Hao Shi, Graduate Student

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Education

Ph.D. Physics, College of William and Mary, Williamsburg, VA, USA, 2016 (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   2011-2015

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:

    1. adding symmetry in both trial wave function and projector to AFQMC.

    2. developing the release constraint method.

    3. using force-bias method to improve the efficiency in Metropolis framework.

    4. solving the infinite variance problem.

- Used these developments to study the two dimensional Hubbard model; work has served as benchmark in the Simons Foundation Many Electron Collaboration.

- Studied the two-dimensional strongly interacting Fermi atomic gas, provided valuable benchmarks for future studies, and allowed precise comparisons with experiments.

- Current research includes

    1. studying Rashba spin orbit coupling effect in two dimensional Fermi gas.

    2. calculating dynamic information in AFQMC.

    3. combing AFQMC and Density Matrix Embedding Theory, solving the impurity model by AFQMC.

- Supervised undergraduate students for Constrained Path Monte Carlo research.
- Collaborated with graduate students and postdoctoral researchers in the group and other researchers outside the group.

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

- 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 2012-2015, Simons Collaboration on the Many Electron Problem Annual Meeting, 2015.

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

Skills

- Familiar with programming languages including *Fortran*, *C++*, *Python*, and *Mathematica*.
- Use *Cmake* and *Git* for developing the code.

- Use *MPI* and *OpenMP* for high performance computing.

- Familiar with *Latex*.

Publications

- 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, arXiv:1602.08046 (2016).

- Infinite Variance in Fermion Quantum Monte Carlo Calculations

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

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

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

- 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).

- 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/

- 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).

- Symmetry in Auxiliary-Field Quantum Monte Carlo Calculations

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

- 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).