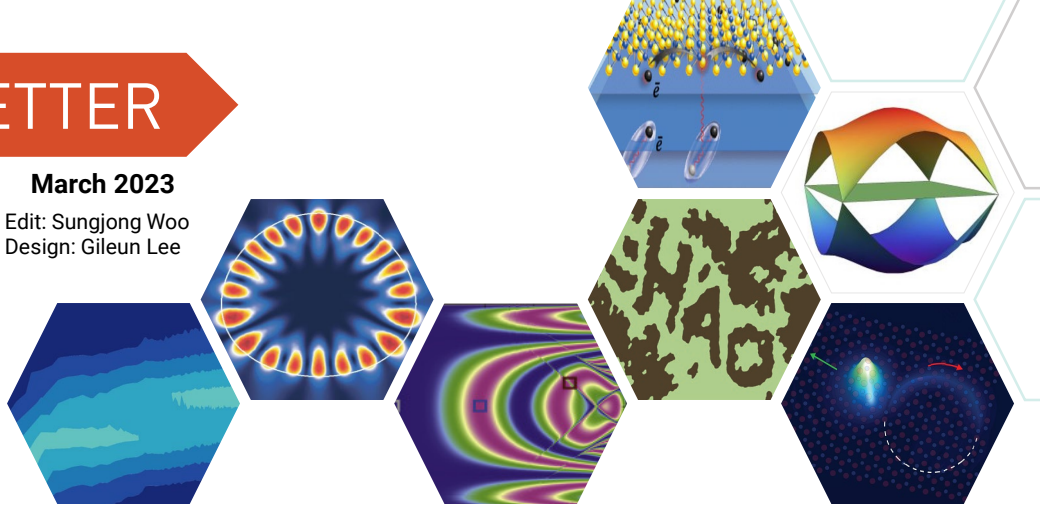
PCS NEWSLETTER

QR to PCS Webpage

March 2023

Edit: Sungjong Woo
Design: Gileun Lee



New members

Dr. **Beom Hyun Kim** has joined PCS as a research fellow. He received his Ph D in 2009 from POTECH, South Korea. He has worked as a postdoctoral researcher at POSTECH and IFW Dresden in Germany, as a contract researcher at RIKEN in Japan, and as an assistant professor at KIAS in South Korea. His main research interests are electronic, magnetic, and excitation properties of strongly correlated electron systems such as transition-metal compounds. He is also interested in quantum spin systems and neural network quantum states.

PCS Workshops and Meetings

PCS, with the Asia Pacific Center for Theoretical Physics, launched the [ICTP Asian Network on Condensed Matter, Complex Systems and Statistical Physics 2023-2026](#).

PCS IBS Seminars

"[Fractional conductances in the strongly interacting 1D system](#)"
by Victor Kagalovsky, Shamoon College of Engineering, Israel (February 7)

"[Fast and slow quantum first hitting times for target search](#)"
by Eli Barkai, Bar-Ilan University, Israel (February 8)

"[Reinforcement learning optimization of the charging of a Dicke quantum battery](#)"
by Gian Marcello Andolina, The Institute of Photonic Sciences, Spain (February 9)

"[Charging a quantum battery in a non-Markovian environment: a collisional model approach](#)"
by Daniele Morrone, University of Milan, Italy (February 14)

"[DMFT+NRG: From models to real materials, from local to nonlocal correlations](#)"
by Seung-Sup Lee, Seoul National University, Korea (February 15)

"[Ab initio DMFT methodologies for correlated quantum materials](#)"
by Sangkook Choi, Korea Institute for Advanced Study (KIAS), Korea (February 15)

"[Physical limits of non-Hermitian and non-reciprocal devices](#)"
by Henning Schomerus, Lancaster University, UK (February 21)

"[Gate-voltage-driven quantum phase transition in quantum point contacts](#)"
by Jongbae Hong, Seoul National University, Korea (February 22)

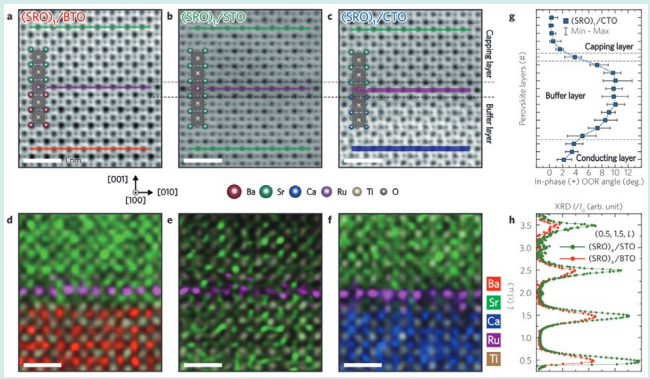
You can find more seminars on ***this page***.

New research results

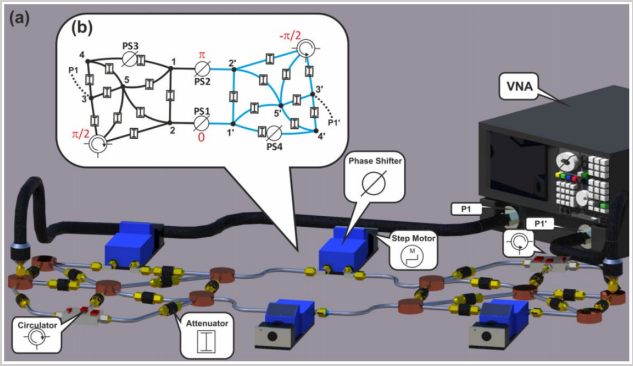
Heteroepitaxial Control of Fermi Liquid, Hund Metal, and Mott Insulator Phases in Single-Atomic-Layer Ruthenates

Jeong Rae Kim, Byungmin Sohn, Hyeong Jun Lee, Sangmin Lee, Eun Kyo Ko, Sungsoo Hahn, Sangjae Lee, Younsik Kim, Donghan Kim, Hong Joon Kim, Youngdo Kim, Jaeseok Son, Charles H. Ahn, Frederick J. Walker, Ara Go, Miyoung Kim, Choong H. Kim, Changyoung Kim, Tae Won Noh

Adv. Mater. 2023, 2208833



Interfaces between dissimilar correlated oxides can offer devices with versatile functionalities, and great efforts have been made to manipulate interfacial electronic phases. However, realizing such phases is often hampered by the inability to directly access the electronic structure information; most correlated interfacial phenomena appear within a few atomic layers from the interface. In this paper, atomic-scale epitaxy and photoemission spectroscopy are utilized to realize the interface control of correlated electronic phases in atomic-scale ruthenate–titanate heterostructures. While bulk SrRuO3 is a ferromagnetic metal, the heterointerfaces exclusively generate three distinct correlated phases in the single-atomic-layer limit. The theoretical analysis reveals that atomic-scale structural proximity effects yield Fermi liquid, Hund metal, and Mott insulator phases in the quantum-confined SrRuO3. These results highlight the extensive interfacial tunability of electronic phases hidden in the atomically thin correlated heterostructure suggesting a way to control interfacial electronic phases of various correlated materials.



Distributions of the Wigner reaction matrix for microwave networks with symplectic symmetry in the presence of absorption

Michał Ławniczak, Afshin Akhshani, Omer Farooq, Małgorzata Białous, Szymon Bauch, Barbara Dietz, and Leszek Sirko

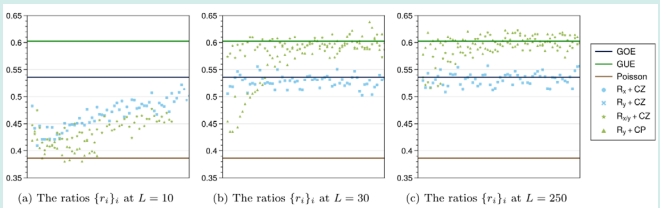
Phys. Rev. E 107, 024203

The authors report on experimental and numerical studies of the distribution of the reflection coefficients, and the imaginary and real parts of Wigner's reaction (K) matrix employing open microwave networks and corresponding quantum graphs, respectively, with symplectic symmetry and varying size of absorption. The results are employed to verify analytical predictions derived for the single-channel scattering case within the framework of random matrix theory (RMT). Furthermore, the authors performed Monte Carlo simulations based on the Heidelberg approach for the scattering (S) and K matrix of open quantum-chaotic systems and the two-point correlation function of the S-matrix elements. The analytical results and the Monte Carlo simulations depend on the size of absorption. Deviations from RMT predictions are attributed to non-universal periodic orbits that are confined to a fraction of the quantum graph.

Quantum chaos and circuit parameter optimization

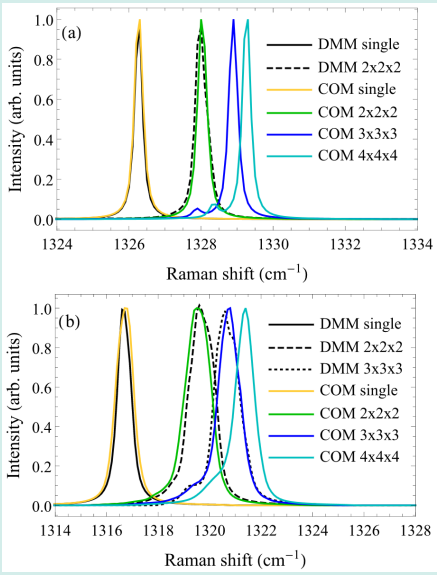
Joonho Kim, Yaron Oz and Dario Rosa

J. Stat. Mech. 023104 (arXiv:2201.01452)



In modern quantum variational algorithms, the tension between the expressibility and the trainability of a given quantum circuit --- often dubbed as barren plateau phenomenon --- is a well-known obstacle preventing algorithms from successfully finding the target ground state. In light of this problem, it is of crucial importance to find diagnostics allowing to identify the optimal depth of the quantum circuit, which optimizes the trade-off between expressibility and trainability. In this paper we show that quantum chaos diagnostics can be used for such a task. They identify the best possible circuit depth in terms of a Poisson/RMT transition of the spectral correlations among eigenvalues of the reduced density matrix obtained from a randomly prepared quantum state.

New research results



Coupled-oscillator model for hybridized optical phonon modes in contacting nanosize particles and quantum dot molecules

S. V. Koniakhin, O. I. Utesov, and A. G. Yashenkin

Phys. Rev. Research 5, 013153

In this study, the authors focus on modification of optical phonon spectra in contacting nanoparticles as compared to the single ones. It is proposed to solve this problem with the simple coupled oscillators model (COM), where an harmonic oscillator is attributed to each phonon mode of a particle and the overlap of the particles leads to appearance of additional couplings for these oscillators with the magnitude proportional to the overlapped volume. For not-too-big overlaps this model describes solutions of the original dynamical matrix eigenvalue problem with outstanding level of accuracy. For the special case of the van der Waals contacts between faceted particles, the modifications of Raman spectra are much below the current accuracy of measurements.

Puzzle of the month

February puzzle answer:

We did not get any solutions. So we are not going to unfold the answer. Let's hope that all readers finished their new year celebrations, skiing holidays, and are back for some brain work. Which is to solve the previous month puzzle.

Puzzle of the month:

100 boxes numbered from 1 to 100. We fill one box with one orange, another with two, another with three, and so on until the last one gets exactly 100 oranges. But in a random way, so there is no correlation between the box number and the orange number. Your task is to find the box with 38 oranges. You have to open a box, check the number of oranges, and if it is not 38, close the box, and open another one. What is the best strategy to find the box with 38 oranges with the smallest number of box openings?

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