectories within the resonator. We also report experimental implementation and characterization of the electron beam-splitter to be used in the QEM. Thin crystals fabricated with focused ion beam and nano-gratings fabricated with electron-beam lithography are two candidate beam-splitters, both of which are characterized by electron diffraction.

¹This work is funded by Gordon and Betty Moore Foundation

Yujia Yang
Massachusetts Inst of Tech-MIT

Date submitted: 14 Nov 2014

Electronic form version 1.4