PCS NEWSLETTER

May 2024

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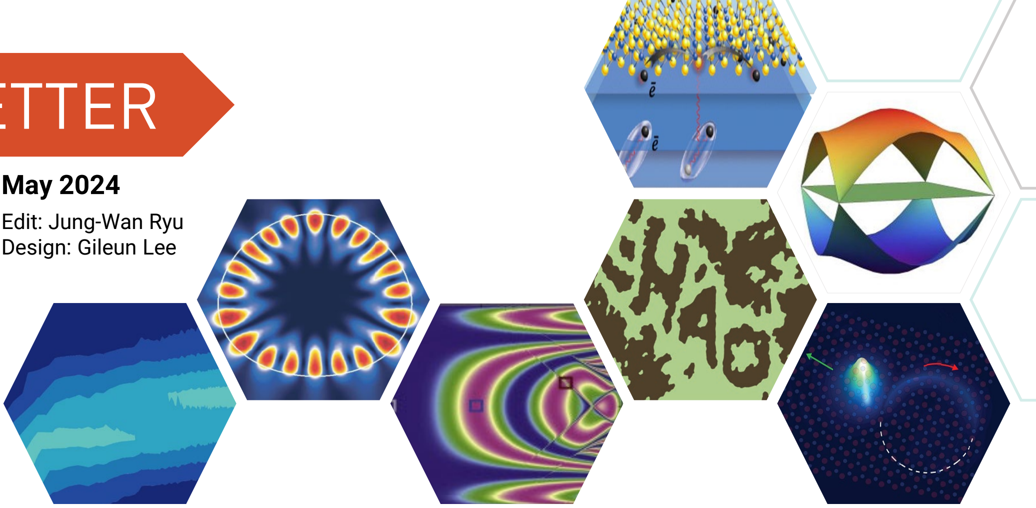


PCS IBS Seminars

"Absence of breakdown of ferrodark solitons exhibiting snake instability"
by Xiaoquan Yu, Graduate School of China Academy of Engineering Physics, China (April 4)

"Effects of electron wave function in optoelectronics and transport"
by Eddwi Hesky Hasdeo, University of Luxembourg, Luxembourg (April 11)

"Thermoelectric transport driven by Spin-orbit coupling"
by Debashree Chowdhury, Centre for Nanotechnology, India (April 16)

"Unraveling Opinion Dynamics: Insights from Network Science and the Ising Model"
by Zulkaida Akbar, National Research and Innovation Agency, Indonesia (April 18)

"Nonlinear Energy and Charge Transport in Silicates. Experiments and semiclassical models"
by Juan Francisco Rodriguez Archilla, University of Sevilla, Spain (April 23)

"Phenomenology of Unexpected Thermal (Hall) Transports"
by Jing-Yuan Chen, Tsinghua University, China (April 30)

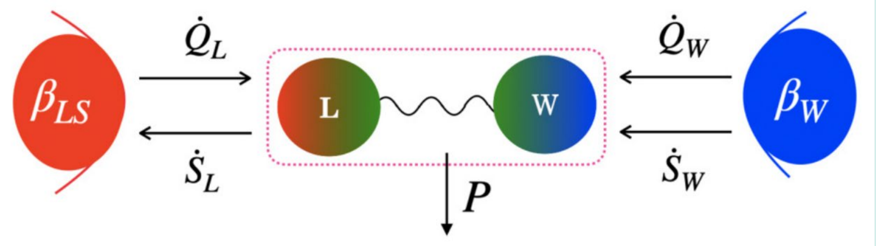
You can find more seminars on ***this page***.

New Research Results

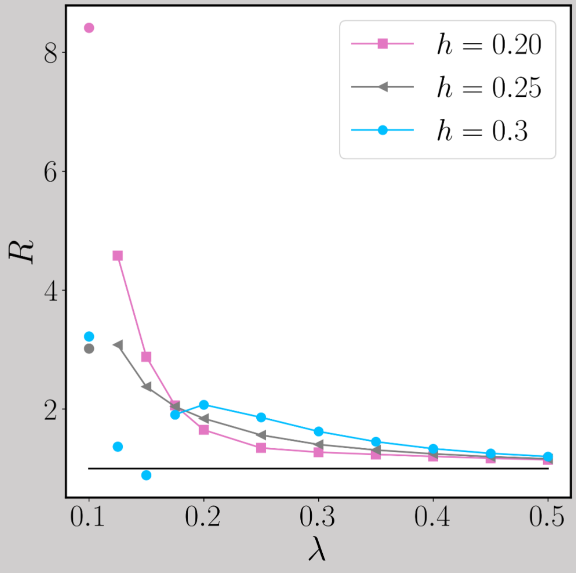
Steady-state quantum thermodynamics with synthetic negative temperatures

Mohit Lal Bera, Tanmoy Pandit, Kaustav Chatterjee, Varinder Singh, Maciej Lewenstein, Utso Bhattacharya, and Manabendra Nath Bera

Phys. Rev. Research 6, 013318 (2024)



The authors study steady-state quantum thermodynamics involving baths with negative temperatures. A bath with a negative temperature is created synthetically using two baths of positive temperatures and weakly coupling these with a qutrit system. These baths are then coupled to each other via a working system. At steady state, the laws of thermodynamics are analyzed. The authors find that whenever the temperatures of these synthetic baths are identical, there is no heat flow, which reaffirms the zeroth law. There is always a spontaneous heat flow for different temperatures. In particular, heat flows from a bath with a negative temperature to a bath with a positive temperature which, in turn, implies that a bath with a negative temperature is "hotter" than a bath with a positive temperature.



Enhancement of superconductivity in the Fibonacci chain

Meng Sun, Tilen Čadež, Igor Yurkevich, and Alexei Andreanov

Phys. Rev. B 109, 134504 (2024)

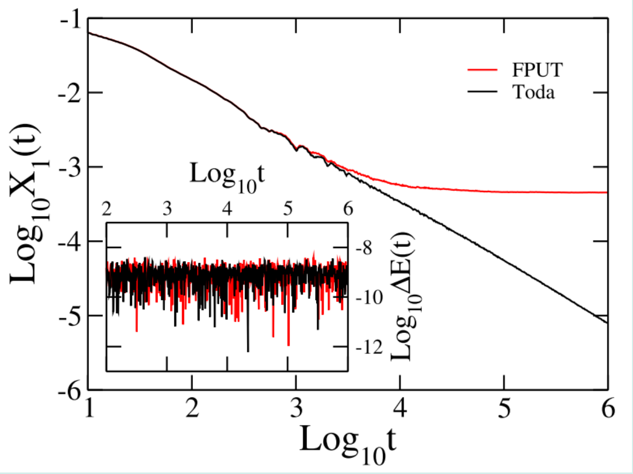
The authors study the interplay between quasi-periodic disorder and superconductivity in a 1D tight-binding model with the quasi-periodic modulation of on-site energies that follow the Fibonacci rule and all the eigenstates are multifractal. They find an enhancement of the critical temperature as compared to the analytical results that are based on strong assumptions of absence of correlations and self-averaging of multiple characteristics of the system, which are not justified for the Fibonacci chain. For the very weak coupling regime, the authors observe a crossover where the self-averaging of the critical temperature breaks down completely and a strong sample-to-sample fluctuations emerge.

Dynamical chaos in the integrable Toda chain induced by time discretization

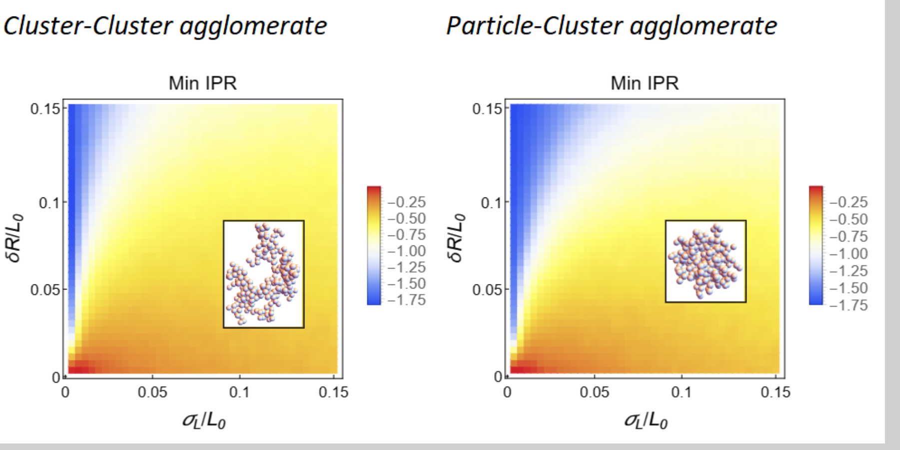
Carlo Danieli, Emil A. Yuzbashyan, Boris L. Altshuler, Aniket Patra, Sergej Flach

Chaos 34, 033107 (2024)

The authors use the Toda chain model to demonstrate that numerical simulation of integrable Hamiltonian dynamics using time discretization destroys integrability and induces dynamical chaos. Specifically, they integrate this model with various symplectic integrators parametrized by the time step τ and measure the Lyapunov time T_Λ (inverse of the largest Lyapunov exponent Λ). A key observation is that T_Λ is finite whenever τ is finite but diverges when $\tau \to 0$. The authors compare the Toda chain results with the nonintegrable Fermi–Pasta–Ulam–Tsingou chain dynamics. In addition, we observe a breakdown of the simulations at times $T_B \gg T_\Lambda$ due to certain positions and momenta becoming extremely large ("Not a Number"). This phenomenon originates from the periodic driving introduced by symplectic integrators and the authors also identify the concrete mechanism of the breakdown in the case of the Toda chain.



New Research Results



Localized and extended collective optical phonon modes in regular and random arrays of contacting nanoparticles: Escape from phonon confinement

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

Phys. Rev. B 109, 155435 (2024)

In recently published paper (Phys. Rev. B 109, 155435), the authors employ the coupled-oscillator model describing the hybridization of optical phonons in touching and/or overlapping particles in order to study the Raman spectra of nanoparticles organized into various types of regular and random arrays including nanosolids, porous media, and agglomerates with tightly bonded particles. For the nanocrystal solids, authors demonstrate that the ratio of the size variance to the coupling strength allows to judge the character (localized or propagating) of the optical phonon modes which left the particles of their origin and spread throughout an array. The relation between the shift and the broadening of the Raman peak and the coupling strength and the disorder is established for nanocrystal solids, agglomerates, and porous media providing us with information about the array structure, the structure of its constituents, and the properties of optical phonons.

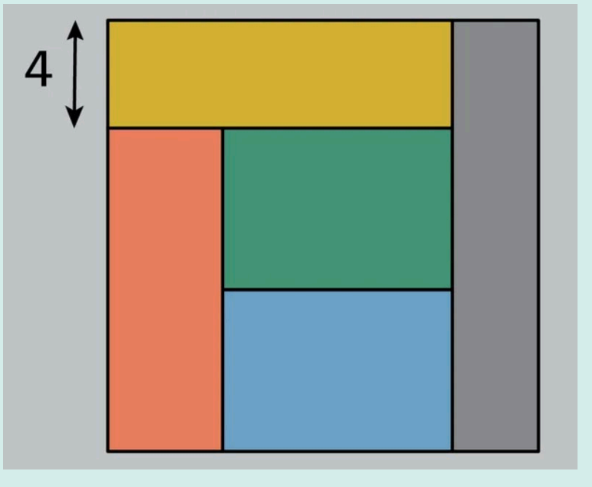
Puzzle of the Month

April puzzle solution: 2*2*(3^32)=7412080755407364

This time we received correct answers from Victor Kagalovsky, Ihor Vakulchyk, Oleg Utesov, and Tomasz Bednarek. Congratulations!

Puzzle of the month:

The square is divided into five rectangles of equal area. We know only the width of one of them. What is the area of the square?



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