Strategic Topics Grant

Topic 3: Establishing Hong Kong as the Leading Integrated Circuits, and Opto-electronics Innovation and Technology Hub in the Guangdong-Hong Kong-Macao Greater Bay Area

Project Title: Photonic integrated platforms based on topological physics

Project Coordinator: Professor Shuang Zhang

Abstract

The proposal aims at revolutionizing the design of integrated photonic circuits by applying the fundamental principles of topological physics. The topology of a structure characterizes discrete properties, which are inherently immune to flaws, are robust to environmental factors. More widely than electronics, incorporating topology into the design of new structured materials opens the door to the photonic realm. Meanwhile, recent development of integrated photonic platforms offers the opportunity of creating sub-wavelength optical waveguides in a large scale while requesting more robust operations. These demonstrations have now created an exciting ecosystem with a variety of high-performance photonic building blocks ready for further integration into larger-scale photonic integrated circuits (PICs) with advanced functionalities. However, there exist open questions such as how to overcome the factors that constrains the density of optical information channels within confined device volume and how to interface photonic communication links with individual isolated quantum systems. Leveraging the recent advances in both topological photonics and integrated photonics, our program will make the attempt to incorporate the principles of topological physics into the design of dynamic and programmable photonic integrated circuit platforms with unparalleled functionalities. Specifically, our project will implement novel concepts such as gauge field and non-Abelian topological pumping, topological singularities such as Dirac points and Weyl points, non-Hermitian and supersymmetric physics, for the design of compact and dynamically tuneable integrated photonic circuits, leveraging the concept of synthetic dimensions in the parameter space and providing new design strategies to achieve robustness against fabrication errors. The existing world-renowned local research strength of different universities will be assembled and propelled to a higher level by this strategic project. Local young talents will be incubated and trained, and global talents will be attracted to Hong Kong. Hong Kong is currently unique in having a critical mass of photonic scientists, fully capable of making fundamental discoveries and taking such discoveries to real world applications, benefiting industries in the Greater Bay Area.

策略專題研究資助金

主題三: 打造香港成為粵港澳大灣區領先的集成電路和光電創新科技中心

項目名稱：基於拓撲物理的集成光路

項目統籌：張霜教授

簡介

集成光子平台有機結合了成熟的微電子和光電子技術，既減小了芯片尺寸，降低成本和功耗、又提高了可靠性。它是未來高速流量傳輸處理的基礎，但當前仍存在一些未解決的問題，例如如何克服有限空間下光信息通道密度的限制以及如何將光子通信線路與單個孤立的量子系統對接。本項目將利用拓撲光子學和集成光子學的最新進展，將拓撲物理學的原理融入到具有新穎功能和動態可編程的光子集成電路平台設計中。系統的拓撲性質表徵着其離散的特性，具有內在的免疫力和魯棒性，而拓撲概念已經在凝聚態物理領域和光學領域得到應用。具體而言，我們將利用新穎的拓撲概念，如規範場和非阿貝爾拓撲泵，拓撲奇點，如狄拉克點和外爾點，非厄米和超對稱物理等，用於設計緊湊和動態可調的光子集成電路。我們還將利用參數空間的合成維度的概念，提供新的設計策略，以實現對製造誤差的魯棒性。該項目將集合香港各大學在集成光子學方向的研究力量，推動該領域的發展，並促進光通信與大規模人工智能相關產業界之間的合作。此外，項目還將培訓本地青年人才，吸引全球人才來到香港。該項目的成果將應用到實際器件中，促進大灣區在光子學方向的產業發展。