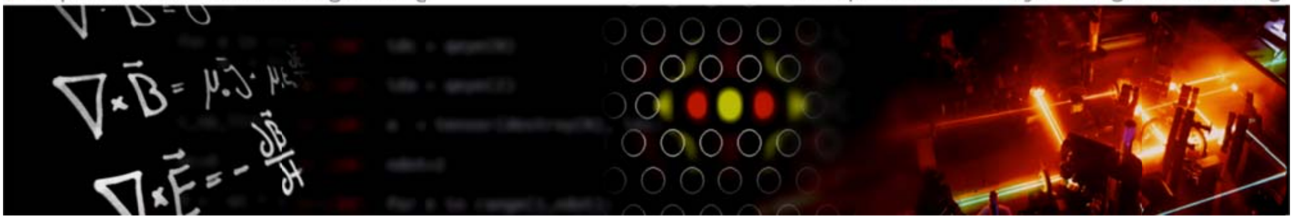
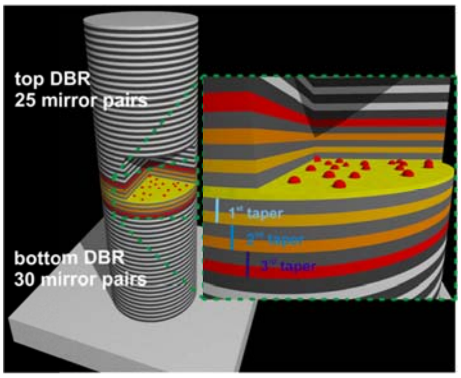


M.Sc. project

Preventing a system from going classical: The quantum Zeno effect

Quantum mechanics has the nonintuitive consequence that a system can exist in several states at the same time and it is only upon measurement that a specific state becomes favoured. Schrödinger's cat is in a superposition of life and death and its faith is not determined until observed. However, a system invariably interacts with the environment, eventually leading to a loss of coherence between the different elements of the superposition and restoring of classical behaviour. Thus, quantum mechanical behaviour is very difficult to observe in macroscopic objects, like cats. In this project we will explore the quantum mechanics of ultra-small semiconductor structures, i.e. quantum dots, artificial man-made atoms, coupled to optical nanocavities, see Fig. 1. Such systems are of great interest for generating and manipulating the quantum bits of future quantum computers. However, lattice vibrations (phonons) destroy the quantum coherence and is an important task to find methods that prevent this. In this project we will investigate the use of the quantum Zeno effect for protecting the system against going classical. The project is theoretical, but closely coupled to experimental activities.

(a)



(b)

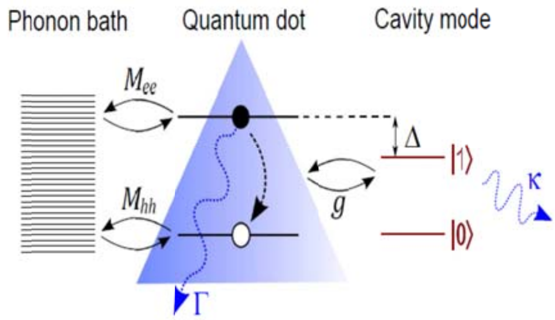


Fig. 1. (a) Illustration quantum dots coupled to a micropillar cavity with Bragg mirrors and (b) schematic of the interacting systems. The quantum coherence is destroyed by scattering with phonons (lattice vibrations).

The quantum Zeno effect is weird: If a system is observed it does not change! Quantum mechanically, an observation collapses the wavefunction onto a specific state, and if the observations are made frequently enough, the system will not evolve away from that initial state. The effect has been experimentally observed in cold atoms, but here we aim to understand what the conditions are for observing it in a quantum dot.

This project is intended for students with a strong background and interest in quantum mechanics and theoretical physics. The project will involve numerical simulations, so knowledge of computer modelling is required (e.g. Matlab).

If you want to hear more about the project, just come by my office or send me a mail.

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References related to the topic:

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