Lei Zhang

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EDUCATION

University of Michigan (USA)   *Sept. 2020 – present*
Ph.D. in Physics

University of Science and Technology of China (China)   *Sept. 2015 – Jul. 2019*
B.S. in Physics

RESEARCH EXPERIENCE

Research Assistant   *Sept. 2020 – present*
University of Michigan, MI, USA

- Controlled Analytic Continuation from Matsubara data
  - Presented a systematically improvable approach for numerical analytic continuation
  - Developed a compact representation to efficiently compress Matsubara data with minimal degrees of freedom
  - Created the PronyAC and MiniPole libraries for analytic continuation and beyond
- Real-frequency fitting for spectral functions
  - Developed a method to achieve high-precision fitting of the real-frequency spectral function using a minimal number of complex poles
  - Resolved artificial parameter dependencies and other limitations inherent in existing methodologies
- Non-crossing and one-crossing approximations for quantum impurity models
  - Developed C++ code for non-crossing and one-crossing approximations
  - Utilized various schemes such as block-diagonalization and non-uniform meshes to speed up the computation
- Inchworm algorithm for multi-orbital steady-state impurity models
  - Studied inchworm algorithm for non-equilibrium systems
  - Participated in the development of the InchMOSS project

Research Assistant   *Jul. 2017 – Jul. 2020*
University of Science and Technology of China, AH, China

- Loop-Cluster algorithm for q-state Potts model
  - Presented the solution to couple different representations of the q-state Potts model
  - Formulated a novel Monte Carlo algorithm: Loop-Cluster (LC) algorithm
  - Proposed an efficient method to carry out simulations
- Graphical representations and worm algorithms for the O(N) spin model
  - Presented a variety of graphical representations for the classical O(N) spin model
  - Formulated corresponding worm algorithms to perform simulations
  - Explored the dynamic properties of these algorithms

PUBLICATIONS

- **"Compact representation and long-time extrapolation of real-time data for quantum systems"**,
  by André Erpenbeck, Yuanran Zhu, Yang Yu, **Lei Zhang**, Richard Gerum, Olga Goulko, Chao Yang, Guy Cohen and Emanuel Gull,
  available on 16 June 2025 in *arXiv:2506.13760*.

- **"Minimal pole representation for spectral functions"**,
  by **Lei Zhang**, André Erpenbeck, Yang Yu and Emanuel Gull,
  published on 3 June 2025 in *J. Chem. Phys. 162, 214111 (2025)*.

- **"Minimal pole representation and analytic continuation of matrix-valued correlation functions"**,
  by **Lei Zhang**, Yang Yu and Emanuel Gull,
  published on 12 December 2024 in *Phys. Rev. B 110, 235131 (2024)* **[Editors' Suggestion]**.

- **"Green/WeakCoupling: Implementation of fully self-consistent finite-temperature many-body perturbation theory for molecules and solids"**,
  by Sergei Iskakov, Chia-Nan Yeh, Pavel Pokhilko, Yang Yu, **Lei Zhang**, Gaurav Harsha, Vibin Abraham, Ming Wen, Munkhorgil Wang, Jacob Adamski, Tianran Chen, Emanuel Gull and Dominika Zgid, published in *Comput. Phys. Commun. 306, 109380 (2025)*.

- **"Steady-state properties of multi-orbital systems using quantum Monte Carlo"**,
  by Andre Erpenbeck, Thomas Blommel, **Lei Zhang**, Wei-Ting Lin, Guy Cohen and Emanuel Gull, published on 4 September 2024 in *J. Chem. Phys. 161, 094104 (2024)*.

- **"Feynman diagrammatics based on discrete pole representations: A path to renormalized perturbation theories"**,
  by Daria Gazizova, **Lei Zhang**, Emanuel Gull and J. P. F. LeBlanc,
  published on 27 August 2024 in *Phys. Rev. B 110, 075158 (2024)*.

- **"Minimal Pole Representation and Controlled Analytic Continuation of Matsubara Response Functions"**,
  by **Lei Zhang** and Emanuel Gull,
  published on 24 July 2024 in *Phys. Rev. B 110, 035154 (2024)*.

- **"Tensor train continuous time solver for quantum impurity models"**,
  by A. Erpenbeck, W.-T. Lin, T. Blommel, **L. Zhang**, S. Iskakov, L. Bernheimer, Y. Núñez-Fernández, G. Cohen, O. Parcollet, X. Waintal and E. Gull,
  published on 26 June 2023 in *Phys. Rev. B 107, 245135 (2023)*.

- **"Graphical Representations and Worm Algorithms for the O(N) Spin Model"**,
  by Longxiang Liu*, **Lei Zhang***, Xiaojun Tan and Youjin Deng,
  published on 10 November 2023 in *Commun. Theor. Phys. 75, 115702 (2023)*,
  (*: equal contribution).

- **"Loop-Cluster Coupling and Algorithm for Classical Statistical Models"**,
  by **Lei Zhang**, Manon Michel, Eren M. Elçi and Youjin Deng,
  published on 12 November 2020 in *Phys. Rev. Lett. 125, 200603 (2020)*.

PRESENTATIONS

Oral Presentations

- Controlled analytic continuation of Matsubara correlation functions using minimal information principle: invited talk at USTC, 2025
- Minimal pole method for spectral functions: invited talk at USTC, 2025
- Controlled analytic continuation of Matsubara correlation functions using minimal pole representation: APS Global Physics Summit 2025 (Anaheim) (Condensed Matter community)
- A fresh look at the analytic continuation problem: insights from the minimum information principle and from Nevanlinna theory:
  APS Global Physics Summit 2025 (Anaheim) (Lattice QCD community)
- Loop-Cluster Coupling and Algorithm for Classical Statistical Models:
  APS March Meeting 2021 (Online) and 2022 (Chicago)

Poster Presentations

- Controlled analytic continuation of Matsubara correlation functions using minimal pole representation:
  School on Electron Correlations and Topology, Houston, TX, USA, 2025
  Electronic Structure Workshop, El Paso, TX, USA, 2025
  Simons Foundation Superconductivity Summer School, Minneapolis, MN, USA, 2025
- Application of the Prony Method in Analytic Continuation:
  Autumn School on Correlated Electrons, Jülich, Germany, 2023
  MQC Entanglement Conference, Lansing, MI, USA, 2024

SELECTED AWARDS

- Rackham One-Term Dissertation Fellowship   2025
- MICDE Fellowship   2024
- Outstanding Graduate of Anhui Province (highest honor)   2019
- Outstanding Graduate of USTC   2019
- Special Scholarship of SINANO, Chinese Academy of Sciences   2018
- National Encouragement Scholarship   2017
- First Prize in National College Students' Mathematics Competition   2016 & 2017
- Yan Jici Scholarship, Chinese Academy of Sciences   2015 – 2019

TEACHING EXPERIENCE

- Physics 506 (Electromagnetism II), graduate course   Winter 2022 & Winter 2023
- Physics 505 (Electromagnetism I), graduate course   Fall 2022
- Physics 151 (Life Sciences Lab I), undergraduate course   Fall 2021
- Physics 136 (Life Sciences Lab I), undergraduate course   Fall 2020 & Winter 2021

TECHNICAL SKILLS

Programming Languages: Python, C++, Fortran, MATLAB, Julia, Java, Mathematica
Libraries and Tools: NumPy, Matplotlib, Mpmath, Eigen, CMake, Git, LaTeX, TikZ, Gnuplot