

Spécialité de Master « Optique, Matière, Paris »

Stage de recherche (4 mois minimum, à partir de début mars)

Proposition de stage (ne pas dépasser 1 page)

Date de la proposition : 17/10/2016

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| Nom du Laboratoire: Centre de recherche sur l'hétéro-épitaxie et ses applications | |
| Code d'identification : CRHEA CNRS UPR 10 | Organisme :cnrs |
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Titre du stage: Demonstration of coherent emission from a bound state in the continuum of radiation

Bound states in the continuum of radiation are the result of accidental phase matching between incident, reflected and in-plane waves at seemingly random wave vectors in the band structure, an effect proposed for electrons a long time ago by Von Neumann and Wigner[1]. For several decades after, the idea lay dormant in large part because it was regarded primarily as a mathematical curiosity. Recent efforts and progress in optics, and in particular in two dimensional periodic hole arrays (2D photonic crystals), allowed the discovery of **optical bound state in the continuum of radiation**[2-5].

Harnessing optical modes residing in the radiation continuum, BIC can be used as high quality factor optical cavities that do not decay (Fig 1). These counterintuitive cavities, at the first glance highly coupled to radiative modes, are based on resonantly trapped symmetry-compatible modes that destructively interfere to cancel the scattering effect in free space. These new cavities open exciting avenues towards coherent sources with intriguing topological properties for optical trapping, biological imaging, and quantum communication. The subject of this internship is to demonstrate a resonantly trapped bound state in the continuum laser based on GaN/AlGaIn quantum wells.

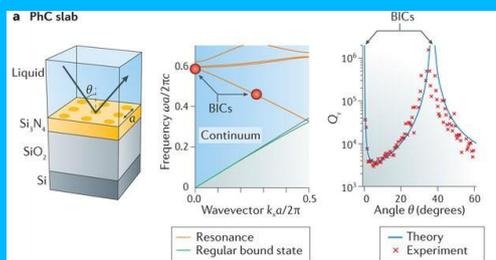


Figure 1: Bound state in the continuum (BIC) from a single resonance in a photonic crystal (PhC) slab. The left panel is a schematic illustration of the system. The middle panel shows the photonic band structure. The leaky resonance turns into two BICs at wavevectors $k_x = 0$ (due to symmetry) and $k_x a / 2\pi \approx 0.27$ (through tuning) as marked by red circles. The radiative quality factor, Q_r , diverges to infinity at the two BICs, as shown by the experimental data (red crosses) and theory (blue line) in the right panel. Adapted from [2].

The intern will design BIC cavities using rigorously coupled mode analysis. He/she will be involved in the fabrication using molecular beam epitaxy (MBE) growth of the GaN-based quantum heterostructures on ZnO substrate. Subsequently, the optical bound state lasers will be further processed by optical and electronic lithographies, at CRHEA's clean room (CRHEATEC: <http://www.crhea.cnrs.fr/crheatec/>). Depending on progress, he/she will perform experimental optical and electrical characterization of devices fabricated at CRHEA.

This project is proposed in collaboration with Prof. Boubacar Kanté (assistant professor of Electrical and Computer Engineering and a Qualcomm faculty scholar at the University of California San Diego (UCSD)).

References:

- 1- J. von Neumann and E. Wigner, "On some peculiar discrete eigenvalues", Phys. Z 30, 467 (1929).
- 2- Hsu CW, Zhen B, Lee J, Chua SL, Johnson SG et al. Observation of trapped light within the radiation continuum. Nature 2013; 499: 188–191.
- 3- Yang Y, Peng C, Liang Y, Li ZB, Noda S. Analytical perspective for bound states in the continuum in photonic crystal slabs. Phys Rev Lett 2014; 113: 037401.
- 4- T. Lepetit and B. Kanté, "Controlling Multipolar Radiation with Symmetries for Electromagnetic Bound States in the Continuum", Phys. Rev. B (Rapid Communication) 90, 241103 (2014).
- 5- R. Gansch, S. Kalchmair, P. Genevet, T. Zederbauer, H. Detz, AM Andrews, W. Schrenk, F. Capasso, M. Loncar, G. Strasser, Measurement of bound states in the continuum by a detector embedded in a photonic crystal, Light: Science and Applications, Volume 5, 9, e16147 (2016)

Web Perso: <http://2dphotonics.weebly.com/>

Ce stage pourra-t-il se prolonger en thèse ? Possibility of a PhD ? : Yes

Si oui, financement de thèse envisagé/ financial support for the PhD: ERC Starting Grant

Lumière, Matière, Interactions

Lasers, Optique, Matière

