PCS NEWSLETTER

November 2021

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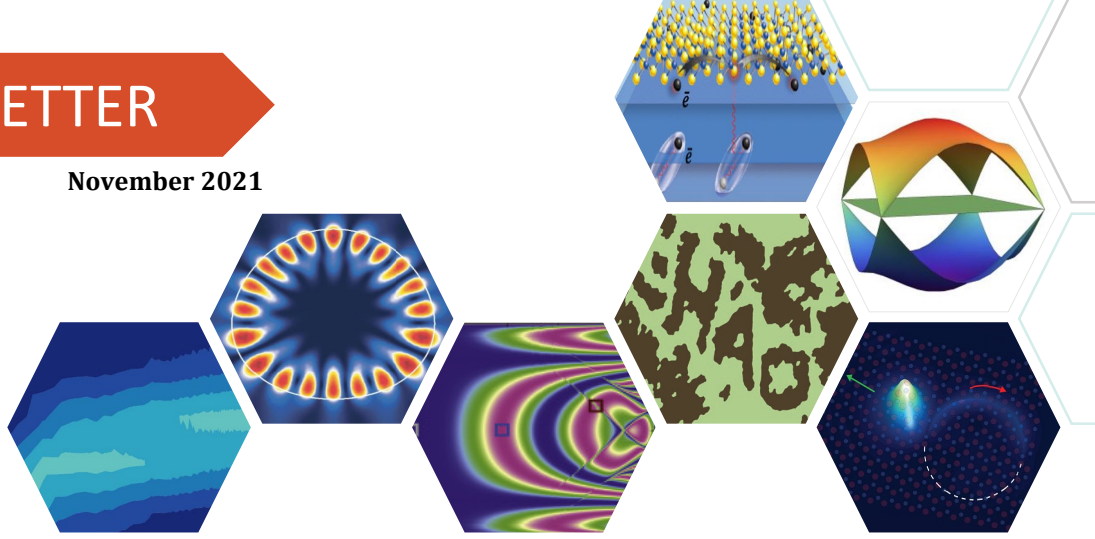
Design: Gileun Lee



PCS Workshops and Meetings

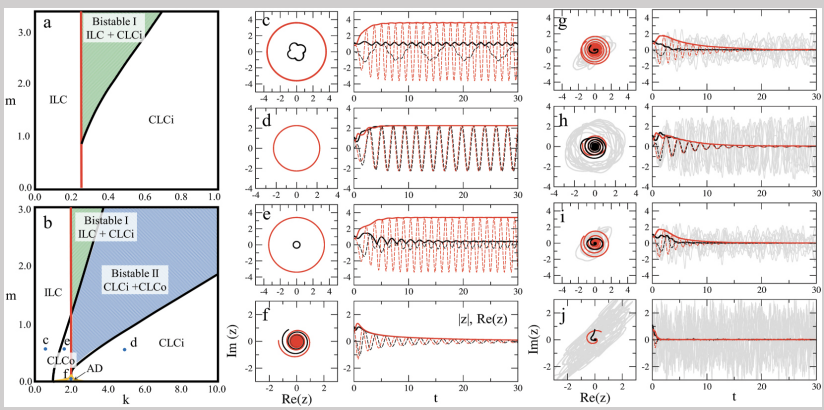
PCS successfully hosted the **'International Workshop Searching for Galactic Axions and Superconducting Devices with Quantum Efficiency'** through PCS Video Conference, Oct. 25 - 29, 2021. We enjoyed twenty invited talks including the IBS Physics Colloquium given by Prof. Michael Tobar (Univ. of Western Australia) with 73 participants.

New research results

Stochastic thermodynamics of inertial-like Stuart–Landau dimer

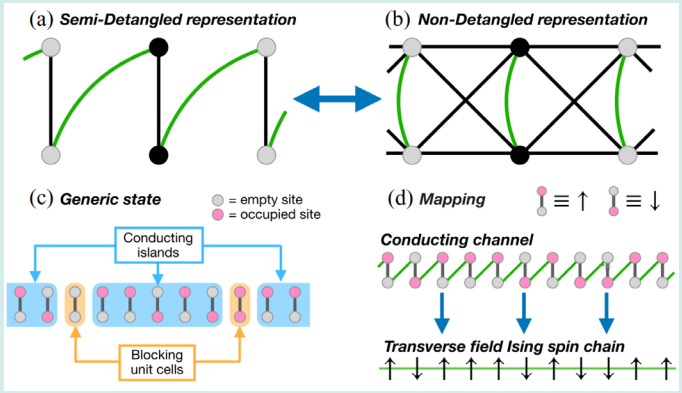
Jung-Wan Ryu, Alexandre Lazarescu, Rahul Marathe, Juzar Thingna

New J. Phys. **23**, 105005 (arXiv:2107.00208)



The authors generalize the standard Stuart–Landau dimer model to include an inertia-like term and noise. At zero temperature, with absence of noise, the dynamics show the emergence of a bistable phase with the coexistence of coherent and incoherent limit cycles. At finite temperatures, it develops a stochastic thermodynamic framework based on the dynamics of a charged particle in a magnetic field, so to generate heat and work. Although such stochastic system no longer exhibits the bistable phase, the thermodynamic observables, such as work, show bistability. The authors have demonstrated that an inertial-like Stuart–Landau dimer operates like a machine, doing substantial work if oscillators are synchronized coherently while doing only minimal work if oscillators are not. It shows the importance of coherent synchronization within the working substance in the operation of a thermal machine.

New research results



Heat percolation in many-body flatband localizing systems

Ihor Vakulchik, Carlo Danieli, Alexei Andreanov and Sergej Flach

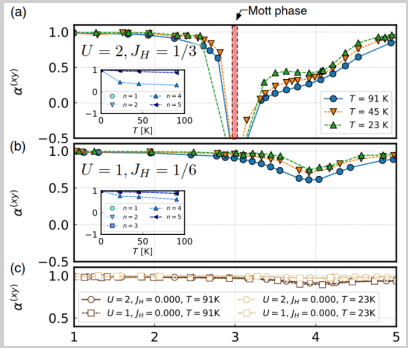
Phys. Rev. B **104**, 144207 (arXiv:2106.01664)

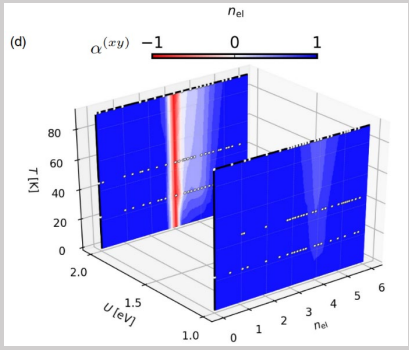
The authors demonstrate robust ergodicity breaking in interacting many-body systems in arbitrary Euclidian dimension based on disorder-free many-body localization. Suitable short-range many-body interactions enforce complete suppression of particle transport due to local constraints and lead to ergodicity breaking termed many-body flat-band localization. However, heat might still flow between spatially locked charges. They establish a universal bound on the filling fraction below which the heat transport is suppressed. The bound is based on the mapping to a classical percolation problem.

Hund's metallicity enhanced by a van Hove singularity in cubic perovskite systems

Hyeong Jun Lee, Choong H. Kim, and Ara Go

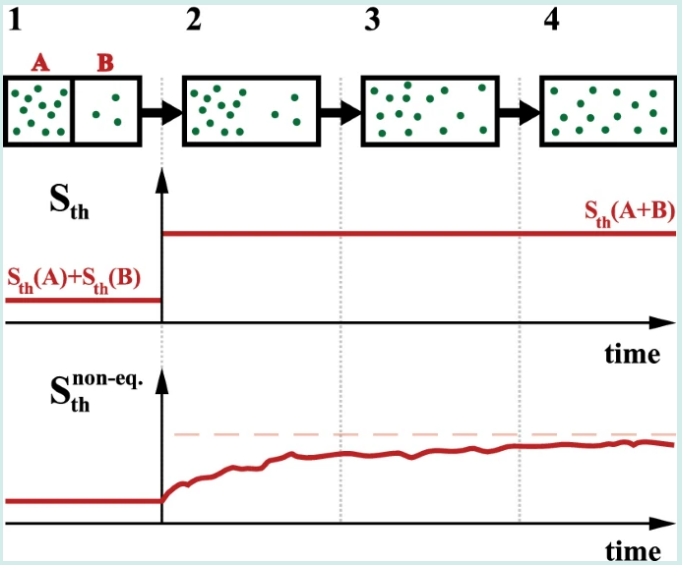
Phys. Rev. B **104**, 165138 (arXiv:2107.05906)





The authors find that the van Hove singularity is a very crucial factor in the Hund's metallicity. Constructing simple cubic perovskite lattice models, they systematically test the van Hove singularity and if by which they can control the incoherence of electron transport due to the Hund's coupling.

The results explain why ruthenate compounds of $(t_{2g})^4$ can exhibit the Hund physics largely compared to other transition metal compounds. This study provides possibilities of a control of the Hund physics represented by orbital selectivity, strong correlations, and incoherence when one can engineer electronic structures with the van Hove singularity such as using a next-nearest hopping in our model or strain effect.



A Brief Introduction to Observational Entropy

Dominik Šafránek, Anthony Aguirre, Joseph Schindler, J. M. Deutsch

Foundations of Physics **51**, 101 (arXiv:2008.04409)

In this paper, the authors review recent advances in the theory of observational entropy, and its application in isolated quantum systems. Observational entropy is a quantum generalization of Boltzmann entropy, and it grows in closed quantum systems, for any initial state and any generic Hamiltonian, thus representing the statement of the second thermodynamic law: "Entropy of a Universe increases".

Puzzle of the month

October puzzle answer:

The velocity field of the rolling wheel is identical with the velocity field of the wheel rotating around the wheel-ground touching point. This is precisely what we learn(ed) in classical mechanics courses. However, the acceleration fields are different. That is why the naive calculation of the centrifugal acceleration does not work. If you want to do it properly, remember that the point mass is following a cycloid curve. In its top point the curvature is 4R, not 2R. With that full agreement with the correct solution of the September puzzle is obtained.

The first correct answer came from Sungjong Woo, the second one from Barbara Dietz. Congratulations!

Puzzle of the month:

Suppose you are always getting yourself tested for rare diseases with no real reason to think you have them. Now suppose one of those diseases occurs in 1 in 10,000 people from the general population. Further, let's say the test is 99% accurate both for positive cases and negative ones. You take the test, the test comes back positive. What are the chances you have the disease?

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