Institute for Basic Science

Center for Integrated Nanostructure Physics

SUNG KYUN KWAN UNIVERSITY(SKKU)

IBS CINAP Seminar

June 27, 2019, 5:00PM

Room 86120 (N Center), Sungkyunkwan University, Suwon

Topological edge modes in Kagome lattice photonic crystals

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Abstract

Photonic topological insulators are promising as a new photonic platform due to the unidirectional edge states insensitive to bending and fabrication imperfections. A recently proposed all-dielectric perturbed honeycomb photonic crystal design [1], however, intrinsically suffers from back-reflection due to the symmetry breaking at the interface. Here, we propose an all-dielectric photonic topological insulator based on the kagome lattice geometry [2,3] in which the topological edge modes do not undergo back reflection for the Gamma-K inclination.

By investigating the valley Chern numbers, we numerically show that it has non-trivial topology and emulates the so-called quantum valley Hall effect (QVHE) [4]. Interestingly, the edge modes do not intrinsically suffer from back scattering for a broad spectrum but are sensitive to the inclination. The edge modes are shown to be robust against sharp bending, and importantly, in contrast to the perturbed honeycombs, part of them are lying below the light cone, leading to significantly reduced out-of-plane outcoupling of light.

[1] L.-H. Wu and X. Hu, “Scheme for Achieving a Topological Photonic Crystal by Using Dielectric Material,” Phys. Rev. Lett., vol. 114, 223901, 2015.

[2] M. Saba, S. Wong, M. Elman, S. S. Oh, and O. Hess, “The Role and Nature of Topological Protection in Reciprocity Symmetric Photonic Topological Insulators,” *in preparation*.

[3] S. Wong, M. Saba, and O. Hess, and S. S. Oh, “Gapless Unidirectional Photonic Transport Using All-Dielectric Kagome Lattices,” *in preparation*.

[4] X.-D. Chen, F.-L. Zhao, M. Chen, and J.-W. Dong, “Valley-contrasting physics in all-dielectric photonic crystals: Orbital angular momentum and topological propagation,” Phys. Rev. B, vol. 96, 020202, 2017.

Biography

Sang Soon Oh is a Sêr Cymru II Rising Star Fellow in the School of Physics and Astronomy. He has been working in the field of photonic crystals, metamaterials, plasmonics, semiconductor lasers and topological photonics He is interested in theory and numerical modelling of topological physics and chiral light-matter interactions. His current projects focus on photonic topological insulator lasers using the III-V semiconductor nanowires, group theoretical approach to dielectric photonic topological insulators and topological pasmonics.

He received a PhD degree in Physics from Korea Advanced Institute of Science and Technology (KAIST) in South Korea (2007). During his PhD course, he visited University of St. Andrews in Scotland (2004-2005). After a post-doctoral fellowship at Electronics Telecommunications Research Institute (ETRI) in South Korea (2007-2010), he joined the Department of Physics at University of Surrey, UK as a postdoc (2010) and moved to the Condensed Matter Theory (CMTH) Group in the Department of Physics and Optical Semiconductor Device (OSD) Group in Electrical and Electronics Engineering Department at Imperial College London. In 2017, he joined the Institute for Compound Semiconductors at Cardiff University as a Rising Star Fellow.

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