Academic Statement of Purpose

Department of Physics at the University of Wisconsin-Madison

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 Wisconsin-Madison, 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 Wisconsin-Madison

UW-Madison 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 the chance to explore related topics within this field. UW-Madison provides the ideal environment to get the education, experience, and expertise I need to go forward into a career, onto the frontier of research. In particular, Dr. Friesen, Dr. Joynt, and Dr. Woods' research interests me, and I'm drawn to the strong collaborative dynamic within this trio and with experimental researchers across the department. Their complementary research would allow me to explore similar topics and ideas without straying too far from my core area of interest, and would provide me multiple avenues of support in my future research — this is an opportunity unlike any other physics graduate program, and is the reason UW-Madison is a perfect fit for my academic journey.

I'm most interested in Dr. Friesen and Dr. Joynt's research due to its proximity to my undergraduate research, while also delving into areas applicable to quantum computing. Their work touches on familiar topics like semiconductor heterostructures and electronic structures, which would allow me to leverage my background while expanding into areas like quantum error correction and quantum processing. These areas of overlap would be strong starting points in understanding more complex, interesting topics like quantum dots, quantum error correction, and quantum processing. Also, the frequent collaboration with experimental groups is very appealing, and I believe I'd be more fulfilled in graduate school when working with experimental groups from a computational, theoretical approach. I can see myself being a strong contributor to the Friesen and Joynt groups in the future and look forward to the opportunity to work with him.

Dr. Woods seems to have similar, but more distinct research which interests me because it has even more similarities to my undergraduate research than Dr. Friesen and Dr. Joynt's research, and seems to explore a slightly different niche than their work as well. Dr. Woods' research focuses a lot on semiconductors and electronic structures and spans to areas like nanowires and Majorana devices, topics that I am interested in but inexperienced with. I believe that I'd be a strong addition to Dr. Woods' research team given my thorough computational, theoretical research experience and my strong foundation of knowledge in condensed matter physics.

I'm eager to apply all that I've learned towards the fascinating research at UW-Madison, and I look forward to the opportunity to learn from and contribute to the collaborative efforts of professors Friesen, Joynt, Woods, as well as their experimental collaborators. I'm confident that I'd make a capable, committed researcher and condensed matter physicist. Thank you for your time and for considering my application.