

## New members



**Dr. Dario Rosa** has joined PCS as a Junior Research Team Leader. His research activity is mostly devoted to understand how quantum chaos (or its absence) affects the physics of quantum manybody systems. This long-term goal has to be attacked from several viewpoints: on one hand, a more precise definition of what we mean by quantum chaos is mandatory; on the other hand it is important to understand what are the universal dynamics induced by quantum chaos. Of particular relevance are also the ways that a quantum many-body system has to escape from quantum chaos and thermalization, the main examples being many-body localization and quantum scarred systems

He is currently inviting new team members. For those who would like to join his team, please contact <u>dario.rosa85@gmail.com</u>.

## Awards



Congratulations! Dr. Ivan Savenko - a Junior Research Team Leader of PCS - won the 2020 IBS Researcher of the year award for his outstanding research performance.



Congratulations! Mr. Ma-Young Kim – a PCS staff alumni - won the 2020 IBS excellent staff of the year award for his dedicated contributions.



## New research results

#### Topological delocalization in the completely disordered two-dimensional quantum walk

## Phys. Rev. B 102, 224202 (https://arxiv.org/abs/2005.00203)

Janos K. Asboth, Arindam Mallick This theoretical work investigates the effect of spatial disorder on two-dimensional split-step discrete-time quantum walks with two internal coin states, where the positiondependent coin parameters are generated from a Haar random distribution. In contrast to the usual Anderson localization, the authors have observed diffusive spreading. Using scattering theory and critical scaling analysis they have revealed the reason: The Haar random disorder places the quantum walk to a critical points between different anomalous Floquet-Anderson insulating topological phases. It is reminiscent of the integer quantum Hall effect in solid state physics.



## Right lead Left lead Reflected part IJ = 6Transmitted part Input part IJ $\mathbf{2}$

Ouantum walk (scattering) region

#### Giant persistent photoconductivity in monolayer MoS<sub>2</sub> fieldeffect transistors

#### npj 2D Materials and Applications 5, 15 (https://arxiv.org/abs/2012.04044)

A. George, M. V. Fistul, M. Gruenewald, D. Kaiser, T. Lehnert, R. Mupparapu, C. Neumann, U. Hübner, M. Schaal, N. Masurkar, L. M. R. Arava, I. Staude, U. Kaiser, T. Fritz and A. Turchanin

The authors reports the observation of extremely long-living giant persistent photoconductivity (GPPS) in monolaver molybdenum disulfide (MoS<sub>2</sub>) field-effect transistors exposed to ultraviolet light. They demonstrate a large conductivity enhancement up to a factor of  $10^7$ , and the photoconductivity persists after removal of the irradiation up to 30 days. The work shows that the GPPC arises from the intrinsic properties of MoS<sub>2</sub> monolayer such as lattice defects that induce a large number of localized states. It provides a basis for the defectbased engineering of monolayer transition metal dichalcogenides for device applications.

## Analysis of human mitochondrial genome co-occurrence networks of Asian population at varying altitudes

#### Scientific Reports 11,133

(https://www.biorxiv.org/content/10.1101/2019.12.21.885905v3) Rahul K. Verma, Alena Kalyakulina, Cristina Giuliani,

Pramod Shinde, Ajay Deep Kachhvah, Mikhail Ivanchenko, Sarika Jalan

The Tibetan plateau, known to be the highest altitude region ever inhabited by humans since the last Largest Glacial Maxima, has attracted evolutionary scientists enormously due to its distinctive environment and migratory profile.

Furthermore, Mitochondrial DNA (mtDNA) variations have been acclaimed as one of the key players in understanding the biological mechanisms behind adaptation to extreme conditions. By analyzing underlying co-occurrence mtDNA genomic networks of Asian population at varying altitudes, this study reveals the presence of interactions specific to high altitude.





## New research results



# Coherent photogalvanic effect in fluctuating superconductors

### Phys. Rev. B 103, 024513 (https://arxiv.org/abs/2007.04566)

V.M. Kovalev, K. Sonowal, I. G. Savenko This work proposes a new effect, using the properties of superconducting fluctuations. The effect reveals itself near the critical temperature of superconducting transition and can influence the conductivity of the sample. In particular, the coherent photogalvanic effect shows the interplay of two light fields with single and double frequencies while alteration of the effect can occur in the presence of superconducting fluctuations.

## Nonequilibrium theory of the photoinduced valley Hall effect *Phys. Rev. B* **103**, 035434 (https://arxiv.org/abs/2008.13186)

I. Vakulchyk, V. M. Kovalev, and I. G. Savenko The authors have developed the first theory of the nonequilibrium valley Hall effect (VHE). Usually, to observe the VHE, symmetry breaking is required. It is done by exposing two-dimensional Dirac materials to external polarized light. The system immediately becomes nonequilibrium, and the so-far existing theories are not applicable. Also, we have explained the operation of the optical transistor based on the VHE.





#### Bethe strings in the spin dynamical structure factor of the Mott-Hubbard phase in the one-dimensional fermionic Hubbard model

#### *Phys. Rev. B* 103, 045118 (https://arxiv.org/abs/2101.06198) Jose M. P. Carmelo and T. Cadez

The spectra and role in the spin dynamical properties of bound states of elementary magnetic excitations named Bethe strings that occur in some integrable spin and electronic onedimensional (1D) models have recently been identified and realized in several materials by experiments. In this work the authors study Bethe strings and their effects on the spin dynamical structure factor in a paradigmatic strongly correlated system, the 1D Hubbard model at half filling. They find that the most significant spectral weight contribution from Bethe strings leads to a gapped continuum in the spectrum of the spin dynamical structure factor, which is very weakly dependent on the Coulomb repulsion strength U.



## Puzzle of the month

- 1. Clara has two kids and one of them is a boy. What is the probability that the second child is a boy as well?
- 2. Clara has two kids and one of them is a boy. But now we also learn, that that boy was born on a Tuesday. What is then the probability that Clara has two boys?

#### Send your solution to **eun@ibs.re.kr**.

The first correct solution comes with a prize, and the winner will be announced in the next issue.

#### January puzzle answer: Happy New Year !!!

$$\begin{split} \left[ \sqrt{2021 + 4\sqrt{2021 + 4\sqrt{2021 + 4\sqrt{\dots}}}} \right] \times \left[ \sqrt{2021 - 4\sqrt{2021 - 4\sqrt{2021 - 4\sqrt{\dots}}}} \right] =??? \\ y(x) &= \sqrt{2021 - x\sqrt{2021 - x\sqrt{2021 - \dots}}} > 0 \ , \ y(4) \cdot y(-4) =? \\ y^2 + xy - 2021 = 0 \ , \ y(4) = 43 \ , \ y(-4) = 47 \ \longrightarrow \ y(4) \cdot y(-4) = 2021!!! \end{split}$$

