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Editorial: Topological Photonics

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Editorial on the Research Topic

Topological Photonics

As one of the research frontiers of photonics in recent years, topological photonics plays an essential role in fields of both fundamental physics and device applications. Topological photonics provides a new and robust platform to study the interactions between light and matter based on a topological degree of freedom, which has triggered the discovery of a kaleidoscope of new physical effects and new device applications. These findings are bringing substantial potential in transformative technologies.

The purpose of this Research Topic is to systematically reflect on the latest research progress of topological photonics, and promote the development of topological photonics in new directions. The scope of the Research Topic includes design, fabrication, and measurement of photonic topological insulators, synthetic dimensions, non-Hermitian topological photonics, high-order topological states, quantum topological photonics, topological microwaves, topological acoustics, and their applications.

This Research Topic includes nine original research articles and five review articles covering fundamental physics and device applications of topological photonics. The nine original research articles report the latest research progress and direction of topological photonics. Yuan et al. reported a novel design strategy for constructing optical topological cavities using photonic crystals (Yuan et al.), which could provide valuable guidance when constructing topological optical devices. Jia et al. reported the fabrication of a pseudospin-dependent topological acoustic insulator by using hexagonal rods (Jia et al.), which could offer useful reference when constructing multi-functional acoustic devices. Li et al. reported the fabrication of two-dimensional acoustic higher-order topological insulators, and demonstrated the coupling effects of topological corner modes (Li et al.), which provided a new platform for the study of high-order topological photonics and non-Hermitian physics. Lai et al. reported the construction and characterization of tunable topological surface states of three-dimensional acoustic crystals (Lai et al.), where various multi-functional topological acoustic devices could be realized. Peng et al. reported the theoretical results of the properties of topological one-way edge states in an air-hole honeycomb gyromagnetic photonic crystal biased by an external magnetic field (Peng et al.), which may open a new door towards the observation of nontrivial edge states. Elshahat and Lu reported a unidirectional and bidirectional rainbow trapping, realized based on trapping a chirped photonic crystal as a sandwich between two edge states (Elshahat and Lu), which provided a new way to construct topological nanophotonic devices. Liao et al. reported an equivalent circuit model for topological engineering of the iso-frequency contours in connection-type metamaterials (Liao et al.), which may provide a new pathway for the realization of novel nanophotonic devices. Zhao et al. reported the theoretical finding

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of multiple one-way edge modes in sonic crystals with large Chern numbers (Zhao et al.), and the realization of acoustic diodes by joining sonic crystals with different Chern numbers. This work offers a new route for the realization of novel acoustic non-reciprocal devices. Li et al. reported the realization of multiport routing of topologically optical transport based on the merging of valley-dependent edge states and second-order corner states (Li et al.), which provided a valuable reference for the realization of topological photonic integrated circuits.

Review articles are indispensible for both the specialists and beginners engaged in the field of topological photonics. We are excited that this Research Topic includes a high-quality collection of in-depth reviews. Xie et al. give a systematical review of topological semimetal phases in artificial photonic microstructures and their applications in coupling spin-polarized electromagnetic waves, anomalous reflection, vortex beams generation, bulk transport, and non-Hermitian effects (Xie et al.). This article will promote the study of higher-order topological semimetals and their applications. Jiang et al. provide an in-depth review of recent progress in the chiral topological quantum interface (Jiang et al.), which will be a valuable reference for the research of quantum topological photonics. Luo et al. offer a systematical and in-depth review of Hermitian and non-Hermitian Dirac-like cones in photonic and phononic structures (Luo et al.), which would promote the research of non-Hermitian topological photonics and phononics. Wang et al. give a comprehensive review of fundamentals and applications of topological polarization singularities (Wang et al.), which will help to improve the applications of topological photonics in fields of optical communication, biosensing, and so on. Haixiao Wang et al. offer a review of the all-dielectric topological photonic crystals from the aspect of topological phases (Wang et al.), which will surely improve the developments of all-dielectric topological photonics.

The topic of "Topological Photonics" has brought rich physical phenomena, and will stimulate more interest due to the unique properties of topological protection. We believe that this Research Topic will provide valuable guidance for the future research direction and applications of topological photonics. Both new physics and various new kinds of functional nanophotonic devices and chips will be expected to be realized based on topological photonics in the near future. Last but not least, we wish to express our sincere gratitude towards all the excellent scientists, including authors and reviewers, whose invaluable contributions made this Research Topic a reality.

AUTHOR CONTRIBUTIONS

All authors listed have made a substantial, direct, and intellectual contribution to the work and approved it for publication.

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