

# Jiachen He

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## SKILLS SUMMARY

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- **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

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- **Graduate Research Assistant** University of Kentucky  
*Experimental Realization of a Sensitive Optical Magnetometer Based on the Resonant Faraday Effect* 2019 - 2025
  - **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, estimating a shot noise limited sensitivity of  $4.8 \times 10^{-11}$  G/ $\sqrt{\text{Hz}}$  under SEOP operating temperature ( $\sim 510$  K).
  - **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  $\sim 200$  kHz/h – over 110 times more stable than unlocked systems. Implemented sideband locking over 24 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.
  - **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 longitudinal field gradient was reduced by a factor of 4 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 Design:** Independently designed and developed a magnet box prototype using COMSOL and MATLAB Simulink, this early career project achieving a 7 G 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.
  - **Ongoing Projects:** Implementing machine learning algorithms for real-time magnetic field cancellation.
- **Summer Research** University of Kentucky  
*Research on Etch Track-Directed Growth of Carbon Nanotubes on Graphite* May 2018 - August 2018
- **Graduation Project** Shenzhen University  
*Research on the Control System of Intelligent Fish Tank Based on Single Chip Microcomputer* September 2015 - May 2016
- **Open Laboratory Fund Project** Shenzhen University  
*Research on the Design of Temperature-controlled Automatic Watering Device* September 2012 - October 2013

## EDUCATION

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- **University of Kentucky** United States  
*Ph.D. in Physics* August 2019 - November 2025  
**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 (equivalent to EE)* September 2010 - July 2017  
**Thesis:** Research on the Control System of Intelligent Fish Tank Based on Single Chip Microcomputer.

## PUBLICATIONS

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

## PRESENTATIONS

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### In Person

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

### Poster Presentations

- **J. He, 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*
- **J. He, 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
- **J. He, 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

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- 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

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- **Alumni Liaison** *February 2025 - Present*
- **Department Representative at Graduate Student Congress (GSC)** *August 2023 - August 2024*
- **Collaboration with Engineers** *2019 - 2025*  
Partnered with machine shop engineers with a strong track record of designing custom-built electronic and mechanical devices, including a Merritt coil winding system.
- **Undergraduate Mentorship** *2021 - 2025*  
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.
- **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.

## PROFESSIONAL AFFILIATIONS

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- American Physical Society (APS) *2021 - Present*
- Society of Photo-Optical Instrumentation Engineers (SPIE) *2024 - Present*