Kyungmin Lee

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PROFESSIONAL SUMMARY

Expert in numerical methodologies in theoretical physics of quantum materials. Studied novel phenomena in quantum systems using numerical techniques including spectral analyses, Monte Carlo simulations, and optimizations. Successfully completed several large-scale numerical computation projects. Expert in C++, Python, and Julia

PROFESSIONAL/RESEARCH EXPERIENCE & PUBLICATIONS

2010–2016 **Research Assistant in Theoretical Physics, Cornell University, NY**

- Investigated spontaneous rotation-symmetry breaking in interacting quantum mechanical systems using *Krylov space techniques* & *determinant quantum Monte Carlo* (Fortran, C++ with OpenMP & MPI)
- Studied superconducting vortex physics, topological superconductivity, and spontaneous symmetry breakings with *high-dimensional optimization using iterative methods* (C++ with TBB & MPI, Python)
  K. Lee, M.H. Fischer, E.-A. Kim, New J. Phys. **15**, 053048 (2013).
  K. Lee, A. Vaezi, M.H. Fischer, E.-A. Kim, Phys. Rev. B **90**, 214510 (2014).
  K. Lee, S.A. Kivelson, E.-A. Kim., Phys. Rev. B **94**, 014204 (2016).
- Numerically simulated experimental signatures of electron-boson coupling with *massively parallel matrix spectral analysis using GPGPU programming* (C++ with CUDA, Python)
  M.P. Allan, K. Lee, A.W. Rost, et al., Nat. Phys. **11**, 177-182 (2015).
- Discovered exotic phase of matter using *matrix eigendecomposition and dimensionality reduction using translation (Abelian) symmetry* (C++ with PETSc/SLEPc, Python)
  Z. Liu, A. Vaezi, K. Lee, E.-A. Kim, Phys. Rev. B **92**, 081102(R) (2015).
- Confirmed a mechanism of spontaneous rotation-symmetry breaking of 2D electron gas with *variational Monte Carlo* (~2 billion steps) *using Metropolis-Hastings algorithm* (C++ with TBB, Python, Cython)
  K. Lee, J. Shao, E.-A. Kim, F.D.M. Haldane, E.H. Rezayi, Phys. Rev. Lett. **121**, 147601 (2018) [Editor's Suggestion].

2016–2019 **Postdoctoral Researcher in Condensed Matter Theory, The Ohio State University, OH**

- Identified topological phases of matter with *high-dimensional optimization using iterative methods* (Julia)
  K. Lee, T. Hazra, M. Randeria, N. Trivedi, Phys. Rev. B **99**, 184514 (2019).
- Simulated structural formations of adatoms with *discrete optimization using simulated annealing* (Julia)
  J. Choe, K. Lee, et al., Phys. Rev. B **99**, 064420 (2019).

2019–present **Postdoctoral Scholar in Condensed Matter Theory, National High Magnetic Field Laboratory, Florida State University, FL**

- Studied quantum thermalization using *matrix eigendecomposition with dimensional reduction using space group (Abelian and non-Abelian)* & developed a library for it (Julia)
  K. Lee, R. Melendrez, A. Pal, H.J. Changlani, Phys. Rev. B **101**, 241111(R) (2020).
  K. Lee, A. Pal, H.J. Changlani, Phys. Rev. B **103**, 235133 (2021).
- Investigated properties of magnon quasiparticles in *one-dimensional magnetic chains using tensor-network-based optimization / time-evolution techniques* (C++, Julia)
  P. Sharma, K. Lee, H.J. Changlani, accepted to Phys. Rev. B (2022).

EDUCATION

2009–2016 **Ph.D. in Theoretical Physics, Cornell University, NY**

- Advisor: Prof. Eun-Ah Kim
- Thesis: Theoretical Studies on Electronic Spectra of Heterogeneous Unconventional Superconductors

2002–2009 **B.S. in Physics, B.S. in Computer Science and Engineering (Dual Major), Seoul National University, South Korea**

- GPA: 4.06/4.30 (Graduated with summa cum laude)

TECHNICAL SKILLS

C++ Proficient. Developed 100k+ lines of code for high performance numerical methods in quantum mechanics to run on HPC clusters (spectral analysis, Monte Carlo, optimization)

Python Proficient. Developed 50k+ lines of code for various projects on numerical methods in quantum mechanics. (prototyping for C++, statistical analysis)

Julia Proficient. Developed 100k+ line libraries for efficient representation of generic interacting quantum mechanical Hamiltonian with nontrivial statistics (bosonic and fermionic) and dimensionality reduction using group theoretical techniques.

CUDA Familiar. Developed code for parallelized spectral analysis of quantum mechanical systems.

MPI Familiar. Used with C++ for large scale eigendecomposition on HPC clusters.

CERTIFICATIONS

2021 **Machine Learning**, offered by Stanford University on Coursera

2021 **Deep Learning Specialization**, offered by DeepLearning.AI on Coursera
Neural Networks and Deep Learning / Improving Deep Neural Networks: Hyperparameter Tuning, Regularization and Optimization / Structuring Machine Learning Projects / Convolutional Neural Networks / Sequence Models

AWARDS

2015 **Douglas Fitchen Memorial Award, Cornell University, NY**

- Awarded to a students in support of travel abroad to study, pursue research, or participate in international physics related events.

2009–2014 **Overseas Ph.D. Scholarship, Korea Foundation for Advanced Studies, Korea**

- Awarded to outstanding Ph.D. students enrolled in world's top universities.

2003–2008 **Undergraduate Student Scholarship Program, KFAS, Korea**

- Awarded to undergraduate students for their excellence.

2001 **32nd International Physics Olympiad – Solver Medal, Antalya, Turkey**

2000 **31st International Physics Olympiad – Honorary Mention, Leceister, UK**

PERSONAL SOFTWARE PROJECTS

Numerical Method Packages used for Quantum Materials written in Julia

- LatticeTools.jl -- Julia package that provides functionalities to define lattices and perform symmetry analyses useful for studying interacting quantum many-body Hamiltonians.
- QuantumHamiltonian.jl -- Julia package for constructing interacting quantum many-body Hamiltonians.
- QuantumHamiltonianParticle.jl -- Particle extension for QuantumHamiltonian.jl.
- HartreeFockBogoliubov.jl -- Hartree-Fock-Bogoliubov solver for generic interacting fermion Hamiltonians.
- MinimalPerfectHash.jl -- Implementation of Minimal Perfect Hashing using CHD algorithm.
- SuperLU.jl -- Julia interface to SuperLU.

Others

- unicode-widget -- Input helper for unicode characters. Essential for physics presentations.