Binbin LIU

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Educations

2020–2023 **M. S. in Physics**, *Beihang University,* Beijing, China.
Major GPA: 3.96/4, ranking **1/20**.

2016–2020 **B. S. in Applied Physics**, *Beihang University,* Beijing, China.
Major GPA: 3.91/4, ranking **top 3**%.

Honors and Awards

05.2023 Presidential PhD Scholarship Award. Imperial College London. *30/600*
05.2023 First Prize in the academic poster competition. Beihang U. ***3***%
09.2022 National Scholarship. Ministry of Education, China. ***1***%
05.2019 "Yuanhang" Global Study Summer Research Scholarship Award. Beihang U. ***1.5***%
2018–2022 First Prize in the Learning Excellence Scholarship×4. Beihang U. ***3***%

Publications

[1] **Binbin Liu** et al., *Second-order and real Chern topological insulator in twisted bilayer α-graphyne*, Phys. Rev. B 106, 035153 (2022). [PDF]

[2] Wang Yang*, **Binbin Liu***, et al., *Large bilinear magnetoresistance from Rashba spin-splitting on the surface of a topological insulator*, Phys. Rev. B 106, L241401 (2022), (Letter). [PDF]

[3] Xu-Tao Zeng, **Binbin Liu**, et al., *Three-dimensional real Chern insulator in bulk γ-graphyne*, Phys. Rev. B 108, 075159 (2023). [PDF]

[4] **Binbin Liu**†, Zeying Zhang, Xian-Lei Sheng†, Yuxin Zhao and Shengyuan A. Yang, *Projective Symmetry Enriched Berry Curvature Effects in Space and Time Invariant Crystals*. (To be submitted to PRL.)

[5] Xu-Tao Zeng, Ziyu Chen, Cong Chen, **Binbin Liu**, et al., *Topological hinge modes in Dirac semimetals*, Front. Phys. 18, 13308 (2023). [PDF]

[6] *Threefold relativistic particles in moiré heterostructure Bi/$FeCl_2$*. (In preparation. Theory first author.)

[7] **Binbin Liu** et al., *First and second-order topological insulator in 2D elementary materials*. (Invited review, in preparation.)

[8] **Binbin Liu** and Chueng Ji, *Anatomy of nucleon self-energy from equal-time to light-front*. (To be submitted to PRD.)

(* equal contributions, † correspondence)

Skills

Coding Matlab, Mathematica, Python, Linux, Latex, Markdown, C, Fortran.

Software VASP, Wannier90, VESTA (material); Irvsp (Irreps), Magnetic TB/k·p (model), MindQuantum (quantum computation), Hspice (circuit simulation), Github, Blender, AI, PS...

Vasplib A powerful Matlab package for condensed matter and materials research: build effective models from first-principals, identify topology, interface with VASP, QE, etc...(Developed by our group including me.)

Miscellaneous **Problem-solving**, project leadership, team collaboration, rapid learning, and a strong motivation to pursue an academic career.

Research

2023– **Moiré-induced threefold relativistic particles in 2D $FeCl_2$/Bi(111)**, Online

Advisors Dr. Frank Schindler, Imperial College London, Prof. Titus Neupert, U. of Zurich, and Prof. Niels Schroeter, MPI

Description Relativistic crossings at the K point of the mini Brillouin zone in a moiré structures formed by several layers of Bismuth on top of a $FeCl_2$ substrate. Developed a theoretical effective model combined with first-principle calculations to elucidate the origin of the moiré-induced threefold relativistic particles, which is due to the band warping effect for the surface bands at Fermi level. [6].

2022–2023 **Projective Symmetry Enriched Berry Curvature Effects in Space and Time Invariant Crystals.**, Nanjing U, Nanjing, China

Advisors Prof. Shengyuan A. Yang, Singapore U. of Technology and Design, Prof. Yuxin Zhao, HKU., and Prof. Xian-Lei Sheng, Beihang U.

Description Proposed a projectively enriched space and time inversion symmetry and investigated its nontrivial implications: the existence of Weyl points even in the presence of projective space and time symmetry [4].

2021–2022 **Higher-order Topology in Graphyne Families**, Beihang U, Beijing, China

Advisors Prof. Xian-Lei Sheng, Beihang U. and Prof. Shengyuan A. Yang, Singapore U. of Technology and Design.

Description Identified twisted bilayer α-graphyne as a second-order topological insulator in 2D and γ-graphyne as a real Chern insulator with higher-order hinge states in 3D using first-principles calculations [1,3]. Demonstrated that higher-order topological states in these materials are induced by effective moiré magnetism or Zeeman fields [1,3,5,7].

2021–2022 **Large Bilinear Magnetoresistance (BMR) from Rashba Spin-Splitting on the Surface of a Topological Insulator**, Online

Advisors Prof. John Q. Xiao, U. of Delaware, Prof. Xian-Lei Sheng, Beihang U. and Prof. Shengyuan A. Yang, Singapore U. of Technology and Design.

Description Discovered Rashba spin-splitting quantum well states developed near the surface of Bi_2Se_3 decorated with transition-metal atoms Cu or Au, explaining the observed unusual large BMR in experiments [2].

2019–2022 **Anatomy of Nucleon Self-energy from Equal-time to Light-front**, NC, USA

Advisors Prof. Chueng Ji, APS fellow, North Carolina State U.

Description First to derive the leading non-analytic behavior of a light-front instantaneous Feynman diagram, providing new insights into understanding the backward moving part of a nucleon-pion loop in light-front dynamics [8].

Presentation

12.2021 Light-Cone 2021 (Korea). Anatomy of nucleon self-energy from equal-time to light-front.

Advanced Courses

M. S. Group Theory (98), Quantum Many-Body Theory (95), Quantum Optics (96). Advanced Statistical Physics (92).

B. S. Advanced Quantum Mechanics (94), Solid State Physics II (95).

Extracurricular Activities

2021/2022 Teaching Assistant, Solid State Physics (delivering lectures and revising homework).

2020–2021 Student President of Academic Associations, Department of Physics, Beihang University.

2012– Classical Pianist (Bach, Beethoven, Chopin, Mozart).

2017– Membership in the Opera House, World Genius Directory.

References

Name	Affiliation	Email
○ Prof. Shengyuan Yang	○ U. of Macau,	○ yangshengyuan@um.edu.mo,
○ Prof. Xian-Lei Sheng	○ Beihang U.	○ xlsheng@buaa.edu.cn
○ Dr. Frank Schindler	○ Imperial College	○ f.schindler@imperial.ac.uk
○ Prof. Chueng Ji	○ NC State	○ crji@ncsu.edu

(Available upon request)