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*
Bachelor in Physics

EXPERIENCE

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

- Controlled Analytic Continuation from Matsubara data
  * Presented a controlled way for performing numerical analytic continuation, a task considered impossible for the past few decades
  * Discovered the most compact representation to compress the Matsubara data using minimal degrees of freedom
  * Developed the PronyAC and MiniPole libraries for performing analytic continuation
- 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
- Hybridization fitting for quantum impurity models
  * Designed a method for precise fitting of the hybridization function with arbitrary accuracy
  * Overcame performance bottlenecks in current optimization techniques, significantly improving computational efficiency
- Non-crossing and one-crossing approximations for quantum impurity models
  * Developed C++ code for non-crossing and one-crossing approximations
  * Ulitized various schemes such as block-diagonalization and non-uniform mesh to speed up the computation
  * Ran simulations for systems with spin-orbit coupling
- Inchworm algorithm for muti-orbital steady-state impurity models
  * Studied inchworm algorithm for non-equilibrium system
  * 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

Associated with the U-M degree:

- **"Minimal pole representation for spectral functions"**,
  by **Lei Zhang**, André Erpenbeck, Yang Yu and Emanuel Gull, in preparation.

- **"Minimal pole representation and analytic continuation of matrix-valued correlation functions"**,
  by **Lei Zhang**, Yang Yu and Emanuel Gull,
  published on 12 December 2024 by *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 by *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 by *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 JPF LeBlanc,
  published on 27 August 2024 by *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 by *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 by *Phys. Rev. B 107, 245135 (2023)*.

Associated with the undergraduate degree:

- **"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 by *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 by *Phys. Rev. Lett. 125, 200603 (2020)*.

PRESENTATIONS

Oral Presentations

- Loop-Cluster Coupling and Algorithm for Classical Statistical Models:
  APS March Meeting 2021 (Online) and 2022 (Chicago)

- Controlled analytic continuation of Matsubara correlation functions using minimal pole representation:
  APS March Meeting 2025 (Anaheim, upcoming)

Poster Presentations

- 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

MICDE Fellowship	2024 – 2025
Outstanding Graduate of Anhui Province, top 3%	2019
Outstanding Graduate of USTC	2019
Special Scholarship of SINANO, Chinese Academy of Sciences, top 2%	2018
National Encouragement scholarship	2017
First Prize in National College Students Mathematical Competition, top 2%	2016, 2017
Yan Jici Scholarship, Chinese Academy of Sciences	2015 – 2019

TECHNICAL SKILLS

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