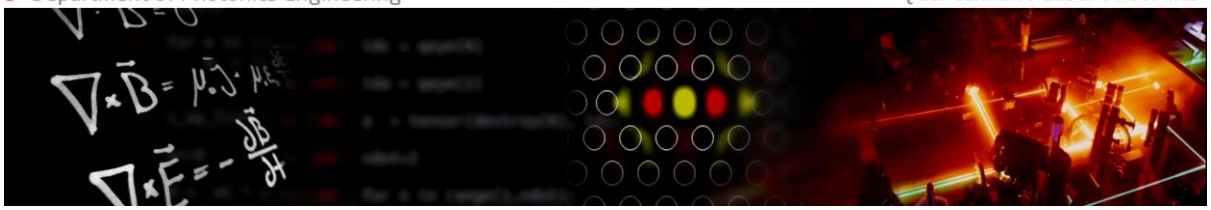

B.Sc or M.Sc. project

Devices for on-chip quantum information technology

Since the invention of the integrated circuit, computing power has increased exponentially. However, as we approach the fundamental size limit of the transistor, this progress has slowed. To overcome this limitation, we must consider new paradigms for computing. One such approach is to use photons to transport information rather than electrons. This would significantly lower cooling requirements, and provide a platform for novel types of computing. However, unlike electrons in conventional computers, photons do not interact with each other. This prevents direct photon-photon logic operations, and instead one must rely on light-matter coupling to mediate interactions [1]. A promising solution for the development of these so-called 'photonic gates' is to use semiconductor quantum dots in one-dimensional photonic crystal waveguides. Such couplings have been experimentally realized with near unity efficiency [2].

Specific goals: This project will investigate how photons interact with quantum dots in semiconductor cavity QED systems. The goal is to theoretically design and characterize a simple device for quantum information technology such as a controlled few-photon gate [3], a controlled photon switch, or a multi-photon entanglement protocol (Figure 1) [4].

Prerequisites: Besides being interested in Quantum mechanics, a basic knowledge of quantum mechanics corresponding to the intro course (10102) is needed as well as a strong mathematical background. One or more of the following courses is an advantage: Advanced Quantum Mechanics (10112), Quantum Optics (10380), Nanophotonics (34051).

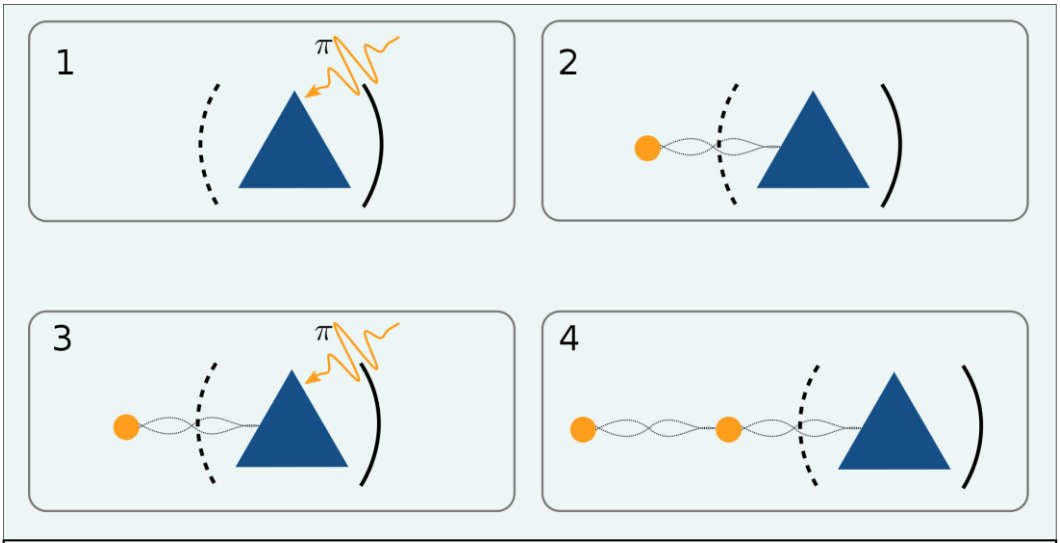

Figure 1: Illustration of a multi-photon entanglement protocol.

Supervisor: Kristoffer Joanesarson (kjoa@fotonik.dtu.dk), Emil Denning (emvo@fotonik.dtu.dk), Jesper Mørk (jesm@fotonik.dtu.dk), building 345A/272.

References:

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[3] A. Nysteen et al., PRA **95**, 062304 (2017).
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