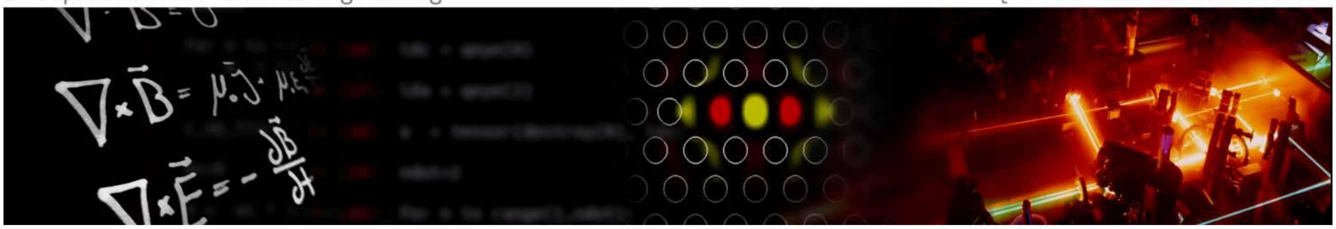

BSc or MSc. project: Bound states in continuum (BICs) in photonic crystal membranes

Confining a photon to the smallest possible space for the longest time is one of the most fascinating and interesting goals of photonics, which is done by employing an optical micro-cavity [1]. To achieve it various structures have been suggested such as photonic crystal cavities, micro-ring cavities, micro-disk cavities, micro-pillar cavities, etc [1]. Photons are confined in these cavities due to either a photonic bandgap or total internal reflection mechanism. Recently, another mechanism for confining the photon has been found, attracting lots of attention [2]. Multiple unbound states, each of which alone is unbound in a cavity, can destructively interfere outside the cavity, leading to a strongly bound composite state. Interestingly, the photon lifetime of this bound state can be infinite at specific condition. These resonances with an infinite photon lifetime (or equivalently quality-factor) are referred to as bound states in continuum (BICs) [2]. BICs are observed in various photonic structures and may enable various novel structures for applications in lasers, sensors or filters.

Recently, we have found that the BIC phenomenon occurs in one-dimensional (1D) photonic crystal membrane, referred to as high-contrast grating (HCG), as shown in Fig. 1(a). Right now, a BIC-laser has been fabricated, as shown in Fig. 1(b). This laser is integrated onto a silicon wafer and is a promising light source for optical interconnects on silicon chips. In this project, we aim at understanding more clearly the BIC mechanism as well as properties of the BIC in HCGs. Based on this understanding, new designs for the current laser structures and/or another novel device application is expected to be obtained.

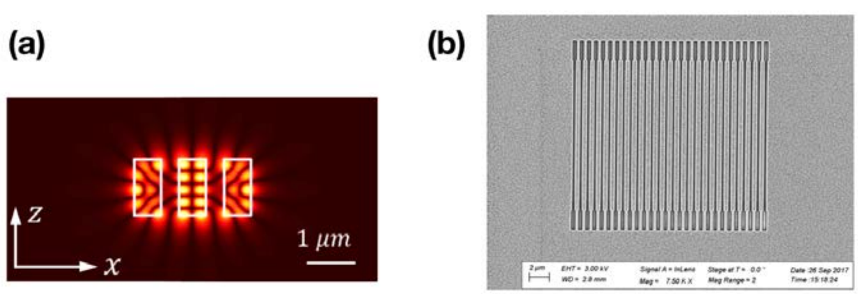

Fig. 1. (a) Field profile of a quasi-BIC from three unit cells structure. (b) Scanning electron microscope (SEM) image of a fabricated BIC laser sample integrated on a silicon wafer.

This project can be formulated as theory or experimental projects. For a theory project, students are expected to have a strong background and interest in photonics and numerical simulations. For an experimental project, no prior knowledge on numerical simulations is not required. Please do not hesitate to contact supervisors for further information.

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References:

[1] Kerry J. Vahala, “Optical microcavities,” Nat., vol. 424, pp. 839-846 (2003).

[2] Hsu, Chia Wei, Bo Zhen, Jeongwon Lee, Song-Liang Chua, Steven G. Johnson, John D. Joannopoulos, and Marin Soljačić. “Observation of trapped light within the radiation continuum,” Nat. vol. 499, no. 7457, pp. 188-191 (2013).