PCS NEWSLETTER

QR to PCS Webpage

December 2024

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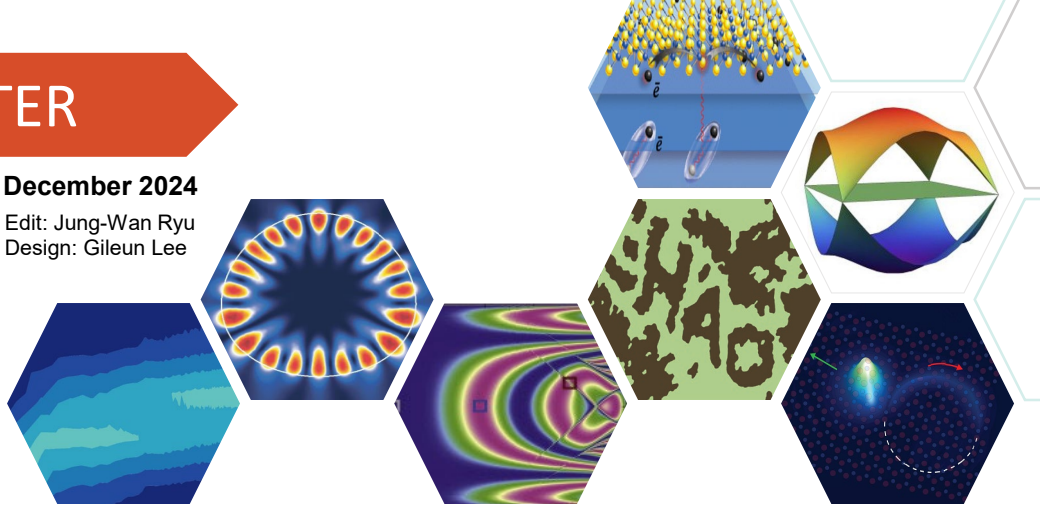
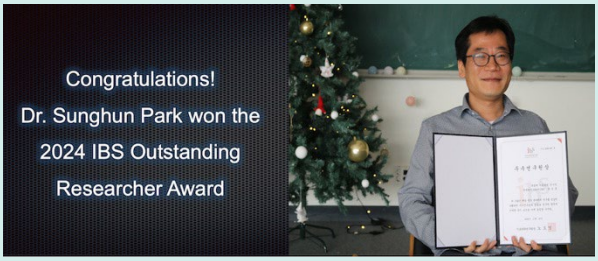


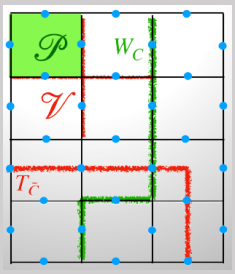
Awards



Congratulations!
Dr. Sunghun Park won the 2024 IBS Outstanding Researcher Award.

PCS Workshops and Meetings

PCS, with APCTP successfully hosted International Workshop on Effective Field Theory Beyond Ordinary Symmetries on December 2 – 6, 2024. We enjoyed 25 talks with 85 participants.



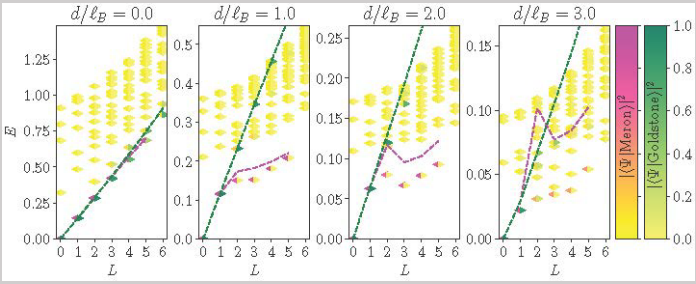
PCS IBS Seminars

"Localization in Flatbands: Disorder and Impurities"
by Yeongjun Kim, PCS IBS, Korea (November 27)

"Chaos Computing Using Spintronics"
by Gyuyoung Park, Korea Institute of Science and Technology (KIST), Korea (November 28)

You can find more seminars on this page.

New Research Results



Successive electron-vortex binding in quantum Hall bilayers at $\nu = 1/4 + 3/4$

Glenn Wagner and Dung X. Nguyen

Phys. Rev. B 110, 195106 (2024)

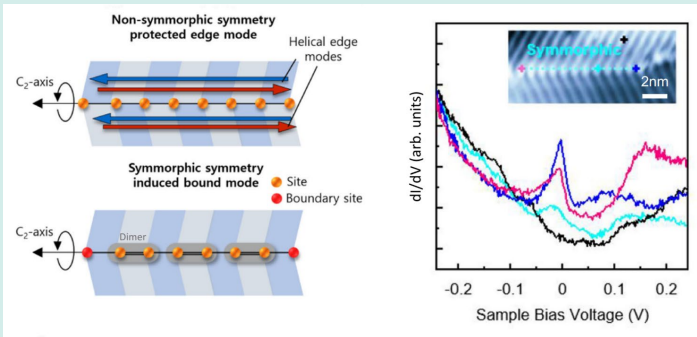
The authors study the quantum Hall bilayer system v=1/4+3/4, at different interlayer separations d using composite particles. At small d, the system behaves as paired electrons and holes, transitioning to composite fermions with four attached vortices at larger d. Exact diagonalization shows that the number of vortices per electron increases with d. Trial wave functions for the Goldstone mode and meron excitation align well with low-energy states, capturing the system's evolving quantum state.

Hierarchical zero- and one-dimensional topological states in symmetry-controllable grain boundary

Won-Jun Jang, Heeyoon Noh, Seoung-Hun Kang, Wonhee Ko, JiYeon Ku, Moon Jip Park & Hyo Won Kim

Nature Communications 15, 9328 (2024)

The research investigates the realization of hierarchical zero- and one-dimensional topological states in symmetry-controllable grain boundaries of 1T′–$MoTe_2$. By leveraging a scanning tunneling microscope, the authors engineered distinct grain boundaries that are governed by symmorphic and nonsymmorphic symmetries. These structures exhibit first-order and higher-order topological phases, with unique edge and boundary states. The study offers new insights into the interplay between crystal symmetry and topological states, opening up potential applications in quantum materials and devices.



Connection between quantum relative entropy difference and retrodiction

$$D_{\mathrm{BS}}(\rho\|\gamma) - D_{\mathrm{BS}}(\mathcal{M}(\rho)\|\mathcal{M}(\gamma)) = D_{\mathrm{BS}}\left({}^tQ_F \middle\| {}^tQ_R^\gamma\right) \tag{37}$$

Observational entropy with general quantum priors

Ge Bai, Dominik Šafránek, Joseph Schindler, Francesco Buscemi, and Valerio Scarani

Quantum 8, 1524 (2024)

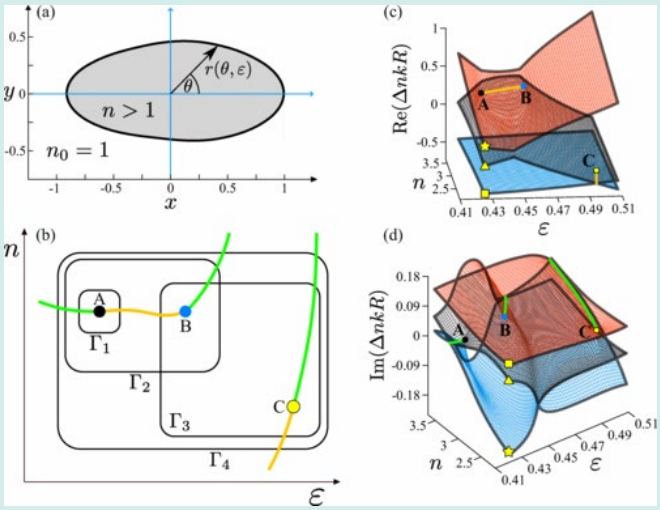
Standard observational entropy is defined with a uniform prior - the maximally mixed state. Considering this state represents the maximal temperature state, the question is how to define observational entropy with thermal state instead as the prior, which would represent more the physical situations encountered daily. The authors find there are three reasonable definitions, some of which allow connection between observational entropy and theory of retrodiction.

New Research Results

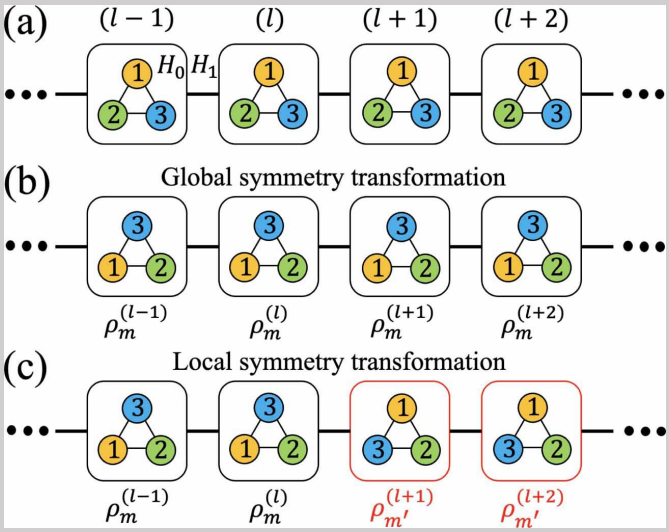
Realization of geometric-phase topology induced by multiple exceptional points

Jung-Wan Ryu, Jae-Ho Han, and Chang-Hwan Yi

Phys. Rev. A 110, 052221 (2024)



Non-Hermitian systems have Riemann surface structures of complex eigenvalues that admit singularities known as exceptional points. Combining with geometric phases of eigenstates gives rise to unique properties of non-Hermitian systems, and their classifications have been studied recently. However, the physical realizations of classes of the classifications have been relatively limited because a small number of modes and exceptional points are involved. The authors show in microcavities that all five classes of three modes can emerge with three exceptional points. In demonstrations, they identify various combinations of exceptional points within a two-dimensional parameter space of a single microcavity and define five distinct encircling loops based on three selected exceptional points. According to the classification, these loops facilitate different mode exchanges and the acquisition of additional geometric phases during the adiabatic encircling of exceptional points.



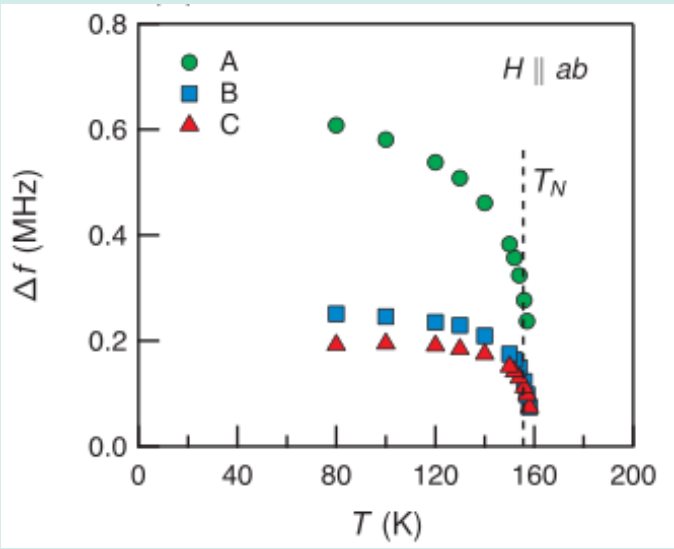
Orthogonal flatbands in Hamiltonians with local symmetry

Jung-Wan Ryu, Alexei Andreanov, Hee Chul Park and Jae-Ho Han

J. Phys. A: Math. Theor. 57, 495301 (2024)

The authors derive symmetry-based conditions for tight-binding Hamiltonians with flatbands to have compact localized eigenstates (CLS) occupying a single unit cell. The conditions rely on unitary operators commuting with the Hamiltonian and are associated with local symmetries that ensure the existence of orthogonal compact localized states and a flatband. They also demonstrate the inverse: orthogonal flatbands, whose CLS can be made to occupy a single unit cell, always have associated local symmetries that satisfy their conditions. The authors illustrate their analytical result with several model Hamiltonians with given local symmetries, including examples with finite-range hopping and higher-dimensional ones.

New Research Results



Anisotropic optical band structure of van der Waals antiferromagnet NiPS3
Jonghyeon Kim, Junghyun Kim, Beom Hyun Kim, Je-Geun Park, and Jae Hoon Kim
Phys. Rev. B Letters 110, L180406 (2024)

The authors conducted nuclear magnetic resonance (NMR) experiments on the van der Waals magnet $NiPS_3$. The NMR signals revealed a discontinuity in the order parameter (see Figure) and the absence of critical slowing down of spin correlations near the critical temperature. These findings strongly support the characterization of the magnetic transition as first-order. A complementary Landau mean-field study suggested that the first-order transition is driven by a charge stripe instability, arising from self-doped ligand holes

Puzzle of the Month

November Puzzle:

two answers received, both not correct. Try harder! We are repeating the puzzle with some additional hints.

December puzzle:

An airplane (with infinite fuel supply) starts on the equator in direction north east 60 degrees with velocity v, and keeps this direction fixed. When will it cross the equator again?

Send your solution to eun@ibs.re.kr
The winner will be announced in the next issue.