

Undergraduate Research: I was involved in three major research projects in my time as an undergraduate student: my undergraduate thesis research at Penn State, an NSF REU at the National Optical Astronomy Observatory (NOAO), and research at Lawrence Livermore National Laboratory (LLNL) as part of the selective Lawrence Livermore Summer Internship Program (LLSIP).

I began working with Dr. Lee Samuel Finn in Penn State's Center for Gravitational Wave Physics in September of 2001 and I remained a member of his group until my graduation from Penn State in May of 2004. During that time, I created SenseMonitor: a piece of software that measures in real-time the sensitivity of the LIGO interferometers in terms of the distance at which they would detect a gravitational wave standard candle. This tool is now one of the principle indicators of detector stability at the LIGO sites and its output is the standard figure-of-merit for detector performance; it is so important that the range vs. time plot produced by SenseMonitor is always displayed on one of the three panel displays at the front of the control room. I was responsible for the majority of the coding for SenseMonitor, with the remainder of the work performed by Dr. Patrick Sutton, a former postdoctoral researcher at Penn State (now at Caltech). In particular, I produced the code that calculates the power spectral density of the raw data, as well as the calibration code that computes the physically important strain measurements. Furthermore, I produced the numerical integrator for the ultimate numerical calculation of the range. I was also significantly involved in producing the code that automatically creates an up-to-date webpage with the important range information. As a result of this work, I have been included as a coauthor on the LIGO consortium's publications involving the analysis of data from its first science runs. My thesis involved the use of the time-series range data produced by SenseMonitor to study the long-term sensitivity and stability of the LIGO interferometers over the first three science runs.

In the summer of 2003 I was at the NOAO as part of the NSF's REU program. While there, I worked with Dr. Kenneth J. Mighell and was responsible for the production of a data analysis pipeline that automatically identified variable stars in archival Hubble Space Telescope (HST) observations. In particular, my pipeline was designed to utilize photometric data from the HSTphot analysis package (an automated PSF-fitting photometry routine optimized for use with HST's Wide Field Planetary Camera 2); the pipeline used a modified chi-squared test to identify possible variable stars in the time-series photometry produced by HSTphot. The first stellar population I analyzed was the globular cluster M54 and my pipeline discovered at least 50 previously unobserved variable stars (many of them likely RR Lyraes) in the core of the cluster. Our results indicated that many RR Lyrae stars in dense globular clusters may have been missed in earlier ground based studies due to crowding, leaving the classification of these clusters incomplete. Therefore, these results could affect the Oosterhoff classification of dense globular systems. Furthermore, if the census of globular cluster RR Lyrae populations is incomplete, it is impossible to classify a cluster in the appropriate Oosterhoff group. This is an important finding,

as Arp showed in 1955 the Oosterhoff classification of a cluster reflected differences in the metallicities of globular clusters -- one of the most important parameters in globular cluster models. This and other recent work suggests that M54 is intermediate in the Oosterhoff classification scheme. I presented my results as a poster at the 2003 AAS meeting in Atlanta.

During the summer of 2004 I was a part of the prestigious LLSIP where I worked with Dr. Kem Cook on simulations of atmospherically induced ellipticity on the point-spread function (PSF) of points sources spread across large fields-of-view. Atmospheric turbulence can mimic the effects of weak gravitational lensing in astronomical images, so it is necessary to understand to what degree turbulence affects PSFs so that any artifacts introduced by the atmosphere can be removed from future weak lensing measurements. Working independently, I studied the ellipticity induced upon the PSFs of a grid of simulated stars separated by distances ($d \sim 1'$) that will be characteristic of Large Synoptic Survey Telescope (LSST) images. I observed that while atmospherically induced ellipticity changes on small scales ($d < 0.5'$), it will be possible to correct for the changes. As a result it will therefore be possible to remove the effects of the atmosphere from LSST weak lensing observations. I reported my findings in a technical report to the LSST science working group.

Graduate Research: From September 2004 to August 2006 I worked with Tom Abel at the Kavli Institute for Particle Physics and Cosmology (KIPAC) while earning my master's degree in scientific computation and computational mathematics from Stanford University. While there, I modified the cosmological hydrodynamics and n-body code Enzo for use in hydrodynamic simulations of molecular core collapse, and I verified the utility of the modifications by running several standard molecular core collapse test problems. Preliminary results of this project were reported as a poster at Protostars and Planets V, and a paper detailing our findings is in preparation.

Since my arrival at the University of California, Santa Cruz (UCSC) in September 2006 I've worked with Raja Guhathakurta and his student Evan Kirby on the use of state-of-art machine learning algorithms for the calculation of photometric redshifts for galaxies in the DEEP2 redshift survey for which spectroscopic redshifts are unavailable. During the course of this proposed project, I will also work with David Koo and the rest of the DEEP team at UCSC. I've also begun cross-disciplinary collaborations with members of the UCSC's excellent Bayesian statistics group in its Applied Mathematics and Statistics Department, specifically David Draper and Herbie Lee.

The coherent thread of my all of my past research has been non-traditional data analysis and advanced computation in astronomy and astrophysics, which I believe has prepared me well for my proposed research into photometric redshifts and their uses.

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