EECS 598: Quantum Optoelectronics

Instructor: Mack Kira (mackkira@umich.edu)

Term: Winter, 2020

Meeting time: Tentatively Mo/We 12-1:30pm, room 3433 EECS

Ever wondered how the future of optics and electronics will look like, and which unexpected answers rational quantum engineering could deliver?

If yes, you are ready to encounter the bizarre possibilities of the quantum realm – only enthusiasm and basic knowledge about quantum mechanics and electromagnetism is required!

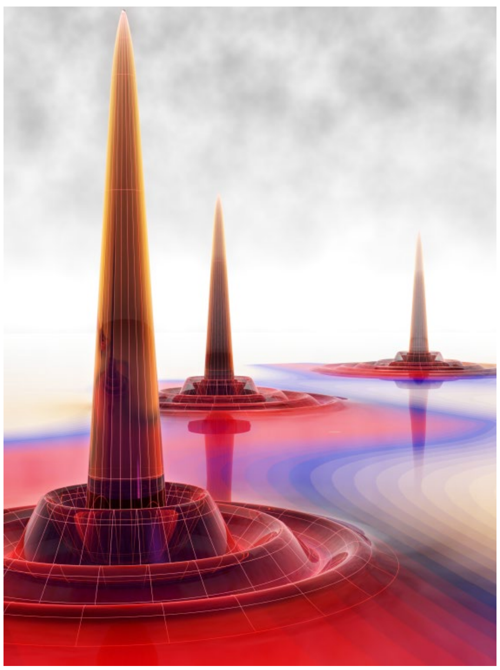

Illustration of dropletons, measured and computed through *quantum (optical) spectroscopy*.

Optoelectronic devices are already being revolutionized by the prospects of quantum technology. Ever smaller and faster components will inevitably reach a level where a collective can outperform individual parts due to emergent quantum effects such as entanglement. This lecture welcomes you to the central concepts of quantum engineering of semiconductors to explore optoelectronic, quantum-optical, and many-body processes, relevant for state-of-the-art experiments and the future of quantum technology.

Rough Syllabus: This lecture will provide a pragmatic and brief introduction to solid-state theory, many-body formalism, semiconductor quantum optics, and lightwave electronics to explore pragmatic possibilities for quantum technology. To develop your insights on rational quantum design, the coupling of the quantized light field to electrons is investigated in detail, while the many-body Coulomb interaction of charge carriers is systematically included. For example, we will analyze which quantum effects and quasiparticles can be used in optoelectronics devices from sensors to quasiparticle accelerators. To extend these quantum ideas further, we will follow how including quantum fluctuations of light to laser spectroscopy will transform it to quantum spectroscopy, a new realm where dropleton, entanglement, quantum memory etc. effects can be systematically explored and utilized.

Textbook: M.Kira and S.W. Koch, *Semiconductor Quantum Optics*, Cambridge Univ. Press, 2012.