PCS NEWSLETTER

QR to PCS Webpage

April 2024
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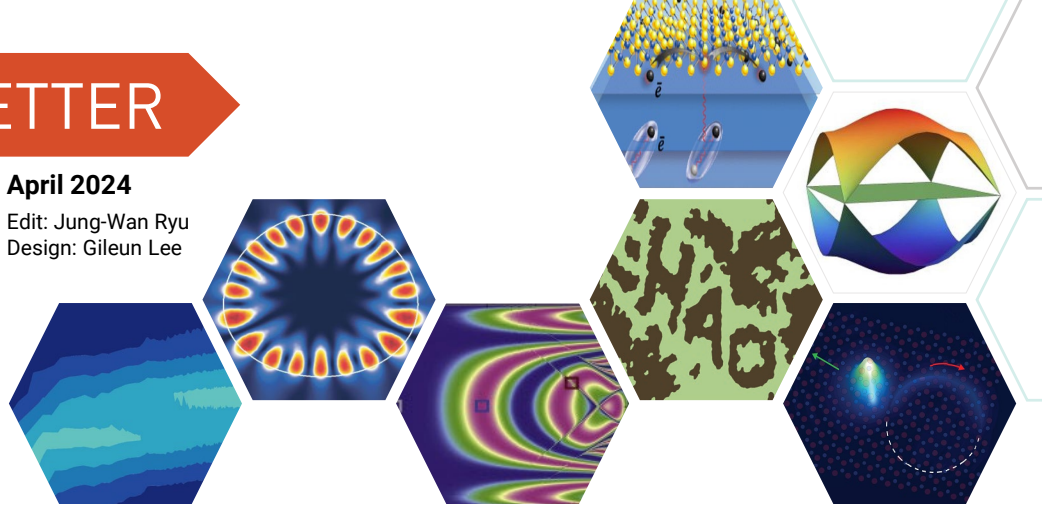


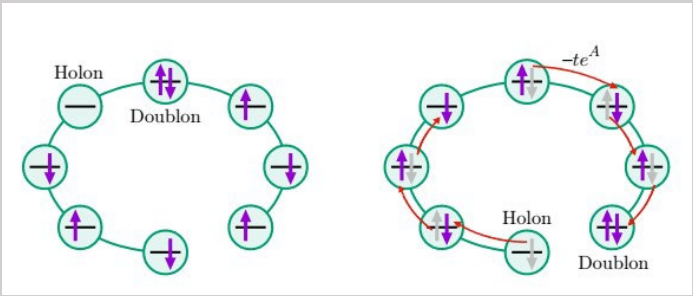
PCS IBS Seminars

"Topological phases and optimal control in the arrays of superconducting qubits"

by Maxim Gorlach, ITMO University, Russia (March 21)

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

New Research Results



Collective non-Hermitian skin effect: point-gap topology and the doublon-holon excitations in non-reciprocal many-body systems

Beom Hyun Kim, Jae-Ho Han, and Moon Jip Park

Communications Physics 7, 73 (2024)

The non-Hermitian skin effect describes the macroscopic collapse of bulk states to the boundary in non-reciprocal systems. Previous studies have shown that the Pauli exclusion principle and Coulomb repulsion prevent this effect in many-body systems. In this study, the authors present a counterexample by demonstrating the collective skin effect of doublon-holon excitations. They furthermore establish this effect reveals a bulk-boundary correspondence mediated by the point gap topology within the many-body energy spectrum.

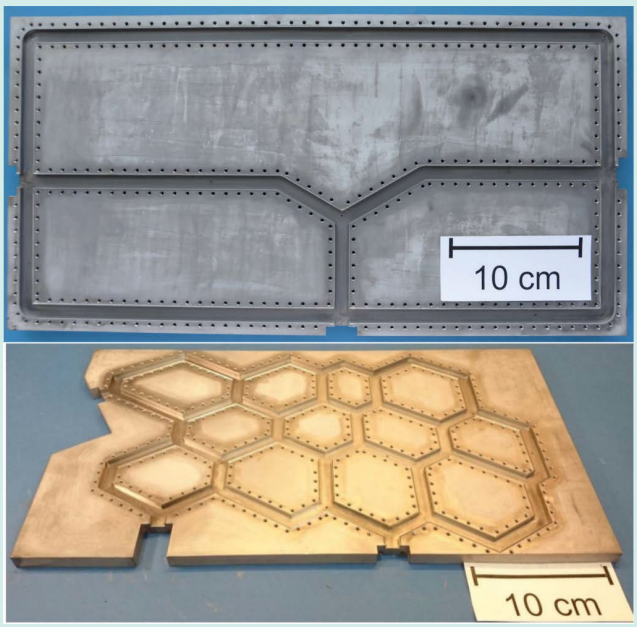
New Research Results

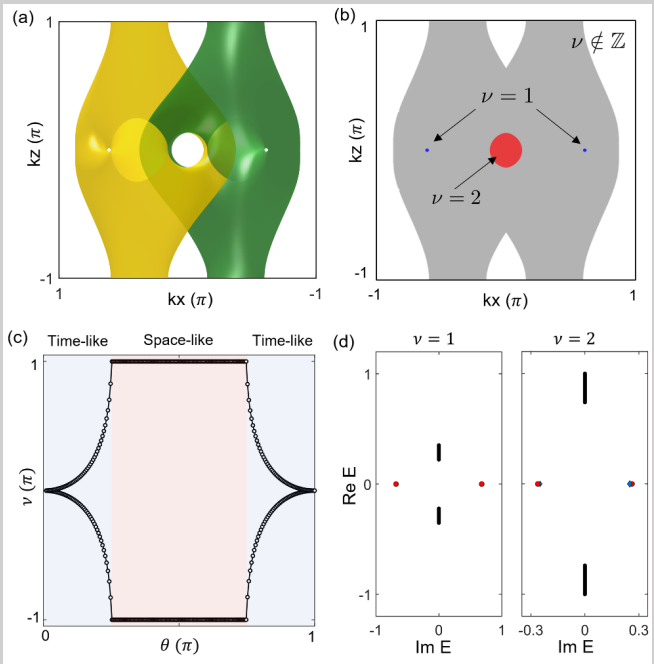
Closed and open superconducting microwave waveguide networks as a model for quantum graphs

Barbara Dietz, Tobias Klaus, Marco Masi, Maksym Miski-Oglu, Achim Richter, Tatjana Skipa, and Marcus Wunderle

Phys. Rev. E 109, 034201 (2024)

The authors report on high-precision measurements that were performed at the TU Darmstadt with superconducting waveguide networks with the geometry of a tetrahedral and a honeycomb graph. They consist of junctions of valency three that connect straight rectangular waveguides of equal width but incommensurable lengths. The experiments were performed in the frequency range of a single transversal mode, where the associated Helmholtz equation is effectively one-dimensional and waveguide networks may serve as models of quantum graphs with the joints and waveguides corresponding to the vertices and bonds. The authors investigate the spectral properties of closed waveguide networks and fluctuation properties of the scattering matrix of open ones and find good agreement with random matrix theory predictions for the honeycomb waveguide graph.





PT-symmetric non-Hermitian Hopf metal

Seik Pak, Cheol Hun Yeom, Sonu Verma, and Moon Jip Park

Phys. Rev. Research Letters 6, L012053 (2024)

Hopf insulator characterized by integer-valued Hopf invariant, is a representative class of three-dimensional delicate topological insulators beyond the standard topological classification methods based on K-theory. The Hopf invariant can be trivialized by adding trivial bands either above or below the Fermi energy and also in the presence of additional non-Hermitian degrees of freedom. In this work, the authors discover the metallic counterpart of the Hopf insulator in the non-Hermitian systems and show that the PT-symmetry stabilizes the Hopf invariant even in the presence of the non-Hermiticity. They discover that the non-Hermitian Hopf bundle exhibits the topologically protected non-Hermitian degeneracy, characterized by the two-dimensional surface of exceptional points. Despite the non-Hermiticity, the Hopf metal has the quantized Zak phase, which results in bulk-boundary correspondence by showing drumhead-like surface states at the boundary. Finally, the authors show that by breaking PT-symmetry, the nodal surface deforms into the knotted exceptional lines. Their discovery of the Hopf metal phase for the first time confirms the existence of the non-Hermitian topological phase outside the framework of the standard topological classifications.

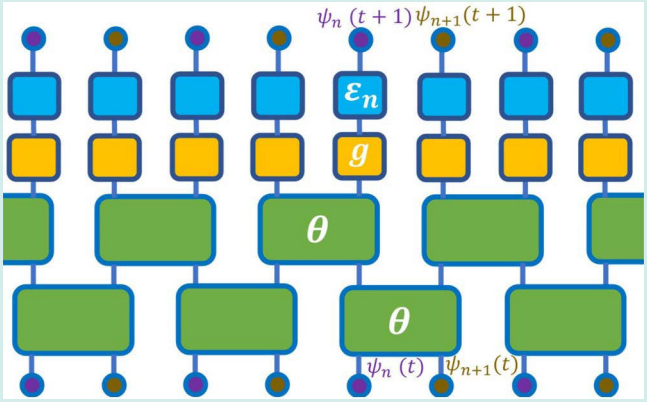
New Research Results

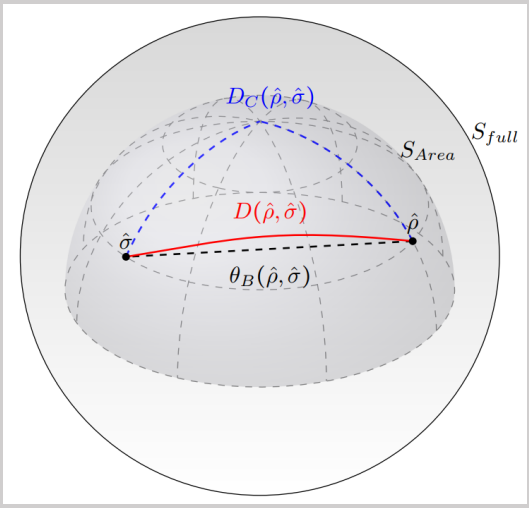
Thermalization universality-class transition induced by Anderson localization

Weihua Zhang, Gabriel M. Lando, Barbara Dietz, and Sergej Flach

Phys. Rev. Research Letters 6, L012064 (2024)

The authors study the disorder-induced crossover between the two recently discovered thermalization slowing-down universality classes, characterized by long- and short-range coupling, in classical unitary-circuit maps close to integrability. The computed Lyapunov spectra display qualitatively distinct features depending on whether the proximity to the integrable limit is short or long range. For sufficiently small nonlinearity, translationally invariant systems fall into the long-range class. Adding disorder to such a system triggers a transition to the short-range class, implying a breaking of this invariance, and in the very limit of vanishing nonlinearity Anderson localization emerges. The crossover from the long- to the short-range class is attained by tuning the localization length.





Minimal time required to charge a quantum system

Ju-Yeon Gyhm, Dario Rosa, and Dominik Šafránek

Phys. Rev. A 109, 022607 (2024)

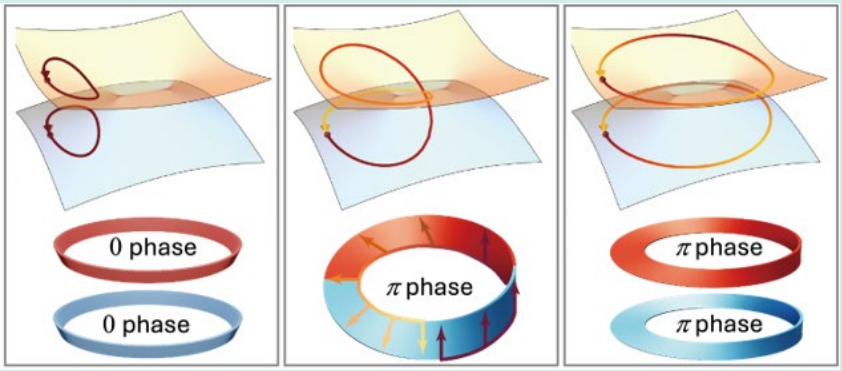
Quantum batteries are a concept in which a quantum system, starting with a low mean energy, is charged to a high energy state, which can be used later. The advantage of these over classical batteries is that they can be charged faster, by going through an entangled state, which is not possible classically, and thus achieving a "shortcut". In the paper, the authors study what is the minimal time of charging from one state (depleted) to another (charged). While the result for pure states is known, the interesting part is that for the mixed states, which shows that the charging distance does not continuously depend on the eigenvalues of the density matrix. Instead, this dependence is discontinuous, when the rank of the density matrix changes.

New Research Results

Exceptional classifications of non-Hermitian systems

Jung-Wan Ryu, Jae-Ho Han, Chang-Hwan Yi, Moon Jip Park, and Hee Chul Park

Communications Physics 7, 109 (2024)



Eigenstate coalescence in non-Hermitian systems is widely observed in diverse scientific domains encompassing optics and open quantum systems. Recent investigations have revealed that adiabatic encircling of exceptional points (EPs) leads to a nontrivial Berry phase in addition to an exchange of eigenstates. Based on these phenomena, the authors propose in this work an exhaustive classification framework for EPs in non-Hermitian physical systems. In contrast to previous classifications that only incorporate the eigenstate exchange effect, their proposed classification gives rise to finer Z_2 classifications depending on the presence of a π Berry phase after the encircling of the EPs. Moreover, by mapping arbitrary one-dimensional systems to the adiabatic encircling of EPs, they can classify one-dimensional non-Hermitian systems characterized by topological phase transitions involving EPs. Applying their exceptional classification to various multiband systems, the authors expect to enhance the understanding of topological phases in non-Hermitian systems.

Puzzle of the Month

March puzzle solution: 153846, 230769, 307692

Indeed, we represent the six digit numbers as a four digit number A and a two digit number B. Each phone number is then 100×A+B. Chopping and permuting leads to 10000×B+A. If this triples the original number it follows 23×A=769×B (note that 23 and 769 are primes). Since B is two digit and must be a multiple of 23, it can only be 46,69,92 (it can not be 23 since A must be four digit). So the solutions for A are 2×769, 3×769 and 4×769.
The first correct solution was sent in by Alireza Akbari, and the second one by Oleg Utesov. Congratulations to both!

Puzzle of the month:

The sum of several positive integers equals 100. What is the maximum value their product can take?

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