PCS NEWSLETTER

QR to PCS Webpage

January 2025

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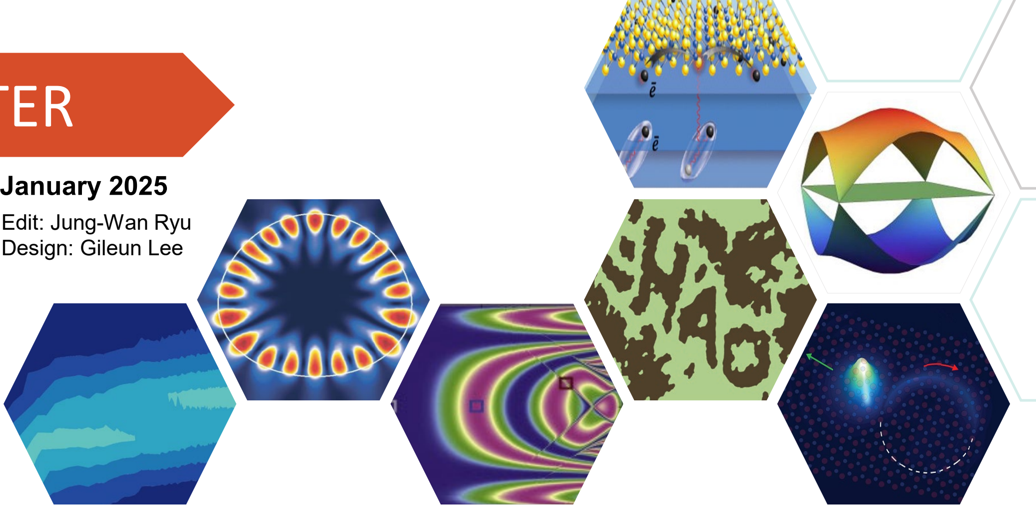


PCS IBS Seminars

"Symmetry-Protected Topological phases and Duality"
by Masaki Oshikawa, University of Tokyo, Japan (December 3), *IBS Physics Colloquium @ Daejeon*

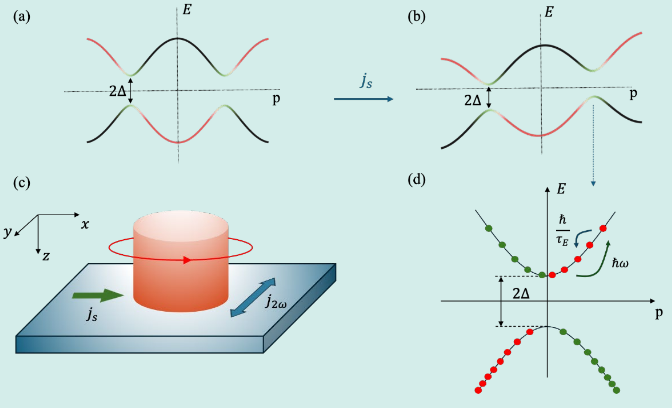
"The Ising dual-reflection interface: Z4 symmetry, Majorana strong zero modes and SPT phases"
by Sergej Moroz, Karlstad University, Sweden (December 10)

"Spin dynamics of coupled Ti spins on ultra-thin MgO layers probed by ESR-STM"
by Valeria Sheina, Center for Quantum Nanoscience, IBS, Korea (December 12)

"Quantifying quantum resources using the nonclassical values of Kirkwood Dirac quasiprobability and strange weak value"
by Agung Budiyono, National Agency for Research and Innovation Agency (BRIN), Indonesia (December 19)

You can find more seminars on this page.

New Research Results



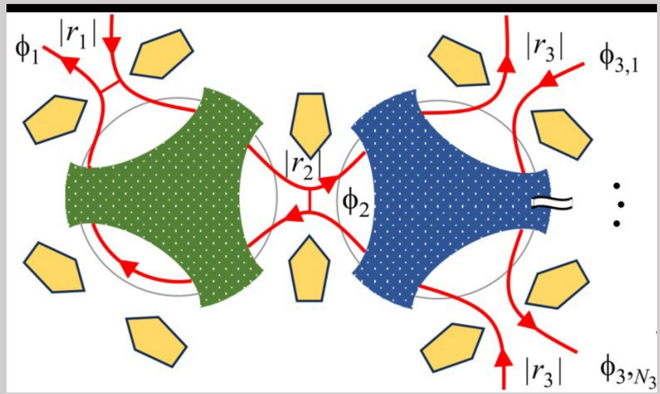
Nonlinear ac Hall effect in two-dimensional superconductors
K. Sonowal, A. V. Parafilo, V. M. Kovalev and I. G. Savenko
Phys. Rev. B 110, 205413 (2024)

The authors consider a BCS single-band 2D superconductor illuminated by a circularly polarized light with frequency $\omega \ll \delta/\hbar$, where δ is the superconducting gap, along with a built-in supercurrent j_s which breaks the inversion symmetry of the system. The resulting photoinduced current calculated using the non-equilibrium Keldysh diagram technique reveals the emergence of an ac Hall current oscillating at double the frequency of the electromagnetic field in the direction transverse to the in-built supercurrent. This current's strength is influenced by inelastic relaxation rate, dc supercurrent direction, and light polarization, with the ac current density being tunable via electron density. Thus, a nonlinear ac-Hall effect is proposed in the 2D superconductor, which is found to be shaped by temperature, light frequency and material characteristics.

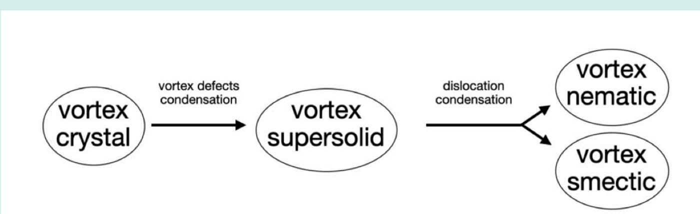
New Research Results

Manifestation of Luttinger liquid effects in a hybrid metal-semiconductor double-quantum dot device
A. V. Parafilo
Low Temp. Phys. 50, 1180–1188 (2024)

The author studies the transport properties of a hybrid nanodevice comprised of two large metallic islands incorporated in a two-dimensional electron gas. The high-tunability of the conducting channels, which electrically connect the two islands to each other and to the leads, allows the setup to be treated as a realization of a multi-channel two-site charge Kondo (2SCK) model. It is shown that the leading temperature dependence of the conductance in the 2SCK circuit satisfies the conductance scaling of a single-impurity problem in a Luttinger liquid, whose interaction parameter is fully determined by the number of conducting channels in the device. It is demonstrated that the finite weak backscattering in all conducting channels features the appearance of the subleading temperature dependencies in linear conductance. At the special critical point, an equivalency between the 2SCK nanodevice and a single-site two-channel charge Kondo problem, where one Kondo channel is implemented by a non-interacting electron gas and the second Kondo channel is attributed to the Luttinger liquid, is predicted.



On quantum melting of superfluid vortex crystals: From Lifshitz scalar to dual gravity
Dung Xuan Nguyen, Sergej Moroz
SciPost Phys. 17, 164 (2024)

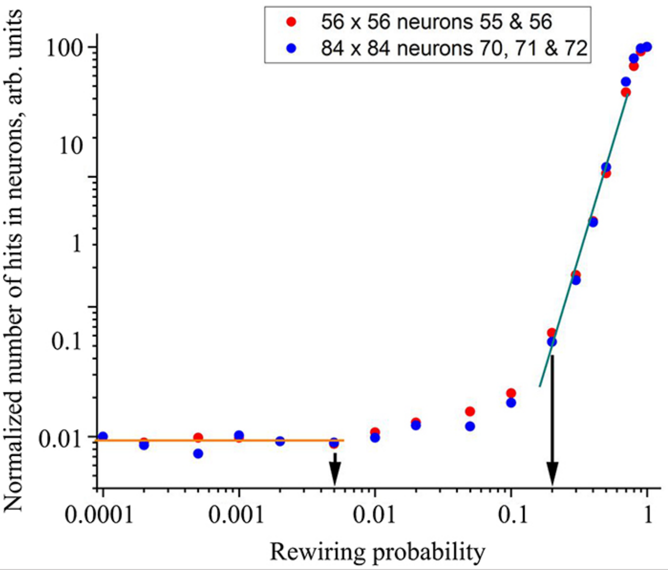


The authors explore the poorly understood quantum melting of vortex crystals in rotating superfluids. Using a fracton-elasticity duality approach, they examine the 2D vortex lattice in the fast rotation regime, where the low-energy dynamics are governed by the Lifshitz model for Tkachenko modes. The research incorporates topological defects and evaluates potential quantum melting scenarios caused by their proliferation. Additionally, it establishes a foundation for a dual non-linear emergent gravity framework to describe superfluid vortex crystals.

New Research Results

Unsupervised techniques to detect quantum chaos
Dmitry Nemirovsky, Ruth Shir, Dario Rosa, Victor Kagalovsky
Low Temp. Phys. 50, 1127-1134 (2024)

Conventional spectral probes of quantum chaos require eigenvalues, and sometimes, eigenvectors of the quantum Hamiltonian. This involves computationally expensive diagonalization procedures. The authors test whether an unsupervised neural network can detect quantum chaos directly from the Hamiltonian matrix. They use a single-body Hamiltonian with an underlying random graph structure and random coupling constants, with a parameter that determines the randomness of the graph. The spectral analysis shows that increasing the amount of randomness in the underlying graph results in a transition from integrable spectral statistics to chaotic ones. The authors show that the same transition can be detected via unsupervised neural networks, or more specifically, self-organizing maps by feeding the Hamiltonian matrix directly into the neural network, without any diagonalization procedure.

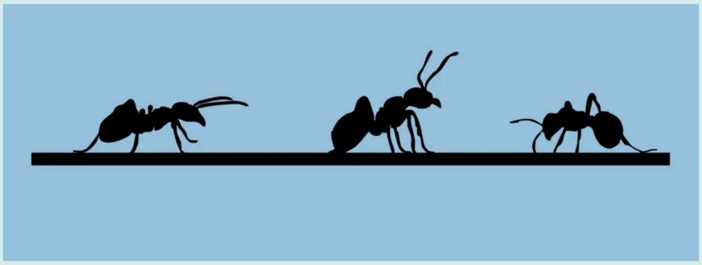


Puzzle of the Month

December puzzle solution:

Never, simple! When keeping the north east direction, the plane will always move north, never south. It will spiral up to the north pole, and never cross the equator again.
The correct solution was communicated by Jaehee Kwon, congratulations!

January puzzle:



25 ants are placed at random positions on a 1m long narrow stick. Each has a random initial direction of crawling left or right, and all crawl with the same velocity 1cm/s. When two ants collide, they can not pass each other, because the stick is so narrow. Instead, when colliding, they turn around, revert their velocity directions and crawl in opposite directions. When an ant reaches the end of the stick, it falls down into some soft grass.
One of the ants is called Alice. How long will it take for Alice at most to fall down?

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