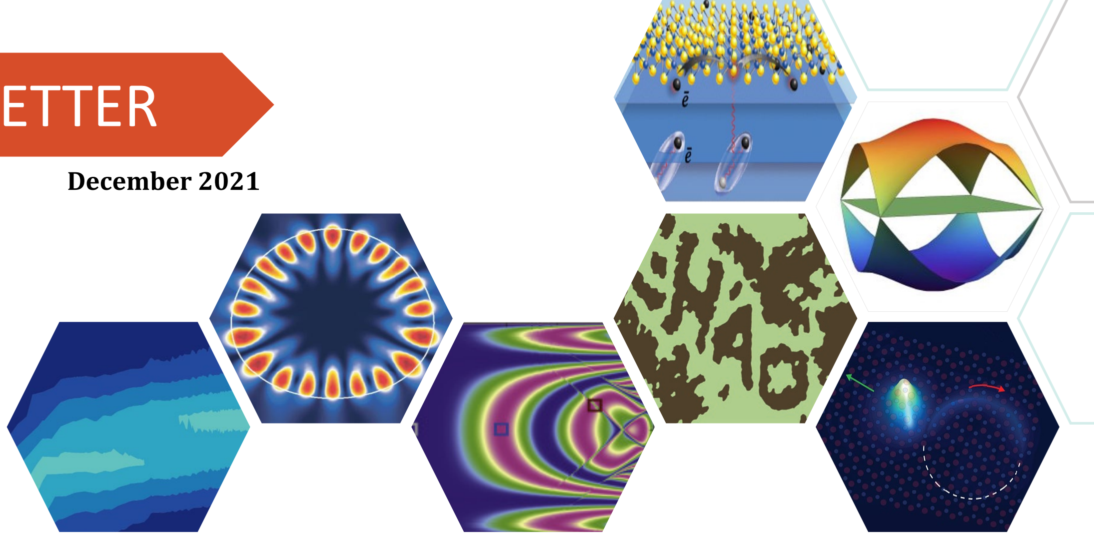
PCS NEWSLETTER

December 2021



Edit: Sungjong Woo
Design: Gileun Lee

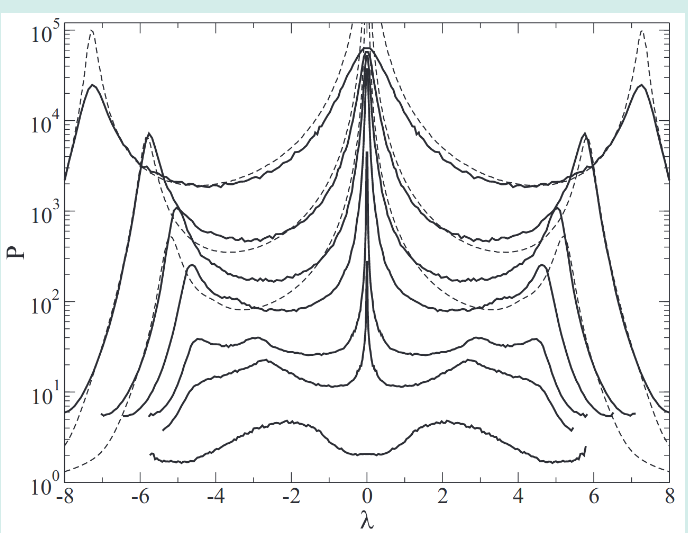
New members

Dr. Grigory Bendik has joined PCS as a research fellow and the team of Moon-Jip Park. His research interests are with various properties of topological semimetals which include novel strongly interacting phases as well as unconventional transport, and extending to magnetic properties of recently discovered twisted bilayer materials.

PCS Workshops and Meetings

PCS will have a Retreat Dec. 13 - 15 with additional guest participants from the Asia-Pacific Center for Theoretical Physics (Pohang).

New research results



Anderson localization of excitations in disordered Gross-Pitaevskii lattices
Yagmur Kati, Mikhail V. Fistul, Alexander Yu. Cherny, and Sergej Flach
Phys. Rev. A **104**, 053307 (arXiv:2107.01449)
The authors study the one-dimensional Gross-Pitaevskii lattice at zero temperature in the presence of uncorrelated disorder. They obtain analytical expressions for the thermodynamic properties of the ground state field and compare them with numerical simulations both in the low- and high-density regimes. By analyzing weak excitations and the localization properties of Bogoliubov–de Gennes modes it is found that, in the long-wavelength limit, such modes delocalize in accordance with the extended nature of the ground state. For high densities, they derive a divergence of the localization length at finite energy/wavelength due to an effective correlated disorder induced by the weak ground state field fluctuations.

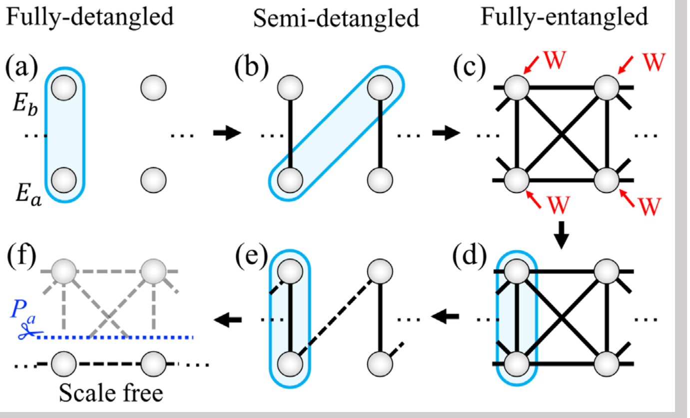
New research results

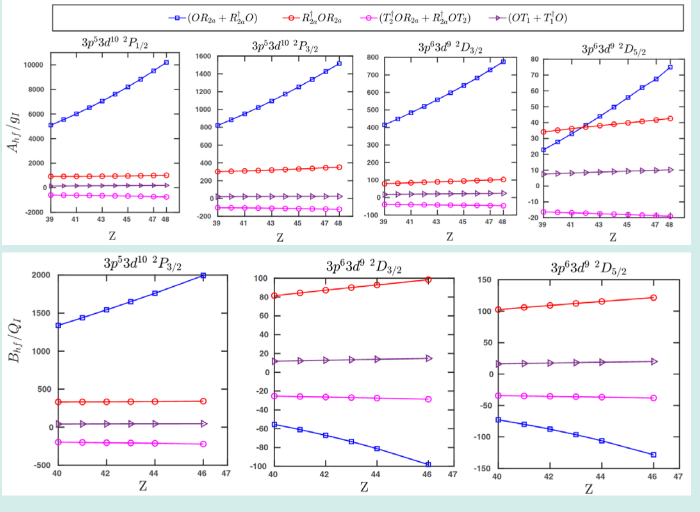
Metal-insulator transition in infinitesimally weakly disordered flat bands

Tilen Čadež, Yeongjun Kim, Alexei Andreanov, and Sergej Flach

Phys. Rev. B **104**, L180201 (arXiv:2107.11365)

The authors report on the discovery of a metal-insulator transition in very weakly disordered flatband systems: adding disorder to an insulator can result in a metal. Their results highlight and provide important insights into the physics of macroscopic degeneracies and the emerging phases when perturbing them: flatbands react sensitively and differently to seemingly similar very weak perturbations. A tiny change in the tiny perturbations causes the entire system to go from metal to insulator. Their analysis methods will benefit both theoretical and experimental research in various condensed matter, optics, as well as photonic systems.





Relativistic-coupled-cluster-theory analysis of properties of Co-like ions

Dillip K. Nandy and B. K. Sahoo

Phys. Rev. A **104**, 052812 (arXiv:2108.09784)

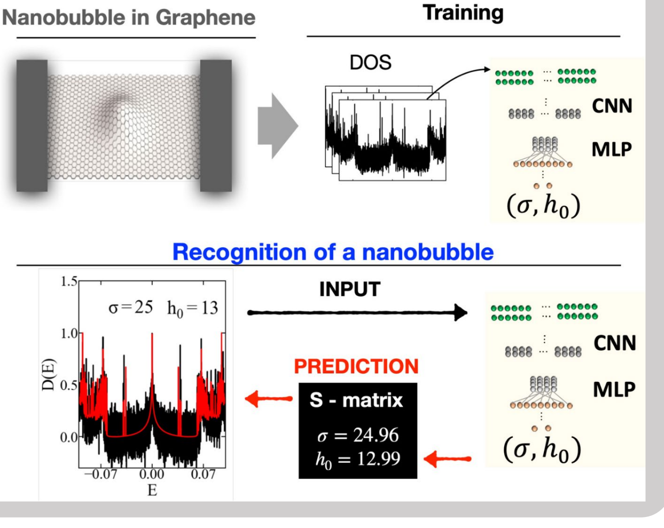
The authors have investigated various spectroscopic properties such as excitation energies, transition probabilities, the lifetime of excited states, and hyperfine coupling constants of the atomic states in the highly charged ions (HCIs) of Co-like elements using the relativistic coupled-cluster (RCC) method. They further quantify various leading order bound quantum electrodynamic effects (QED) that occur between electron-nucleus and electron-electron in these HCIs for calculating the atomic states. The role of the electron correlation effect in calculating these atomic properties is assessed by comparing the RCC results with mean-field and second-order many-body perturbation theory. Their calculated excitation energies are in excellent agreement with the available experimental results.

Machine learning approach to the recognition of nanobubbles in graphene

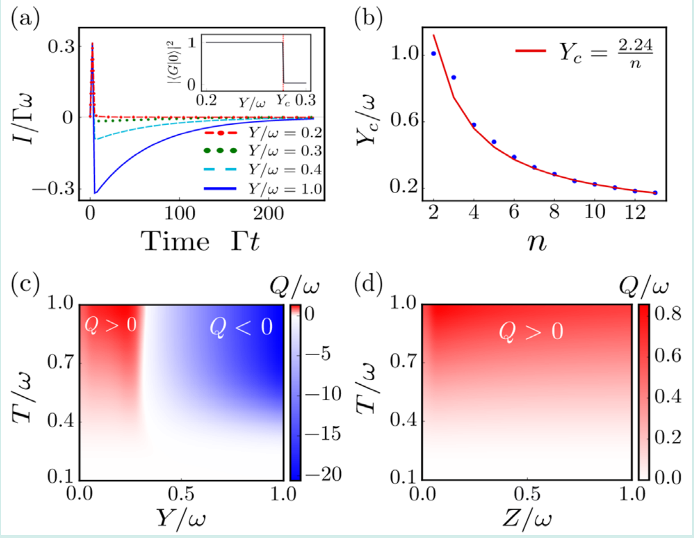
Taegeun Song, Nojoon Myoung, Hunpyo Lee, and Hee Chul Park

Appl. Phys. Lett. **119**, 193103

The authors propose a way to recognize the presence of nanobubbles in graphene by analyzing electronic properties based on a machine learning approach. Their machine learning algorithm efficiently classifies the density of states spectra by the height and width of the nanobubbles, even in cases with a substantial magnitude of noise. The machine-learning-based analysis of electronic properties proposed in this study may introduce a changeover in the probing of nanobubbles from image-based detection to electrical-measurement-based recognition.



New research results



Quantum transient heat transport in the hyperparametric oscillator

JungYun Han, Daniel Leykam, Dimitris G. Angelakis, and Juzar Thingna

Phys. Rev. A **104**, 052220 (arXiv:2011.02663)

The authors investigate nonequilibrium quantum heat transport in nonlinear bosonic systems in the presence of hyperparametric oscillation between two cavities. They estimate the thermodynamic response of Kerr type and non-Kerr type interaction analytically by constructing the su(2) algebra and predict that the system exhibits a negative excitation mode in the presence of non-Kerr type interaction. Consequently, this specific form of interaction enables the cooling of the system by inducing a ground-state transition when the number of particles increases, even though the interaction strength is smaller than the resonance frequency. In comparison, the Kerr type interaction always yields heating to the system. It demonstrates a transition of the heat current numerically and verify their estimation in the presence of symmetric coupling between the system and the bath and show long relaxation times in the cooling phase.

Puzzle of the month

November puzzle answer:

Don't panic, relax, take a sip of your favorite drink. You are most probably - a bit more than 99% - healthy. Take a population of one million. 100 are ill, 999900 are healthy. Test them all. You get 99 positive (correct) results from the ill ones, and 9999 positive (incorrect) results from the healthy ones. Since you know you are tested positive, you are in the group of 99 ill plus 9999 healthy ones. the probability to be ill is 99/9999 and a bit less than one percent.

The first correct solution came from Victor Kagalovsky, narrowly followed Ihor Vakulchyk (6 minutes later), Merab Malishava, Sungjong Woo, Sergei Koniakhin, and Dario Rosa and Jan Olle. Congratulations! Weiter so!

Puzzle of the month:

What is the smallest positive integer n such that $2n$ is a perfect square and $3n$ is a perfect cube and $5n$ is a perfect fifth power?

Send your solution to eun@ibs.re.kr

The winner will be announced in the next issue.