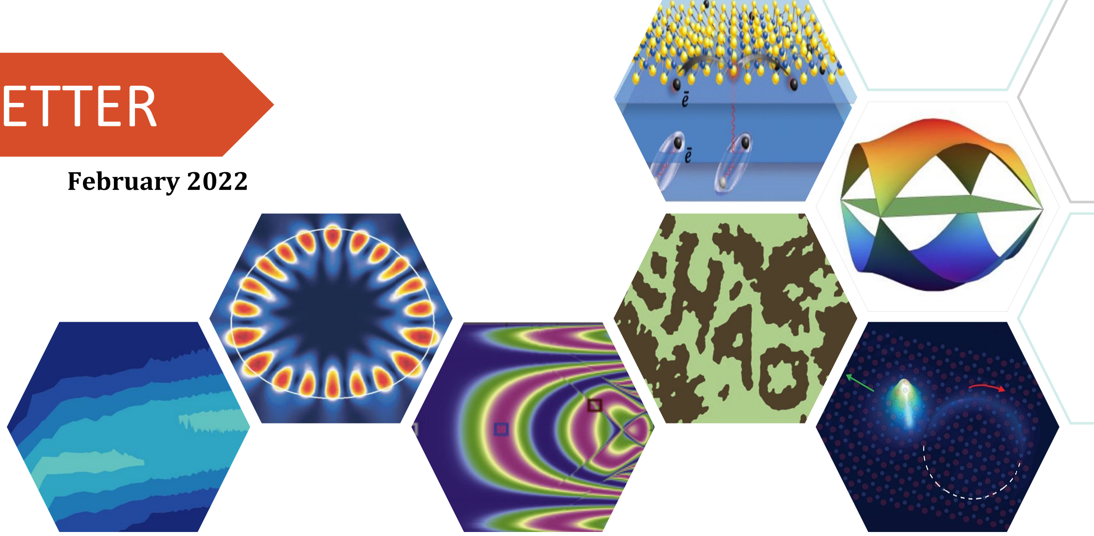
PCS NEWSLETTER

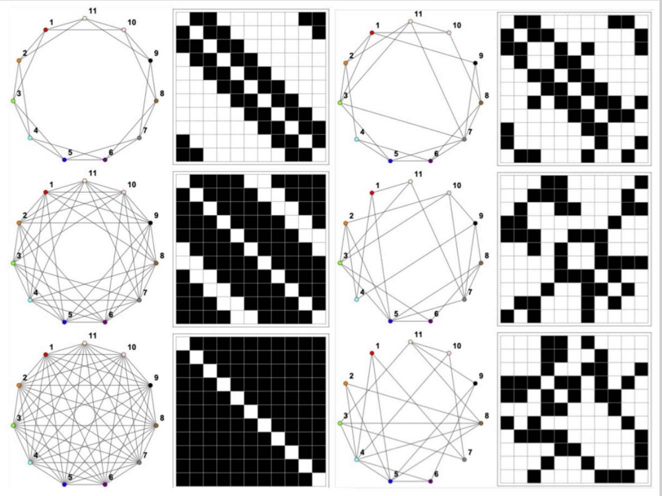
February 2022

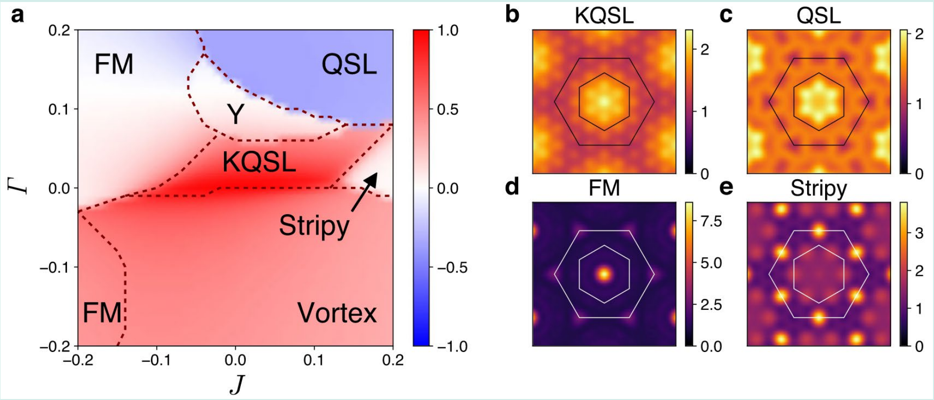
Edit: Sungjong Woo
Design: Gileun Lee



New research results

Operator delocalization in quantum networks
Joonho Kim, Jeff Murugan, Jan Olle, and Dario Rosa
Phys. Rev. A **105**, L010201 (arXiv:2109.05301)
The authors investigate the delocalization of operators in nonchaotic quantum systems, whose interactions are encoded in an underlying graph or network. In particular, they study how fast operators of different sizes delocalize as the network connectivity is varied. They argue that these delocalization properties are well captured by Krylov complexity and show, numerically, that efficient delocalization of large operators can only happen within sufficiently connected network topologies. Finally, they demonstrate how this can be used to furnish a deeper understanding of the quantum charging advantage of a class of Sachdev-Ye-Kitaev (SYK)-like quantum batteries.

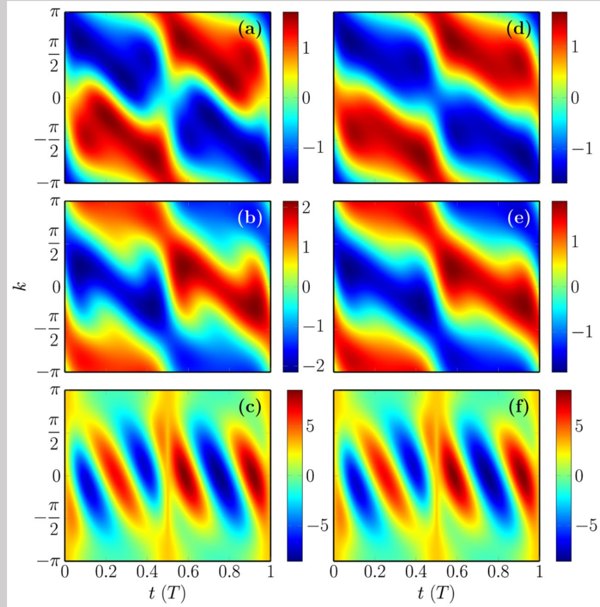


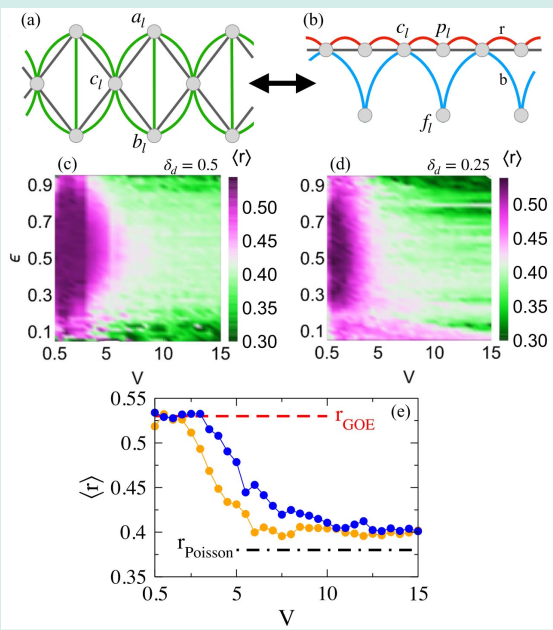


Identification of a Kitaev quantum spin liquid by magnetic field angle dependence
Kyusung Hwang, Ara Go, Ji Heon Seong, Takasada Shibauchi, Eun-Gook Moon
Nature Communications **13**, 323 (arXiv:2004.06119)
Quantum spin liquid realizes massive entanglement and fractional quasiparticles, proposing an avenue toward quantum technology. In particular, topological quantum computations are suggested in Kitaev quantum spin liquid with Majorana fermions. The authors propose a way to identify the non-abelian Kitaev quantum spin liquid by dependency on the magnetic field angles. Topologically protected critical lines exist on a plane of magnetic field angles, whose shape decides the microscopic spin interaction. This work shows that the chirality operator can be used to evaluate topological properties of the non-abelian Kitaev quantum spin liquid without Majorana fermion descriptions.

New research results

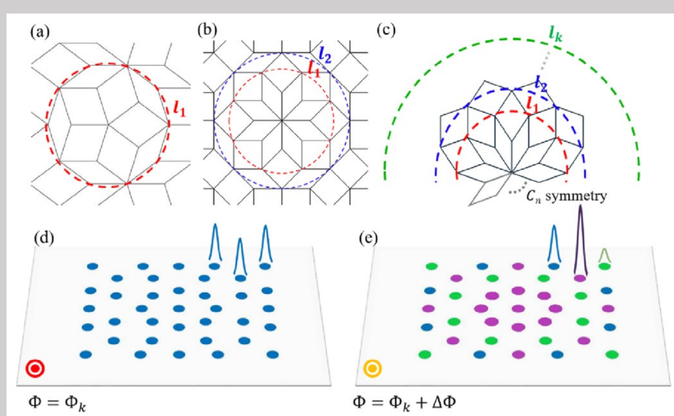
Floquet engineering of Lie algebraic quantum systems
Jayendra N. Bandyopadhyay and Juzar Thingna
Phys. Rev. B **105**, L020301 (arXiv:2103.15923)
Floquet engineering is the quantum-alchemy of designing desired exotic quantum Hamiltonians, in which the desired effective Hamiltonian is observed stroboscopically. Since such an inverse problem is not uniquely defined and is difficult to solve in general, in most cases, an additional high or low frequency driving is required to simplify the calculations. In this work, the authors eliminate the need for such additional driving constraints at the cost of exploiting the Lie algebraic structure of the simple static and stroboscopic exotic Hamiltonians. In the case of two-band systems that naturally follow *SU(2)* algebra, the authors are able to engineer a cross-stitched lattice that has one band flat and another dispersive from a simple on-site static Hamiltonian. The versatility of the theory is displayed in the wide range of applications ranging from simple few-band non-interacting systems to interacting superconductors.





Many-body localization transition from flat-band fine tuning
Carlo Danieli, Alexei Andreanov, and Sergej Flach
Phys. Rev. B **105**, L041113 (arXiv:2104.11055)
Translationally invariant flatband Hamiltonians with interactions lead to a many-body localization transition. The authors use single-particle lattices hosting a mix of flat and dispersive bands which are equipped with fine-tuned two-body interactions. Fine-tuning of the interaction results in an extensive set of local conserved charges and a fragmentation of the Hilbert space into irreducible sectors. The conserved charges in each sector originate from the flatband and act as an effective disorder, inducing a transition between ergodic and localized phases upon variation of the interaction strength. Such fine-tuning is possible in arbitrary lattice dimensions and for any many-body statistics. This work presents computational evidence for this transition with spinless fermions.

Length scale formation in the Landau levels of quasicrystals
Junmo Jeon, Moon Jip Park, and SungBin Lee
Phys. Rev. B **105**, 045146 (arXiv:2106.07782)
The authors develop a general theory of the Landau levels for quasicrystals. Focusing on two-dimensional quasicrystals with rotational symmetries, they find that quasiperiodic tilings induce anomalous Landau levels where electrons are localized near the rotational symmetry centers. Interestingly, the localization length of these Landau levels has a universal dependence on *n* for quasicrystals with *n*-fold rotational symmetry. Furthermore, macroscopically degenerate zero-energy Landau levels are present due to the chiral symmetry of the rhombic tilings. This work provides a general scheme to understand the electron localization behavior of the Landau levels in quasicrystals.



Puzzle of the month

January puzzle answer:

1. 222^0
2. 22 – 20
3. $\sqrt{(20-2)/2}$
4. $2 + 2 - 0^2$
5. 20/(2 + 2)
6. $\sqrt{(20 - 2) \times 2}$
7. $(2 + 0!)^2 - 2$
8. (20/2) – 2
9. (20 – 2)/2
10. $20/\sqrt{2 \times 2}$

A slightly different solution was sent in by Sungjong Woo. Congratulations!

Puzzle of the month:

There are three boxes:
1. a box containing two gold coins,
2. a box containing two silver coins,
3. a box containing one gold coin and one silver coin.

The question is to calculate the probability, after choosing a box at random and withdrawing one coin at random, if that happens to be a gold coin, of the next coin drawn from the same box also being a gold coin.

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