PCS NEWSLETTER

QR to PCS Webpage

December 2023

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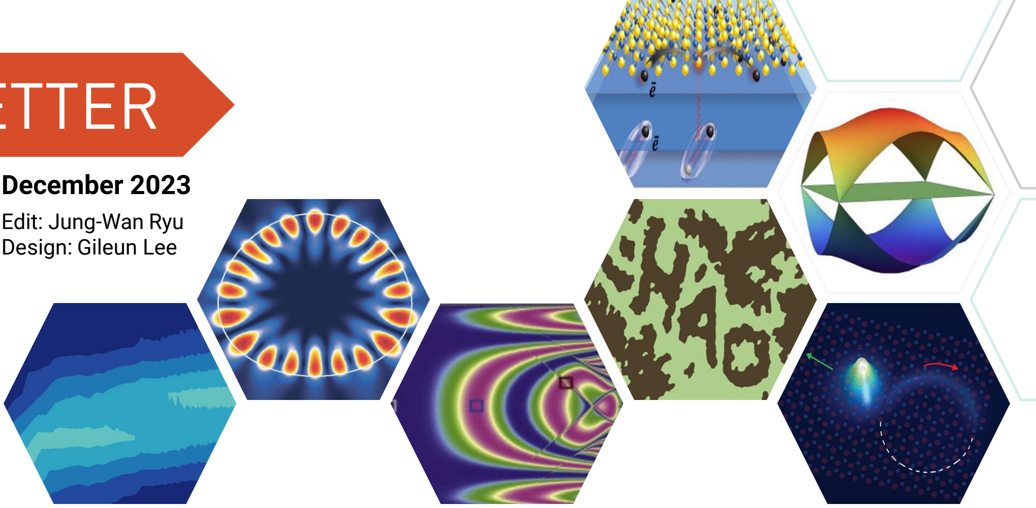


PCS Workshops and Meetings

PCS will co-host KIAS-IBS-PCS Workshop Correlation and Topology in Quantum Matter at the Orakai Daehakro Hotel, Seoul, South Korea on December 18 – December 21, 2023.

PCS Seminars

"A Stochastic Method to Compute the L2 Localisation Landscape"
by Keith Slevin, Osaka University, Japan (November 1)

"Attosecond science and the Nobel prize in physics in 2023"
by Tran Trung Luu, The University of Hong Kong, China (November 2)

"Unifying the Anderson Transitions in Hermitian and Non-Hermitian Systems"
by Tomi Ohtsuki, Sophia University, Japan (November 3)

"Wolfram Technology for LLMs"
by Farid Pasha, Wolfram Research, Inc., USA (November 9), *IBS Physics Colloquium @ Daejeon*

"Hierarchical Organization of Communicating Active Smarms"
by Igor Aronson, Pennsylvania State University, USA (November 23)

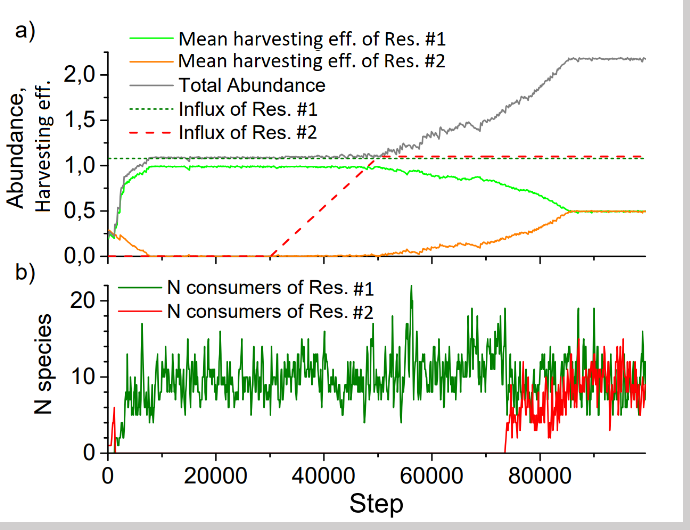
"Introduction into the complex Ginzburg-Landau equation. Part 1"
by Igor Aronson, Pennsylvania State University, USA (November 27)

"Introduction into the complex Ginzburg-Landau equation. Part 2"
by Igor Aronson, Pennsylvania State University, USA (November 29)

"Measuring entanglement at finite temperatures"
by Cheolhee Han, Tel Aviv University, Israel (November 30)

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

New Research Results



Effects of resource competition on evolution and adaptive radiation

Sergei V. Koniakhin

[Eur. Phys. J. Spec. Top. (2023)]

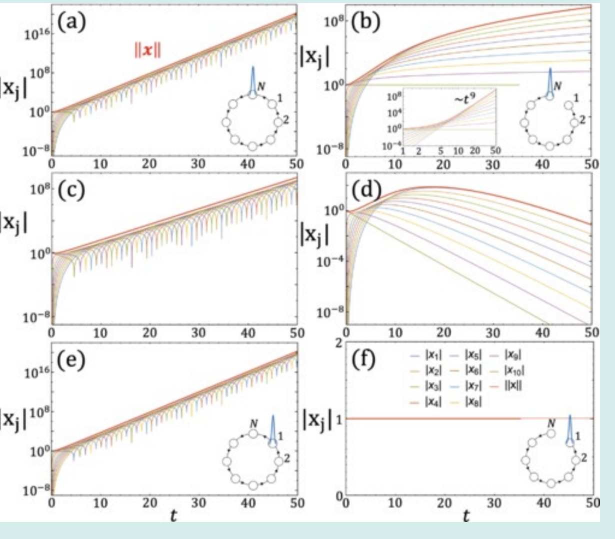
Biology has garnered considerable attention from physicists such as Erwin Schrödinger, Carl Woese, and Francis Crick. The latter achieved global renown and received the Nobel Prize for his pivotal contributions to the discovery of DNA. Within biology, ecology, a specialized field, studies the spatiotemporal evolution of populations of living organisms. This often involves the models based on nonlinear and stochastic equations, sharing the investigative methods with those employed in physical kinetics and the physics of complex systems. In the present study, the author realistically incorporates the effects of beneficial and deleterious mutations on the coefficients within the equations governing population dynamics (in fact, the generalized Lotka-Volterra equations). The outcome of the study is a valuable tool for examining the impact of diversity and influx fluctuations in available resources on the details of speciation within the studied ecosystem.

Dynamics in non-Hermitian systems with nonreciprocal coupling

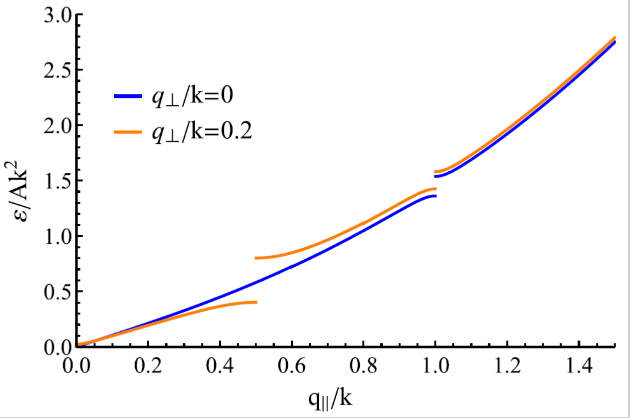
Jung-Wan Ryu

[Phys. Rev. A 108, 052205 (2023)]

Non-Hermitian Hamiltonians with nonreciprocal coupling can achieve amplification of initial states without external gain due to a kind of inherent source. The author discusses the source and its effect on time evolution in terms of complex eigenenergies and nonorthogonal eigenstates. Demonstrating two extreme cases of Hamiltonians, namely one having complex eigenenergies with orthogonal eigenstates and one having real eigenenergies with nonorthogonal eigenstates, the author elucidates the differences between the amplifications from complex eigenenergies and from nonorthogonal eigenstates.



New Research Results



Ferromagnetic monolayer with interfacial Dzyaloshinskii-Moriya interaction: Magnon spectrum and effect of quenched disorder

Oleg I. Utesov and Arseny V. Syromyatnikov

[Phys. Rev. B 108, 174414 (2023)]

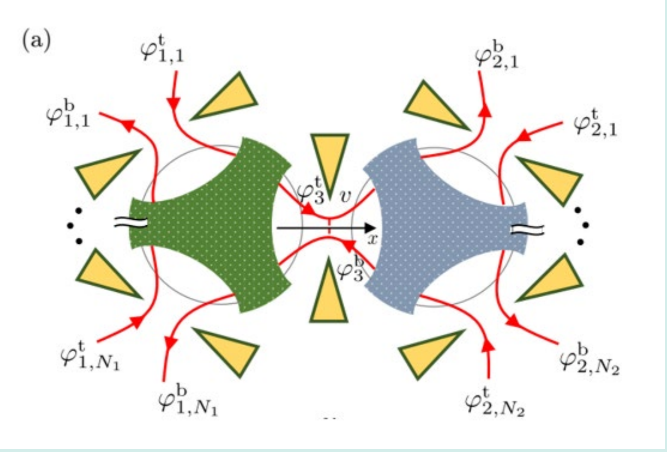
Properties of the single-modulated cycloid phase of a monolayer with interfacial Dzyaloshinskii-Moriya interaction were considered. In particular, the authors show that the low-energy part of the spectrum is essentially modified by the umklapp terms of the Hamiltonian. The obtained magnon spectrum is highly anisotropic and quasi-1D: it is linear in the momentum component along the cycloid modulation vector and quadratic in the perpendicular component. Moreover, the umklapps play a crucial role in the formation of the magnon band structure. The authors also show that the quasi-1D magnon spectrum leads to power-law divergence of the correction to ordered spin at finite temperatures, in contrast to usual for 2D systems weak Mermin-Wagner-like logarithmic divergencies. Finally, the influence of bond disorder and vacancies on the ordering at T=0 was studied. For a single defect bond, the authors obtain the well-known dipole-field solution for the cycloid distortions. However, at large distances thanks to the quasi-1D structure of the susceptibility the result corresponds to a 1D dipole. As a consequence, at a finite concentration of defects c the disorder destroys the long-range order and the short-range one persists with the correlation length which has a power-law dependence on 1/c.

Probing Luttinger liquid properties in a multichannel two-site charge Kondo simulator

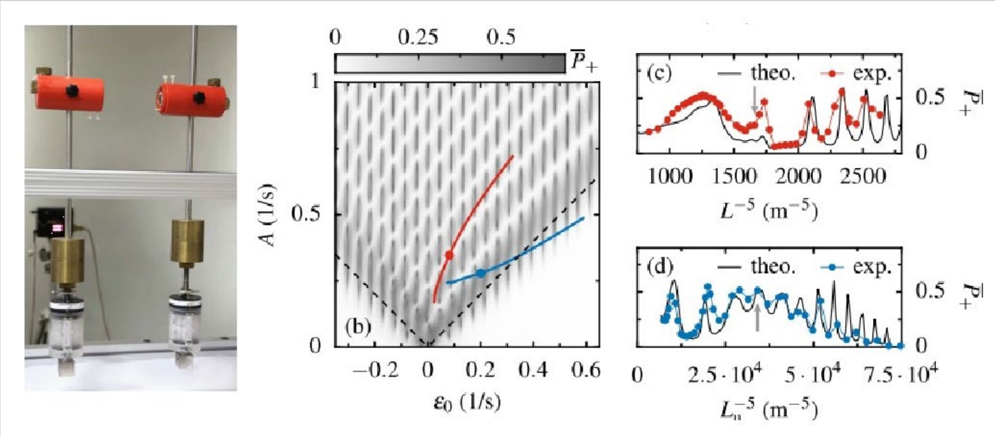
A. V. Parafilo, V. M. Kovalev, and I. G. Savenko

[Phys. Rev. B Letters 108, L201101 (2023)]

The authors study the effects of many-body interactions in a multichannel two-site charge Kondo simulator by considering a hybrid metal-semiconductor double-quantum dot device operating in the fractional quantum Hall regime. The authors show that the number of open ballistic channels connected to both quantum dots (N_1 and N_2) as well as the fractional filling factor n=1/m (m is odd integer) uniquely determine the transport properties of the setup at low temperatures. The conductance scaling at the strong and weak interdot coupling shows the Luttinger liquid scaling for the conductance and fully features by the effective interaction parameter $K=nN_1N_2/(N_1+N_2+N_1N_2)$. In the particular case $N_1=N_2=1$, the authors predict a universal Kondo scaling in the vicinity of quantum (tri-critical) point, characterized by the emergence of fractional Z_{3m} excitation.



New Research Results



Classical analogue to driven quantum bits based on macroscopic pendula

Heribert Lorenz, Sigmund Kohler, Anton Parafilo, Mikhail Kiselev & Stefan Ludwig

[Scientific Reports 13, 18386 (2023)]

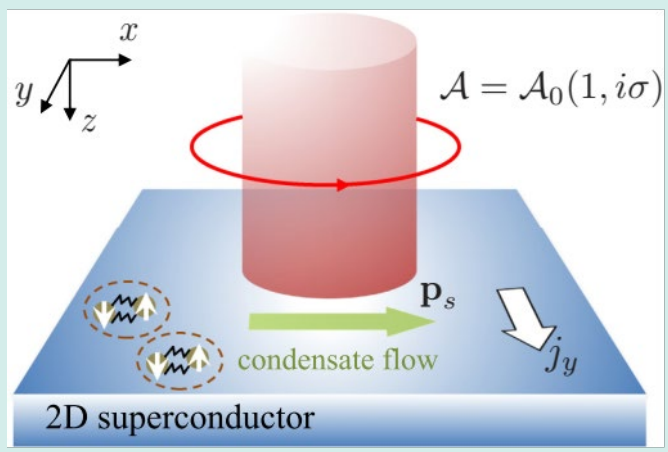
The authors study theoretically and experimentally the “classical-to-quantum” correspondence between oscillations of the macroscopic coupled pendula and the coherent dynamics of a driven quantum bit. For this, the authors investigate the time evolution of the in- and out-of-phase modes of two detuned pendula coupled via magnetic dipole-dipole interaction of two magnets placed in the lower part of each pendulum; one of the magnets rotates creating time-dependent coupling. The authors presented three key quantum bit experiments with coupled pendula, namely Rabi oscillations, Landau-Zener transitions and Landau-Zener-Stueckelberg-Majorana interferometry. Comparing measurements with the prediction of the Schrödinger equation the authors demonstrated that their classical experiments directly visualize Schrödinger’s wave mechanics.

Photoinduced anomalous supercurrent Hall effect

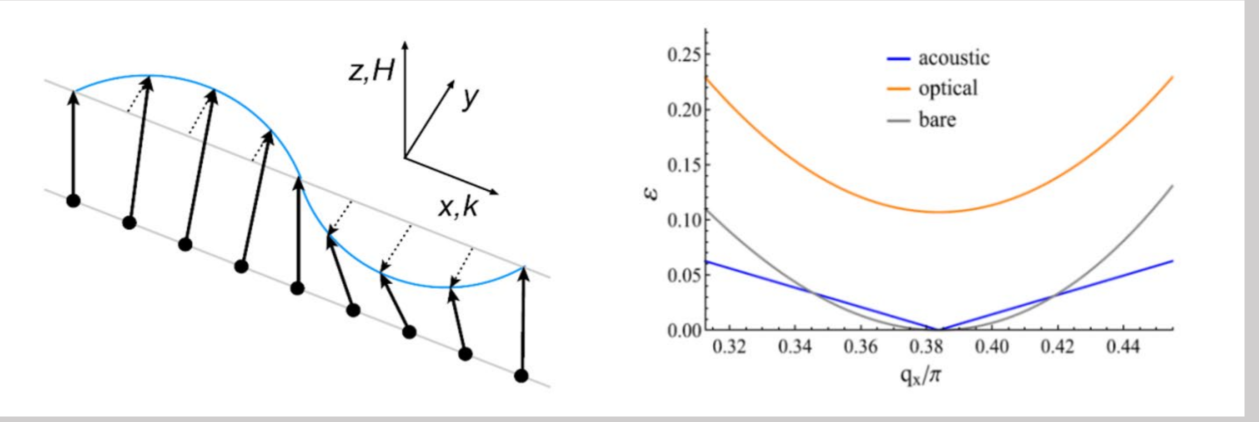
A. V. Parafilo, V. M. Kovalev, and I. G. Savenko

[Phys. Rev. B Letters 108, L180509 (2023)]

The authors developed a theory of the nonlinear photoresponse in a single-band 2D isotropic superconductor with a built-in supercurrent exposed to an external electromagnetic field. In case of circularly polarized electromagnetic field, the authors predict an anomalous photoinduced supercurrent Hall-like phenomenon. It reveals itself in the emergence of Cooper pair condensate flow in the direction transverse to the initial built-in supercurrent, which arises to compensate for the light-induced electric current of quasiparticles photoexcited across the superconducting gap. The theory accounts for the presence of impurities in the sample, which destroys the Galilean invariance for the transverse transport to take place. The supercurrent Hall effect opens a way to manipulate the direction of superconducting condensate flow via optical tools without external magnetic field.



New Research Results



Magnons in the fan phase of anisotropic frustrated antiferromagnets
Oleg I. Utesov
[Journal of Magnetism and Magnetic Materials 589, 171544 (2024)]
Magnon spectrum of the fan phase of anisotropic frustrated antiferromagnets was studied. The recently proposed perturbative approach to the fan structures at a near-to-saturation magnetic field was utilized to obtain the bilinear part of the Hamiltonian suitable for linear spin wave theory calculations. For low-energy elementary excitations anomalous and umklapp terms of the Hamiltonian play a crucial role. The latter mix magnons with momenta which differ by two modulation vectors of the fan structure. As a result of their strong hybridization, the low-energy sector of the spectrum consists of gapless phason and gapped amplitude oscillations branches.

Puzzle of the Month

October puzzle, once again:

apologies to all who tried - there was a typo in the original question - the correct condition must be '… each time they are allowed to remove only either 2, or 4, or 9, or 16 marbles …'. The typo added the number 1, unfortunately. Our puzzle solver giant Oleg Utesov tried hard with the incorrect condition, and found a possible solution to that much harder problem. Without judging the details, we herewith declare Oleg Uetsov as the winner of the October puzzle!

Now to the November puzzle: the answer is 360 degrees, as correctly solved by Mats Jonson, Amnon Aharony, and Tilen Cadez. Congratulations!

Puzzle of the month:

a,b,c are positive integers.

ab+c=2023
a+bc=2024

Do you know the solution?

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