2019 Summer Research Poster Pitches

LSST Corporation Program for Undergraduate Researchers

LSST

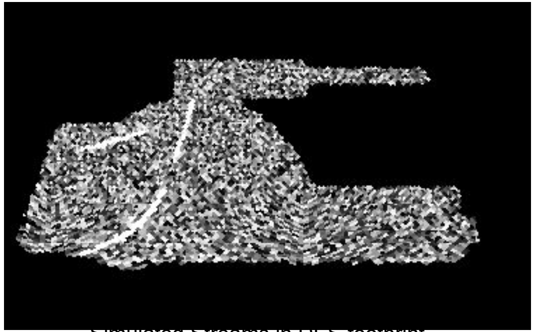
Large Synoptic Survey Telescope

Praveen Balaji, University of Chicago
Fermilab

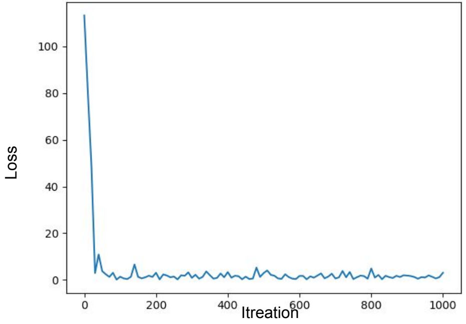
Advisor: Alex Drlica-Wagner & Brian Nord

Research question: Can we use a neural network to detect and localize stellar streams given a skymap?

Outcomes: We've created a simulation to use as training data for the YOLO object detection network and have successfully trained the network (exponentially decaying loss). We have yet to validate the trained network.

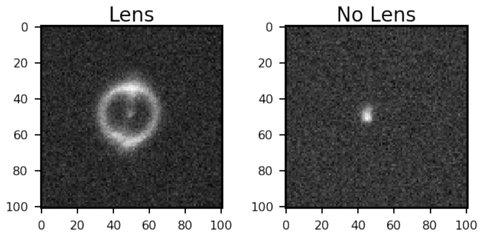


Simulated Streams in DES footprint



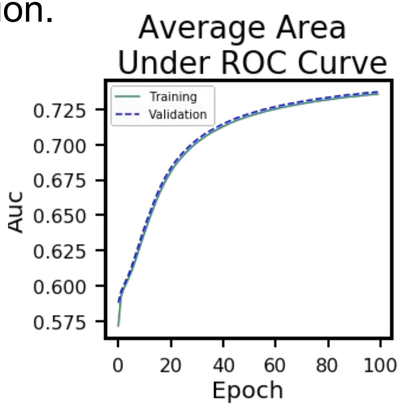
Iteration vs Loss during training

Callista Christ, University of Chicago
Fermilab



Top: Sample of lensing data.

Bottom: ROC curves for training and validation.



Advisor: Brian Nord

Research question: What combination of neural network models and hardware are most efficient in classifying gravitational lensing images for LSST?

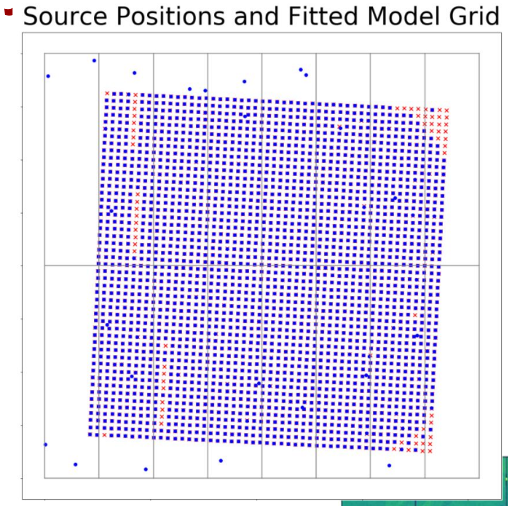
Outcomes: We trained a ResNet50 model on a GPU and got about 70% accuracy. My next step is to run my model on all available images and write code to access the FPGA.

Laurel Doyle, Cornell University
DOE SULI program (SLAC)

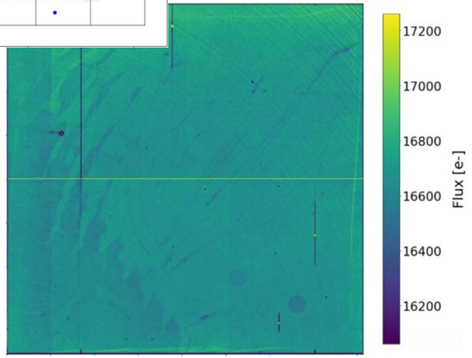
Advisor: Aaron Roodman and Adam Snyder

Research question: What is the nature of astrometric shifts caused by sensor effects in the LSST CCDs?

Outcomes: We computed astrometric shifts on one sensor using projected light source patterns. Looking into estimating shifts from flat field images.



Flat Field



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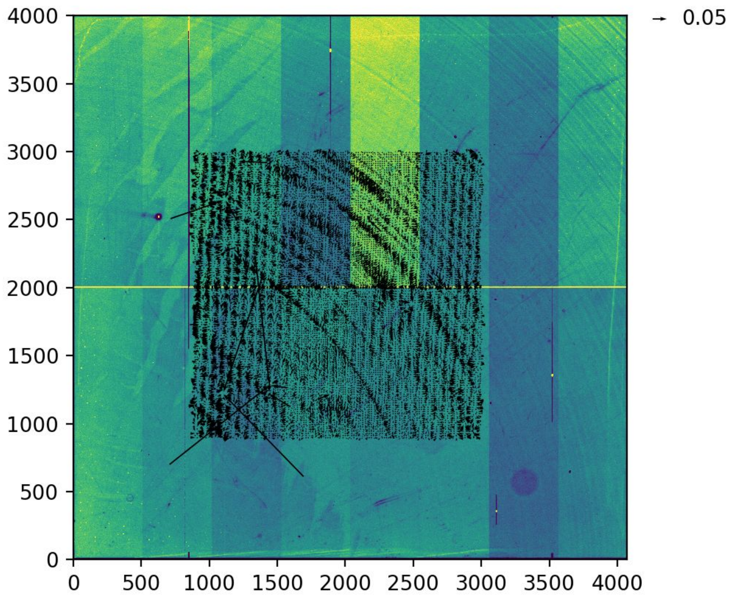
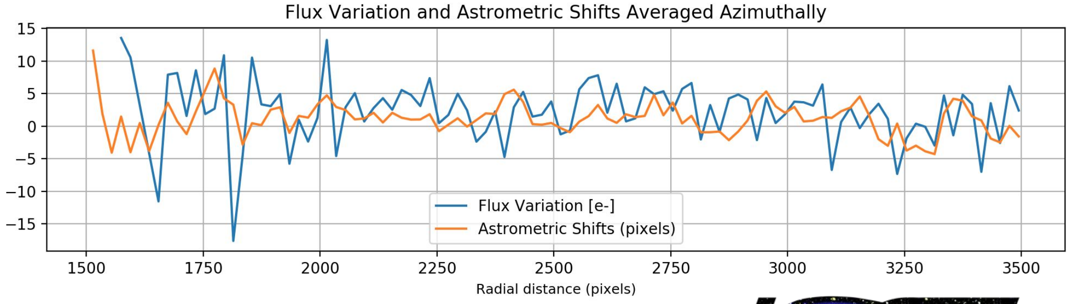
Elisa Tabor, Stanford University

Advisor: Aaron Roodman and Adam Snyder

Research question: What is the nature of astrometric shifts caused by sensor effects in the LSST CCDs?

Outcomes: We succeeded in calculating the astrometric shifts caused by tree rings and found no evidence of shifts caused by the features we call "coffee stains."





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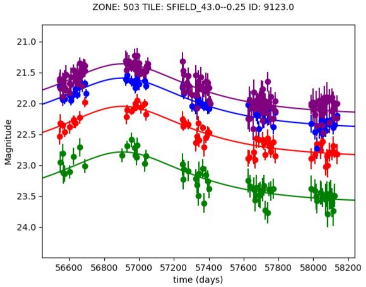
Erin Hayes, University of Pennsylvania

Advisor: Masao Sako

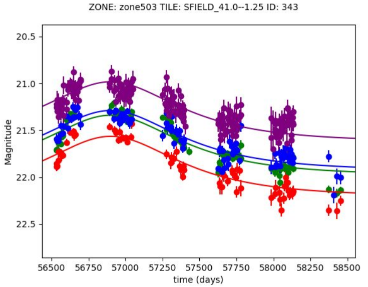
Research question: How can gravitational microlensing events caused by 10-100 solar mass black holes be identified in DES data?

Outcomes: Data cuts have been proven in simulations to successfully return only those graphs with fitted parameters close to their true values. These cuts are now being applied to real data and potential microlensing candidates are being identified.

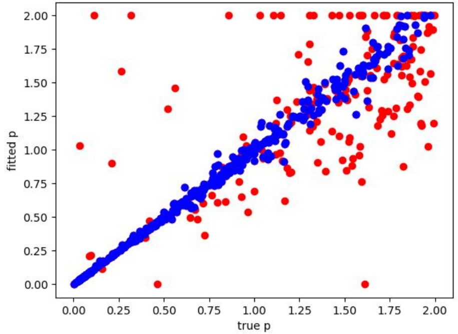
Simulated Data



Real Data



Fitted vs True *p* Value

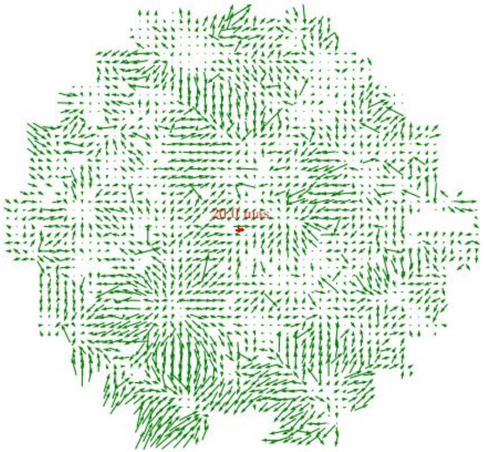


Austin Fortino, University of Pennsylvania

Advisor: Gary Bernstein

Research question: Can you model **astrometric shifts** with a Gaussian Process Regression model?

Outcomes: Astrometric variance is **reduced by a factor of 5** in initial tests.



Before

After

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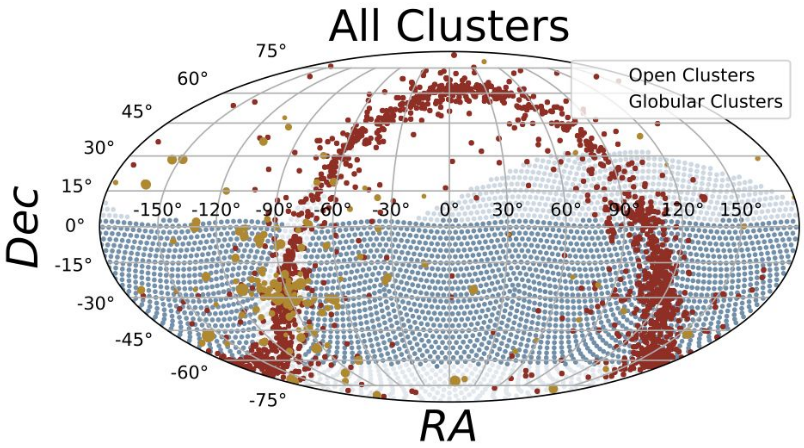
Andrew Bowen, Northwestern University
CIERA NSF REU Program 2019

Advisor: Dr. Aaron M. Geller

Research question: Find the period-recovery rate of LSST for eclipsing binaries in clusters.

Outcomes: We simulated and analyzed binary populations for ~2,000 clusters. Our period recovery rate (**~17%**) is similar to that of galactic (non-cluster) eclipsing binaries.



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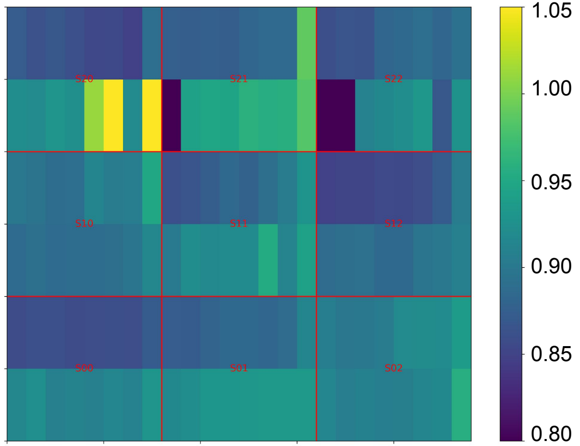
Ted Grosson, Rice University
DOE SULI program (SLAC)

Advisor: Kevin Reil

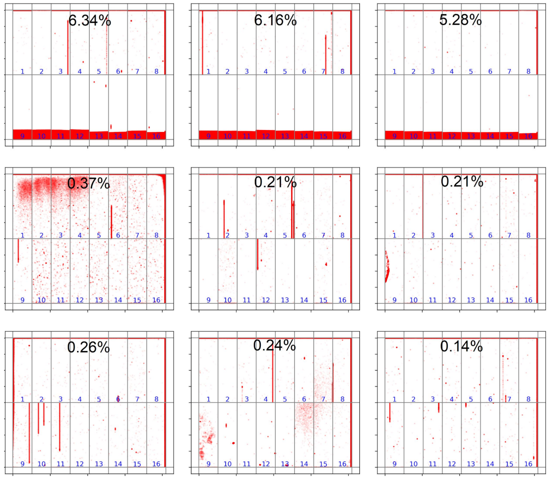
Research objective: Look at early image data to provide context for taking and analyzing images on-sky.

Outcomes: We set up and began testing ComCam in Tucson, identified ComCam amplifier gains with the PTC method, and created a bad-pixel map.

ComCam Amplifier Gains (e-/ADU)



ComCam Rejected Pixels



Anand Jain, UChicago
Fermilab

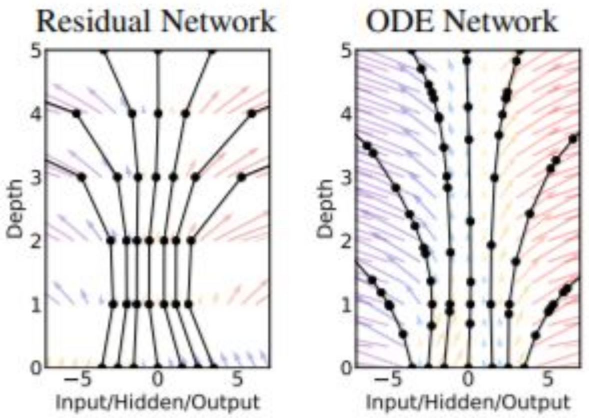
Advisor: Brian Nord

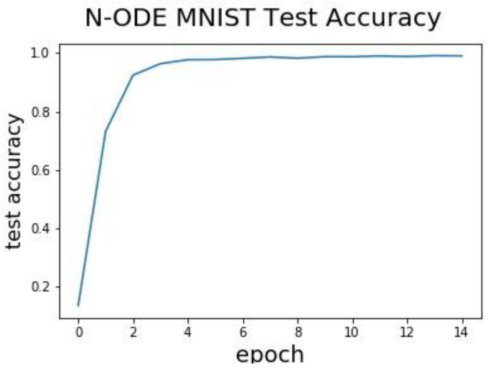
Research question: Are neural differential equations an effective tool for function approximation, classification, and time series analysis?

Outcomes: NODE models perform well on various regression and classification tasks. The ability to avoid discretizing time series makes an important tool in efficient data analysis/classification.

Next steps:

1. Encoding Poisson process.
2. Augment input space topology.
3. Continuous Reinforcement Learning.





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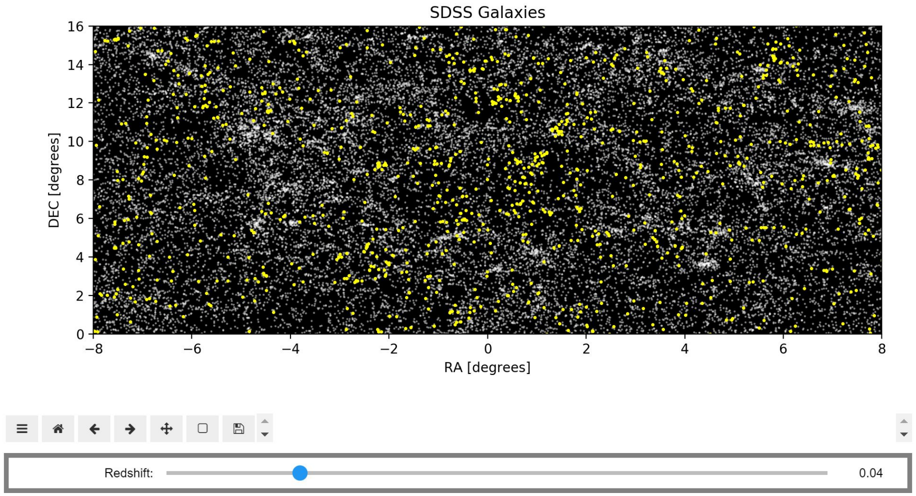
Andy Jaramillo, University of Arizona

TIMESTEP Internship Program @ NOAO

Advisors: Connie Walker, Knut Olsen

Objective: Adapt the Teen Astronomy Café Jupyter notebooks to work in a classroom environment.

Outcomes: With the implementation of interactive widgets, a consistent styling, and a classroom-specific revision, we have the approval of some local Tucson high school teachers and students.



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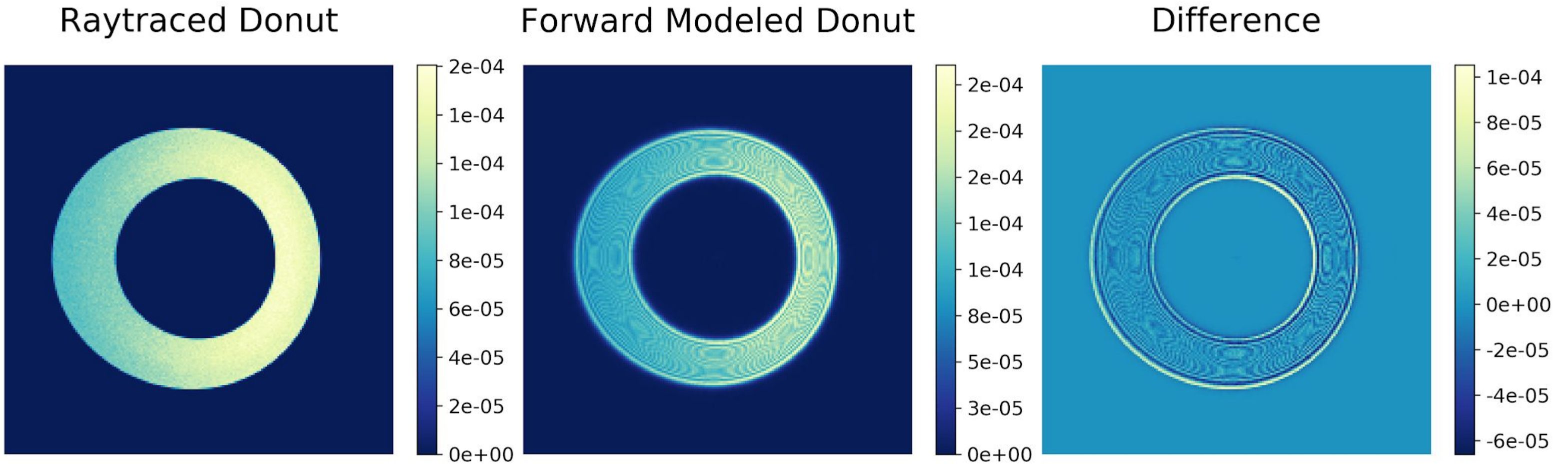
Emmy Li, Stanford University

Advisor: Steven Kahn & David Thomas

Objective: Active Optics - estimate the wavefront by forward-modeling donut images.

Outcome: Forward-model's success evaluated against difference between simulated and its own prediction; overall, accurately estimates the wavefront, but must be faster.

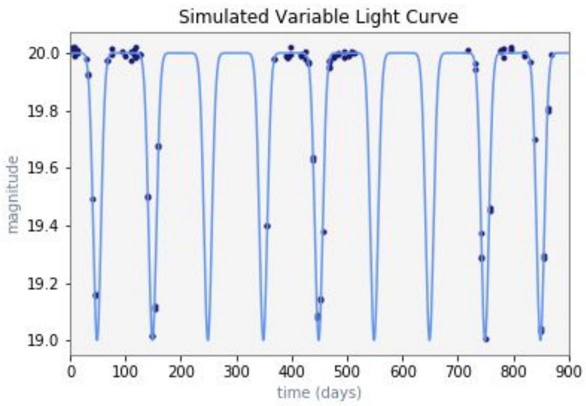


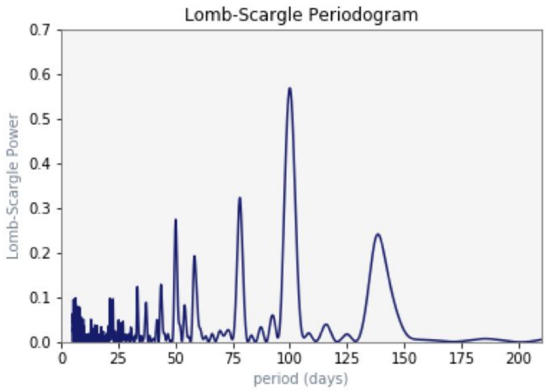
Jen Locke, University of Pennsylvania

Advisor: Masao Sako

Research objective: To implement an algorithm to sort different types of variable stars from non-variable objects in DES data using a Lomb-Scargle periodogram, so that we can build a statistical sample of all variable stars.

Outcomes: The Lomb-Scargle periodogram can sufficiently detect the correct periods from simulated light curves with real MJD data, but there is still a lot to be done with interpreting the results from real sources.





Shifra Mandel, Columbia University

Advisor: Kathryn Johnston

Research question: How can we determine the merger histories of galaxies?

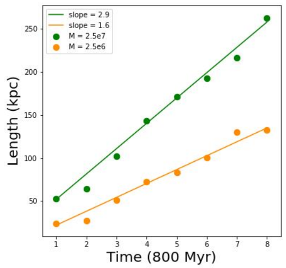
Outcomes: My algorithm can efficiently evaluate properties of tidal debris substructures in galactic halos, which can be used to test theories of hierarchical galaxy formation.

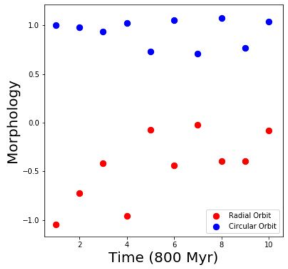
Stream

NGC 5907, apod.NASA.gov

Shell

NGC 474, apod.NASA.gov





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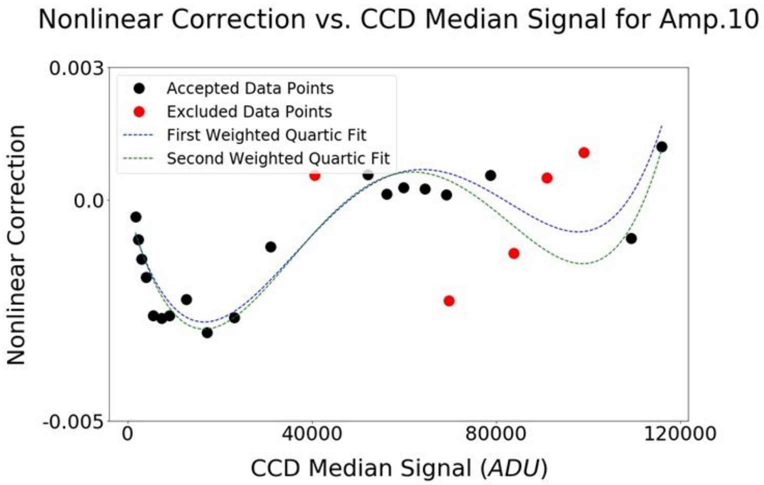
Jorge Morales, University of Puerto Rico
DOE SULI program (SLAC)

Advisors: Aaron Roodman, Eric Charles, Seth Digel

Research question: How can we correct the nonlinearities of the LSST CCD's production readout electronics? What is causing those nonlinearities?

Outcomes: We found a function can be used to correct the small nonlinearities of the production readout electronics. We also identified a potential source of those nonlinearities.

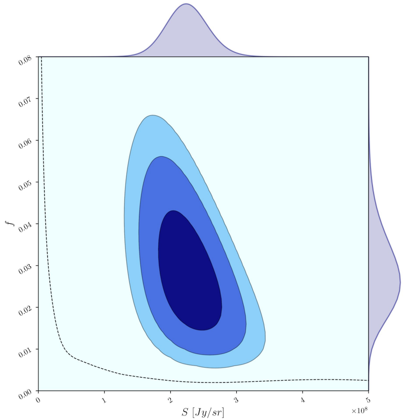


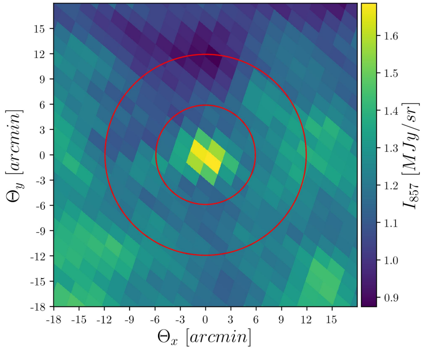
Jacob Nibauer, University of Pennsylvania

Advisors: Bhuvnesh Jain, Eric Baxter

Research: Using CMB surveys and statistical models to place constraints on key properties of circumstellar debris disks through their emission at submillimeter wavelengths.

Outcomes: We find a significant detection in the 545 and 857 GHz *Planck* maps, and place constraints that are consistent with findings in the literature. We identify previously unknown stellar candidates likely to host debris disks.





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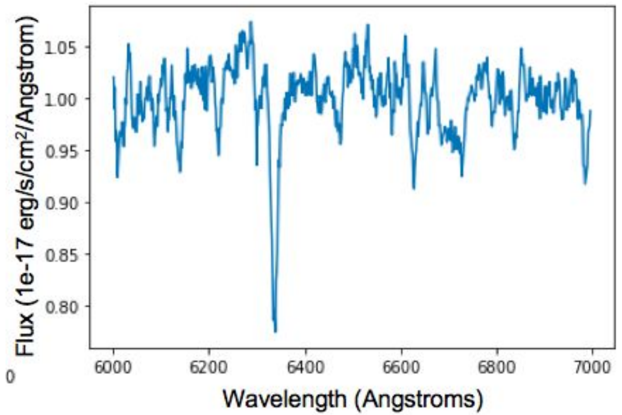
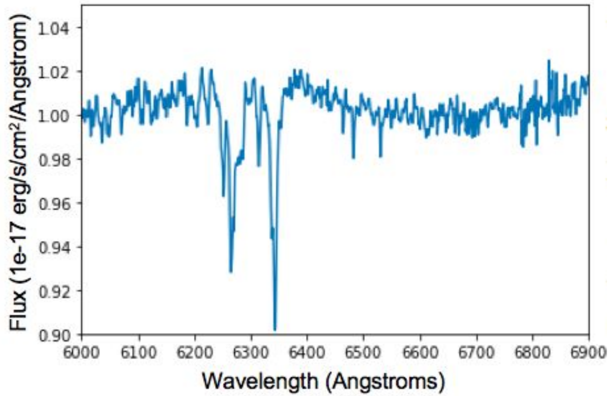
Swati Ravi, Columbia University

Advisor: Melissa Ness

Research: Data-driven modeling of MaNGA galaxies using near-field Milky Way stellar spectra.

Outcomes: Simple models using Milky Way stars are already reproducing Balmer lines. More sophisticated models currently underway are providing new applications for near-field data.



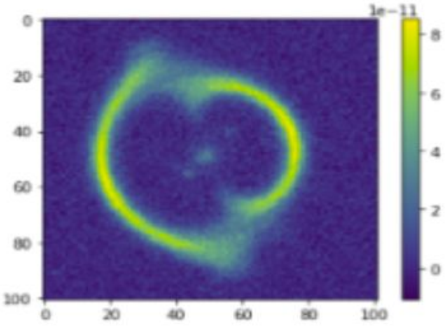


Marwah Roussi, University of Chicago
Fermilab

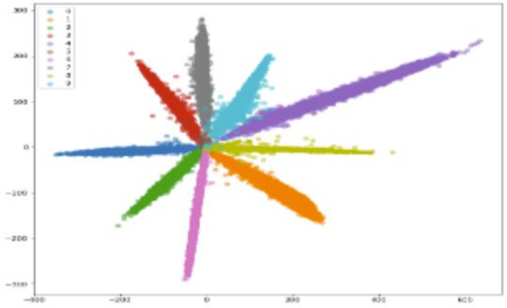
Advisor: Dr. Brian Nord

Research question: How do we adopt neural networks to anomaly situations, where only few images are available for training, in our case, gravitational lensing?

Outcomes: Siamese networks are efficient at differentiation, and extracting important feature embeddings specific to input images.We find for the MNIST dataset nearly 99% accuracy, which exceeds or is on par with traditional methods.



Example Lensed Image.

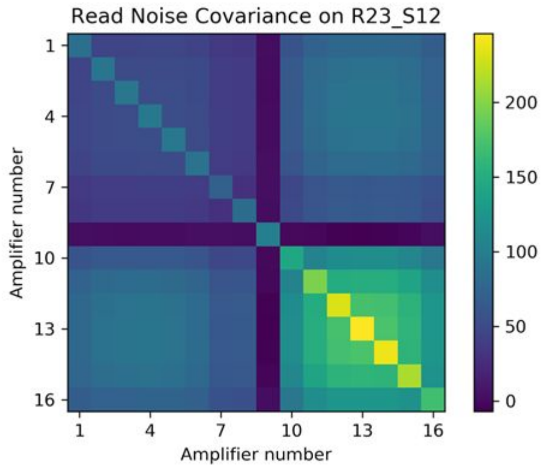


George Iskander, Yale University
Summer Research - Early Identification Program (Stanford)

Advisors: Aaron Roodman, Pat Burchat

Research question: Will correlated read noise in the LSST CCDs affect the galaxy two-point correlation function?

Methodology:
1. Simulate read noise
2. Model effect of read noise on observed galaxy flux
3. Recalculate 2-pt correlation function



Covariance matrix between amplifiers on the R23_S12 CCD

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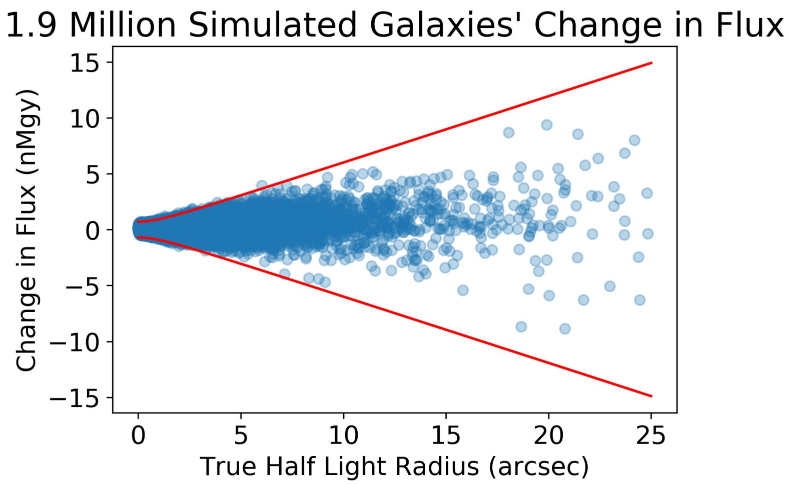
Julian Rovee, Stanford University

Advisors: Aaron Roodman, Pat Burchat

Research question: Will correlated read noise in the LSST CCDs affect the galaxy two-point correlation function?

Outcomes:

- Successfully modeled noise and effect of noise on galaxy flux.
- To do: calculate galaxy two point correlation function using this model.

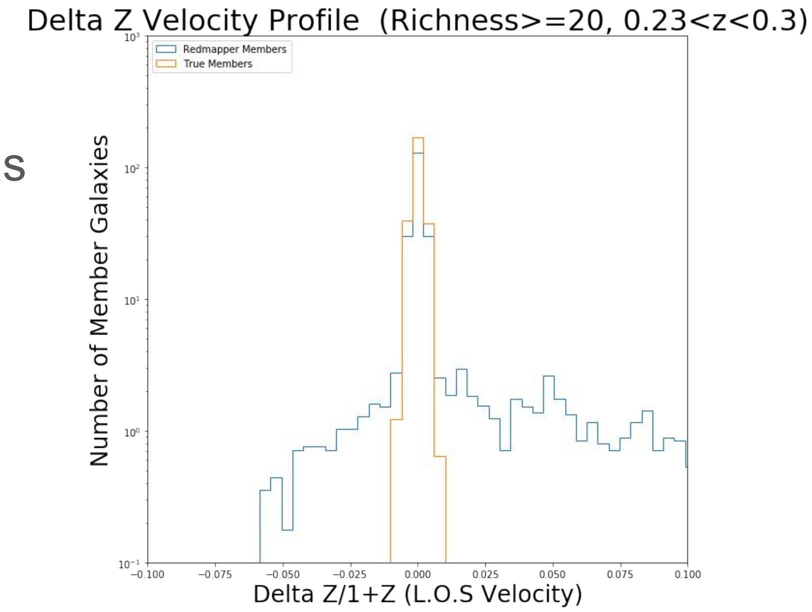


Kathlynn Simotas, Stanford University

Advisor: Risa Wechsler & Chun-Hao To

Research question: How can we quantify the impact of projection effects and orientation bias on optically selected cluster samples?

Outcomes: We are investigating projection’s impact on line of sight velocity and number density profiles using simulations for the ultimate purpose of formulating a map from those profiles to projection effects and triaxiality.

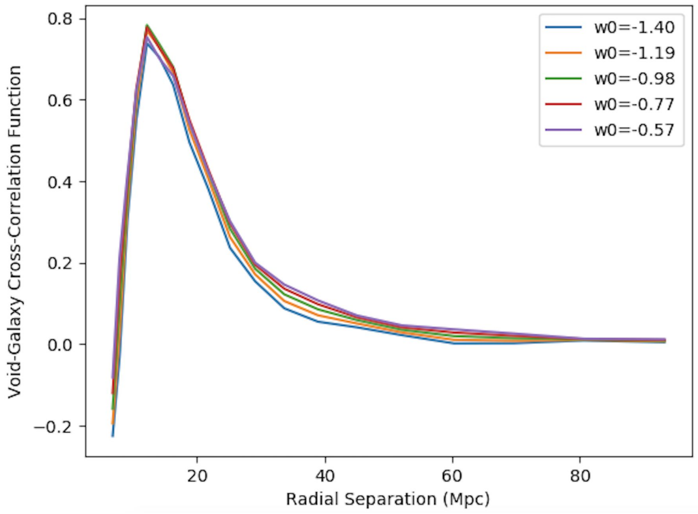


Jake Stanton, Brown University
Leadership Alliance & Summer Research - EIP (Stanford)

Advisor: Dr. Risa Wechsler

Research question: Can we accurately emulate the void-galaxy cross-correlation over a range of cosmological parameters using Gaussian Processes?

Outcomes: We’ve created an emulator for void-galaxy cross-correlation with a static HOD and are currently testing its accuracy in constraining cosmological parameters.



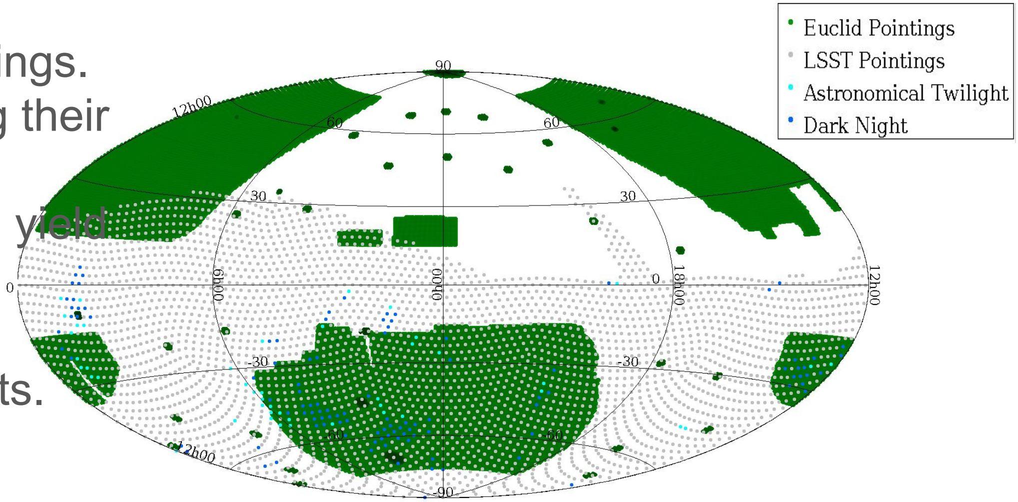
Luke Surber, University of Washington

Advisor: Dr. Mario Jurić, and Dr. Siegfried Eggl

Research question: What are the potential benefits of simultaneous observations of Solar System Objects (SSO) by the LSST, and the space-borne Euclid?

Outcomes:

- There are ~7,200 intersecting pointings.
- ~240,000 can be triangulated giving their distance and position instantly.
- Combined photometric data would yield the object's classification.
- Multiple simultaneous observations would yield accurate orbital elements.



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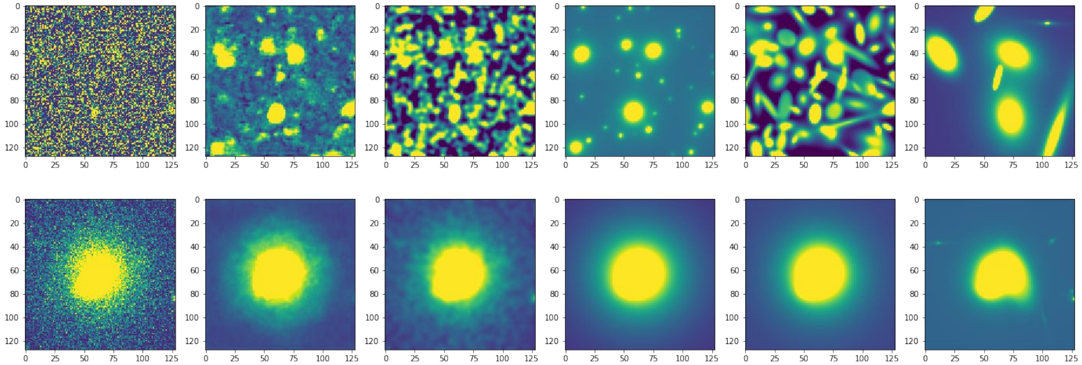
Yunchong Zhang, University of Chicago
Fermilab

Advisor: Brian Nord

Research question: Can we train a neural network for denoising astronomical images without the ground truth of the signal or any estimation of the noise?

Outcomes: With self-supervision, our deep learning algorithm demonstrates potential in image denoising.



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Thank you!!