Duke Kunshan University Mathematical Research Seminar Series

Analysis and computation of topological photonic materials

Prof. Yi Zhu, Tsinghua University

Venue: DKU Academic Building 1084
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About the speaker:

Dr. Yi Zhu received his B.S. and Ph.D in applied mathematics at Tsinghua University and undertook postdoctoral research in the University of Colorado at Boulder. Then he joined Zhou Pei-Yuan Center for Applied Mathematics at Tsinghua University as an associated professor. Dr. Yi Zhu's research interest lies in the mathematical modeling, analysis and computations of scientific problems in optics, material science and complex fluids. Recently he focuses on the linear and nonlinear wave motion in the topological materials.

Abstract: In this talk, we will introduce our recent results on the analysis and computation of the topological edge states in photonic graphene, which is an easily realizable topological material and has wide applications. Specifically, we study the propagation of electromagnetic waves governed by the two-dimensional Maxwell equations in honeycomb media. Thanks to the symmetries of the media, existence of Dirac points and corresponding Dirac dynamics are rigorously analyzed. Moreover, the introduction through small and slow variations of a domain wall across a line-defect gives rise to the bifurcation from Dirac points of highly robust (topologically protected) edge states. Via a rigorous multi-scale analysis, we give an explicit description (to leading order) of the edge states. However, the analysis does not apply for large and non-adiabatic line defects, thus we turn to numerical solutions and propose a novel gradient recovery method based on Bloch theory for computation of such edge states. Compared to standard finite element methods, this method provides higher order accuracy with the help of gradient recovery technique. This higher accuracy is highly desired for constructing the full electromagnetic fields under propagation.