PCS NEWSLETTER

QR to PCS Webpage

June 2023

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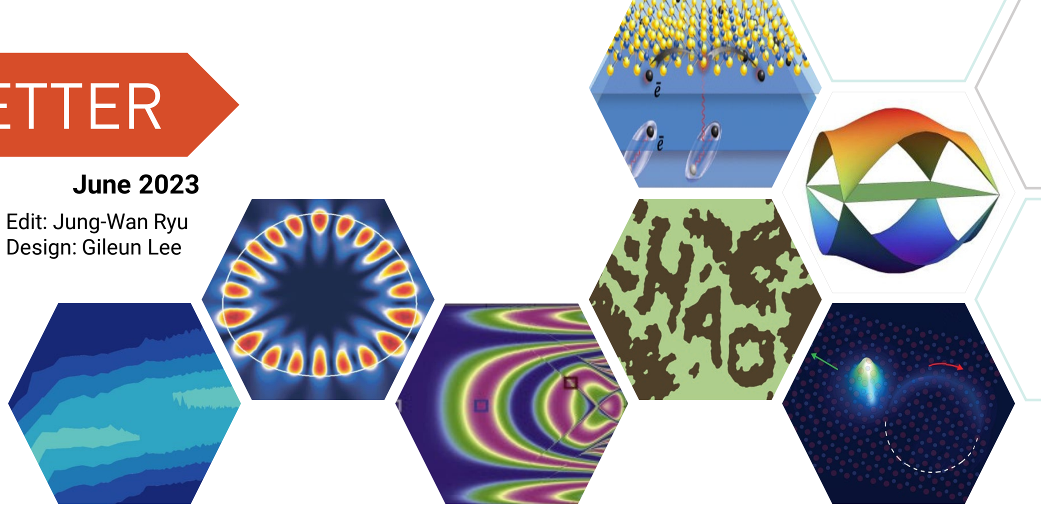


New Members

Dr. Oleg Utesov has joined PCS as a research fellow. He received his PhD in 2016 from St. Petersburg State University, Russia. He has worked as a researcher at Petersburg Nuclear Physics Institute and as an assistant professor at St. Petersburg State University and at St. Petersburg School of Physics, Mathematics, and Computer Science, HSE University. His main research interests include topological, noncollinear, and frustrated magnetism, quantum and classical phase transitions, and nanostructures' optical and vibrational properties.

PCS Workshops and Meetings

PCS will run and host [International Workshop Condensed Matter Solitons] on June 28 – June 30, 2023. To apply for participation, complete the online [application form] by June 16, 2023.

PCS IBS Seminars

"Explorations of Dissipative Quantum Chaos from Non-Hermitian Random Matrix Theory"
by Jonah Kudler-Flam, Institute for Advanced Study, USA (May 4)

"Chiral induced spin selectivity and time-reversal symmetry breaking"
by Amnon Aharony, Tel Aviv University, Israel (May 9)

"Is nature natural?"
by Hyung Do Kim, Seoul National University, Korea (May 11), *IBS Physics Colloquium @ Daejeon*

"Mechanically assisted Andreev reflection"
by Leonid Gorelik, Chalmers University of Technology, Sweden (May 16)

"Fractional conductance in one dimension"
by Igor Yurkevich, Aston University, UK (May 17)

"Chaos and Krylov complexity"
by Zhuo-Yu Xian, Wurzburg University, Germany (May 18)

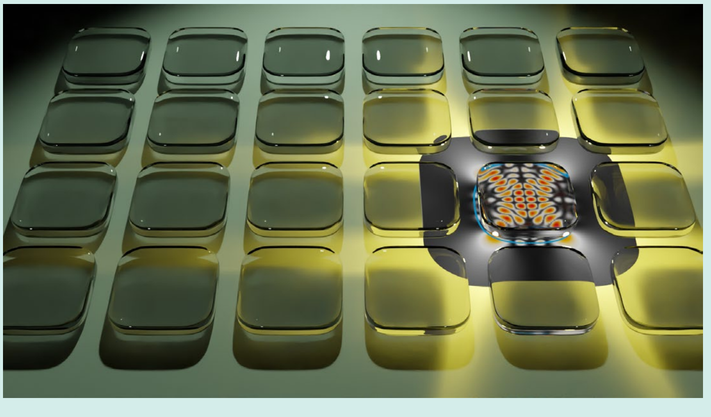
"Resource Saving via Ensemble Techniques for Quantum Neural Networks"
by Massimiliano Incudini, University of Verona, Italy (May 23)

"Internal clock for many-body delocalization"
by Soumya Bera, Indian Institute of Technology Bombay, India (May 25)

"Role of magneto-crystalline anisotropies in complex rare-earth systems"
by Bruno Tomasello, University of Kent, UK (May 31)

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

New Research Results



Bloch theorem dictated wave chaos in microcavity crystals
Chang-Hwan Yi, Hee Chul Park, and Moon Jip Park
Light: Science & Applications 12, 106 (2023)
In this work, the authors extend wave chaos theory to cavity lattice systems, uncovering the intrinsic coupling between crystal momentum and internal cavity dynamics. The authors demonstrate that the coupling, coined by authors as "cavity-momentum locking," can replace the role of deformed boundary shapes in single microcavities, allowing for in-situ examination of microcavity light dynamics. It turns out that the transmutation of wave chaos in periodic lattices induces a dynamical localization transition, with scar-mode spinors localizing around regular islands in phase space. This study pioneers the exploration of wave chaos in periodic systems, with potential applications in controlling light dynamics.

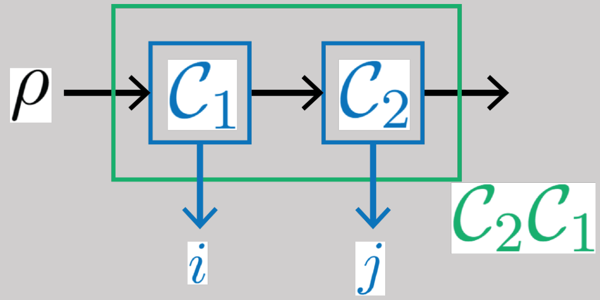
New Research Results

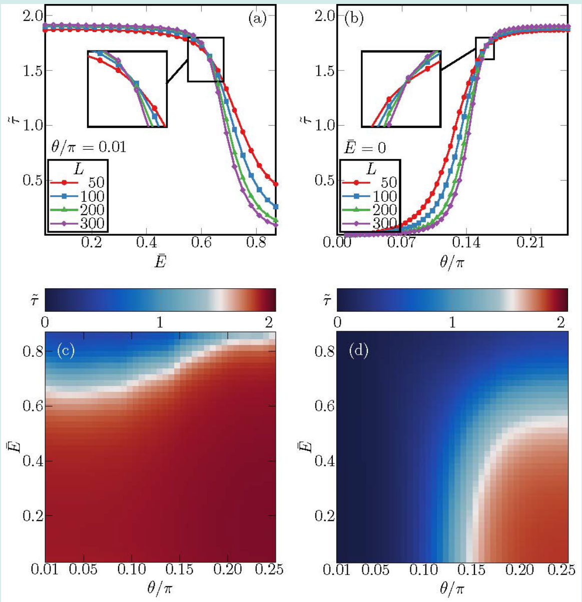
Observational entropy, coarse-grained states, and the Petz recovery map: information-theoretic properties and bounds

Francesco Buscemi, Joseph Schindler and Dominik Šafránek

New J. Phys. 25, 053002 (2023)

The authors study the mathematical properties of observational entropy from an information-theoretic viewpoint, making use of recently strengthened forms of the monotonicity property of quantum relative entropy, and the Petz recovery map from the theory of approximate recoverability. The authors present new general bounds on observational entropy and identities related to sequential and post-processed measurements. Most importantly, the authors show that the difference between Observational entropy and von Neumann entropy bounds the quantum relative entropy between the true state of the system, and the coarse-grained state inferred from the measurement. This indicates new ways of identifying the quantum system alternative to quantum tomography and provides further evidence for the quantum Bayes theorem.





Flat band induced metal-insulator transitions for weak magnetic flux and spin-orbit disorder

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

Phys. Rev. B 107, 174202 (2023)

When the flatband and weak perturbations are combined, the eigenstates evolve nonperturbatively, leading to various interesting and unexpected effects. The authors have previously reported the occurrence of a metal-insulator transition in all-bands-flat lattices under weak onsite disorder. In this paper, the authors derive the effective model describing the perturbed all-bands-flat eigenstates in the presence of weak magnetic flux disorder and weak spin-orbit disorder on an all-bands-flat lattice manifold, and numerically study the localization properties of eigenstates. For weak magnetic flux disorder authors observed particle-hole symmetry and anomalous localization (a.k.a. frozen) eigenstate at flatband energies in (d = 1, 2). For weak spin-orbit coupling disorder in (d=2) the authors identify tunable metal-insulator transition with mobility edges.

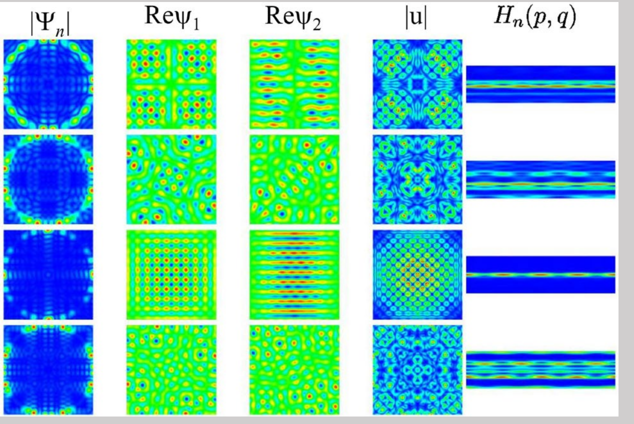
New Research Results

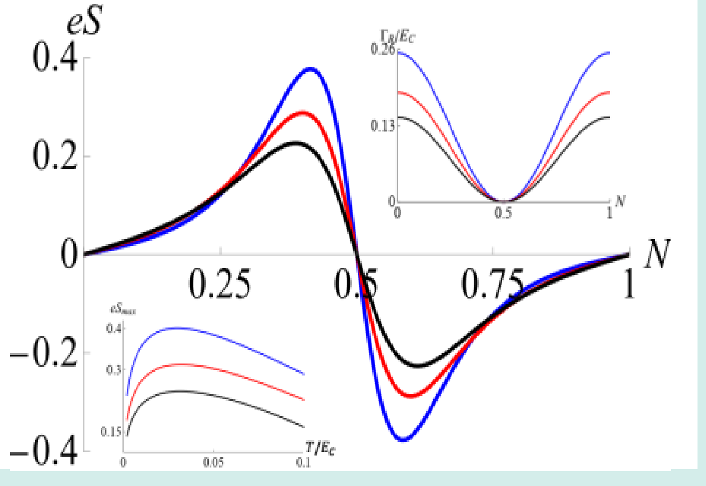
Semi-Poisson Statistics in Relativistic Quantum Billiards with Shapes of Rectangles

Barbara Dietz

Entropy 25(5), 762 (2023)

The eigenstates of rectangular neutrino billiards (NBs) can be classified according to their transformation properties under rotation by π (or π/2 if all side lengths are the same). The author analyzes the properties of these symmetry-projected eigenstates and of the corresponding symmetry-reduced NBs which are obtained by cutting them along their diagonal, yielding right-triangle NBs. Independently of the ratio of their side lengths the spectral properties of the former follow semi-Poisson statistics, whereas those of the complete eigenvalue sequence exhibit Poissonian statistics. The spectral properties of the latter follow quarter-Poisson statistic in the ultrarelativistic limit if they exhibit semi-Poisson statistics in the nonrelativistic limit, but they exhibit the same scarred wave functions. The figure shows the momentum distribution, real part of the spinor components, local current and the Husimi function for rotationally invariant eigenstates of the square NB.





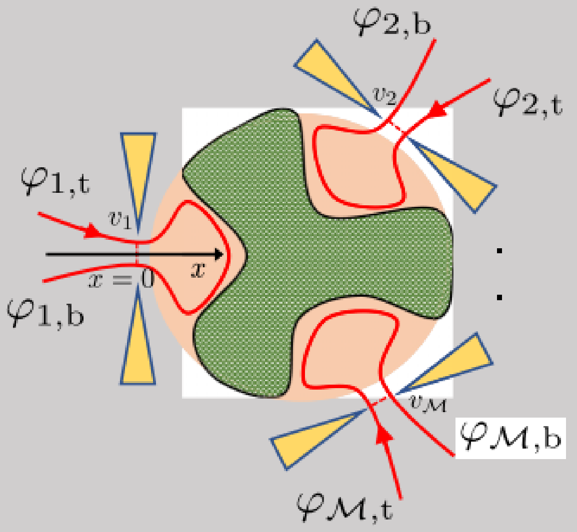
Thermopower of a Luttinger-liquid-based two-channel charge Kondo circuit: nonperturbative solution

A. V. Parafilo, T. K. T. Nguyen

Communications in Physics 33, 1 (2023)

Recently, the influence of electron-electron interactions on the thermoelectric transport in a two-channel charge Kondo circuit has been studied in Phys. Rev. B 105, L121405 (2022). In the current work, the authors revisit the Seebeck thermopower, S, of the Luttinger liquid-based single-electron transistor device by considering the limit when the spin mode is a noninteracting, while the interaction in the charge mode is repulsive. Applying a nonperturbative methods, the authors find that the maximal value of the thermopower increases when electron-electron interaction becomes stronger, while its position in the S(N) plot become closer to the Coulomb peak.

New Research Results



Multiterminal open quantum dot circuit operating in the fractional quantum Hall regime

A. V. Parafilo

Phys. Rev. Research 5, 023019 (2023)

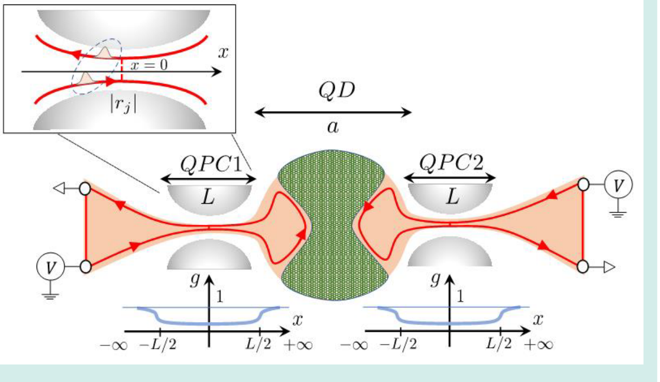
A large quantum dot in the fractional quantum Hall regime that is strongly coupled to M leads via single-mode quantum point contacts (QPC) is studied theoretically. In the case M = 2, when the system is mapped onto the two-channel charge Kondo problem, a universal expression for the conductance in the vicinity of a strong-coupling fixed point is found. The power of the leading temperature correction to the maximal conductance is determined by the fractional filling factor $\nu = 1/m$. For M > 2, the authors examine the case in which M − 1 QPCs are fully open, reproducing a single-channel circuit coupled to a dissipative Ohmic environment. The system is treated as a Luttinger liquid with an impurity, whose effective interaction parameter is defined as $K = \nu(M - 1)/M$.

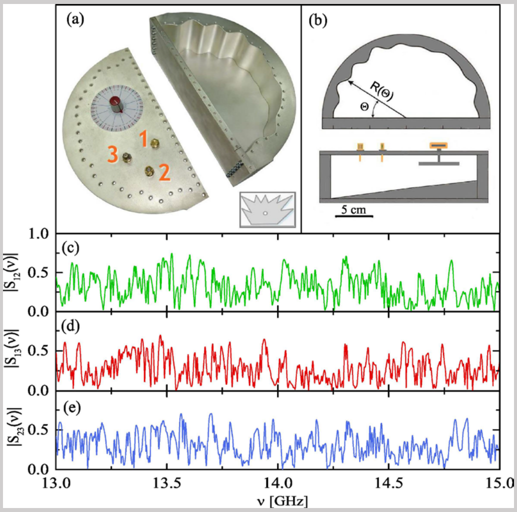
Charge Kondo circuit as a detector for electron-electron interactions in a Luttinger liquid

T. K. T. Nguyen, A. V. Parafilo, H. Q. Nguyen, and M. N. Kiselev

Phys. Rev. B 107, L201402 (2023)

The authors investigate the effects of the electron-electron interaction on the quantum transport through a two-channel charge Kondo circuit. The device is made as a hybrid metal-semiconductor single-electron transistor, where the quantum dot is coupled to two leads by two nearly transparent single mode quantum point contact (QPC); the whole setup is placed in a strong magnetic field and the regime of the integer quantum Hall effect is achieved. It is assumed that the finite length Luttinger liquid is formed in the vicinity of two narrow QPC constrictions. The power-law temperature dependence of the linear conductance is predicted to be modified by the effects of the electron-electron interactions in the Luttinger liquid through the Luttinger parameter g. Notably, when the system approaches the two-channel charge Kondo intermediate coupling fixed point, the universal temperature scaling of the conductance is fully determined by the non-Fermi liquid behavior.





Experimental study of the elastic enhancement factor in a three-dimensional wave-chaotic microwave resonator exhibiting strongly overlapping resonances

Małgorzata Białous, Barbara Dietz, and Leszek Sirko

Phys. Rev. E 107, 054210 (2023)

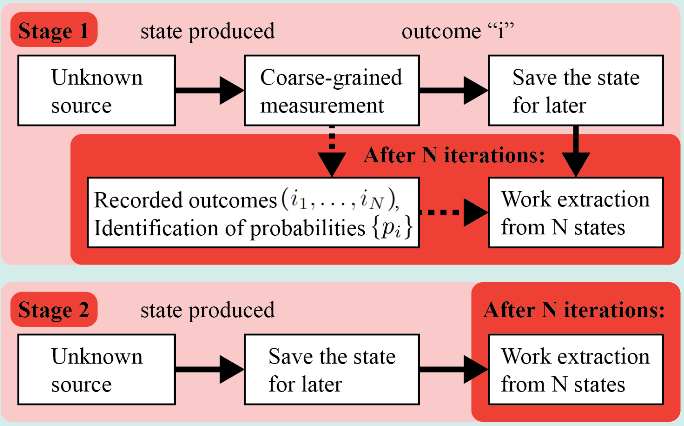
The authors study the elastic enhancement factor and the two-point correlation function of the scattering matrix obtained from measurements of reflection and transmission spectra of a three-dimensional wave-chaotic microwave cavity in regions of moderate and large absorption. They are used to identify the degree of chaoticity of the system in the presence of strongly overlapping resonances, where other measures such as short- and long-range level correlations cannot be applied. To confirm this finding the authors analyzed spectral properties in the frequency range of lowest achievable absorption using missing level statistics.

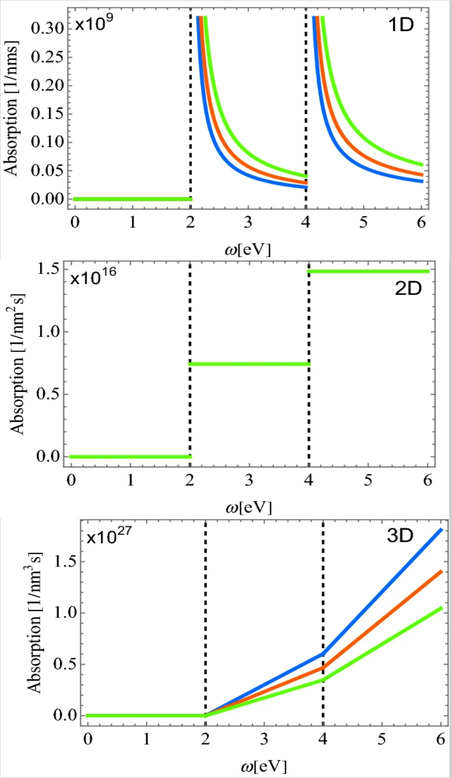
Work Extraction from Unknown Quantum Sources

Dominik Šafránek, Dario Rosa, and Felix C. Binder

Phys. Rev. Lett. 130, 210401 (2023)

In many realistic scenarios, experimental control is limited and only a single type of coarse-grained measurement is available to characterize a quantum state. Moreover, sources of energy are usually not fully characterized, and typically – if the energy source comes from outside, its inherent quantum state is not known. The authors solve the open problem of unitary work extraction from isolated quantum systems without perfect knowledge of the initial state ensemble and with limited experimental control.





Bogolon-mediated light absorption in atomic condensates of different dimensionality

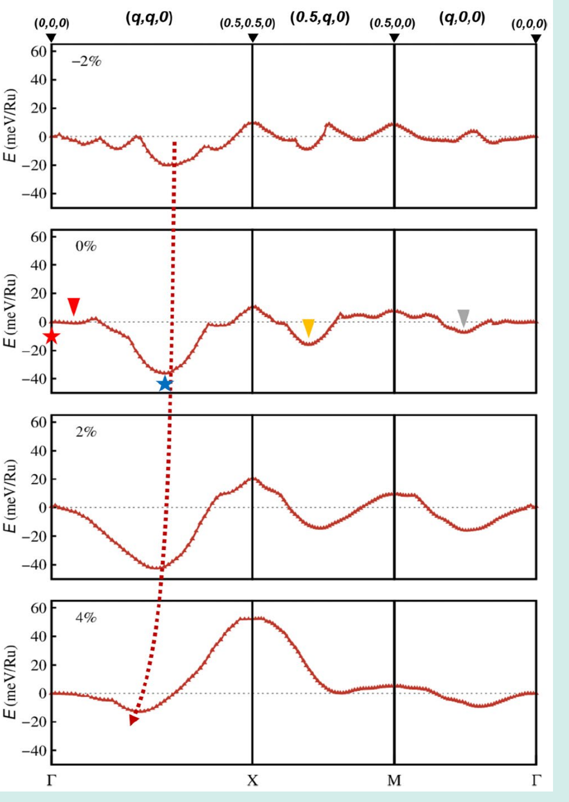
Dogyun Ko, Meng Sun, Vadim Kovalev, and Ivan Savenko

Scientific Reports 13, 6358 (2023)

The authors develop a microscopic theory of light absorption by a Bose–Einstein condensates of cold atoms in various dimensions, utilizing the Bogoliubov model of a weakly-interacting Bose gas. Thus, the authors address the transitions between a collective coherent state of bosons and the discrete energy levels corresponding to excited internal degrees of freedom of non-condensed individual bosons. Such transitions are mediated by single and double bogolon excitations above the condensate, which demonstrate different efficiency at different frequencies and strongly depend on the condensate density, which influence varies depending on the dimensionality of the system.

New Research Results

Competing spin fluctuations in Sr2RuO4 and their tuning through epitaxial strain
Bongjae Kim, Minjae Kim, Chang-Jong Kang, Jae-Ho Han, and Kyoo Kim
[Phys. Rev. B 107, 144406 (2023);](https://doi.org/10.1103/PhysRevB.107.144406)
Strontium ruthenates are intensively studied material for their possibility of topological superconductivity. Although it turns out not to be an odd-parity superconductor in a pure form, it is still attractive due to its multi-orbital nature and strong correlations. Also, the epitaxial strain can change the physical properties because of proximity to the van Hove singularities, which gives hope to finding a topological superconducting state using strain engineering. In this study, the authors investigate magnetic fluctuations in Sr2RuO4, which is important for the superconducting and magnetic instabilities. Using the generalized Bloch approach, the authors find various magnetic fluctuations in addition to the spin-density-wave and ferromagnetic fluctuation and their evolution under strains.



Puzzle of the Month

May puzzle answer:

Disappointingly we did not get any answers so far. Come on! There is no puzzle that physicists can't solve! We repeat the puzzle. You have one month to solve it, send the solution to us, and become famous!

Puzzle of the month:

When you accelerate a car, the front goes up, and the back down. When you brake, the opposite happens. Why? Can you construct a car which does everything the other way around?

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