



Seminar

Helical Symmetry Breaking and Quantum Anomaly in Massive Dirac Fermions

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Time: 3:00pm, April. 7, 2022 (Thursday)

时间: 2022年4月7日 (周四) 下午3:00

Venue: Room W563, Physics building, Peking University

地点: 北京大学物理楼, 西563会议室

Abstract

Helical symmetry of massive Dirac fermions is broken explicitly in the presence of electric and magnetic fields. Here we present two equations for the divergence of helical and axial vector currents following the Jackiw-Johnson approach to the anomaly of the neutral axial vector current. We discover the contribution from the helical symmetry breaking is attributed to the occupancy of the two states at the top of the valence band and the bottom of the conduction band. The explicit symmetry breaking fully cancels the anomalous correction from quantum fluctuation in the band gap. The chiral anomaly can be derived from the helical symmetry breaking. It provides an alternative route to understanding the chiral anomaly from the point of view of the helical symmetry breaking. The pertinent physical consequences in condensed matter are the helical magnetic effect, which means a charge current circulating at the direction of the magnetic field, and the mass dependent positive longitudinal magnetoconductivity as a transport signature. The discovery not only reflects anomalous magnetotransport properties of massive Dirac materials, but also reveals the close relation between the helical symmetry breaking and the physics of chiral anomaly in quantum field theory and high energy physics.

Reference:

H. W. Wang, B. Fu, and S. Q. Shen, Phys. Rev. B **104**, L241111 (2021)

About the speaker

Professor Shun-Qing Shen, an expert in the field of condensed matter physics, is distinguished for his research works on topological insulator, quantum transport, spintronics, quantum magnetism and orbital physics in transition metal oxides, and novel quantum states of condensed matters. He proposed topological Anderson insulator, and theory of weak-localization and anti-localization in topological insulators. He has published a single-authored monograph, Topological Insulators (Springer, 1st ed. 2012; 2nd ed. 2017), which is the first book on the topic.

Professor Shen received his BS, MS, and PhD in theoretical physics from Fudan University in Shanghai. He was a postdoctoral fellow in China Center of Advanced Science and Technology (CCAST), Beijing, Alexander von Humboldt fellow in Max Planck Institute for Physics of Complex Systems, Dresden, Germany, and JSPS research fellow in Tokyo Institute of Technology, Japan. In December 1997 he joined The University of Hong Kong.