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Statement of Purpose

Matthew Kowalski

This spring, I will graduate from Michigan State University (MSU) with degrees in Advanced Mathematics, Physics, and Computational Mathematics with a minor in Computer Science. My primary research interests are in mathematical physics and probability theory, so I am interested in UCLA because of the abundance of research being conducted in a mixture of the two. I am particularly excited at the prospect of working with Dr. Menz for his work in probability theory and statistical mechanics, Dr. Jun Yin for his work on Wigner matrices, and Dr. Biskup for his work on random walks.

My most significant research experience has been with the IceCube Neutrino Observatory, a computational and experimental physics group. Despite my focus on mathematics, I worked with IceCube throughout undergraduate for the mixture of computational mathematics, computer science, and particle physics that I encountered. My focus at IceCube was analyzing the effects of computational shortcuts used in IceCube's simulation, notably photodetector oversizing. It was my concern that oversizing made incorrect assumptions about photon flux and was producing inconsistent results. In order to test my concern, I built a Monte Carlo simulation of photons scattering within IceCube. The most significant hurdle in this construction was efficiently determining the geometry of scattering photons. To optimize this, I came up with a system that leaves each photon stationary at the origin, pointed in the z direction, and then rotates and translates the detector to "move" the photon. With the program in a working state, I was able to conclusively determine that my concerns were valid by simulating a variety of events that displayed significant changes with oversizing. I presented these findings to my group, who agreed with the conclusion.

On top of my time with IceCube, I conducted mathematical physics research with Professor Abbas last spring. My project was focused on contemporary topics in symplectic geometry, specifically Gromov's non-squeezing theorem and its applications.

In addition to my research, I have challenged myself through advanced coursework. By the time that I graduate, I will have completed four graduate mathematics courses and five graduate physics courses. These include the qualifying analysis sequence and the qualifying quantum mechanics, classical mechanics, and classical electrodynamics sequences. Despite the difficulty of these, I have enjoyed each and managed to maintain a perfect 4.0 grade point average throughout. Along with these courses, I am participating in an independent study on quantum information theory with Professor Schenker this upcoming spring semester.

The final aspect of my application that I would like to highlight is my experience in teaching students. Throughout my time at MSU, I have had the opportunity to TA for three separate courses. My role in these courses was focused on answering student questions and providing clarity on lecture topics. By the end of these, I found myself passionate about the students and their learning. It was rewarding to see the dawn of understanding on a student's face and to see the gradual progress of returning students.

Thank you for your consideration of my application.