

ALIREZA PARHIZKAR

Theoretical physicist — quantum materials: moiré & van der Waals systems, flat bands, and topological matter

Postdoctoral Researcher, University of California, Santa Cruz • Supervisor: Prof. Aris Alexandradinata

Ph.D. in Physics, Joint Quantum Institute — University of Maryland • Advisor: Prof. Victor Galitski

B.Sc. & M.Sc. in Physics, University of Tehran

RESEARCH KEYWORDS

moiré & van der Waals materials • twisted & strained bilayer graphene • flat bands & localization • topological materials • strongly correlated physics • quantum geometry • quantum anomalies

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Google Scholar

LinkedIn

arXiv

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PAPERS
& LETTERS

9

MAIN
CONTRIBUTIONS

2

EDITORS'
SUGGESTIONS

3

INVITED
TALKS

32+

NEWS OUTLETS
MEDIA COVERAGE

I develop elegant frameworks that blend field-theoretic and geometric tools for strongly correlated and emergent physics of **quantum materials** — showing how flat bands, localization, and *magic* arise in condensed matter systems such as twisted and strained bilayer and multilayer graphene, and how topology and quantum geometry govern their electronic and optical response. I am also extending these frameworks to non-equilibrium settings.

PUBLICATIONS

2025

Geometric Delocalization in Two Dimensions

L. Shou, A. Parhizkar, and V. Galitski • Phys. Rev. Lett. 135, 226302 (2025)

LETTER

2025

Zero-Flux Localization: Magic Flat Bands via Non-Abelian Gauge Fields

A. Parhizkar and V. Galitski • Phys. Rev. B 112, L201115 (2025)

LETTER

EDITORS' SUGGESTION

2025

A Field Theory of Localization

A. Parhizkar • Ph.D. Dissertation, University of Maryland, College Park

PH.D. THESIS

2024

Path-Integral Approach to Quantum Anomalies in Interacting Models

A. Parhizkar, C. Rylands, and V. Galitski • Phys. Rev. B 109, 155109 (2024)

2024

Localizing Transitions via Interaction-Induced Flat Bands

A. Parhizkar and V. Galitski • Phys. Rev. Lett. 133, 166502 (2024)

LETTER

2024

Generic Topological Criterion for Flat Bands in Two Dimensions

A. Parhizkar and V. Galitski • Phys. Rev. B 110, L121111 (2024)

LETTER

2022

Strained Bilayer Graphene, Emergent Energy Scales, and Moiré Gravity

A. Parhizkar and V. Galitski • Phys. Rev. Research 4, L022027 (2022)

LETTER

MEDIA COVERAGE • 32+ OUTLETS

2022

Non-Abelian Bosonization in a (3+1)-D Kondo Semimetal via Quantum Anomalies

C. Rylands, A. Parhizkar, and V. Galitski • Phys. Rev. B 105, 195108 (2022)

2022

Moiré Gravity and Cosmology

A. Parhizkar and V. Galitski • arXiv:2204.06574

LETTER

2021

Chiral Anomaly in Interacting Condensed Matter SystemsC. Rylands, A. Parhizkar, A. A. Burkov, and V. Galitski • Phys. Rev. Lett. **126**, 185303 (2021)

LETTER

EDITORS' SUGGESTION

UNDER REVIEW & IN PREPARATION

2026

Bosonic Codes from Compact Phase Spaces

D. Roberts, A. Slipper, A. Parhizkar, V. V. Albert, and M. Hafezi • arXiv:2608.31156

PREPRINT

2026

Single-Shot Realization of 10,000-Mode Octave-Spanning Artificial Gauge Fields

L. Xu, A. Padhye, S. Sarkar, A. Parhizkar, C. J. Flower, G. Moille, K. Srinivasan, M. Hafezi, and M. J. Mehrabad • arXiv:2606.23960

UNDER REVIEW • SCIENCE

2025

Quantum Metamorphosis: Programmable Emergence and the Breakdown of Bulk–Edge Dichotomy in Multiscale Systems

M. J. Mehrabad, A. Parhizkar, L. Xu, G. Moille, A. Dutt, D. Englund, K. Srinivasan, D. Leykam, M. Hafezi • arXiv:2511.13831

UNDER REVIEW • NATURE

2026

Zero-Flux Localization: Floquet Flat Bands at Magic Drives

IN PREPARATION

A. Parhizkar, A. Alexandradinata, M. Hafezi, and V. Galitski

Flat Floquet bands and exact dynamical localization from a phase-space return criterion for driven quantum matter.

2026

Flat-Band Bulk Photovoltaics

IN PREPARATION

A. Parhizkar and A. Alexandradinata

Efficiency theory for flat-band photovoltaics, with rhombohedral pentalayer graphene as a small-gap infrared platform.

2026

Covariant Response Tensors, Time-Reversal Characters, and Photoconductivity in Twisted Nanowires

IN PREPARATION

A. Parhizkar and A. Alexandradinata

*Symmetry framework for photovoltaic and photoconductive response; handedness-activated photocurrent in twisted and screw-dislocated wires.***INVITED TALKS**

Dec. 2025

A Landau Level at Zero Flux: A Minimal Exactly-Solvable Route to Magic Flat BandsCondensed Matter Seminar, *University of Toronto*

Feb. 2025

A Landau Level at Zero Flux, Magic, and Perfectionist InteractionsCondensed Matter Seminar, *University of California, Santa Cruz*

Sep. 2024

Magic Revealed: How Flat Bands Appear and Disappear in Moiré MaterialsCondensed Matter Seminar, *Ohio State University***CONTRIBUTED TALKS & SEMINARS**

Mar. 2025

Zero-Flux Localization: How Flat Bands Magically Appear and DisappearAPS March Meeting, *Anaheim*

Mar. 2024

Flat Bands and Transition into Localization in Interacting SystemsAPS March Meeting, *Minneapolis*

Feb. 2024

Graphene to GravityFriday Quantum Seminar, *JQI–UMD*

Sep. 2023

Index, Zero-Modes, and Band-Flattening TransitionsFriday Quantum Seminar, *JQI–UMD*

Mar. 2023

Interacting Anomaly: Anomalous Massive Propagation and Thermal TransportAPS March Meeting, *Las Vegas*

Apr. 2022

Moiré GravityAPS April Meeting, *New York*

Mar. 2022

Interacting Chiral AnomalyAPS March Meeting, *Chicago*

EARLIER RESEARCH EXPERIENCE

- 2015–2016 Master's Research — **Holography in Black-Hole Spacetimes**
Supervisor: Dr. Ali Shojai, Department of Physics, University of Tehran
- Spring 2015 Physical & computational simulation of spinning-top motion
Supervisor: Dr. Ali Shojai, University of Tehran
- Spring 2014 Studies of cellular automata: Conway's Game of Life and its physical aspects
Supervisor: Dr. Ali Shojai, University of Tehran

TEACHING EXPERIENCE

TEACHING ASSISTANTSHIPS

- 2019 Moderator & Teaching Assistant — **Exploring Quantum Physics**
Coursera MOOC with ~50,000 enrollments • Department of Physics, University of Maryland
- 2015–2016 **Gravitation I & II (graduate), Elementary Particle Physics, Physics of Music, Special & General Relativity**
Department of Physics, University of Tehran
- Fall 2010 Introduction to Computer Programming
Department of Physics, University of Tehran

INSTRUCTION & COACHING

- 2013–2016 Head of the Physics Chamber, Allameh Helli High School • coached a student team to CERN Beamline for Schools (2014)
- 2008–2016 Taught high-school & middle-school physics at Allameh Helli School for gifted & talented students
Organized 30+ workshops • designed curricular physics courses • founded 8 extracurricular science courses
- 2018–2023 Instructor & coach for physics teachers — online programs on phenomenology, new course materials, workshops & scientific competitions

SERVICE & OUTREACH

- 2020–2024 Referee for Physical Review journals (APS) and Annals of Physics
- 2022 Mentor, incoming graduate-student mentoring program, UMD Physics
- 2019–2023 Designed & taught public outreach courses — “Tea with Physics” and “Special Relativity for Enthusiasts”
Modern physics & fact-checking for general and non-physics audiences
- 2018–2021 *Sieve (Alak)* — a program of comprehensive fact-checking of public myths through physics
- Fall 2018 *The Footprint of Physics in Classical Persian Literature* — interdisciplinary research & presentation
- Spring 2018 APS Science-Fair volunteer, Walter E. Washington Convention Center, Washington, D.C.

SELECTED CONFERENCES, SCHOOLS & WORKSHOPS

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|---|---|
| 2025 Boulder School for Condensed Matter & Materials Physics | 2024 Simons Collaboration on Ultra-Quantum Matter, Annual Meeting |
| 2025 APS March Meeting, Anaheim | 2023 Princeton Summer School on Condensed Matter Physics |
| 2025 Topological Dynamics, Princeton University | 2023 APS March Meeting, Las Vegas |
| 2025 Simons Collaboration on Ultra-Quantum Matter, Annual Meeting | 2022 APS April Meeting, New York |
| 2024 Princeton Summer School on Condensed Matter Physics (IAS) | 2022 APS March Meeting, Chicago |
| 2024 APS March Meeting, Minneapolis | 2022 Simons Collaboration on Ultra-Quantum Matter, Annual Meeting |