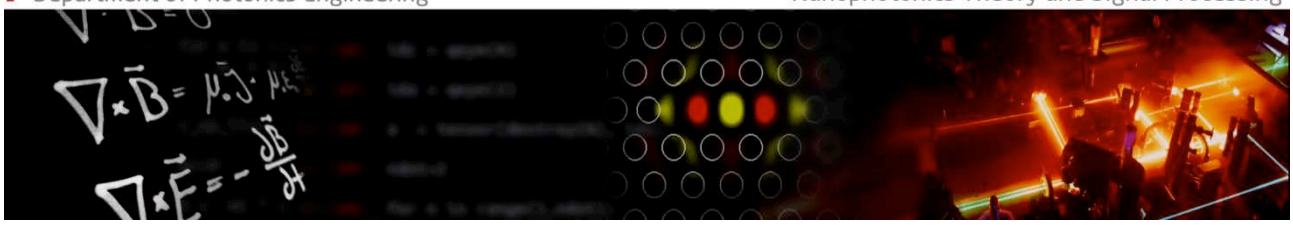

B.Sc or M.Sc. project

Theory of Fano lasers

A Fano resonance [1] is a general phenomenon occurring in Nature, whenever a continuum of states interacts with a single, discrete, state. It was recently suggested that such a resonance can be used to realize an ultra-small laser with remarkable properties, such as the possibility of generating ultrashort optical pulses [2]. A sketch of the laser is shown in Figure 1. The active region of the laser is composed of quantum wells or quantum dots and the Fano resonance occurs due to the interaction of the optical mode in the nanocavity and the waveguide mode.

Initial results for the laser have been published [2], but the physics of the laser is not yet well understood and many interesting properties of the laser are still to be explored. In this project a mathematical model for the laser will be formulated and used to investigate, numerically and analytically, the fundamental laser properties. An important goal of the project is also to investigate the aspects of the laser design that are critical for experimental implementations. Experimental results on passive Fano structures have recently been obtained [3], and the plan is to extend the experimental investigations to Fano lasers.

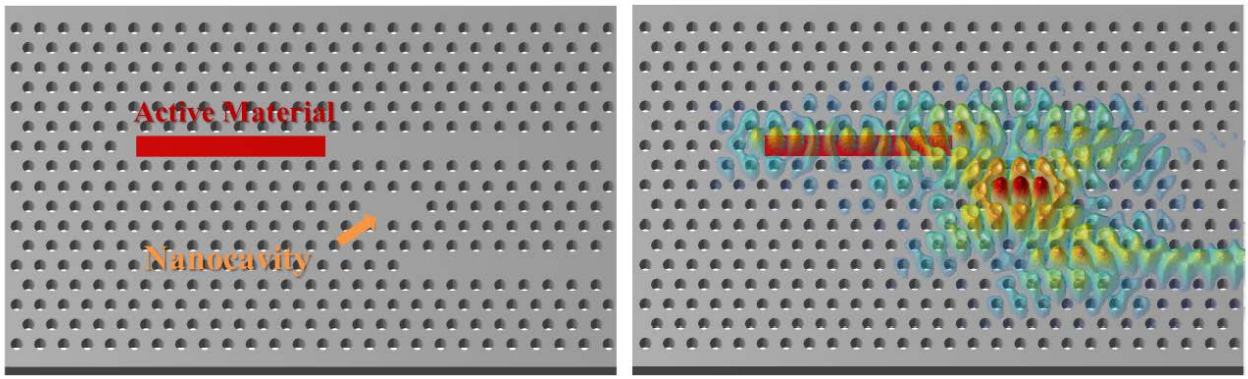

Figure 1. Schematic of a photonic crystal Fano laser. The active material (red bar) is composed of quantum wells or quantum dots. The waveguides and nanocavity are realized as defect structures in a photonic crystal membrane. The right part of the figure shows a numerical simulation of the electromagnetic field.

This project is intended for students with a strong background and interest in photonics, mathematics and numerical modelling. Prior knowledge of Matlab or other numerical modelling tools is required.

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References related to the topic:

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2. J. Mørk, Y. Chen, and M. Heuck, "Photonic crystal Fano laser: Terahertz modulation and ultrashort pulse generation," Phys. Rev. Lett., vol. 113, pp. 163901, 2014.
3. Y. Yu, M. Heuck, H. Hu, W. Xue, C. Peucheret, Y. Chen, L. K. Oxenlowe, K. Yvind, and J. Mørk, "Fano resonance control in a photonic crystal structure and its application to ultrafast switching," Appl. Phys. Lett., vol. 105, pp. 061117, 2014.