Jiachen He

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GitHub: https://github.com/jhe274 Portfolio: https://jhe274.github.io/portfolio-bruce.github.io//

SKILLS SUMMARY

• Laser & Optical Systems: Laser optics, fiber optics, solid-state lasers, polarization modulation ellipsometry, spin-exchange optical pumping (SEOP), polarimetry, interferometry

- Instrumentation & Electronics: Cryogenic systems, lock-in amplifiers, electro-optic modulators, RF signal generators, spectrum analyzers, oscilloscopes, photodetectors
- Software & Programming: Python (scientific programming, hardware automation), C++, MATLAB, Zemax, COMSOL, Autodesk Inventor, LabVIEW, Mathematica
- Simulation & Modeling: Magnetic field design (Merritt coils, finite element analysis), optical metrology, quantum light-matter interaction
- Platforms & Systems: Unix/Linux, Windows, Python based synchronous data acquisition system

Professional Experience

Graduate Research Assistant

University of Kentucky

Email: jiachen.he@outlook.com

Experimental Realization of a Sensitive Optical Magnetometer Based on the Resonant Faraday Effect

August 2019 - Present

- o Optical Metrology: Expert in polarization modulation ellipsometry, specializing in precise optical alignment, system calibration, and optimization. Developed a system for detecting minute magnetic field variations associated with spin-polarized helium-3 targets using magneto-optic effects without magnetic shielding, achieving a shot noise limited sensitivity of $4.8 \times 10^{-11} \,\mathrm{G/\sqrt{Hz}}$ under SEOP operating temperature ($\sim 510 \,\mathrm{K}$).
- o Laser Frequency Stabilization: Extensive experience in spectroscopic laser locking using PDH and DSAS techniques with optical cavities and alkali metals (Rb, K), reducing laser frequency drift to ~ 200 kHz/h – over 110 times more stable than unlocked systems. Implemented sideband locking over 40 GHz using a 6 GHz bandwidth EOM for precise frequency control.
- Software Development: Published two Python packages on GitHub using object-orientated programming to interface with scientific instruments like wavelength meter and Gaussmeter, eliminating reliance on low-level SCPI commands while optimizing buffer management and communication protocols.
- Lab Automation: Proficient in developing modular Python-based synchronous data acquisition systems for communication with scientific instruments such as wavelength meter, laser controller, lock-in amplifiers, and Gaussmeter. The system efficiently initializes, configures, and synchronizes instruments, sending TTL-level pulse trigger signals and recording data in their buffers with sub-millisecond time differences.
- o Merritt Coil Development and Implementation: Developed a compact Merritt coil system using advanced parametric mechanical modeling in Autodesk Inventor, achieving a 6x reduction in size compared to traditional Helmholtz coils. The design doubled the longitudinal field gradient and expanded the uniform field range by 33%. Collaborated with machine shop teams to ensure manufacturability and successful implementation, supported by Python for simulation and optimization.
- Compact Magnetic Field Deisgn: Independently designed and developed a magnet box prototype using COMSOL and MATLAB Simulink, this early career project achieving a 7G magnetic field with a 20 mG/cm gradient over a 10 cm range. Enhanced expertise in finite element analysis by leveraging concepts such as magnetic scalar potential and image fields.
- Cryogenic and Vacuum Systems: Contributed to system calibration and maintenance of a cryogenic system, gaining hands-on experience with vacuum technologies over five years.
- o Ongoing Projects: Implementing machine learning algorithms for real-time magnetic field cancellation.

Summer Research

Research on Etch Track-Directed Growth of Carbon Nanotubes on Graphite

University of Kentucky May 2018 - August 2018

Graduation Project

Research on the Control System of Intelligent Fish Tank Based on Single Chip Microcomputer

Shenzhen University September 2015 - May 2016

Open Laboratory Fund Project

Research on the Design of Temperature-controlled Automatic Watering Device

Shenzhen University

September 2012 - October 2013

EDUCATION

University of Kentucky

United States

Ph.D. in Physics

(Expected May 2025) August 2019 - Present

Foci: Magnetic field modeling, quantum light-matter interaction, magneto-optic effects, optical metrology, spin-exchange optical pumping, optical homodyne detection, and laser frequency stabilization.

University of Kentucky

United States

M.S. in Physics

August 2017 - May 2019

Shenzhen University

China

B.E. in Measurement Control Technology and Instruments September 2010 - July 2017

Thesis: Research on the Control System of Intelligent Fish Tank Based on Single Chip Microcomputer.

Publications

- Korsch, W., Broering, M., Timsina, A., Leung, K.K., Abney, J., Budker, D., Filippone, B.W., <u>He, J.</u>, Kandu, S., McCrea, M. and Roy, M., 2024. Electric charging effects on insulating surfaces in cryogenic liquids. Review of Scientific Instruments, 95(4).
- <u>Jiachen He</u>, Wolfgang Korsch, "Experimental Realization of a High-Sensitivity Optical Magnetometer Using the Resonant Faraday Effect": "In preparation"

Presentations

In Person

- <u>J. He</u>, W. Korsch, "Using the resonant Faraday effect to probe external magnetic fields": American Physical Society Global Physics Summit, Anaheim, March 2025
- <u>J. He</u>, W. Korsch, "Resonant Faraday rotation measurements in a potassium vapor cell.": American Physical Society April meeting, Sacramento, April 2024

Poster Presentations

- <u>J. He</u>, W. Korsch, "Resonant Faraday rotation measurements in a potassium vapor cell.": Department of Physics & Astronomy, University of Kentucky, August 2024

 Awarded Second Overall Best Poster
- <u>J. He</u>, W. Korsch, "A compact magnet design to create low-gradient magnetic field in the presence of magnetic shielding.": National Nuclear Physics Summer School, Massachusetts Institute of Technology, Cambridge, July 2022
- <u>J. He</u>, W. Korsch, "A compact magnet design to create low-gradient magnetic field in the presence of magnetic shielding.": Department of Physics & Astronomy, University of Kentucky, August 2021

Honors & Awards

• Graduate Student Congress (GSC) Conference Award

April 2024

• Huffaker Travel Scholarship, Department of Physics & Astronomy, University of Kentucky

2022, 2024, 2025

• Departmental fellowship for graduate students with an outstanding curriculum

August 2017 - May 2019

• Max Steckler Fellowship, Graduate School Fellowship, University of Kentucky

August 2018

LEADERSHIP & COLLABORATIONS

• Alumni Liaison February 2025 - Present

• Department Representative at Graduate Student Congress (GSC)

August 2023 - August 2024

• High School Mentorship

September 2023 - May 2024

Guided a high school student in a scientific project exploring light polarization and measuring the speed of light using Herriott style cavity mirrors and custom built rotating mirror.

• Undergraduate Mentorship

2021 - 2024

Supervised multiple undergraduate students in research, including a Research Experiences for Undergraduates (REU) participant from MIT, providing theoretical guidance on the resonant Faraday effect in a two-level system. The project culminated in a presentation at the 2024 Division of Nuclear Physics (DNP) Meeting.

• Collaboration with Engineers

2019 - Present

Partnered with machine shop engineers with a strong track record of designing custom-built electronic devices and developing a Merritt coil winding system.

PROFESSIONAL AFFILIATIONS

• American Physical Society (APS)

2021 - Present

• Society of Photo-Optical Instrumentation Engineers (SPIE)

2024 - Present