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院士講座系列

The 14th Lecture Series by Academicians from the Chinese Academy of Sciences (CAS)

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Speaker: **Prof. Chang Kai**
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Chinese Academy of Sciences
中國科學院數學物理學部

Title: **二維量子材料中的激子絕緣體相**
Exciton Insulator Phase in Two-dimensional Quantum Materials

Date: **Wednesday, 17 April 2024**
Time: **16:00 – 17:30**
Venue: **Cho Yiu Hall, University Building**
Registration: **http://www.cuhk.edu.hk/cneo/cas_2024/**

Biography

Prof. Kai Chang, an academician of the Department of Mathematics and Science of the Chinese Academy of Sciences, is currently a chair professor and doctoral supervisor at the School of Physics, Zhejiang University. He is currently a member of the Standing Committee of the 14th National Committee of the Chinese People's Political Consultative Conference, a member of the Central Standing Committee of the China Democratic League, and the director of the Central Science and Technology Committee of the China Democratic League. He has been committed to the research of basic semiconductor physics and device physics for a long time. He has published more than 200 SCI papers including Nature sub-journals, PRL and other SCI papers. The papers have been cited more than 10,000 times. Many of his works have received widespread attention and positive evaluation from international peers, and be included in review articles and monographs. He won the second prize of the National Natural Science Award in 2004, received funding from the National Outstanding Youth Fund in 2005, and was selected into the National Hundreds and Thousands of Talents Project in 2013; and was awarded the "National Young and Middle-aged Experts with Outstanding Contributions". Was awarded the 2013 Chinese Physical Society Huang Kun Solid State Physics and Semiconductor Physical Science Award. In 2019, he was elected as an academician of the Department of Mathematics and Science of the Chinese Academy of Sciences. He is currently a member of the C8 Committee on Semiconductor Physics of the International Union of Pure and Applied Physics (IUPAP).

Abstract

Exciton insulator was firstly proposed by Prof. Mott in 1961. When the binding energy of exciton in these systems is larger than the single-particle bandgap, the systems becomes unstable, and open a bandgap forming an exciton insulator phase. This concept has been widely studied theoretically and confirmed experimentally in recent years. Here, We demonstrate theoretically the existence of topological exciton insulating phases in two-dimensional (2D) semiconductor systems, based on the multi-band k*p theory and the BCS-like many-body theory. We consider two kinds of systems: InAs/GaSb quantum wells and 2D Van der Waals heterostructures. In InAs/GaSb quantum wells, i.e., a 2D topological insulator, we demonstrate theoretically that the ground state of the system is no longer the 2D topological insulator, but a topological exciton insulator when the Coulomb interaction between electrons and holes is included. The system displays the topological edge states for the inverted band case with strong spin-orbit interactions. We find that the topological exciton insulator phase can still survive even under very strong in-plane magnetic fields up to B=35T. For a 2D VdH system, we find that a perpendicular electric field can decrease the bandgap, which even becomes smaller than the exciton binding energy, leading to the formation of exciton insulator phase. Due to large exciton binding energy, the exciton insulator phase in the 2D VdH system could be observed at room temperature. We propose an excitonic insulator phase of spin triplet state in the Semihydrogenated Graphene. Recently we have also discovered flat-band induced topological exciton insulator density waves in new two-dimensional material systems.

Language: Putonghua

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