Research Statement

I have a number of research interests which I believe would be a good fit with Carleton's Physics Department. My Masters of Science in Science Education has led me to working on improving my teaching through action research. With my background in observational astronomy, I have research skills using X-ray, radio and optical data, which most recently I have applied to extragalactic clusters and groups of galaxies and large scale structure. However, the skills I have developed could easily be applied to other areas of astronomy to create a breadth of topics within the field as necessary. I also have some research interest in climate change models; this would be a new direction for me but one I feel I could bring a great deal of passion and students would find very relevant.

My science education research has pivoted around improving student engagement and outcomes in our introductory astronomy course. We have developed a number of laboratory exercises which use the small telescope at St. Thomas; my question revolved around the impact of this telescope use on the student experience. I found that students are indeed happier when they have ownership of the data – not only that the data is from our telescope but it is their data. More surprisingly, there were small but significant gains in student understanding as measured on exams. Students who performed worse on the pre-test also increased more to equal or surpass those students who had initially done better but had not known the data was from our telescope and their own data. This adds to already existing research that student engagement and ownership is vital in our courses. My current thoughts on moving this research forward involves finding new ways for our biology and pre-med students to gain ownership over physics as well, as I teach the pre-med algebra-based physics class.

My astronomy research involves studying X-ray and radio emissions of clusters and groups of galaxies. After a hiatus to focus on science education, recently I've been working with an undergraduate research student to develop her astrophysics research skills. As we begin to prepare her toward applying for REU programs for next summer, I am working to give her the skills necessary to succeed in astrophysics. I am working closely with her to define a research project that she is interested in – not necessarily within my own sub-field – but for which there is ample archival data to work with. The goal at the moment is not to necessarily come up with a publishable paper but to ensure that her skill set is rounded through a number of data analysis and programming techniques. However, as we are settling in to a direction, we are now beginning to define projects that may lead to proposal time for observations and hopefully eventually a paper. While this student is unlikely to transfer at this point in her career, should I receive an appointment I would expect to continue to work with her throughout the following year to her graduation.

I especially want to pursue research areas that work well with undergraduate students while also adding to our existing knowledge. I have a number of areas of research that I believe would be excellent for these goals. When I was working on clusters of galaxies as a graduate student, I stumbled upon some interesting groups that had interesting and unexpected radio properties. In the course of that research, I determined that while the brightest clusters may be easier to observe, the smaller groups were likely far more important in the grand scheme of large scale structure. I have a number of colleagues working on groups and through those connections believe I could build a good research program that would appeal to students. In addition, with my background working at the Chandra X-ray

observatory I also have a number of colleagues with whom I could partner on the topics of X-ray galaxies, clusters of galaxies and active galactic nuclei. All of these are good observational astronomy projects which would lend themselves well to undergraduate students learning and applying physics to larger systems.

I also like the idea of organizing student-accessible research in climate change, which is a very cross-disciplinary field with ties to geology, mathematics, and computer science. If we consider impacts as well, biology and social sciences have a direct bearing on this research which makes it even more important. While working toward my science education degree, I took a number of geology graduate courses, in part due to my interest in planetary science. One of these was a course in climate change, and through these contacts and others I have made since I have a few ideas of numerical modeling using the climate change models in existence. For example, there are a number of outstanding questions about how the southern hemisphere differs from the northern hemisphere. This would be a new and exciting – and very applicable – area of research to me, but I also think that it would be possible for undergraduates to learn about the models and begin to work with them. I would hope to be able to partner with the geology department as well.

Fortunately, working with astronomical data does not need a large startup fund. I believe several PC computers with appropriate software, much of which is developed by the astronomical community and free for use, along with a RAID data storage computer would be sufficient. Space for these computers could be in a small lab or mixed-use space; I would like students to be able to have physical access to the computers at least some of the time. I would expect to be running a form of linux, which would provide students the opportunities to learn and possibly maintain computers as part of the skillsets developed. I would like for each student to work toward developing a greater set of skills than just astronomical software, should they decide to work outside of academia.

I believe my research interests in astronomy and climate change would appeal to students at Carleton; the ability to tailor research interests further to students will depend on the number of students and good fit with the department. As I have a colleagues across numerous areas of astrophysics and the large availability of archival and telescope data we will be able to choose a path that students find rich, rewarding, and relevant.