PCS NEWSLETTER

QR to PCS Webpage

April 2023

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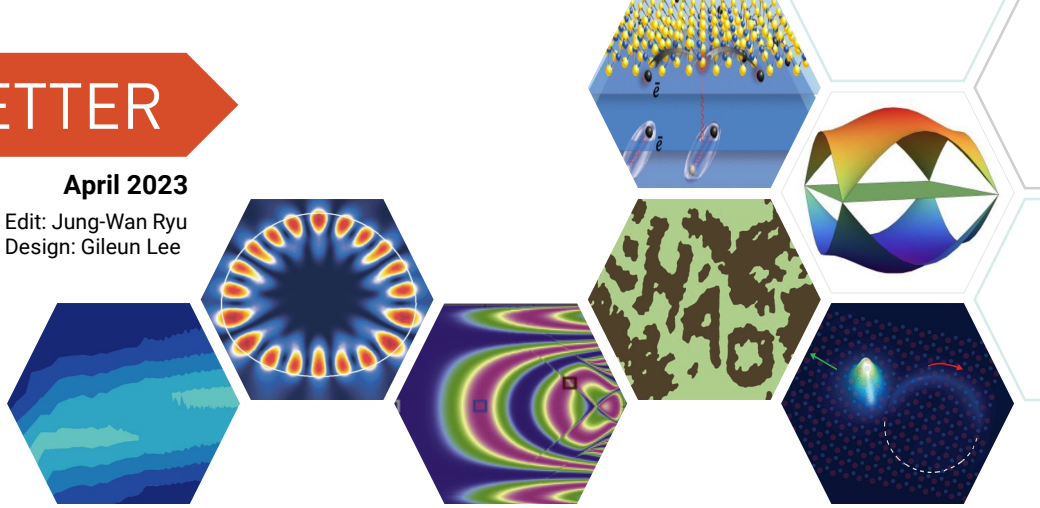
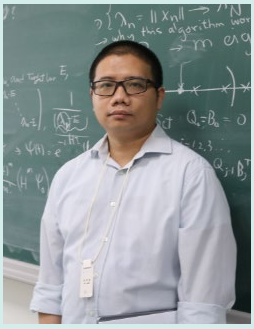


New Members

Dr. **Aniket Patra** has joined PCS as a research fellow. He received his PhD degree from Rutgers University in USA. He has worked as a guest scientist and a postdoctoral researcher at Max-Planck-Institut für Physik komplexer Systeme in Germany and Aarhus University in Denmark. His research interest falls under the following two main rubrics – (1) far-from-equilibrium systems and (2) intrinsic topological order in strongly interacting systems. His goal is to develop unconventional theoretical frameworks that are applicable to broad classes of such experimentally relevant and fundamentally important phenomena, which are realized in different solid state, cold atom, chemical, and biological systems. Thus far, he has explored the following topics: fractional quantum Hall physics in lattice systems; quantum coherent dynamics governed by strong time-dependent fields, and their connection to quantum integrability; interplay of nonlinear phenomena and driven-dissipative dynamics – e.g., dissipative quantum chaos; and optically controlled electron-transfer reaction, and nonequilibrium solvation dynamics.

Si Min Chan has joined PCS as a student researcher for three months in the team of Complex Condensed Matter Systems. She is currently a PhD student at the National University of Singapore. Her research topic will focus on strong correlations and superconductivity on flat band systems.

New Junior Research Team



Dr. **Dung Xuan Nguyen** has launched a new junior research team "Topological Quantum Matter." The team research focuses on strongly correlated electron systems, lattice gauge models, topological phase transitions, fractonic systems, topological properties of Hermitian and non-Hermitian photonic systems, and quantum transport and optical response in (multilayer) low dimensional systems.

PCS IBS Seminars

"The quantum carpets in a leaky-box: Poincare's recurrences in the continuous spectrum"
by Marko Ćosić, Vinča Institute of Nuclear Sciences, Serbia (March 7)

"The complexity of Bohmian positron dynamics inside a chiral carbon nanotube"
by Marko Ćosić, Vinča Institute of Nuclear Sciences, Serbia (March 14)

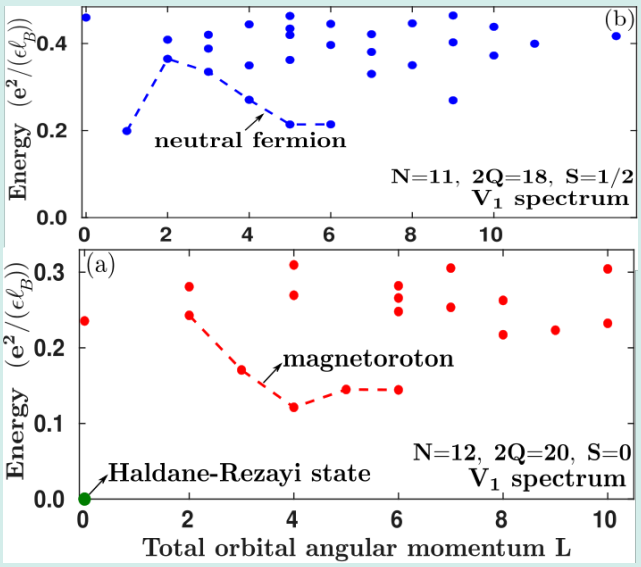
"The morphological analysis of the collagen straightness in the colon mucosa away from the cancer"
by Marko Ćosić, Vinča Institute of Nuclear Sciences, Serbia (March 21)

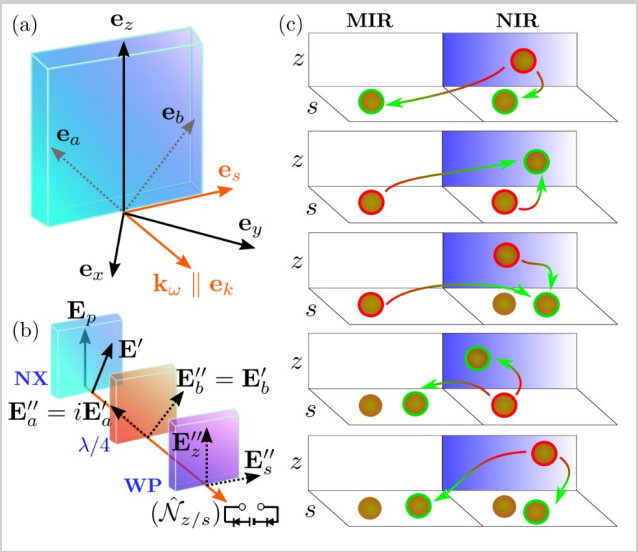
"Adiabatic eigenstate deformations and weak integrability breaking of Heisenberg chain"
by Denis Kurlov, University of Basel, Switzerland (March 23)

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

New Research Results

Supergravity model of the Haldane-Rezayi fractional quantum Hall state
Dung Xuan Nguyen, Kartik Prabhu, Ajit C. Balram, and Andrey Gromov
Phys. Rev. B 107, 125119 (2023)
A connection between the neutral fermion mode in even-denominator fractional quantum Hall states and the gravitino of supergravity has been speculated before. However, this is the first study that establishes a concrete connection between the two for the Haldane Rezayi state, particularly via the derivation of the expected boundary theory of the FQH state from a SUGRA bulk theory. In addition to the FQH spin-2 graviton mode (the magnetoroton excitation), it has a neutral fermion mode with spin J=3/2 which the authors identify as the gravitino in their model. The authors substantiate their theoretical findings with numerical exact diagonalization calculations that support the appearance of the emergent graviton and gravitino excitations.





Back action in quantum electro-optic sampling of electromagnetic vacuum fluctuations
T. L. M. Guedes, I. Vakulchyk, D. V. Seletskiy, A. Leitenstorfer, A. S. Moskalenko, and Guido Burkard
Phys. Rev. Research 5, 013151 (2023)
The influence of measurement back action on electro-optic sampling of electromagnetic quantum fluctuations is investigated. Based on a cascaded treatment of the nonlinear interaction between a near-infrared coherent probe and the mid-infrared vacuum, the authors account for the generated electric-field contributions that lead to detectable back action. Specifically, the authors theoretically address two realistic setups, exploiting one or two probe beams for the nonlinear interaction with the quantum vacuum, respectively. The setup parameters at which back action starts to considerably contaminate the measured noise profiles are determined. Due to the vacuum fluctuations entering at the beam splitter, the shot noise of two incoming probe pulses in different channels is uncorrelated.

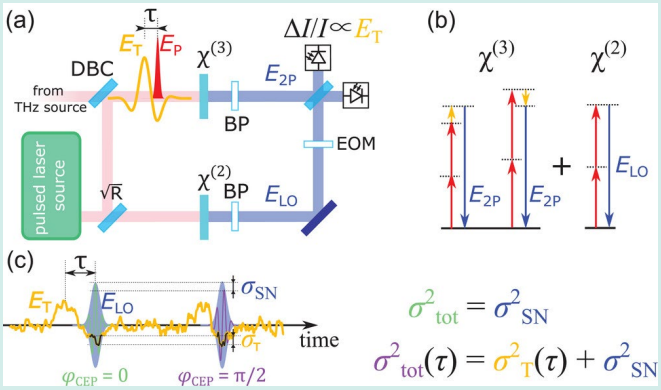
New Research Results

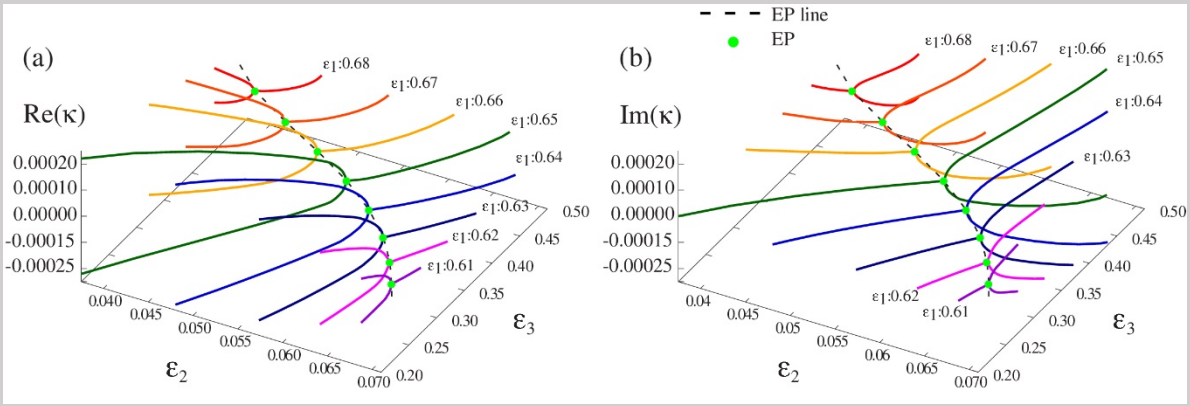
Self-Referenced Subcycle Metrology of Quantum Fields

Sinan Gündoğdu, Stéphane Virally, Marco Scaglia, Denis V. Seletskiy, Andrey S. Moskalenko

Laser & Photonics Reviews (2023)

A new time-domain method for subcycle metrology of quantum electric fields using a combination of a third order nonlinear optical process and homodyne detection with a local oscillator field is proposed and analyzed. The new method enables isolation of intrinsically weak quantum noise contribution by subtraction of the shot noise of the local oscillator on a pulse-by-pulse basis. Together with the centro-symmetric character of the nonlinearity, this method unlocks novel opportunities toward terahertz and mid-infrared quantum field metrologies.





Maximization of a frequency splitting on continuous exceptional points in asymmetric optical microdisks

Hyundong Kim, Sunjae Gwak, Hyeon-Hye Yu, Jinhyeok Ryu, Chil-Min Kim, and Chang-Hwan Yi

Optics Express 31, 12634-12644 (2023)

In this work, the authors investigate the formation of exceptional points (EPs) in an optical microdisk and explore the parametric generation of chiral EP modes. The study identifies that the frequency splitting around EPs depends on the fundamental strength of EPs and the extra responding strength of added perturbations. It is highlighted that examining the continuous formation of EPs is crucial to achieving a maximal sensitivity of EP-based sensors.

Puzzle of the Month

March puzzle answer:

go to box 38, count the oranges, say this number is n(38). Go to box n(38), count the oranges, go to box n(n(38)). And so on. You will finally run into a box with 38 oranges. Which is the last box on the loop you discovered if you were to continue the protocol. In short, any random distribution of the oranges corresponds to a certain number of loops of different length. The longest loop is 100, and the shortest 100 loops have length 1. In general there is something in between. Interestingly there is a 30% probability that all loops are shorter than 50.

Congratulations to Dung Xuan Nguyen for the correct solution!

Puzzle of the month:

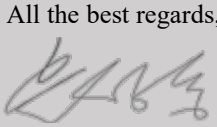
You have a set of weights - 1kg, 2kg, 3kg, …, 40kg.
What is the minimum number (which ones?) you have to choose from them, in order to be able to weigh any integer weight between 1kg and 40kg on a classical scale?

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

Farewell

It has already been two years since PCS began to distribute its Newsletter and I have served as the first editor. It feels like yesterday that I and other PCS staffs gathered together on a round table to come up with ideas of how to design and what to put onto the new born Newsletter. Every end of each month, I collected the intros of PCS publications from PCS authors and, together with the PCS members, I tried to make them 'easily readible' for broad physicists who are not in the specific research field. It has been a nice experience since I could learn what others were doing while editing each one's research from the intro level. It has been also a fun to meet a fresh science quiz every month provided by our director, professor Sergej Flach, which are original and frequently contrary to common sense. It is a 'who's gonna solve it first' contest and since I know the quiz - not the answer! - before the newsletter is distributed, I could not solve it myself. I, however, sometimes enjoyed sending in the answer myself if nobody got the right one within the time. I now quit working on the editor since I leave the Center. Last five years as a researcher and last two years as the editor of the Newsletter, I enjoyed my research and life at PCS. I sincerely thank everybody at PCS for giving me such a joy and wish each of you good luck in your future career. I will see you around. Bye bye!!

All the best regards,



Sungjong Woo