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沖縄科学技術大学院大学

## THEORETICAL SCIENCES VISITING PROGRAM

# TSVP TALK

# Excitonic Bose Einstein Condensation in Flat Bands

**2024 THU. Dec.19**

**13:00–14:00**

**HYBRID** | L4E01, ZOOM

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An excitonic insulator (EI) phase can be stabilized in narrow-gap semiconductors/semimetals when spontaneously formed excitons, bound bosonic pairs of electrons and holes, condense at low temperatures. The search for excitonic Bose-Einstein condensate (BEC) in intrinsic semiconductors has received tremendous attention in the past decade, but so far convincing evidence remains lacking. Several material candidates have been recently proposed computationally, but these studies are limited to single exciton calculations and the effects of interactions, if included, are approximated using mean-field approach. In this talk, I will discuss our recent work investigating the role of topological flat bands (FBs) in promoting excitonic BEC. First, I will show that flat valence and conduction bands (so-called yin-yang FBs) of quantum semiconductors [1], such as the one having a diatomic Kagome lattice as exemplified in a superatomic graphene, conspire to indicate a triplet EI state, based on DFT-GW and BSE calculations for a single exciton formation. Next, using exact diagonalization method to solve an extended Hubbard lattice model of yin-yang FBs, I will show directly spontaneous BEC of triplet excitons, based on analyses of multi-exciton formation energies and wave functions [2]. I will demonstrate the critical role of FBs in promoting quantum coherence, as evidenced by off-diagonal long-range order in many-exciton states. These works significantly enriches FB and excitonic physics while providing a unique platform for material realization of spinor BEC and spin superfluidity.



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## Feng Liu


Feng Liu received his B.Sc. in Engineering physics from Tsinghua University in 1984 and earned his Ph.D. in 1990 at Virginia Commonwealth University in Chemical physics. He is currently a Distinguished and Ivan B. Cutler endowed chair Professor in the Department of Materials Science and Engineering at the University of Utah. His research interests lie in the theoretical modeling and computer simulation, from electronic to atomic and to mesoscopic scales, to study a wide spectrum of physical behavior of materials, with a special focus on surfaces/interfaces, thin films and low-dimensional materials. His best-known work includes theoretical modeling of strain-induced self-assembly of quantum dots and quantum wires in epitaxial growth of thin films, prediction of organic two-dimensional topological materials and surface-based topological states, and prediction of many-body quantum states of yin-yang flat bands. He is recipient of 2023 American Physical Society Davisson-Germer Prize in Surface Physics. He is a Fellow of American Physical Society. He served as Divisional Associated Editor of Physical Review Letters. He is a founding editor-in-chief for Coshare Science, a new international journal of video research articles.


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