

Ultrastrong Coupling of Free Electrons in the Ultrafast Transmission Electron Microscope

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The quantized interaction between free electrons and femtosecond laser pulses in electron microscopes has shown intriguing new prospects for light-matter interaction.

This talk will discuss our theory and experiments with the ultrafast transmission electron microscope:

We will present recent measurements of the quantized interactions of free electrons with a photonic cavity, enabling strong interactions with very low laser pulse energy. By achieving phase-matching conditions we further enhance the electron-light interaction towards ultrastrong coupling of a free electron with the vacuum electromagnetic excitations.

The talk will conclude with our new theory results on the arbitrary control of electrons' temporal wavepacket and energy spectrum, revealing the intrinsic conservation laws of all such quantum electron-laser interactions. We will show how such capabilities enable creating a free-electron qubit.