Hao Shi, Graduate Student

College of William and Mary
Department of Physics
Small Hall, Room 140, 300 Ukrop Way
Williamsburg, VA 23185

Phone: (757) 603-5543
Fax: (757) 221-3540
Email: hshi@email.wm.edu
Website: www.boruoshihao.com

Education

Ph.D. Physics, College of William and Mary, Williamsburg, VA, USA, 2017 (expected).

M.S. study, Computational physic, Renming University, Beijing, China, 2008-2011.

B.A. Physics, Nanjing University, Nanjing, China, 2004-2008.

Research Experience

College of William and Mary W&M Computational Materials Physics Group 2011-2016

Research focuses on studying strongly correlated systems by Auxiliary Field Quantum Monte Carlo (AFQMC) and other numerical methods.

- Developed a variety of new AFQMC methods [7,11,12].
- Used these developments to study the two dimensional Hubbard model; work has served as benchmark in the Simons Foundation Many Electron Collaboration [9].
- Studied the two-dimensional strongly interacting Fermi atomic gas, provided valuable benchmarks for future studies, and allowed precise comparisons with experiments [8].
- Made first exact numerical study to determine the ground state properties of the 2D Fermi gas with Rashba spin-orbit coupling [6].
- Current research includes:
  - studying three band Hubbard model.
  - calculating dynamic information in AFQMC.
  - combining Hartree-Fock-Bogoliubov theory with AFQMC.

Renming University Strongly Correlated Physics Computational Group 2008-2011

- Worked on Exact Diagonalization for the topological phase transition in interacting Haldane model.

- Research experience in Dynamic Mean Field Theory, Continuous Time Quantum Monte Carlo and Density Matrix Renormalization Group.

Honors

- Roy L. Champion Research award, awarded to graduate student in physics who has demonstrated outstanding research achievement, May 2016
- The Materials Computation Center travel award of $1900 for "4th Les Houches school in computational physics," Les Houches, France, June 2014
- The Materials Computation Center travel award of $950 for "Quantum Monte Carlo methods at work for novel phases of matter," Trieste, Italy, Jan 2012

Presentations

- **Invited talk**: "Ground-state properties of the two-dimensional strongly interacting Fermi atomic gas and the interplay between superfluidity and spin-orbit coupling "

  XVIII International Conference on Recent Progress in Many-Body Theories, Niagara Falls, NY, August 2015 .

- **Invited talk**: "Recent developments in auxiliary-field quantum Monte Carlo: magnetic orders and spin-orbit coupling"

  ES2015 Workshop: Developments in electronic structure theory and excited states beyond ground state DFT, Seattle, WA, June 2015.

- Contributed talk: APS March Meeting 2012-2016, Simons Collaboration on the Many Electron Problem Annual Meeting, 2015.

  More presentations can be found at: www.boruoshihao.com/research

Publications

1. Quantum Monte Carlo simulation with Hartree-Fock-Bogoliubov wave function

   Hao Shi and Shiwei Zhang, in preparation.

2. Coupling quantum Monte Carlo and independent-particle calculations: self-consistent constraint for the sign problem based on density or density matrix

   Mingpu Qin, *Hao Shi*, and Shiwei Zhang, Phys. Rev. B. 94, 235119 (2016).

3. Cluster size convergence of density matrix embedding theory with an auxiliary field quantum Monte Carlo solver: cellular and dynamical cluster formulations

Bo-Xiao Zheng, Joshua S. Kretchmer, *Hao Shi*, Shiwei Zhang, and Garnet Kin-Lic Chan, arXiv:1608.03316 (2016).

4. Computation of dynamical correlation functions for many fermions systems with auxiliary-field quantum Monte Carlo

   Ettore Vitali, *Hao Shi*, Mingpu Qin, and Shiwei Zhang, **editors' suggestion**, Phys. Rev. B 94, 085140 (2016).

5. A benchmark study of the two-dimensional Hubbard model with auxiliary-field quantum Monte Carlo method

   Mingpu Qin, *Hao Shi*, and Shiwei Zhang, Phys. Rev. B. 94, 085103 (2016).

6. Rashba spin-orbit coupling, strong interactions, and the BCS-BEC crossover in the ground state of the two-dimensional Fermi Gas

   Hao Shi, Peter Rosenberg, Simone Chiesa, and Shiwei Zhang, Phys. Rev. Lett. 117, 040401 (2016).

7. Infinite Variance in Fermion Quantum Monte Carlo Calculations

   Hao Shi and Shiwei Zhang, Phys. Rev. E 93, 033303 (2016).

8. Ground-state properties of strongly interacting Fermi gases in two dimensions

   Hao Shi, Simone Chiesa, and Shiwei Zhang, Phys. Rev. A 92, 033603 (2015).

9. Solutions of the Two Dimensional Hubbard Model: Benchmarks and Results from a Wide Range of Numerical Algorithms

   J. P. F. LeBlanc, Andrey E. Antipov, Federico Becca, Ireneusz W. Bulik, Garnet Kin-Lic Chan, Chia-Min Chung, Youjin Deng, Michel Ferrero, Thomas M. Henderson, Carlos A. Jiménez-Hoyos, E. Kozik, Xuan-Wen Liu, Andrew J. Millis, N. V. Prokof'ev, Mingpu Qin, Gustavo E. Scuseria, *Hao Shi*, B. V. Svistunov, Luca F. Tocchio, I. S. Tupitsyn, Steven R. White, Shiwei Zhang, Bo-Xiao Zheng, Zhenyue Zhu, and Emanuel Gull, Phys. Rev. X **5**, 041041 (2015).

10. CPMC-Lab: A Matlab package for Constrained Path Monte Carlo calculations

    Huy Nguyen, *Hao Shi*, Jie Xu and Shiwei Zhang, Computer Physics Communications 185, 12 (2014).

    Details about the CPMC-Lab package at http://cpmc-lab.wm.edu/

11. Symmetry-projected wave functions in quantum Monte Carlo calculations

    Hao Shi, Carlos A. Jiménez-Hoyos, R. Rodríguez-Guzmán, Gustavo E. Scuseria, and Shiwei Zhang, Phys. Rev. B 89, 125129 (2014).

12. Symmetry in Auxiliary-Field Quantum Monte Carlo Calculations

Hao Shi and Shiwei Zhang, Phys. Rev. B 88, 125132 (2013).

13. Charge-density-wave and topological transitions in interacting Haldane model

    Lei Wang, *Hao Shi*, Shiwei Zhang, Xiaoqun Wang, Xi Dai, and X. C. Xie, *ArXiv:1012.5163 (2010)*.