

# Statement of Purpose

Department of Physics and Astronomy at University of Alabama

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## My Academic Experience

As I'm sure is the case with any condensed matter physicist, I haven't always known I would pursue condensed matter physics. Telescopes inspire children to astronomy, microscopes inspire children to biology, and condensed matter physics is left to allure the occasional, unsuspecting undergraduate student like myself.

During my time at Western Michigan University, I grew to be fascinated by the physics of the small and the physics governing the technology of the modern world. After assisting with semiconductor defect research for over a year, I knew I wanted to pursue condensed matter physics in graduate school. This research affirmed my deep appreciation for computers, and ever since I've been certain that I want to work with simulations, models, and work in fields applicable to computers, either quantum or classical. This is why I'm motivated to pursue condensed matter physics and quantum information science in graduate school. Graduate school is my next step, as it will allow me to further develop these interests, setting me up for my goal of researching semiconductors or quantum computing in the industry or as a professor. The University of Alabama, given the diversity and depth of research in these fields, is the perfect place for me to accomplish this goal.

In my four years at WMU, I've been working towards physics and mathematics majors with computer science and astronomy minors. This wasn't always the goal, as I realized halfway through my undergraduate experience that I enjoyed learning about and working with computers too much to not incorporate computer science into my education. I also realized that I could benefit from the stronger math skills that came with math as a major instead of a minor, and I now find concepts like topology and group theory in physics more approachable than they would have been otherwise. The workload, time management, and work ethic I learned in these four years ensure I can handle the responsibilities of graduate school.

Despite the hefty course load, I've been a dean's list student, been awarded a research scholarship through WMU's Undergraduate Research, Ingenuity and Creativity Summer Scholarship program (URICS), and most notably, I've received the Paul Rood Physics Scholarship from the Physics Department acknowledging exceptional performance within the department. I have certainly laid the foundations to be successful in computational physics research through both coursework and research experience, and I believe these accolades prove my capability.

**By far my most extensive research experience is my research on semiconductor deep acceptor center defects with Dr. O'Hara of the Physics Department**, which I currently run on Michigan State University's High-Performance Computing Cluster (HPCC). The goal of this research is to calculate formation energies and model structural distortions of defects in gallium and aluminum rich AlGaAs alloys to corroborate and explain experimental findings. This research has familiarized me with solid state physics, semiconductors, crystal lattice structures, density functional theory, VASP, different functionals like PBE and HSE, alloying techniques like the virtual crystal approximation (VCA), explicit quasi-random structures, and much more. I've also learned countless things about how to interface with computer clusters, how to move files around, how to analyze data, and how to write scripts to do all of this efficiently. I've attached a digital copy of a poster from my URICS scholarship work that I presented at WMU's Lee Honors College, summarizing my preparatory work and alluding to my current research.

Additionally, this spring, I've begun a semester project with Dr. Korista of WMU's Physics Department modeling stellar evolution in different classes of stars. This will provide me with a diversity of experiences with computational physics and data analysis across fields and with many programming languages.

During my time at WMU, I've learned to operate and collect data from the Tandem Van de Graaff Accelerator in Rood Hall and have occasionally worked with the research team that regularly operates it. The peak of my involvement was in the summer of 2024, when the department received cable samples from NASA with the request that we measure radiation tolerances. As of this semester, I have also been spending time with the physics department's machine shop specialist learning to manufacture simple parts, learning machine shop etiquette and safety, and how to communicate jobs effectively with machinists. Although my skills are best suited for theoretical, computational work, I believe my familiarity with the lab setting and part manufacturing has made me a well-rounded physicist and better able to help in experimental settings when necessary.

### **Why I choose the University of Alabama**

The University of Alabama would provide me with ample opportunity to build upon my knowledge and skills I've gained in computational condensed matter physics research, while also providing opportunities to explore related topics. My confidence in navigating large computer clusters and running jobs on them is a directly transferable skill that would enable me to quicker contribute to theoretical, computational groups such as those of Dr. Tse and Dr. Schwiete. UA is the perfect place to get the education, experience, and expertise I need to go forward into a career, onto the frontier of research. The Tse, Schiwete, and Hauser groups interest me the most.

I'm primarily interested in the Tse group, as I'll have over a year of continuous experience in condensed matter research by the time I graduate, and I'm interested in pushing my knowledge to other types of semiconductors and semiconducting materials and their defects. I believe my strong foundation in computational research regarding semiconductors, distortions, and defects will provide me a strong starting point for learning from and contributing to Dr. Tse's research. His research also is most closely aligned with work that I'd like to find in industry after graduation.

Leaning into a similar interest in computational many-body research, I can see myself working with Dr. Schiwete's group. While his work strays a bit farther away from familiar territory, I'm looking to explore unfamiliar territory and especially the low-level quantum physics of Dr. Schwiete's research, and I'm well equipped for such undertakings.

While I do lean more towards the computational side of things, I am drawn towards Dr. Hauser's experimental research as well and what opportunities it could provide me after graduate school, seeing as I'd like to work in industry. A large reason I've developed such an interest in condensed matter physics is the practicality of it, and Dr. Hauser's work seems to embody that. I'd be very interested in spending time with his group if admitted.

I'm eager to apply all that I've learned towards the fascinating research at UA, and I look forward to the opportunity to learn from and contribute to your research teams. I am confident that I'd make a capable, committed researcher and condensed matter physicist. Thank you for your time and for considering my application.