Yahui Zhang

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Education

2014.8-2019.8 Ph.D., Physics, **Massachusetts Institute of Technology**

2009.9-2014.6 B.Sc., Physics, **Peking University**

Employments

2022.1-present Assistant Professor, **Johns Hopkins University**

2019.9-2021.12 Postdoc scholar, **Harvard University**

Honors and Awards

2024 Alfred P. Sloan Research Fellowship

2023 NSF Early Career Award

Supervised students and postdocs

Boran Zhou, PhD student, 03/2022-present

Xiaofan Wu, PhD student, 09/2022-present

Jingyu Zhao, postdoc, 09/2024-present

Hanbit Oh, postdoc, 09/2023-present

Hui Yang, postdoc, 09/2022-08/2025, next position: postdoc at University of Pittsburgh

Invited Presentations

- High Tc Superconductor v2.0
  Workshop on Ultra-Quantum Matter, IAS, NJ, USA, 10/2025
- Exciton condensation and quantum criticality in quantum Hall multilayers
  Purdue University*, West Lafayette, IN, USA, 09/2025*
- Topological Mott states in twisted bilayer graphene
  MIT, Cambridge, MA, USA, 09/2025
- High Tc superconductor and unconventional metallic state in a bilayer model
  Harvard University, Cambridge, MA, USA, 09/2025
- Topological Mott states in twisted bilayer graphene
  Aspen workshop 'Topological Quantum Many-Body Systems', CO, USA, 08/20255
- Dope a spin-one Mott insulator: application to bilayer nickelate
  Aspen workshop 'Ultra Quantum Matter: Synergy Between Theory and Experiment', CO, USA, 08/2025
- Ancilla theory of Mott physics: from cuprate to twisted bilayer graphene

Cornell University, NY, USA, 04/2025

- Ancilla theory of Mott physics in twisted bilayer graphene

MRS symposium 'Recent Advances and New Opportunities in van der Waals Heterostructures', WA, USA, 04/2025

- Integer and fractional quantum Hall effects at zero magnetic field in moire systems

George Mason University, VA, USA, 02/2025

- Topological Wigner crystal and fractional quantum anomalous Hall effects in pentalayer graphene system

Los Alamos annual Meeting 'Emerging Materials for Microelectronics', Santa Fe, New Mexico, 09/2024

- Topological Wigner crystal and fractional quantum spin Hall effect in moire systems

KITP conference 'Moiré materials: A New Paradigm in Tunable Quantum Matter', CA, USA, 08/2024

- High Tc superconductivity and Fermi liquid transition in bilayer nickelate

KITP program 'correlated gapless quantum matter', CA, USA, 05/2024

- Fractional quantum anomalous Hall effects and fractional quantum spin Hall effects in moire systems

CMTC Seminar, University of Maryland, College park, MD, USA, 04/2024

- Vortex spin liquid with fractional quantum spin Hall effect in moire Chern bands

Kadanoff Seminar, University of Chicago, Chicago, IL, USA, 03/2024

- Fractional quantum anomalous and spin Hall effects in moire superlattices

Yale University, New Haven, CT, USA, 02/2024

- Fractional quantum anomalous Hall phases and phase transitions out of them in moire superlattices

Free University of Berlin, Berlin, Germany, 12/2023

- New high Tc superconductor and symmetric psedudogap metal in the nickelate La3Ni2O7

Max Planck Institute of Quantum Optics, Munich, Germany, 12/2023

- Ancilla wavefunction of Mott insulator and pseudogap metal

Ludwig Maximilian University of Munich, Munich, Germany, 12/2023

- New high Tc superconductor and symmetric pseudogap metal in the nickelate La3Ni2O7

ICTP conference 'Fractionalization and Emergent Gauge Fields in Quantum Matter', Trieste, Italy, 12/2023

- Fractional quantum anomalous Hall phases and phase transitions out of them in moire superlattices

The Pennsylvania State University, PA, USA, 10/2023

- Fractional quantum anomalous Hall phases and phase transitions out of them in moire superlattices

University of Massachusetts, Amherst, MA, USA, 09/2023

- Ancilla wavefunction of Mott insulator and pseudogap metal

MIT, Cambridge, USA, 06/2023

- A variational wavefunction of Mott insulator and pseudogap metal using ancilla qubits

Ohio State University, Columbus, OH, USA, 02/2023

- Exotic exciton phases and quantum spin liquids in quantum Hall bilayer and moire bilayer
  CMTC, University of Maryland, College Park, MD, USA, 10/2022
- Variational wavefunction for the pseudogap metal in hole doped cuprate
  Invited speaker at APS March meeting, Chicago, 03/2022

Selected Recent Publications

[6] Zhao, Jing-Yu, and **Ya-Hui Zhang**. "*Resonating-valence-bond superconductor from small Fermi surface in twisted bilayer graphene*." arXiv preprint arXiv:2510.26801 (2025).

[5] Zhou, Boran, Hui-Ke Jin, and **Ya-Hui Zhang**. "*Variational wavefunction for a Mott insulator at finite U using ancilla qubits.*" Physical Review B 112, no. 11 (2025): 115159.

[4] Oh, Hanbit, Hui Yang, and **Ya-Hui Zhang**. "*High-temperature superconductivity from kinetic energy.*" arXiv preprint arXiv:2411.07292 (2024).

[3] Zhou, Boran, Hui Yang, and **Ya-Hui Zhang**. "*Fractional quantum anomalous Hall effects in rhombohedral multilayer graphene in the moir\'eless limit."* Phys. Rev. Lett. 133, 206504 (2024), **PRL 2024 Collection**

[2] Oh, Hanbit, and **Ya-Hui Zhang**. "*Type-II t− J model and shared superexchange coupling from Hund's rule in superconducting La3Ni2O7*." Physical Review B 108, no. 17 (2023): 174511.

[1] Song, Xue-Yang, and **Ya-Hui Zhang**. "*Deconfined criticalities and dualities between chiral spin liquid, topological superconductor and charge density wave Chern insulator.*" SciPost Physics 15.5 (2023): 215.

Prinprints

[9] Zhao, Jing-Yu, and Ya-Hui Zhang. "Resonating-valence-bond superconductor from small Fermi surface in twisted bilayer graphene." arXiv preprint arXiv:2510.26801 (2025)

[8] Zhao, Jing-Yu, Shubhayu Chatterjee, Subir Sachdev, and Ya-Hui Zhang. "Yamaji effect in models of underdoped cuprates." arXiv preprint arXiv:2510.13943 (2025).

[7] Oh, Hanbit, Hui Yang, and Ya-Hui Zhang. "Doping a spin-one Mott insulator: possible application to bilayer nickelate." arXiv preprint arXiv:2509.02673 (2025).

[6] Zhang, Lu, Ya-Hui Zhang, and Xue-Yang Song. "Charge-4$ e $ Anyon Superconductor from Doping $\text {SU}(4) _1 $ chiral spin liquid." arXiv preprint arXiv:2508.12370 (2025).

[5] Wang, Taige, and Ya-Hui Zhang. "Anyon superfluid in trilayer quantum Hall systems." arXiv preprint arXiv:2508.00058 (2025).

[4] Zhang, Ya-Hui. "Continuous transition from Fermi liquid to A fractional Chern insulator." arXiv preprint arXiv:2507.22130 (2025).

[3] Zhang, Ya-Hui. "Holon metal, charge-density-wave and chiral superconductor from doping fractional Chern insulator and SU (3) $ _1 $ chiral spin liquid." arXiv preprint arXiv:2506.00110 (2025).

[2] Zhao, Jing-Yu, Boran Zhou, and Ya-Hui Zhang. "Mixed valence Mott insulator and composite excitation in twisted bilayer graphene." arXiv preprint arXiv:2507.00139 (2025).

[1] Oh, Hanbit, Hui Yang, and **Ya-Hui Zhang**. "*High-temperature superconductivity from kinetic energy.*" arXiv preprint arXiv:2411.07292 (2024).

Publications List

[49] Zhou, Boran, Hui-Ke Jin, and **Ya-Hui Zhang**. "*Variational wavefunction for a Mott insulator at finite U using ancilla qubits.*" Physical Review B 112, no. 11 (2025): 115159.

[48] Zhao, Jing-Yu, Boran Zhou, and **Ya-Hui Zhang**. "*Topological Mott localization and pseudogap metal in twisted bilayer graphene*." Physical Review B 112, no. 8 (2025): 085107

[47] Zhou, Boran, and **Ya-Hui Zhang**. "*New classes of quantum anomalous Hall crystals in multilayer graphene*." Physical Review Letters 135, no. 3 (2025): 036501.

[46] Jin, Hui-Ke, Hong-Hao Tu, and **Ya-Hui Zhang**. "*Dirac and chiral spin liquids on spin-1/2 square-lattice Heisenberg antiferromagnet.*" Physical Review B 112, no. 3 (2025): 035159.

[45] Yang, Hui, and **Ya-Hui Zhang**. "*Topological incommensurate Fulde-Ferrell-Larkin-Ovchinnikov superconductor and Bogoliubov Fermi surface in rhombohedral tetralayer graphene*." Physical Review B 112, no. 2 (2025): L020506

[44] Yang, Hui, Hanbit Oh, and **Ya-Hui Zhang.** "*Strong pairing and symmetric pseudogap metal in a double Kondo lattice model: From a nickelate superconductor to a tetralayer optical lattice*." Physical Review B 111, no. 24 (2025): L241102

[43] Su, Ruiheng, Dacen Waters, Boran Zhou, Kenji Watanabe, Takashi Taniguchi, **Ya-Hui Zhang**, Matthew Yankowitz, and Joshua Folk. "*Moiré-driven topological electronic crystals in twisted graphene*." Nature (2025): 1-6.

[42] Waters, Dacen, Anna Okounkova, Ruiheng Su, Boran Zhou, Jiang Yao, Kenji Watanabe, Takashi Taniguchi et al. "*Chern insulators at integer and fractional filling in moiré pentalayer graphene*." Physical Review X 15, no. 1 (2025): 011045.

[41] Oh, Hanbit, Boran Zhou, and **Ya-Hui Zhang**. "*Type-II t-J model in charge transfer regime in bilayer La 3 Ni 2 O 7 and trilayer La 4 Ni 3 O 10*." Physical Review B 111, no. 2 (2025): L020504.

[40] Waters, Dacen, Ruiheng Su, Ellis Thompson, Anna Okounkova, Esmeralda Arreguin-Martinez, Minhao He, Katherine Hinds et al. "Topological flat bands in a family of multilayer graphene moiré lattices." Nature Communications 15, no. 1 (2024): 1-9.

[39] Zhou, Boran, Hui Yang, and **Ya-Hui Zhang**. "Fractional quantum anomalous Hall effects in rhombohedral multilayer graphene in the moir\'eless limit." Phys. Rev. Lett. 133, 206504 (2024)

[38] **Zhang, Ya-Hui**. "*Non-Abelian and Abelian descendants of a vortex spin liquid: Fractional quantum spin Hall effect in twisted MoTe2*." Physical Review B 110, no. 15 (2024): 155102.

[37] Yang, Hui, Hanbit Oh, and **Ya-Hui Zhang**. "*Strong pairing from a small Fermi surface beyond weak coupling: Application to La3Ni2O7*." Physical Review B 110, no. 10 (2024): 104517. Editor's suggestion

[36] Wu, Xiaofan, Hui Yang, and **Ya-Hui Zhang**. "*Deconfined Fermi liquid to Fermi liquid transition and superconducting instability*." Physical Review B 110, no. 12 (2024): 125122.

[35] **Ya-Hui Zhang**. "*Vortex Spin Liquid with Fractional Quantum Spin Hall Effect in Moiré Chern Bands*." Physical Review Letters 133, no. 10 (2024): 106502.

[34] Nikolaenko, Alexander, and **Ya-Hui Zhang**. "*Numerical signatures of ultra-local criticality in a one-dimensional Kondo lattice model*." SciPost Physics 17, no. 2 (2024): 034. (2024)

[33] Yang, Hui, and **Ya-Hui Zhang**. "*Exciton-and light-induced ferromagnetism from doping a moiré Mott insulator*." Physical Review B 110, no. 4 (2024): L041115

[32] Song, Xue-Yang, **Ya-Hui Zhang**, and T. Senthil. "*Phase transitions out of quantum Hall states in moiré materials*." Physical Review B 109, no. 8 (2024): 085143

[31] B Zhou, **YH Zhang**, Chiral and nodal superconductors in tJ model with valley contrasting flux on triangular moir\'e lattice. Physical Review B, 108(15), 155111(2023)

[30] Oh, Hanbit, and Ya-Hui Zhang. "Type-II t− J model and shared superexchange coupling from Hund's rule in superconducting La 3 Ni 2 O 7." Physical Review B 108.17 (2023): 174511.

[29] Christos, Maine, Zhu-Xi Luo, Henry Shackleton, **Ya-Hui Zhang**, Mathias S. Scheurer, and Subir Sachdev. *A model of d-wave superconductivity, antiferromagnetism, and charge order on the square lattice. Proceedings of the National Academy of Sciences 120, no. 21 (2023): e2302701120.*

[28] **YH Zhang**, Z Zhu, A Vishwanath, *XY* transition and extraordinary boundary criticality from fractional exciton condensation in quantum Hall bilayer. Phys. Rev. X 13, 031023 (2023)*

[27] Z Dong, **YH Zhang**, *Excitonic Chern insulator and kinetic ferromagnetism in a MoTe2/WSe2 moiré bilayer.* Physical Review B 107 (8), L081101 (2023)

[26] Song, Xue-Yang, and **Ya-Hui Zhang**. "Deconfined criticalities and dualities between chiral spin liquid, topological superconductor and charge density wave Chern insulator." SciPost Physics 15.5 (2023): 215.

[25] **YH Zhang,** *Doping a Mott insulator with excitons in a moiré bilayer: Fractional superfluid, neutral Fermi surface, and Mott transition***,** Physical Review B 106 (19), 195120 (2022)

[24] **YH Zhang**, A Vishwanath, *Pair-density-wave superconductor from doping Haldane chain and rung-singlet ladder.* Physical Review B 106 (4), 045103 (2022)

[23] XY Song, **YH Zhang**, A Vishwanath , *Doping a moiré Mott insulator: A model study of twisted cuprates.* Physical Review B 105 (20), L201102 (2022)

[22] Saien Xie, Brendan D Faeth, Yanhao Tang, Lizhong Li, Eli Gerber, Christopher T Parzyck, Debanjan Chowdhury, **Ya-Hui Zhang,** Christopher Jozwiak, Aaron Bostwick, Eli Rotenberg, Eun-Ah Kim, Jie Shan, Kin Fai Mak, Kyle M Shen, *Strong interlayer interactions in bilayer and trilayer moiré superlattices.* Science advances 8 (12), eabk1911 (2022)

[21] Jixiang Yang, Guorui Chen, Tianyi Han, Qihang Zhang, **Ya-Hui Zhang**, Lili Jiang, Bosai Lyu, Hongyuan Li, Kenji Watanabe, Takashi Taniguchi, Zhiwen Shi, Todadri Senthil, Yuanbo Zhang, Feng Wang, Long Ju, *Spectroscopy signatures of electron correlations in a trilayer graphene/hBN moiré superlattice.* Science 375 (6586), 1295-1299 (2022)

[20] Eric Mascot, Alexander Nikolaenko, Maria Tikhanovskaya, **Ya-Hui Zhang**, Dirk K Morr, Subir Sachdev, *Electronic spectra with paramagnon fractionalization in the single-band Hubbard model.* Physical Review B 105 (7), 075146 (2022)

[19] Jiang-Xiazi Lin, **Ya-Hui Zhang**, Erin Morissette, Zhi Wang, Song Liu, Daniel Rhodes, K Watanabe, T Taniguchi, James Hone, JIA Li, *Spin-orbit–driven ferromagnetism at half moiré filling in magic-angle twisted bilayer graphene.* Science 375 (6579), 437-441(2022)

[18] **YH Zhang**, DN Sheng, A Vishwanath, *SU (4) chiral spin liquid, exciton supersolid, and electric detection in moiré bilayers.* Physical review letters 127 (24), 247701 (2021)

[17] M He, **YH Zhang**, Y Li, Z Fei, K Watanabe, T Taniguchi, X Xu, M Yankowitz, *Competing correlated states and abundant orbital magnetism in twisted monolayer-bilayer graphene.* Nature Communications 12 (1), 4727 (2021)

[16] Alexander Nikolaenko, Maria Tikhanovskaya, Subir Sachdev, **Ya-Hui Zhang***, Small to large Fermi surface transition in a single-band model using randomly coupled ancillas.* Physical Review B 103 (23), 235138 (2021)

[15] XY.Song, A.Vishwanath and **YH.Zhang**$^{+}$, *Doping the chiral spin liquid--topological superconductor or chiral metal*? Physical Review B 103 (16), 165138 (2021)

[14] **Zhang, Ya-Hui**, and Zheng Zhu. "*Fractional Fermi liquid in a generalized t-J model*." Physical Review B 103, no. 11 (2021): 115101.

[13] **YH.Zhang*** and S.Sachdev, *Deconfined criticality and ghost Fermi surfaces at the onset of antiferromagnetism in a metal.* Phys. Rev. B 102, 155124 (2020).

[12] **YH.Zhang*** and S.Sachdev, *From the pseudogap metal to the Fermi liquid using ancilla qubits*. Physical Review Research 2 (2), 023172 (2020), Editor's suggestion.

[11] C Repellin, Z Dong, **YH Zhang**, T Senthil, *Ferromagnetism in narrow bands of moiré superlattices.* Physical Review Letters 124 (18), 187601(2020).

[10] **YH.Zhang*** and A.Vishwanath, *Type-II t-J model in superconducting nickelate* $Nd_xSr_{1-x}NiO_2$. Physical Review Research 2 (2), 023112 (2020).

[9] S.Chen, M.He, **YH.Zhan**g, Valerie Hsieh, Zaiyao Fei, K Watanabe, T Taniguchi, David H Cobden, Xiaodong Xu, Cory R Dean, Matthew Yankowitz*, Electrically tunable correlated and topological states in twisted monolayer-bilayer graphene.* Nature Physics, 10.1038(2020)

[8] **YH.Zhang*** and T. Senthil, *Quantum Hall spin liquids and their possible realization in moir\'e systems*. Phys. Rev. B 102, 115127 (2020).

[7] Guorui Chen, Aaron L Sharpe, Eli J Fox, **Ya-Hui Zhang**, Shaoxin Wang, Lili Jiang, Bosai Lyu, Hongyuan Li, Kenji Watanabe, Takashi Taniguchi, Zhiwen Shi, T Senthil, David Goldhaber-Gordon, Yuanbo Zhang, Feng Wang, *Tunable correlated chern insulator and ferromagnetism in a moiré superlattice.* Nature 579 (7797), 56-61(2020).

[6] **YH.Zhang*** and D.Mao, *Spin liquids and pseudogap metals in the SU (4) Hubbard model in a moiré superlattice.* Physical Review B 101 (3), 035122(2020).

[5] **YH.Zhang***, D.Mao and T. Senthil, *Twisted bilayer graphene aligned with hexagonal boron nitride: anomalous Hall effect and a lattice model*. Physical Review Research 1 (3), 033126 (2019).

[4] **YH.Zhang***, HC.Po and T. Senthil, *Landau level degeneracy in twisted bilayer graphene: Role of symmetry breaking*. Physical Review B 100 (12), 125104 (2019) .

[3] **YH. Zhang*** and T. Senthil, *Bridging Hubbard model physics and quantum Hall physics in trilayer moiré superlattice*. Physical Review B 99 (20), 205150 (2019) Editor's suggestion.

[2] **YH Zhang***, D Mao, Y Cao, P Jarillo-Herrero, T Senthil, *Nearly flat Chern bands in moiré superlattices*. Physical Review B 99 (7), 075127(2019), Editor's suggestion.

[1] Z Dai*, **YH Zhang***, T Senthil, PA Lee, *Pair-density waves, charge-density waves, and vortices in high-Tc cuprates.* Physical Review B 97 (17), 174511 (2018). Editor's suggestion.