Quantum optics with nanowires

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Nanowires offer new opportunities for nanoscale quantum optics; the quantum dot geometry in semiconducting nanowires as well as the material composition and environment can be engineered with unprecedented freedom to improve the light extraction efficiency. By doping a nanowire and making ohmic contacts on both sides, a nanowire light emitting diode can be obtained with a single quantum dot as the active region. Under forward bias, this will act as an electrically pumped source of single photons. Under reverse bias, an avalanche effect can multiply photocurrent and enables the detection of single photons. Another type of nanowire under study in our group is superconducting nanowires for single photon detection, reaching efficiencies, time resolution and dark counts beyond currently available detectors. We will discuss our first attempts at combining semiconducting nanowire based single photon emitters and superconducting nanowire single photon detectors on a chip to realize complete quantum circuits on a chip. We will also discuss the possibility of coupling quantum dots to atomic vapors to frequency lock the dot emission and achieve universal indistinguishable emission.