Topology and Entanglement in Quantum Matter

Report of Contributions

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Contribution ID: **1** Type: **not specified**

Jyong-Hao Chen (National Central University)

Tuesday, 7 April 2026 16:10 (45 minutes)

Contribution ID: **2** Type: **not specified**

Fractional quantum anomalous Hall effects in rhombohedral pentalayer graphene

Tuesday, 7 April 2026 10:05 (1 hour)

The fractional quantum anomalous Hall (FQAH) effect in rhombohedral pentalayer graphene (PLG) has attracted significant attention due to its potential for observing exotic quantum states [1-3]. This talk will discuss two projects exploring the FQAH effect in PLG. First, we present a self-consistent Hartree-Fock theory focusing on the convergence of the calculation with various reference fields and the stability of the FQAH states [4-5]. We demonstrate that the charge neutrality scheme ensures convergence with respect to the momentum cutoff and provides an unambiguous result. Based on the Hartree-Fock band structure, we perform exact diagonalization calculations to investigate the stability of the FQAH states in PLG. The second project examines the intriguing experimental observation of FQAH states at various fractional fillings giving way to integer quantum anomalous Hall (IQAH) states as the temperature is lowered [3]. We propose a mechanism for the appearance of FQAH states within a finite temperature range using a toy model consisting of a flat Chern band and impurities [6]. The effects of impurities on the system's behavior at finite temperatures are analyzed, and we posit that the crossover may arise from the competition between the energy penalty for thermal excitations and the increase in entropy. Numerical calculations using exact diagonalization support our theoretical argument, suggesting that impurities may play a crucial role in the crossover from FQAH to IQAH states in rhombohedral PLG. Together, these projects provide an improved and unified theoretical framework for understanding the FQAH effect in rhombohedral PLG and pave the way for future studies on this captivating quantum phenomenon.

References:
[1] Z. Lu, T. Han, Y. Yao, A. P. Reddy, J. Yang, J. Seo, K. Watanabe, T. Taniguchi, L. Fu, and L. Ju, Fractional quantum anomalous Hall effect in multilayer graphene, Nature 626, 759 (2024).
[2] D. Waters, A. Okounkova, R. Su, B. Zhou, J. Yao,K. Watanabe, T. Taniguchi, X. Xu, Y.-H. Zhang, J. Folk, and M. Yankowitz, Interplay of electronic crystals with integer and fractional Chern insulators in moiré pentalayer graphene, arXiv:2408.10133.
[3] Z. Lu, T. Han, Y. Yao, J. Yang, J. Seo, L. Shi, S. Ye, K. Watanabe, T. Taniguchi, and L. Ju, Extended Quantum Anomalous Hall States in Graphene/hBN Moiré Superlattices, arXiv:2408.10203.
[4] K. Huang, X. Li, S. Das Sarma, and F. Zhang, Self-consistent theory of fractional quantum anomalous Hall states in rhombohedral graphene, Phys. Rev. B 110, 115146 (2024).

Presenter: Prof. LI, Xiao

Contribution ID: **3** Type: **not specified**

Shinsei Ryu (Princeton University)

Tuesday, 7 April 2026 09:00 (1 hour)

Contribution ID: **4** Type: **not specified**

Interference, topology, and new Hilbert-space routes to quantum non-ergodicity

Tuesday, 7 April 2026 15:20 (45 minutes)

A central challenge in nonequilibrium quantum physics is to understand why certain many-body systems fail to thermalize even in the absence of disorder or integrability. In this talk, I will outline a different perspective in which non-ergodicity is governed by hidden geometric structures in Hilbert space rather than by conventional real-space mechanisms. This viewpoint leads to the concept of interference-caged quantum many-body scars (ICQMBS), where exact many-body destructive interference confines eigenstates to small regions of the Fock-space graph. Remarkably, interference zeros and graph automorphisms emerge as universal organizing principles, revealing a class of topological ICQMBS whose robustness originates from local Fock-space topology rather than symmetries or constraints. This framework not only explains diverse non-ergodic phenomena from one-dimensional systems to two-dimensional gauge models but also provides new tools for systematically identifying them. In addition to recent advances of using Fock-space graph to explore quantum ergodicity breaking, I will also summarize the recent applications of caged states in different contexts.

Presenter: HUANG, Yi-Ping (National Tsing Hua University)

Contribution ID: **5** Type: **not specified**

Dualities and Exact Many-Body Scars

Tuesday, 7 April 2026 14:00 (1 hour)

I will first discuss new examples of quantum many-body scars in the two-dimensional XY model. I will then discuss a dual Z_2 gauge theory obtained by gauging a global symmetry of the XY model, and discuss corresponding scars therein. This discussion suggests the possibility of systematic exploration of quantum many-body scars in the web of theories related by dualities. The talk is based on the paper arXiv:2505.21921, in collaboration with Yuan Miao, Linhao Li, and Hosho Katsura.

Presenter: Prof. YAMAZAKI, Masahito (University of Tokyo)

Contribution ID: **6** Type: **not specified**

Non-Hermitian quantum systems and non-unitary criticality

Tuesday, 7 April 2026 11:25 (45 minutes)

Presenter: CHANG, Po-Yao