PCS NEWSLETTER

July 2024

Edit: Jung-Wan Ryu
Design: Gileun Lee

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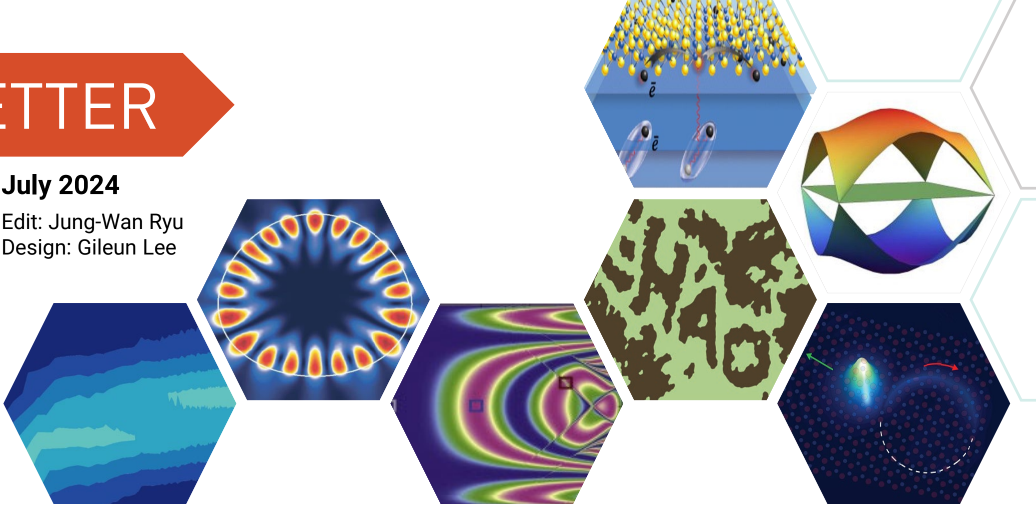


PCS IBS Seminars

“Dirac fermion optics and electron dynamics in anisotropic bilayer graphene billiards”

by Martina Hentschel, Technische Universität Chemnitz, Germany (June 11)

“Driven - dissipative dynamics of trapped ultracold atom systems interacting with background BECs”

by Roland Cristopher F. Caballar, University of Santo Tomas, Philippines (June 18)

“Josephson current signatures of Majorana Fermions in Topological insulator Josephson junction”

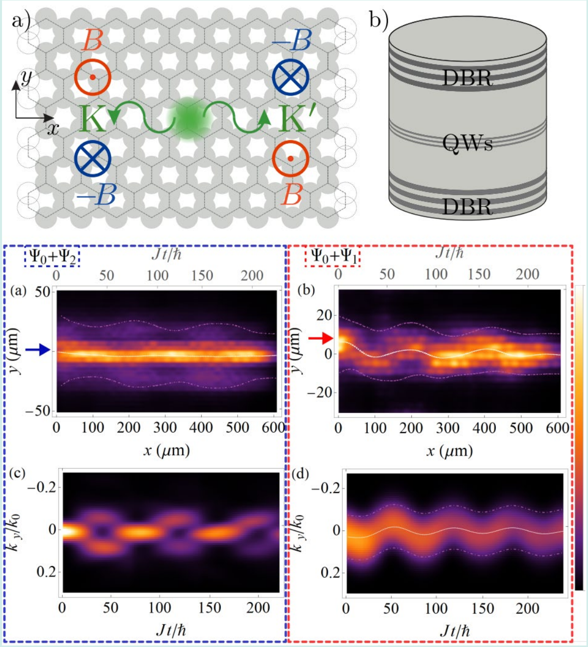
by Hyeongseop Kim, PCS IBS (June 25)

“Experimental works on localized vibrations in nonlinear lattices”

by Masayuki Kimura, Setsunan University, Japan (June 27)

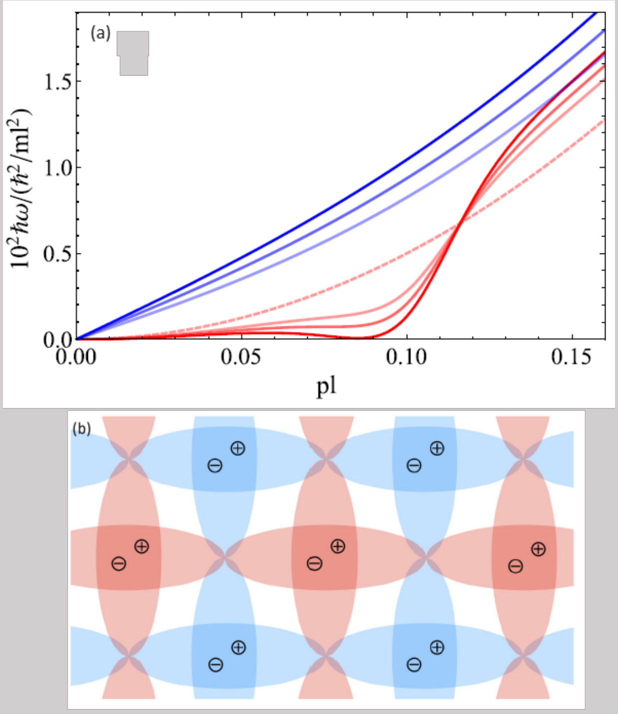
You can find more seminars on ***this page***.

New Research Results



Optical snake states in a photonic graphene
O. M. Bahrova, S. V. Koniakhin, A. V. Nalitov, and E. D. Cherotchenko
[Optics Letters 49(10), 2581-2584 (2024)]

In the study, an optical analogue of electron snake states based on artificial gauge magnetic field in photonic graphene with effective strain implemented by varying distance between pillars is proposed. The authors develop an intuitive and exhaustive continuous model based on tight-binding approximation and compare it with numerical simulations of a photonic structure with realistic geometry. The snake states and their symmetric realization (quantum beats) has specific fingerprints in real and momentum space. Finally, the allowed lateral wave packet propagation direction is shown to be strongly coupled to the valley degree of freedom and the proposed photonic structure may be used a valley filter.



Magnetoroton in a two-dimensional Bose-Bose mixture
O. I. Utesov and S. V. Andreev
[Phys. Rev. B 109, 235135 (2024)]

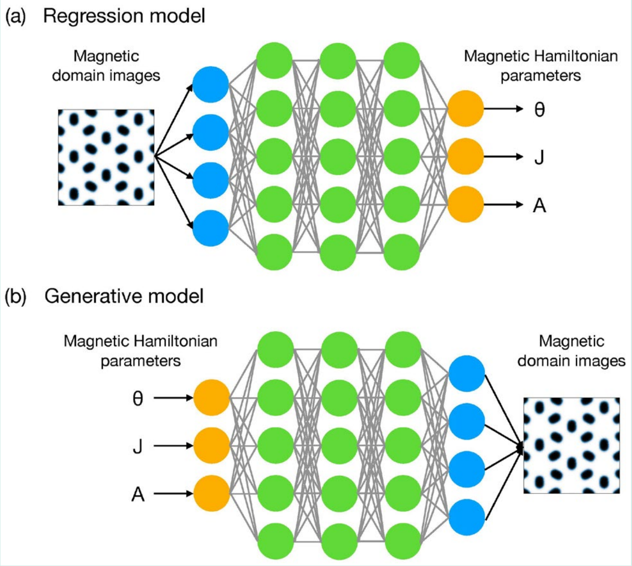
Research on quantum Bose mixtures has been at the forefront of many-body physics for decades and now is boosted due to the realization of degenerate gases of excitons in two-dimensional semiconductors. Several years ago, it was predicted that in three-dimensional space by tuning the system towards p-wave scattering resonance self-localization of magnons and formation of a magnetoroton should take place. However, observation of this discovery is hindered by difficult access to a p-wave resonance in 3D. In this study, the authors extend the magnetoroton theory to 2D. They prove the occurrence of the magnetoroton in 2D on a general basis and show that it may be observed in current experiments with dipolar excitons in bilayers. The stability of the system close to the p-wave resonance turns out to be dramatically enhanced. The authors speculate on the nature of a new ground state beyond the magnetoroton instability and suggest a dilute p-wave crystal of alternating polarization as a possible candidate.

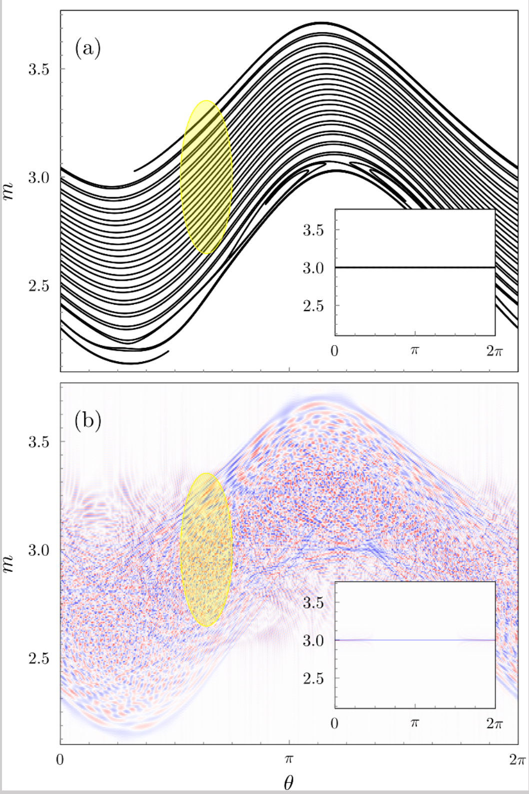
Deep learning methods for Hamiltonian parameter estimation and magnetic domain image generation in twisted van der Waals magnets

Woo Seok Lee, Taegeun Song and Kyoung-Min Kim

[Mach. Learn.: Sci. Technol. 5, 025073 (2024)]

Theoretical analysis of twisted van der Waals magnets has typically depended on computationally intensive atomistic spin simulations to capture the complex magnetic interactions accurately. In response to these challenges, the authors have introduced two novel deep neural network models that are capable of either predicting the magnetic parameters of twisted bilayer magnets from magnetic domain images or generating precise magnetic domain images based on provided magnetic parameters. Once trained, these networks offer the capability to produce the desired data without the need for time-consuming simulations, leading to a substantial reduction in computational resources required. The authors anticipate that these innovative techniques will facilitate a streamlined and dependable analysis of these intricate systems, obviating the necessity for extensive simulations and representing a notable advancement in this field.





Computing Quantum Mean Values in the Deep Chaotic Regime

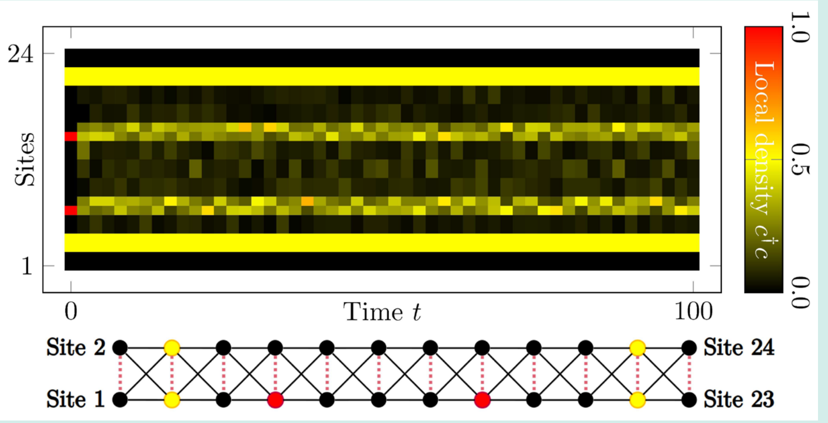
Gabriel M. Lando, Olivier Giraud, and Denis Ullmo

[Phys. Rev. Lett. 132, 260401 (2024)]

A novel semiclassical technique capable of computing quantum mean values in troublesome regimes is put to the test. The method is shown to be remarkably accurate even in the simultaneous presence of strong chaos and small $\hbar$ (a regime known to plague both quantum and semiclassical simulations). More than a mere computational tool, such method emerges as an answer to a deep conceptual problem: The stationary phase approximation, a keystone of semiclassical physics, fails catastrophically when employed to compute quantities as simple as mean values. By identifying and keeping only the integrals that cannot be evaluated by stationary phase, their approach not only achieves groundbreaking results but also sheds light into the inner structure and geometry involved in the computation of quantum mean values.

New Research Results

Trapping hard-core bosons in flat-band lattices
Sanghoon Lee, Alexei Andreanov, Tigran Sedrakyan, and Sergej Flach
[Phys. Rev. B 109, 245137 (2024)](https://doi.org/10.1103/PhysRevB.109.245137)



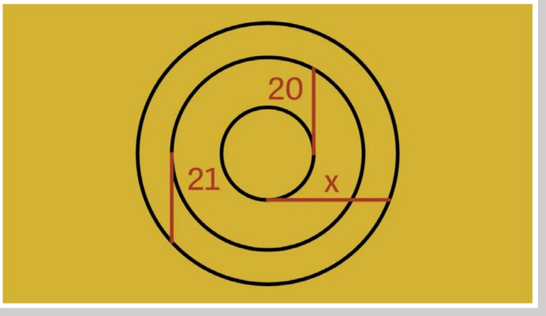
The authors investigate 1D and 2D cross-stitch lattices with hard-core bosons and analytically construct exact groundstates that feature macroscopic degeneracy. The construction relies on the presence of a flatband in the single particle spectrum and the orthogonality of the associated compact localized states (CLS). Also occupied CLS act as impenetrable barriers for bosons both in 1D and 2D, leading to Hilbert space fragmentation. A similar phenomenology also holds for hard-core bosons on the diamond chain and its higher dimensional generalizations. The authors also discuss the mapping of these hard-core models onto spin models with quantum many-body scars.

Puzzle of the Month

June puzzle solution: none. Both threads move into the same direction, no forces, no motion.

The correct solution was sent by Sungjong Woo, congratulations!

Puzzle of the month: x=?



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