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Request: Topological photonics and their application in next-generation optical communication

Summary

Topological photonics is an emerging field that leverages the principles of topology to design photonic systems with robust properties, which are particularly promising for next-generation optical communication technologies. Several recent studies have made significant contributions to this area, focusing on the development of photonic devices with enhanced performance and new functionalities. 1. **Dual-Broadband Topological Photonic Crystal Edge State Based on Liquid Crystal Tunability**: This paper presents a dual-band terahertz transmission system utilizing topologically protected valley photonic crystal edge states. The study demonstrates the excitation of K and K' valleys in specific frequency ranges, highlighting the potential for tunable spectral systems in optical communication. 2. **Carrier Injection Type Topological Edge State Electro-Optic Mach-Zehnder Modulator Based on Valley Photonic Crystals**: This work explores a Mach-Zehnder modulator structure using silicon valley photonic crystals. The modulator achieves intensity modulation through carrier injection, showcasing the application of topological edge states for reconfigurable photonic devices. 3. **On-Chip Active Non-Reciprocal Topological Photonics**: This study reports a non-reciprocal topological silicon chip based on a magneto-optical Indium Antimonide integrated valley Hall system. The chip demonstrates potential for photonic circulators and isolators,

crucial for data communication and signal modulation. 4. **Reconfigurable Chiral Edge States in Synthetic Dimensions on an Integrated Photonic Chip**: The paper introduces a programmable photonic platform for generating and manipulating chiral edge states in synthetic dimensions. This advancement allows for flexible control over topological properties, enhancing the capabilities of integrated photonic systems. 5. **Polarization Excited Optical Switch Based on Valley Topological Photonic Crystal**: This research presents an optical switch utilizing unidirectional coupling excited by a chiral polarization field. The design reduces the device footprint and complexity, offering a promising solution for on-chip optical communication and network applications. These studies collectively highlight the potential of topological photonics to revolutionize optical communication by providing robust, tunable, and compact photonic devices. The integration of topological concepts into photonic systems promises to overcome current limitations and enable new functionalities in optical technologies.

Relevant Articles

1. Rashba spin-orbit coupling and artificially engineered topological superconductors

Date: 2025-06-26

Source: arXiv

URL: http://arxiv.org/abs/2506.21534v1

Abstract: One of the most important physical effects in condensed matter physics is the Rashba spin-orbit coupling (RSOC), introduced in seminal works by Emmanuel Rashba. In this article, we discuss, describe, and review (providing

critical perspectives on) the crucial role of RSOC in the currently active research area of topological quantum computation. Most, if not all, of the current experimental topological quantum computing platforms use the idea of Majorana zero modes as the qubit ingredient because...

2. On the Invariance of Expansive Measures for Flows

Date: 2025-06-26

Source: arXiv

URL: http://arxiv.org/abs/2506.21533v1

Abstract: We study expansive measures for continuous flows without fixed points on compact metric spaces, as introduced in [6]. We provide a new characterization of expansive measures through dynamical balls that, in contrast to the dynamical balls considered in [6], are actually Borel sets. This makes the theory more amenable to measure-theoretic analysis. We then establish a version of the Brin-Katok local entropy formula for flows using these generalized dynamical balls. As an application, we prove tha...

3. WAFT: Warping-Alone Field Transforms for Optical Flow

Date: 2025-06-26

Source: arXiv

URL: http://arxiv.org/abs/2506.21526v1

Abstract: We introduce Warping-Alone Field Transforms (WAFT), a simple and effective method for optical flow. WAFT is similar to RAFT but replaces cost volume with high-resolution warping, achieving better accuracy with lower memory cost. This design challenges the conventional wisdom that constructing cost volumes is necessary for strong performance. WAFT is a simple and flexible meta-architecture with minimal inductive biases and reliance on custom designs. Compared with existing methods, WAFT ranks 1st...

4. The spectrum of global representations for families of bounded rank and VI-modules

Date: 2025-06-26

Source: arXiv

URL: http://arxiv.org/abs/2506.21525v1

Abstract: A global representation is a compatible collection of representations of the outer automorphism groups of the finite groups belonging to a family $\mathscr{U}$. These arise in classical representation theory, in the study of representation stability, as well as in global homotopy theory. In this paper we begin a systematic study of the derived category $\mathsf{D}(\mathscr{U};k)$ of global representations over fields k of characteristic zero, from the point-of-view of tensor-triangular geometr...

5. New plasmon-like mode in PdTe$_{2}$: Raman scattering and memory function study

Date: 2025-06-26

Source: arXiv

URL: http://arxiv.org/abs/2506.21518v1

Abstract: PdTe$_2$ is a type II Dirac semimetal that has garnered significant attention due to its intriguing electronic and topological properties. Here, we report temperature dependent Raman scattering study of PdTe$_2$ in the temperature range from 10 K to 300 K. Our study reveals emergence of a new unreported peak below 100 K, centered around 250 cm^{-1}. We argue that the new mode is not a phonon mode because the Raman spectra calculated using Density Functional Theory shows only two intense peaks ...

6. Excitation of Giant Surface Waves During Laser Wake Field Acceleration

Date: 2025-06-26

Source: arXiv

URL: http://arxiv.org/abs/2506.21503v1

Abstract: We have detected the presence of very high intensity surface waves that are excited during plasma waveguided laser wakefield acceleration. Wakefield acceleration can be enchanced by the introduction of an ``all optical" plasma waveguide that confines and guides a laser pulse at the optimal intensity over long distances,

producing quasimonoenergetic multi-GeV electron bunches. However strong pulses of radio frequency radiation (RF) are also produced, and particle in cell simulations show why: a c...

7. Ad-Hoc Human-AI Coordination Challenge

Date: 2025-06-26

Source: arXiv

URL: http://arxiv.org/abs/2506.21490v1

Abstract: Achieving seamless coordination between AI agents and humans is crucial for real-world applications, yet it remains a significant open challenge. Hanabi is a cooperative card game featuring imperfect information, constrained communication, theory of mind requirements, and coordinated action -- making it an ideal testbed for human-AI coordination. However, its use for human-AI interaction has been limited by the challenges of human evaluation. In this work, we introduce the Ad-Hoc Human-AI Coordi...

8. Observers and Timekeepers: From the Page-Wootters Mechanism to the Gravitational Path Integral

Date: 2025-06-26

Source: arXiv

URL: http://arxiv.org/abs/2506.21489v1

Abstract: Quantum gravity in a closed universe faces two a priori distinct yet seemingly related issues: the problem of time and the fact that its Hilbert space dimension is one. Both have been argued to be resolvable by formulating physics relative to an observer. Using a simple gravitational path integral model, we explain that the two issues arise from two distinct non-perturbative effects: the former from summing over metrics and the latter from summing over topologies. We then revisit the Page-Wootte...

9. Equivalence of Landscape and Erosion Distances for Persistence Diagrams

Date: 2025-06-26

Source: arXiv

URL: http://arxiv.org/abs/2506.21488v1

Abstract: This paper establishes connections between three of the most prominent metrics used in the analysis of persistence diagrams in topological data analysis: the bottleneck distance, Patel's erosion distance, and Bubenik's landscape distance. Our main result shows that the erosion and landscape distances are equal, thereby bridging the former's natural category-theoretic interpretation with the latter's computationally convenient structure. The proof utilizes the category with a flow framework of de...

10. Frustrated edge currents in bilayers formed of s- and d-wave superconductors

Date: 2025-06-26

Source: arXiv

URL: http://arxiv.org/abs/2506.21482v1

Abstract: We explore edge currents in heterostructures formed of a high-T_c cuprate and a conventional s-wave superconductors. The resulting $d\pm is$ superconductor spontaneously breaks time reversal symmetry and, remarkably, exhibits large edge currents along certain edge directions in spite of being topologically trivial. In addition we find that the edge currents are frustrated such that they appear to emerge from or flow into sample corners, seemingly violating charge conservation. Careful self-c...

11. Dual-Broadband Topological Photonic Crystal Edge State Based on Liquid Crystal Tunability.

Date: 2025-06-12

Source: PubMed

DOI: 10.3390/ma18122778

URL: https://pubmed.ncbi.nlm.nih.gov/40572909

Abstract: The rapid advancements in optical communication and sensing technologies have significantly increased the demand for advanced tunable spectral

systems. This study presents a dual-band terahertz transmission and manipulation approach by leveraging the topologically protected properties of valley-topological photonic crystal edge states. The designed structure facilitates the excitation of the K valley within the range of 0.851-0.934 THz and the K' valley from 1.604 to 1.686 THz, while also demons...

12. Dual-Band Metasurface-Based Structured Light Generations for Futuristic Communication Applications.

Date: 2025-02-03

Source: PubMed

DOI: 10.1002/smsc.202400524

URL: https://pubmed.ncbi.nlm.nih.gov/40395347

Abstract: Structured beams carrying orbital angular momentum carry significant potential for various applications, including optical trapping, manipulations, communications, microscopy, and so on. Among these, perfect vortex (PV) beams are highly attractive due to their immunity to topological charge variations and nondiffracting properties. However, conventional PV beam generation methods typically operate at a single wavelength and rely on bulky components, complicating photonic device integration. To a...

13. Topological links and knots of speckled light mediated by coherence singularities.

Date: 2025-04-27

Source: PubMed

DOI: 10.1038/s41377-025-01865-3

URL: https://pubmed.ncbi.nlm.nih.gov/40289134

Abstract: Links and knots are exotic topological structures that have garnered significant interest across multiple branches of natural sciences. Coherent links and knots, such as those constructed by phase or polarization singularities of coherent light, have been observed in various three-dimensional optical settings. However, incoherent links and knots-knotted or connected lines of coherence singularities-arise from a fundamentally different concept. They are "hidden" in the statistic properties of a r...

14. Reconfigurable Chiral Edge States in Synthetic Dimensions on an Integrated Photonic Chip.

Date: Unknown

Source: PubMed

DOI: 10.1103/PhysRevLett.134.143801

URL: https://pubmed.ncbi.nlm.nih.gov/40279606

Abstract: Chiral edge states are a hallmark of topological physics, and the emergence of synthetic dimensions has

provided ideal platforms for investigating chiral topology while overcoming the limitations of real space. Conventional studies have primarily concentrated on symmetric chiral behaviors, limited by complex and inflexible systems. Here, we demonstrate a programmable integrated photonic platform to generate and manipulate reconfigurable chiral edge states in synthetic dimensions within a single ...

15. Optical vortex arrays in a multimode silicon waveguide.

Date: Unknown

Source: PubMed

DOI: 10.1364/OL.555889

URL: https://pubmed.ncbi.nlm.nih.gov/40232485

Abstract: The immense potential of optical vortex arrays (OVAs) has been validated in applications such as particle manipulation, optical imaging, metrology, quantum, and optical communication. Photonic integrated technology has provided a powerful platform for the manipulation of vortex beams, which has the advantages of compact footprint, high controllability, and flexibility. However, since vortex beams are not eigenmodes of rectangular optical waveguides, the on-chip generation of in-plane OVAs has no...

16. Evolution of the Rich Club Properties in Mouse, Macaque, and Human Brain Networks: A Study of Functional Integration, Segregation, and Balance.

Date: 2025-04-13

Source: PubMed

DOI: 10.1007/s12264-025-01393-5

URL: https://pubmed.ncbi.nlm.nih.gov/40221944

Abstract: The rich club, as a community of highly interconnected nodes, serves as the topological center of the network. However, the similarities and differences in how the rich club supports functional integration and segregation in the brain across different species remain unknown. In this study, we first detected and validated the rich club in the structural networks of mouse, monkey, and human brains using neuronal tracing or diffusion magnetic resonance imaging data. Further, we assessed the role of...

17. Carrier injection type topological edge state electro-optic Mach-Zehnder modulator based on valley photonic crystals.

Date: Unknown

Source: PubMed

DOI: 10.1364/OE.554943

URL: https://pubmed.ncbi.nlm.nih.gov/40219487

Abstract: Valley photonic crystals (VPCs) and their topological edge states have been widely studied and applied to many passive devices. However, reconfigurable topological photonic devices remain to be further explored. In this work, we propose a Mach-Zehnder modulator (MZM) structure based on silicon VPCs. One arm of the proposed VPC-MZM is doped and driven by forward-biased voltage to achieve intensity modulation. Theoretically, it is demonstrated that the phase-shifting efficiency of the edge state m...

18. Polarization excited optical switch based on valley topological photonic crystal.

Date: Unknown

Source: PubMed

DOI: 10.1364/OE.550027

URL: https://pubmed.ncbi.nlm.nih.gov/40219477

Abstract: An optical switch, which enables applications covering logical operation, channel conversion control, has attracted extensive research attentions in on-chip optical communication and network. However, in order to construct composite logic operations, traditional wavelength selective optical switches that manipulate the effective refractive index of the light field require complex system design, resulting in a large device footprint. Herein, by using unidirectional coupling excited by a chiral po...

19. On-Chip Active Non-Reciprocal Topological Photonics.

Date: 2025-04-10

Source: PubMed

DOI: 10.1002/adma.202501711

URL: https://pubmed.ncbi.nlm.nih.gov/40207687

Abstract: Chip-scale non-reciprocity is essential for advancing integrated photonics, particularly in realizing photonic circulators and isolators for data communication, signal modulation, and quantum computing. However, achieving a non-reciprocal silicon chip with a small footprint, high isolation ratio, low loss, and active control remains a challenge. Here, a non-reciprocal topological silicon chip based on magneto-optical Indium Antimonide (InSb) integrated valley Hall system is reported. The valley-...

20. T-shaped topological polarization beam splitter based on a synthetic dimension.

Date: Unknown

Source: PubMed

DOI: 10.1364/OL.555633

URL: https://pubmed.ncbi.nlm.nih.gov/40167713

Abstract: In this study, we propose a 2D photonic crystal (PC) with a common bandgap (CBG) for both TM and TE polarizations. Based on the Jackiw-Rebbi theory, a pair of

topological helical edge states along the domain wall can be found in the parity-inversion bandgap. Pseudospin-locked unidirectional propagation and backscattering immunity of topological edge states (TESs) of dual polarization are demonstrated. By employing translation parameters as a synthetic dimension, the evolution of TESs within a pa...

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