Soutenance de thèse

Mercredi 17 Juillet

14h, Amphithéâtre - C2N

DESIGN, STUDY, AND FABRICATION OF COUPLED CAVITY ARRAYS FOR INVESTIGATING NON-HERMITIAN ZERO-MODES

Melissa Hedir

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Lien ZOOM : https://universite-paris-saclay-fr.zoom.us/j/95063754071?pwd=q6dyAgUbXRYZf4JM5YdwfI5IjyrKsm.1

Abstract

Coupled photonic crystal (PhC) cavities are outstanding platforms for many classical and quantum information or computing protocols. They are also highly versatile testbeds for exploring advanced collective optical phenomena, such as the so-called non-Hermitian photonic zero modes. Zero modes are intriguing bound states that have captured attention through the elusive case of Majorana zero modes. In optics, "photonic zero-modes" exhibit zero-energy eigenvalues in a cavity or waveguide array. Being topologically or symmetry-protected modes, they are expected to be robust against coupling disorder, opening up a wide range of applications, from laser mode engineering to optical computing. This thesis work presents the experimental observation of photonic zero modes in small coupled cavity arrays featuring a gain/loss distribution –also called non-Hermitian arrays composed of an odd number of photonic crystal (PhC) cavities, from three to five. Importantly, we have found that controlling the evanescent coupling between the cavities significantly alters the frequency detuning which hampers the realization of zero modes. To address this issue, we developed a new design that we called "image barrier " engineering technique, which enables precise control of coupling strength within 1D arrays of coupled cavities without the concomitant frequency detuning caused by terminations in the chain, thus, significantly expanding the observability range of zero modes. This method also facilitates the construction of cavity chains with non-uniform coupling, thus allowing us to assess the inherent immunity of zero modes to coupling perturbations. Remarkably, the ability to invert coupling signs enabled by our coupling control method leads to achieving an inversion of the zero mode's symmetry, broadening the potential for experimental and theoretical investigations of these modes, either symmetry or topologically protected. This gives a handle to realize in-phase zero-mode oscillation, a crucial requirement to improve the far-field of topological lasers.