PCS NEWSLETTER

September 2021

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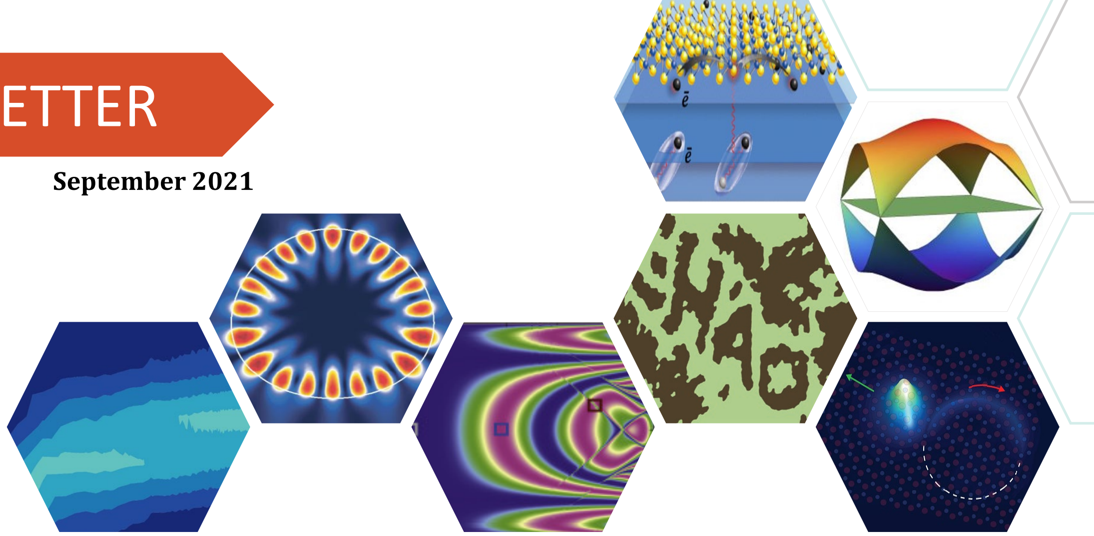
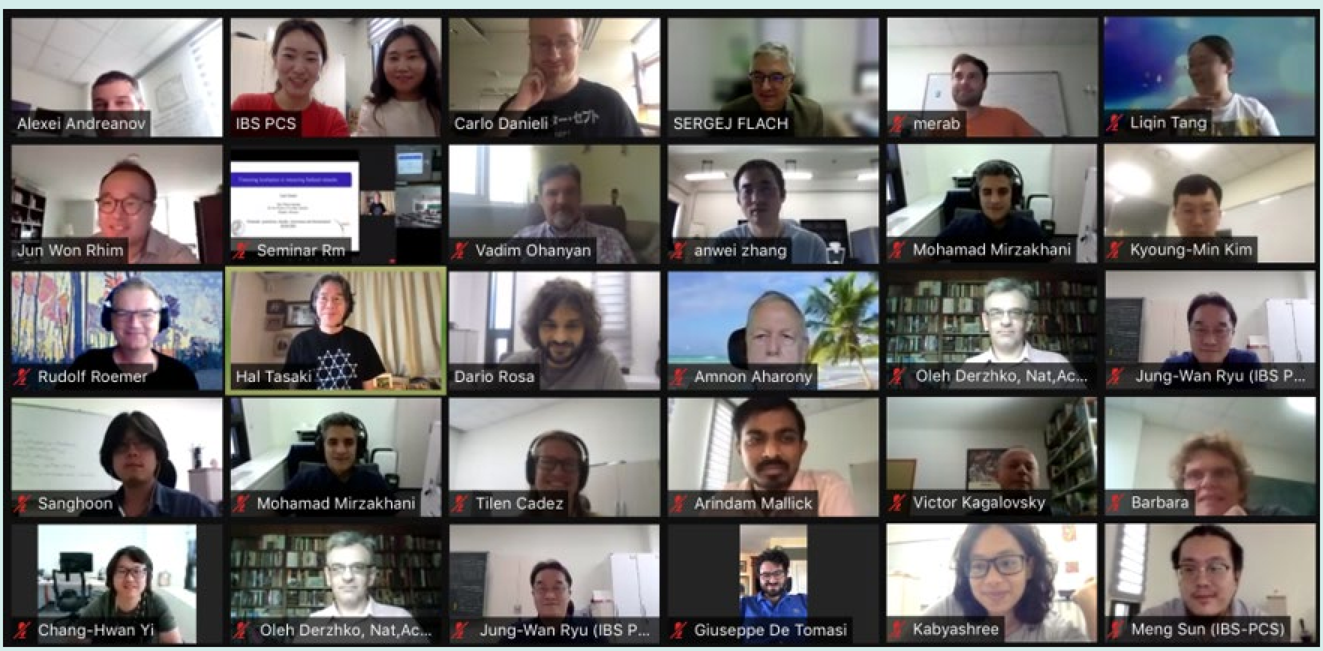


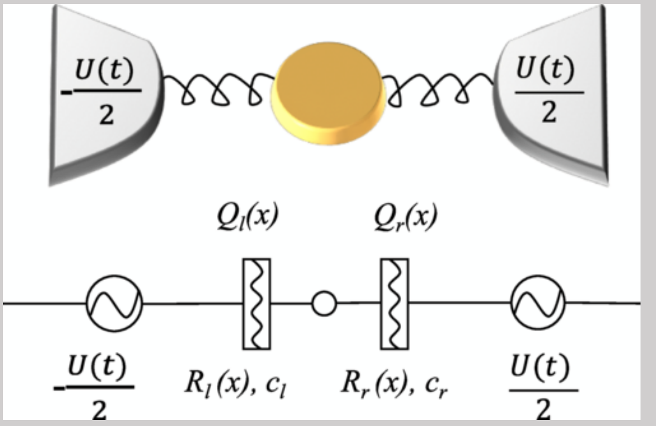
PCS Workshops and Meetings

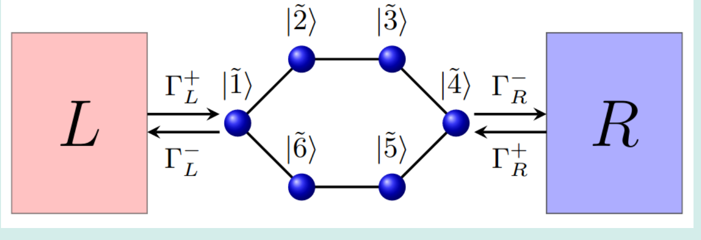
PCS successfully hosted the **IBS Conference on “Flatbands: symmetries, disorder, interactions and thermalization”** Aug. 16 - 20, 2021. We enjoyed seventeen invited talks including the IBS Physics Colloquium held by Dr. Daniel Leykam (National University of Singapore) with 116 participants.



New research results

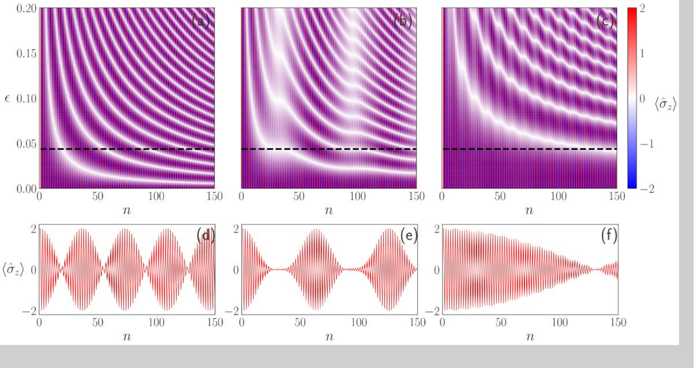
Kick-induced rectified current in a symmetric nanoelectromechanical shuttle
Pinquan Qin and Hee Chul Park
Phys. Rev. B **104**, 064303 (arXiv:2007.08395)
The authors have found the criterion for the chaotic behavior of kicked nano-electromechanical shuttle. The regular impacts assist the interplay between the nano-mechanical dynamics and electron tunneling and cause the phase transition from regular oscillation to chaos. They also point out that the time-translational symmetry breaking of the instantaneous current has an essential role in manipulating the rectified current.

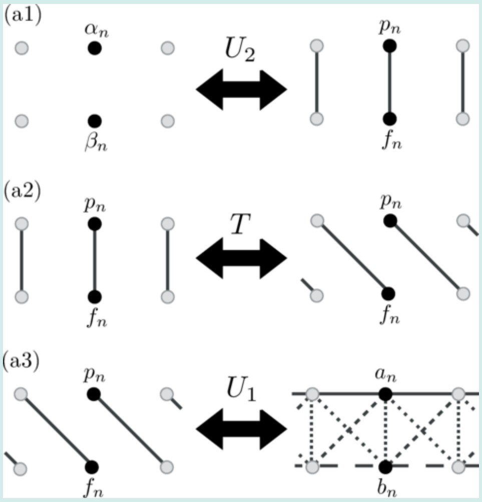


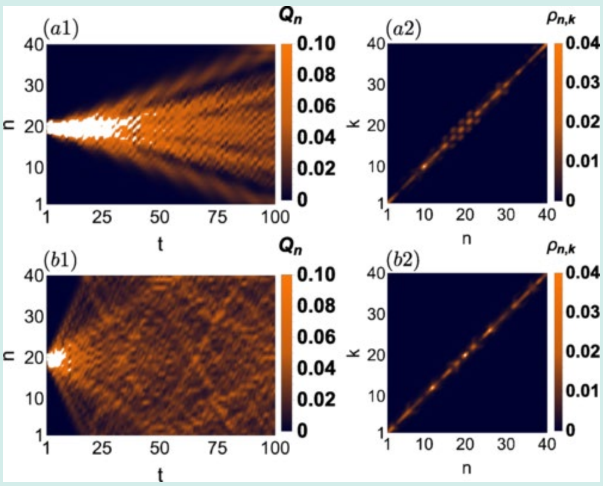


Degenerated Liouvillians and steady-state reduced density matrices
Juzar Thingna and Daniel Manzano
chaos **31**, 073114 (arXiv:2101.10236)
The authors have studied open quantum systems with degenerated Liouvillians that permit multiple steady states. In general, not all steady states are physical if the quantum system is open. In this work, they sort out physical steady-states for complex quantum open systems. The paper describes three approaches that can be used in a wide range of scenarios. The first approach, a symmetry-based decomposition, that can obtain all the physical steady-states, requires a priori knowledge of all the possible open system symmetries. The second one, a numerical approach based on Gram-Schmidt orthogonalization, that requires no symmetry information, is numerically rather cumbersome. The last approach, based on the Large-deviation function, allows one to obtain only the physical steady-states that maximize or minimize currents.

Time molecules with periodically driven interacting qubits
K V Shulga, I Vakulchyk, Y Nakamura, S Flach and M V Fistul
Quantum Sci. Technol. **6**, 035012 (arXiv:2009.02722)
Numerical evidence for a temporal quantum-mechanical interference phenomenon -- time molecules -- is demonstrated. A variety of such stroboscopic states are observed in the dynamics of two interacting qubits subject to a periodic sequence of pulses. The time molecules appear periodically in time and have a large duration. All the time molecules are characterized by almost zero value of the total polarization and a strong enhancement of the entanglement entropy up to the maximum value of indicating the presence of corresponding Bell state.





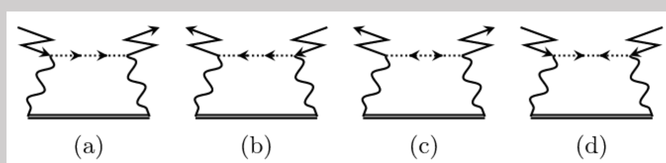


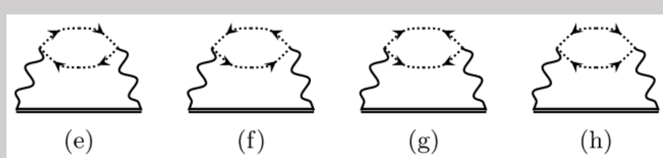
Nonlinear caging in all-bands-flat lattices
Carlo Danieli, Alexei Andreanov, Thudiyangal Mithun, Sergej Flach
Phys. Rev. B **104**, 085131 (arXiv:2004.11871)

Quantum caging in interacting many-body all-bands-flat lattices
Carlo Danieli, Alexei Andreanov, Thudiyangal Mithun, Sergej Flach
Phys. Rev. B **104**, 085132 (arXiv:2004.11880)

In these two works, the authors consider tight-binding lattices with no dispersion -- all the bands are flat -- and short-range hopping. Such lattices can be constructed by applying a sequence of noncommuting local unitary transformations to decoupled sites. As they show, such construction is exhaustive in 1D, while in higher dimensions it remains a conjecture. By construction particles are localized in such systems with no transport. What is the effect of interactions, both nonlinear and quantum, on such systems? In general, interactions break the single-particle localization, inducing transport. However further fine-tuning of the lattice profile and interaction is possible. In the classical case of nonlinear interaction, this leads to caging of any compact initial excitation, while in the quantum case, this implies that transport can only happen by moving pairs of particles. The latter leads to the emergence of an extensive set of conserved quantities and quantum scars in the many-body spectrum.

Strong-coupling theory of condensate-mediated superconductivity in two-dimensional materials
Meng Sun, A. V. Parafilo, V. M. Kovalev, and I. G. Savenko
Phys. Rev. Research **3**, 03166 (arXiv:2106.07821)
The authors develop a strong-coupling theory of Bose-Einstein condensate-mediatedsuperconductivity in a hybrid system, which consists of a layer of two-dimensional electron gas and a layer of indirect exciton in the condensate. Using the Eliashberg theory, they find the superconducting order parameter and estimate the critical temperature of the superconducting transition. The critical temperature reveals its linear dependence on the dimensionless coupling constant. They also calculate the effective bogolon-electron interaction constant for both parabolic and linear electron dispersions and examine the dependence of the critical temperature of the superconducting transition on exciton condensate density.





Puzzle of the month

August puzzle answer:

One drawing is enough. Take one marble from the BW marked box, and you will know what it is - if you find a white marble, it is the WW box, and if you find a black marble - it is the BB box.
Since ALL labels are wrong, the rest is trivial. Say you found a white marble so the box you opened is the WW box. The box labeled with BB can be in truth either WW or BW. But WW is already taken, so the BB labeled box is actually the BW one. And the WW labeled box is therefore the BB one.

The first correct answer came from Barbara Dietz (PCS) - but not through the requested official channel! Dario Rosa (PCS) was the first to use the proper channel. And the first correct answer from abroad (!!!) was sent in by Sarang Gosavi (India). Congratulations to all!

Puzzle of the month:

A wheel rolls without friction on a horizontal surface on Earth. The wheel is a massless frame of radius R, with a point mass M attached to its outer boundary. The axis of the wheel is moving with constant velocity V. What is the critical velocity V at which the wheel will jump up for the first time? What is the location of the mass M at the moment of the first jump occurrence?

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