PCS NEWSLETTER

QR to PCS Webpage

November 2022

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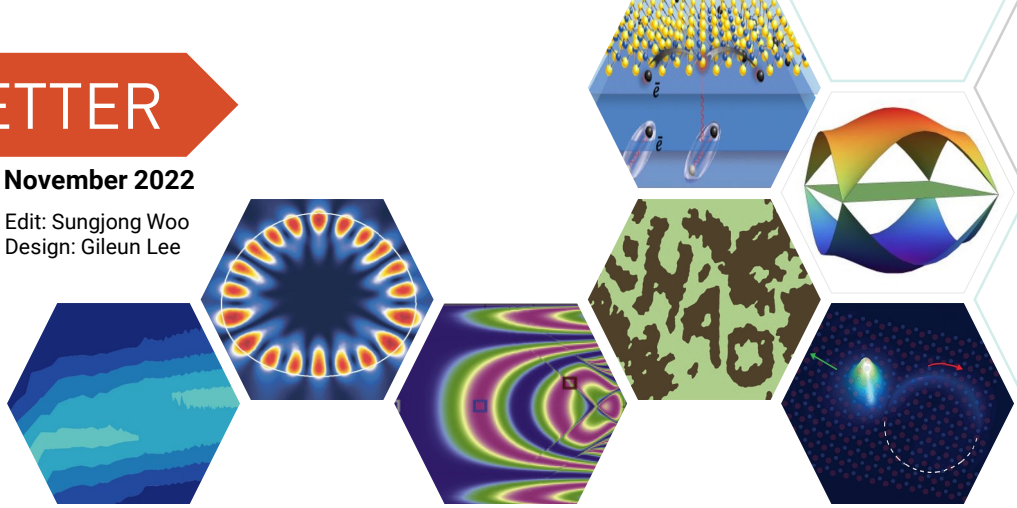


Awards

Congratulations! Ms. Kabyashree Sonowal won a best poster prize for presenting the poster 'Valley spin-acoustic resonance in monolayer MoS_2' at the 771.WE-Heraeus-Seminar on "2D Materials and Hybrids: Hybrid Quasiparticles in Quantum Materials" on September 27 held at Bad Honnef, Germany. Well done!

PCS Workshops and Meetings

PCS successfully hosted ***Dynamics Days Asia Pacific (DDAP12)*** Nov 7 - 11, 2022. We enjoyed twenty two plenary talks, thirty eight invited talks on-site as well as through on-line and thirty one posters with 133 participants.

PCS will host a one day workshop *Focus Workshop Topological Quantum Matter* on December 12, 2022. To participate, please register here.

PCS IBS Seminars

"Tensor networks for classical and quantum machine learning tasks"
by Dario Poletti, Singapore University for Technology and Design, Singapore (October 6)

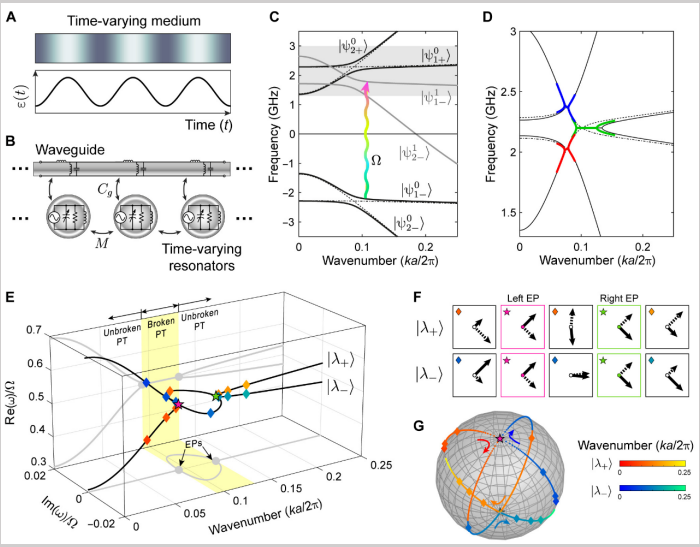
"Ferrodark solitons in a spin-1 Bose-Einstein condensate"
by Xiao-Quan Yu, Graduate School of China Academy of Engineering Physics, China (October 11)

"Master equation approach to conductivity problem or solid-state physics without Green's functions"
by Andrey Kolovsky, Kirensky Institute of Physics, SB RAS, Russia (October 13)

"Many-body Localization in Disordered 1D Hubbard Model with Infinite Onsite Repulsion"
by Boris Altshuler, Columbia University, USA (October 27)

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

New research results



Revealing non-Hermitian band structure of photonics Floquet media

Jagang Park, Hyukjoo Cho, Seojoo Lee, Kyungmin Lee, Kanghee Lee, Hee Chul Park, Jung-Wan Ryu, Namkyoo Park, Sanggeun Jeon, Bumki Min

Science Advances, **8**, eabo6220 (arXiv:2112.01313)

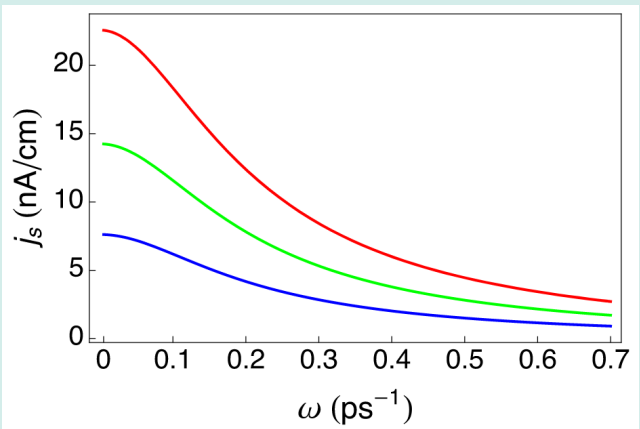
Periodically driven systems are ubiquitously found in both classical and quantum regimes. In the field of photonics, these Floquet systems have begun to provide insight into how time periodicity can extend the concept of spatially periodic photonic crystals and metamaterials to the time domain. However, despite the necessity arising from the presence of nonreciprocal coupling between states in a photonic Floquet medium, a unified non-Hermitian band structure description remains elusive. The authors reveal the unique Bloch-Floquet and non-Bloch band structures of a photonic Floquet medium emulated in the microwave regime with a one-dimensional array of time-periodically driven resonators. These non-Hermitian band structures are shown to be two measurable distinct subsets of complex eigenfrequency surfaces of the photonic Floquet medium defined in complex momentum space.

Photogalvanic transport in fluctuating Ising superconductors

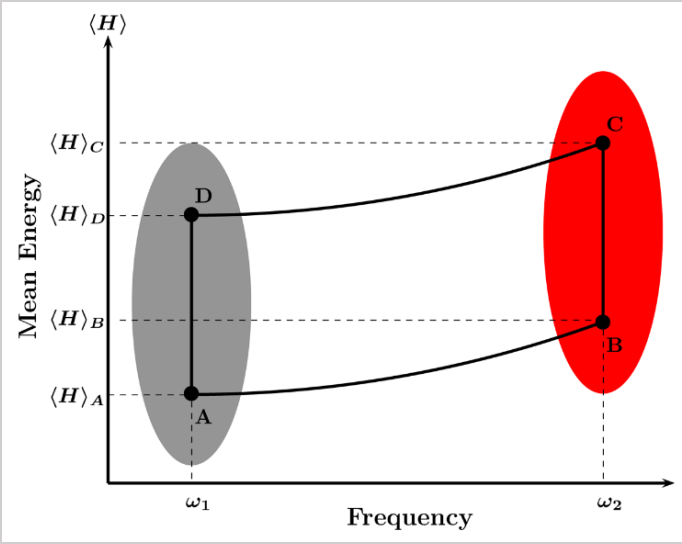
A. V. Parafilo, M. V. Boev, V. M. Kovalev, and I. G. Savenko

Phys. Rev. B 106, 144502 (arXiv:2206.04322)

The interplay between spin-orbit coupling and the Zeeman field may lead to a variety of magnetoelectric effects accompanied by a nonreciprocal current response, which has been widely studied in recent years. Usually, such phenomena are enhanced in the superconducting state. In this work, the authors show that transition metal dichalcogenides may demonstrate pronounced nonreciprocal response in the regime of superconducting fluctuations. A microscopic theory of a linear photo-galvanic effect (PGE) is developed for a fluctuating 2D Ising superconductor subjected to a linearly polarized electromagnetic field. The contribution of the Aslamazov-Larkin type to the electric current is obtained depending on the temperature and frequency of the electromagnetic field. It is also predicted that the PGE current of the normal-state electron gas is finite in the case of electron scattering on Coulomb impurities in a 2D sample.



New research results



Unified trade-off optimization of quantum harmonic Otto engine and refrigerator

Varinder Singh, Satnam Singh, Obinna Abah and Özgür E. Müstecaplıoglu

Phys. Rev. E 106, 024137 (arXiv:2112.10669)

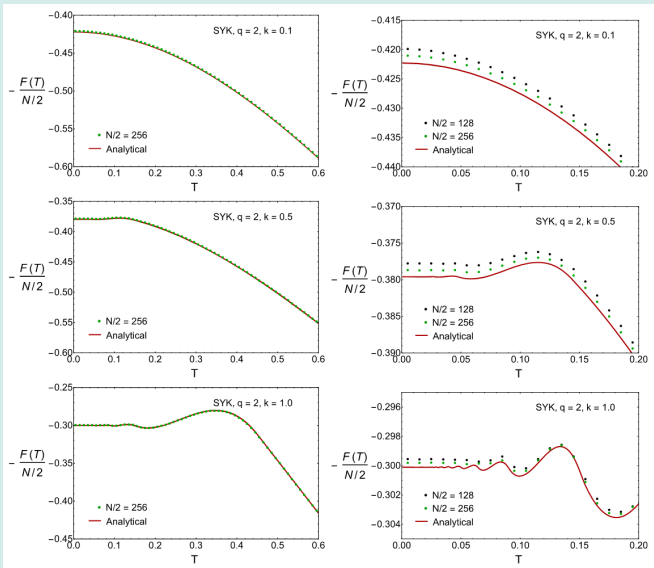
The rapid development in the field of quantum technologies has bring up the question of resource consumption in the thermodynamic landscape. Quantum thermodynamic devices offer the natural avenue to address the fundamental limits of energy consumption at the quantum level. While optimizing quantum thermal devices, one should choose an objective function which pays equal attention to both efficiency and power of the engine, thereby taking care of the environmental and energetic considerations. In this work, the authors investigate quantum Otto engine and refrigeration cycles of a time-dependent harmonic oscillator operating under the conditions of maximum Omega function, a trade-off objective function which represents a compromise between energy benefits and losses for a specific job, for both adiabatic and nonadiabatic (sudden) frequency modulations. They derive analytical expressions for the efficiency and coefficient of performance of the Otto cycle in various operational regimes

Replica Symmetry Breaking for the Integrable Two-Site Sachdev-Ye-Kitaev Model

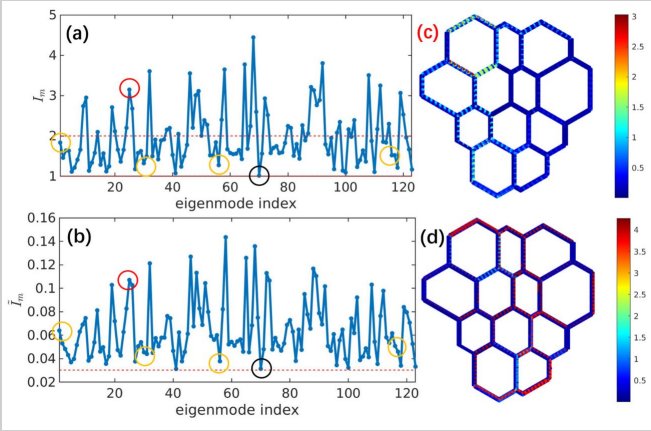
Yiyang Jia, Dario Rosa and Jacobus J. M. Verbaarschot

J. Math. Pays. 63, 103302 (arXiv:2201.05952)

The authors analyze a quadratic nonhermitian two-site Sachdev-Ye-Kitaev model with the couplings of one site complex conjugated to the other site and no explicit coupling between the sites. The model, as a consequence of the partition function factorizing into a product over Matsubara frequencies, shows an infinite number of phase transitions. The quenched free energy can be calculated exactly and compared to the corresponding quartic model to determine which features of the free energy are due to chaotic nature of the quartic model. The high-temperature phase of both models is entropy dominated, and in both cases is determined by the spectral density. The quartic SYK model has a low-temperature phase whose free energy is almost temperature-independent, signaling an effective gap of the theory even though the actual spectrum does not exhibit a gap. However the low-temperature free energy of the quadratic SYK model is not flat, in fact it oscillates to arbitrarily low temperature. This indicates a less desirable feature that the entropy of the quadratic model is not always positive, which most likely is a consequence of the nonhermiticity.



New research results



Experimental study of closed and open microwave waveguide graphs with preserved and partially violated time-reversal invariance

Weihua Zhang, Xiaodong Zhang, Jiongning Che, Junjie Lu, M. Miski-Oglu, and Barbara Dietz

Phys. Rev. E **106**, 044209 (arXiv:2206.07873)

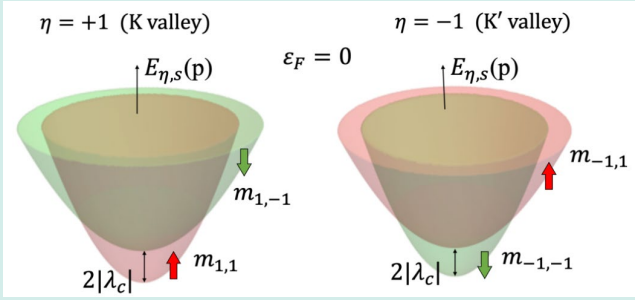
The authors report on experiments that were performed with a microwave waveguide system. They demonstrate that in the frequency range of a single transversal mode waveguide systems may serve as a model for closed and open quantum graphs. These consist of bonds with incommensurate lengths that are connected at vertices. On the bonds, they are governed by the one-dimensional Schrödinger equation with boundary conditions imposed at the vertices. The resulting transport properties through the vertices may be expressed in terms of a vertex scattering matrices which, in distinction to quantum graphs, depend on the wave number. The authors analyze the spectral properties of microwave waveguide systems with preserved and partially violated time-reversal invariance, and for the first time the properties of the associated wave functions. Furthermore, they study properties of the scattering matrix describing the measurement process within the framework of random matrix theory for quantum chaotic scattering systems.

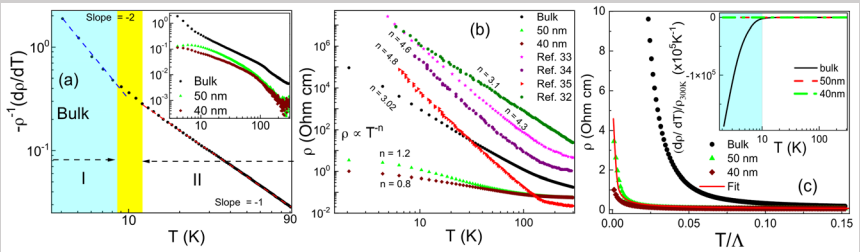
Valley spin-acoustic resonance in MoS_2 monolayers

K. Sonowal D. V. Boev A. V. Kalameitsev V. M. Kovalev and I. G. Savenko

Phys. Rev. B **106**, 155426 (arXiv:2206.11551)

In this publication, the authors theoretically predict the occurrence of spin acoustic resonance accompanied by acoustoelectric current in Monolayer MoS_2, accounting for the presence of strong spin-orbit coupling . Monolayer MoS_2 has a unique band structure comprising spin-split subbands crossing each other at finite momenta with opposite spin orientation in both valleys. When exposed to Rayleigh surface acoustic waves, strain-induced pseudomagnetic fields couple with spin resulting in spin-phonon interaction. On breaking time-reversal symmetry, both the spin acoustic resonance and acoustoelectric current become valley sensitive paving the way for acousto-electric spectroscopy of valley selective phenomena.





Possible transition between charge density wave and Weyl semimetal phase in $Y_2Ir_2O_7$

Abhishek Juyal, Vinod Kumar Dwivedi, Sonu Verma, Shibabrata Nandi, Amit Agarwal, and Soumik Mukhopadhyay

Phys. Rev. B **106**, 155149 (arXiv:2206.00690)

In addition to the fascinating area of non-interacting topological phases, there are rapid recent investigations of strong interaction-driven topological phase transitions where single-particle band structure is modified. For example: at room temperature $(TaSe_4)_2I$ is in the Weyl semimetal (WSM) phase which is a semimetal with topologically protected surface states, while at a low temperature it is in the charge density wave (CDW) phase where periodic distortion causes periodic modulation of density. In this work, the authors provide experimental evidence of possible phase transition in bulk $Y_2Ir_2O_7$ compounds from CDW phase at a low temperature to the WSM phase at a higher temperature using dc and ac transport experiments which is supported by theoretical investigations.

Puzzle of the month

October Puzzle Answer:

127 and 128. Clearly one of them has to be even and the other one has to be prime, and both have to be larger than 100, otherwise 2 × prime will add a third 'no'. Also the even one has to be a pure power of 2s, since otherwise someone beforehand would already say 'no'. So we need a power of 2 larger than 100 but less than 200 and a prime either right before or after it. The only power of 2 which fits is $2^7 = 128$. And it so happens that 127 is prime.

Congratulations to Merab Malishava (Seoul) for the correct answer!

Puzzle of the month:

One day it started snowing in the morning at a heavy and steady rate. A snowplow started out at noon, going 2 miles in the first hour and 1 mile in the second hour. What time did it start snowing?

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