

# Academic Statement of Purpose

## U-M LSA Physics

Ethan Snyder

### 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 Michigan, 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 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, in the spring, I will be beginning 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 Michigan**

U-M 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 a wide range of 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 Dr. Gull's. U-M 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 Gull and Forrest groups interest me the most.

Dr. Gull's research is some of the most exciting, fascinating research I've seen in any physics department. His work is very oriented towards quantum computing applications, is very computationally intensive, and touches on topics familiar to me like many-body quantum systems, lattice systems, and impurity systems. I'm also very interested in software development and exercising my computer science and coding skills, which Dr. Gull's research would allow me to do. This research reaches every interest of mine and would build upon all of my undergraduate computational condensed matter research, and would allow me to gain expertise in the exact niche of physics that I'd like to pursue in my life. For these reasons, I would be beyond excited to work with Dr. Gull at U-M.

Leaning into my interest of experimental work, I find Dr. Forrest's research interesting and can see myself contributing to his team. His work with III-V semiconductors and traditional semiconductors is something familiar to me through my current research experience, although not in the experimental sense, as I haven't yet had the opportunity to grow semiconductors or work with them in the lab setting. The practicality of this work and its applications to the energy sector are very appealing, and I believe my unique background in theoretical work and combined with my experimental, hands-on experience could provide a lot to Dr. Forrest's team.

I'm eager to apply all that I've learned towards the fascinating research at U-M, 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.