Polarization Topology and Optical Bound States in the Continuum

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This paper analyzes how optical modes in photonic crystal slabs can decouple from the environment continuum of radiation through topological protected vortices in the polarization of outgoing radiation. We review previous work done in this area (cite) the symmetry considerations used to find bound states in the continuum (BIC) which are robust yet not protected under symmetry. We analyze photonic crystal slabs periodic in one direction and extended the other, in order to demonstrate the existence of the theorized modes, their robustness and their prevalence in different systems.

I. INTRODUCTION

The field of photonic crystals, periodic structures at the lengthscale of light, has had a great development in recent years, with amazing results in the way we understand and engineer the flow of light. This body of work has resulted in many applications ranging from more efficient optical fibers, new devices, and the realization of novel phenomena like the chiral propagation of light and the realization of systems with Weyl points.

A topic of particular interest to engineering applications is the realization and control of bound states in the continuum (BIC). Usually modes, whose energy and momentum is above the light cone, in a finite system, couple to the external continuum of radiation, leading to losses in the mode. However, in BIC, these modes are completely uncoupled from the outside continuum, enabling them to be long lived.

BIC where initially proposed by von Neuman (and Wigner) in the context of Quantum Mechanics, through the description of very complex potentials. As a result from this complexity, these BIC were not robust under perturbations of the potential so they were never experimentally observed. More recent work had analyzed BIC that arise from a symmetry mismatch between the bound state and the continuum modes, which prevent the BIC to leak couple to the continuum degrees of freedom (cite). In this paper we analyze a new approach, proposed and observed in Zhen's paper, and then explained in the context of topology in a following work (cite).

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