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Dear Application Committee for the Lawrence Research Fellowship,

I hope the following exposition finds you well and adequately details my proposed research project on the Point Spread Function (PSF).

The **objective** of this research is to come up with a mathematical model to describe the PSF. The PSF is a function that takes in some parameters and outputs a matrix. This matrix acts on point sources, essentially distorting images of star light. It would be my job to help in creating a software pipeline that runs a parameter estimation on the PSF and creates diagnostic plots to see how well our estimate performed. We will start by running our model on simulated data where we can compare our model's behavior to the correct answer. Once our model is well calibrated we would like to then use the model on real data captured by the James Webb Space Telescope to generate actual measurements of the PSF. Data is coming in now and so we would be able to work on this from the getgo of the Co-op project.

On a **day to day basis** , I would spend several hours of my time programming with Python, creating a file infrastructure with Linux, and making things accessible for a larger collaboration. Additionally, I aim to read papers in the literature and explore programming libraries pertinent to my research. This will help me build up enough familiarity in the field to embark on some longer term goals.

We are currently using a library called PIFF to do our PSF modeling, and in doing so, we are using its functionality beyond its original purpose. PIFF assumes that the distortion of light is random, which we know not to be the case. As such, one of my **long term goals** is to write my own library to replace it, building off of my knowledge from literature review and advanced coursework.

How I plan to build on previous research and coursework experiences:
I have over 6 months of research experience from a summer internship and self developed research course last fall related to Machine Learning on image data. For this project I will continue to be using image data and so I have a sufficient programming background to contribute from day one. For my research course I wrote an expository paper as a way to ingratiate myself into the literature, which is linked [Here]. This has given me experience in writing clearly about science. During my internship I was selected as one of the top interns to have a fully paid trip to Virginia Tech to present about my research and internship experience, which has given me practice advocating for the quality of my work, something that will be important since Professor McCleary works as apart of a larger collaboration.

Additionally, I would like to highlight several courses that I feel are pertinent to this project. I am currently taking a PhD-Level Class: Math 7223 Riemannian Optimization. This course is allowing me to build up the machinery to tackle optimization problems on smooth manifolds using the Manopt Library, which has implementations in Julia, Matlab, and Python, all languages that play nicely with our current ecosystem. Using Riemannian Optimization techniques in the context of PSF parameter estimation would be a novel approach to the literature and I am actively preparing to implement them. Moreover, the precedent is set for using these techniques on image data, as it is commonplace in robotics and computer vision.

I have also taken or currently am taking Math 4571 Advanced Linear Algebra, Math 3181 Advanced Probability and Statistics, Math 4545 Fourier Series and PDES, Phys 4606 Mathematical and Computational Methods for Physics, Phys 4305 Thermodynamics and Statistical Mechanics, and Phys 3602 Electricity and Magnetism I.

Thank you for taking the time to read about my proposed Co-op project and personal experiences,

Edward Berman,
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