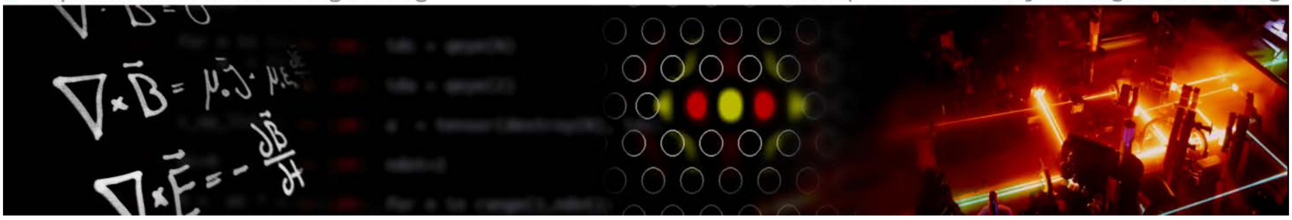
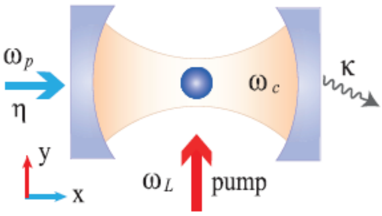


B.Sc. or M.Sc. project

# Photon Blockade effect in a cavity-quantum dot system

Implementations of optical quantum computation and information processing applications require new components such as single-photon sources, transistors and switches. Some or all of the lacking components could be realized by applying nonlinearities at a single photon level which can be achieved by exploiting a photon blockade phenomenon [1-4].

The photon blockade occurs e.g. in a cavity-quantum dot system. Placing a quantum dot into the cavity breaks down the harmonicity of the energy levels of the cavity leading to a photon blockade phenomenon, where only one photon at a time can occupy the cavity-quantum dot system and multiple photons with the selected frequency cannot be simultaneously transmitted through the cavity. The ability to control the photon blockade would allow implementation of a single photon turnstile, a switch or a transistor. Therefore, the nonlinearity provided by the photon blockade effect may be useful for new quantum devices.



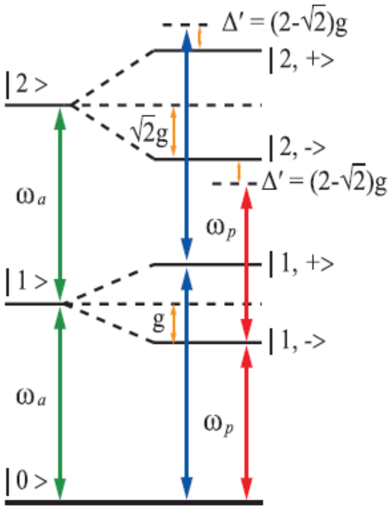




**Figure 1: Photon blockade setup [1].** *Above*: A sketch of the cavity-quantum dot setup for quantum interference based photon blockade. *Right*: The energy diagram of the dressed states of the system.

The overall aim of the project is to establish a theoretical understanding of the physical mechanisms governing the photon blockade phenomenon and to simulate photon transport through the photon blockade system. The project consists of both theoretical and numerical work and seeks a student having background knowledge in quantum mechanics and also basic skills in Matlab programming.

<u>Specific goals of the project</u> (which may be modified according to the interests of the student) are to:

- Understand the physics of the photon blockade phenomenon. Solve analytically for the energy levels of the system and calculate the transmission and reflection coefficients of the cavity.
- Investigate the parameter regimes where the photon blockade occurs and simulate photon transport through the system.
- Simulate quantum interference based photon blockade in a CW laser driven cavity-quantum dot system.
- Investigate the quantum interference based photon blockade for general (time-dependent, quantum state) input and pump fields.

**Supervisors**

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**References**

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