Jia-Cheng He

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Basic Information

- **Gender**: Male
- **Date of Birth**: Feb 10, 1991
- **Nationality**: China

Education

Fudan University, Shanghai, China Sep 2014 – Aug 2022

- **Ph.D.** in Theoretical Physics (Department of Physics)
  - Thesis: Theoretical studies on unconventional superconductivity of SU(4) pairing and of spin triplet pairing
  - Supervisor: Prof. Yan Chen
  - Research area: Unconventional Superconductivity, Strongly Correlated Systems.

Chongqing University, Chongqing, China Sep 2010 – Jun 2014

- **B.S.** in Physics (Department of Physics)

Research Interests

- Theoretical research in the fields of:
  - Altermagnetism and topological superconductivity
  - Unconventional superconductivity
  - Strongly correlated electrons
  - Phase transition
  - Quantum magnetism

Research Experience

- **Research Topic**: Theoretical study of unconventional superconductivity in the Bi/Ni bilayers (please see Refs. arXiv:1810.10403 and PRB 106, 224508 (2022)) Oct 2015 – Jun 2018
  - Our theoretical conductance spectra of the Anderson-Brinkman-Morel (ABM) state can explain the main features of the point contact Andreev reflection (PCAR) spectroscopy results of the epitaxial Bi/Ni bilayers.

- **Research Topic**: Theoretical study of the correlated insulator behavior and unconventional superconductivity in the twisted bilayer graphene (TBG) system (please see Ref. PRB 105, 245117 (2022)) Sep 2018 – Nov 2020
  - We develop the Gutzwiller approximation method to obtain the renormalized Hamiltonian of the SU(4) t-J model with the corresponding renormalization factors.
  - The feature of the superconducting dome in our results in the vicinity of quarter filling is consistent with that of the superconductivity observed in TBG. Corresponding to the region around the charge neutrality point of TBG, the superconducting state does not exist in the case of hole doping away from half-filling, which is also consistent with TBG experiments.

- **Research Topic**: Numerical study of the one-dimensional SU(4) t-J model (Jia-Cheng He, Jun-Hao Zhang, Jie Lou, and Yan Chen, Six-component pairing instability in the SU(4) t-J chain, arXiv:2311.06601) Sep 2020 – Apr 2022
  - We use the density matrix renormalization group (DMRG) method to study the SU(4) t-J chain. We find that, in addition to the conventional repulsive Luttinger liquid phase and phase separation, there are two phases in the attractive Luttinger liquid region dependent on whether the flavor gap is opened or

not. The first with the flavor gap is the molecular superfluid phase (the SU(4) singlet instability) which is well-known in the attractive SU(4) Hubbard model ($U < 0$). The second without the flavor gap is the superconducting phase (the six-component pairing instability). Furthermore, the molecular superfluid instability cannot coexist with the superconducting instability. This is general in SU(N) models with $N > 2$ and is well demonstrated by the theoretical analysis based on the phenomenological bosonization results.

Work Experience

- **Fudan University**: Apr 2023 – Feb 2024
  - **Research Assistant** in Department of Physics
- **Chongqing University**: Apr 2024 – Now
  - **Youthful Teacher** in Centre for Modern Physics

Publications

1. **Jia-Cheng He**, Jie Hou, and Yan Chen, Gutzwiller approximation approach to the SU(4) t-J model, Phys. Rev. B **105**, 245117 (2022).
2. **Jia-Cheng He** and Yan Chen, Evidence of triplet superconductivity in Bi/Ni bilayers: Theoretical analysis of point contact Andreev reflection spectroscopy results, Phys. Rev. B **106**, 224508 (2022).
3. **Jia-Cheng He**, Jun-Hao Zhang, Jie Lou, and Yan Chen, Six-component pairing instability in the SU(4) t-J chain, arXiv:2311.06601.(submitted to Phys. Rev. B)
4. G. J. Zhao*, X. X. Gong*, **J. C. He***, J. A. Gifford, H. X. Zhou, Y. Chen, X. F. Jin, C. L. Chien, and T. Y. Chen, Triplet p-wave superconductivity with ABM state in epitaxial Bi/Ni bilayers, arXiv:1810.10403. (* **Authors have equal contributions for this work**)

Conferences

- **Physics Summer School held in Stockholm, Sweden** Jun 2018
  - Conference: Quantum Connections - The School: Recent Advances in Quantum Phenomena
- **The 12th International Conference on Materials and Mechanisms of Superconductivity and High Temperature Superconductors (M2S-2018, www.m2s-2018.com), Beijing, China** Aug 2018
  - Contributed poster: Theoretical Formalism of Andreev Reflection Spectroscopy for Three-dimensional Triplet Pairing Superconductors

Skills

- **Analytical techniques**:
  - Proficient in group theory and topology
  - Proficient in quantum field theory in condensed matter physics, including functional integral techniques and Feynman diagrams
  - Proficient in bosonization technique and Luttinger liquid
- **Numerical methods**
  - Proficient in the Bogoliubov-de Gennes (BdG) method
  - Proficient in the density matrix renormalization group (DMRG) method
- **Programming Languages**: C/C++, Python, MATLAB, Mathematica

Languages

- Chinese: Native language
- English: Fluent (speaking, reading, writing)

Miscellaneous

- **ORCID**: https://orcid.org/0000-0002-7409-7728