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Topological Physics: From Fundamentals to Applications

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With recent breakthroughs from fundamentals to applications in topological physics, it should provide a snapshot of the state-of-the-art, both experimental and theoretical, for both experienced and young researchers interested in this subject area. The Special Issue on "Topological Physics: From Fundamentals to Applications" edited by Xiaotian Wang, and Gang Zhang, provides an overview of progress beyond the state of the art for a diverse range of ongoing scientific and technological efforts toward to the forecasting and engineering of the properties of topological physics, opening up exciting opportunities for the prediction, design, fabrication, functionalization, and integration of new and emerging research on topological materials.

The topological singularity of the scalar field of a microwave supercavity system, excited adjacent to the avoided mode crossing, was observed. Zahra Manzoor et al. [apxr.202200052] experimentally demonstrated that optimizing the high-index dielectric resonator (HIR) dimensions along with a multipolar composition of the strongly coupled excitation source enabled a more compact supercavity system with a higher quality factor.

Topological magnonics has received a great deal of attention in the past decade owing to its fundamental significance and potential applications. This review provided a comprehensive overview of recent research progress on topological phases of magnons, including Chern insulators, high-order topological insulators, Z2 topological insulators, and topological semimetals of magnons. Additionally, candidate materials and artificial structures suitable for hosting topological magnons were summarized by Fengjun Zhuo et al. [apxr.202300054].

In the van der Waals heterostructures Gr/CrI_3, the spin-polarized density of graphene exhibited a non-monotonic change with electric field due to the unstable charge distribution. Jun-Tong Ren et al. [apxr.202300026] reported that when the interface distance was compressed, the enhanced interaction between graphene and CrI_3 stabilized the charge distribution, and the quantum anomalous Hall gap was tuned from 6 to 22 meV.

Shandite with $Ni_3Pb_2S_2$ chemical formula and $R\bar{3}m$ symmetry contains the kagome sublattice formed by transition metal atoms. Surajit Basak et al. [apxr.202300025] theoretically investigated the dynamical properties of $T_3Pb_2Ch_2$ (T = Pd,Pt, and Ch = S,Se) with a shandite structure. The studied compounds realized the phonon Dirac nodal points and lines, phonon surface states, while $Pt_3Pb_2S_2$ was unstable and exhibited the structural phase transition from $R\bar{3}m$ to $R\bar{3}c$.

Topological spintronics was presented without spin-orbit interaction by Muhammad Nadeem et al. [apxr.202300028], where topological switching of edge state conductance in a topological Dirac spin-gapless material is implemented via bulk-boundary correspondence.

Xiaotian Wang et al. [apxr.202200085] investigated that Nodal-line phonons can be divided into open and closed nodal-line states according to their spatial configurations. Based on the theoretical calculations, the open and closed nodal-line phonons were examined in the realistic materials $Ba(AgS)_2$ and $Ca(ZnP)_2$ with the space group $P\bar{3}m1$, and also detailed explanations of their difference through topological symmetry arguments and effective model analysis were provided.

The fundamental and applicational work of topological physics has far-reaching impacts on the state of the art of academic research and even daily life. We hope the articles in this special issue "Topological Physics: From Fundamentals to Applications" can trigger more research on topological physics, from materials prediction to device applications. Finally, we would like to extend our sincere thanks to all the authors for their vital contributions, as well as to the editorial team of Advanced Physics Research for their great support.

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