



Curtis McCully

Curriculum Vitae

Research Appointments

2014– Present **Las Cumbres Observatory (LCO)/University of California Santa Barbara (UCSB)**, *Postdoctoral Scholar*, Goleta, CA.

Mentor: Prof. D. Andrew Howell

2015– Present **Las Cumbres Observatory**, *Network Operations Scientist*, Goleta, CA.

2008–2014 **Graduate Student**, *Rutgers University*, Department of Physics and Astronomy.
Advisors: Prof. Saurabh Jha and Prof. Charles Keeton

2005–2008 **Intern**, *Science Applications International Corporation*, Oklahoma City, OK.

2007 **Undergraduate Research Assistant**, *NSF REU Program*, Oklahoma University, Department of Physics and Astronomy. Advisor: Prof. Karen Leighly.

2006 **Intern**, *Gravity Probe B*, Stanford University, Palo Alto, CA.

Research Experience

The first kilonova: AT 2017gfo/GW170817

- Our group was one of the six to identify AT2017gfo—the first optical counterpart to a gravitational wave source—within images we obtained less than 12 hours of the LIGO trigger.
- Our photometry was roughly consistent with the models of Kasen and Barnes, but we observed substantially more blue flux than was expected.
- Our optical spectra showed a featureless continuum, but was not consistent with a blackbody suggesting the need for (blended) line opacity. Our spectra may also imply that there was a compositional gradient with a low mass fraction of heavy elements in the outer layers of the ejecta and a higher mass fraction deeper inside which has implications for neutron star merger as a production site of r-process elements.

Global Supernova Project (Las Cumbres Observatory): Provided data reduction and analysis for more than a dozen papers:

Selected results include:

- We showed that SNe IIL have a similar drop in their light curves to those of SNe IIP at late phases.
- We showed that the light curves of SNe Ibn are quite homogeneous, which is surprising since they show strong circumstellar interaction.
- We showed that the light-curve of SN 2017cbv has a blue bump hours after the explosion implying the presence of a non-degenerate donor star.

Peculiar SNe Iax:

- Late-time HST observations of SNe 2012Z, 2008A, and 2005hk: We showed that SN Iax are not nebular even a year after peak brightness, suggesting the SN leaves behind a bound remnant. There is no evidence for unburned oxygen, a key prediction of pure deflagration models.
- SN 2012Z progenitor system: Using deep pre-explosion HST images, we discovered a source coincident with SN 2012Z. This is the first time the progenitor system of thermonuclear SN has ever been detected.
- SN 2012Z remnant: We have continued to follow SN 2012Z \sim 1500 days after peak using HST. Our latest images show that the light curve of SN 2012Z has flattened out but it is still brighter than the progenitor detection. It is likely we are seeing light from a bound remnant.
- UV-spectroscopy of SN 2013dh: HST STIS NUV/Optical spectra of SN 2013dh are nearly identical to those of SN 2011fe, suggesting SNe Iax also have strong iron line blanketing in the UV.
- SN 2008ha remnant system: We discovered a source coincident with SN 2008ha in HST images taken 5 years after peak brightness, reinforcing the bound remnant hypothesis.

Gravitational Lensing:

- LOS Framework: We designed a new framework to account for the perturbing effects due to galaxies along the line of sight (LOS) in gravitational lensing. We employ a hybrid approach that balances the efficiency of the weak lensing approximation but retains accuracy by treating the most important perturbers as strong lenses.
- Lensing Simulations: We tested our LOS framework using mock lensing observables and MCMC fits to characterize the importance of the LOS effects and to show that our framework can adequately account for the effects.

Lensed SNe Ia:

- Analysis of 3 lensed SNe in CLASH: We used SNe Ia that were appreciably magnified but not multiply imaged to constrain the mass models of the intervening CLASH clusters. These constraints were in the intermediate region between the strong and weak lensing features.
- SN Refsdal: We discovered the first resolved, multiply imaged SN using Frontier Fields data from HST. The SN (dubbed Refsdal) was similar to SN 1987A. We were able to measure the time delay of the galaxy-scale lens. The lens models predicted a fifth image of the SN, which we confirmed with further HST follow up.

Education

2004–2008 **Bachelor of Science**, *Southern Nazarene University*, Bethany, OK.
Summa Cum Laude. Major in Physics, Minor in Computer Science

2008–2014 **Ph.D.**, *Department of Physics and Astronomy, Rutgers, The State University of New Jersey*, Piscataway, NJ.
Thesis Advisors: Prof. Saurabh Jha and Prof. Charles Keeton

Awards

- 2011 AAS Chambliss Astronomy Achievement Student Award (Graduate)
- 2009–2010 Richard J. Plano Outstanding Teaching Assistant Award
- 2008 AAS Chambliss Astronomy Achievement Student Award (Undergraduate)

Fellowships and Grants

- 2016 Co-Investigator Cycle 24 HST-GO-14717: \$8,215 (pending final approval), *What is Enhancing the Tidal Disruption Rate of Stars in Post-Starburst Galaxies?*

- 2015 Co-Investigator Cycle 23 HST-GO-14199: \$8,094, *Refsdal Redux: Precise Measurements of the Reappearance of the First Supernova with Multiple Resolved Images*
- 2014-2015 Co-Investigator Cycle 22 HST-GO-14041: \$9,244 *Classifying and Following a Strongly Lensed Likely Supernova with Multiple Images*
- 2012 **Principal Investigator** Cycle 20 HST-GO-12973, *UV Spectroscopy of a Peculiar White Dwarf Supernova*
- 2011-2012 Excellence in Mentoring Fellow
- 2008-2009 Graduate Assistance in Areas of National Need (GAANN) Fellow

Successful PI Proposals

- SALT: Long-slit spectroscopy of a Nearby SN Iax (74406.4s over 4 semesters)
- HST: UV Spectroscopy of a Peculiar White Dwarf Supernova (6 orbits)
- LCO: Difference Imaging Templates for Supernovae (1-m: 265.3h, 2-m: 56h over 3 semesters)
- LCO: Continuous Monitoring of the Gravitational Lens HE 0435-1223 (1-m: 100h)

Observing Experience

- Las Cumbres Observatory (LCO): Imaging and Spectroscopy with FLOYDS
- Hubble Space Telescope: WFPC2, ACS, WFC3, Long-slit Spectroscopy with STIS
- Magellan: Imaging with IMACS and Megacam, Long-slit Spectroscopy
- Keck: DEIMOS Slit-mask and Long-slit Spectroscopy
- Southern African Large Telescope (SALT): Long-slit Spectroscopy

Programming and Data Analysis

- Image Data Reduction Pipeline for all LCO data: <https://github.com/lcoigt/banzai>
- Fast implementation of the LA Cosmic algorithm: <https://github.com/astrophy/astrocrappy>
- Image subtraction pipeline for CLASH, CANDELS, and the Frontier Fields: <https://github.com/cmccully/snhst>
- AstroPy Contributor
- Languages: Python, Cython, IDL, Matlab, Mathematica, C, C++, Java, VB.net, VBA
- Technologies: Django, Celery, MySQL, SQLite, RabbitMQ, Elasticsearch, MS Access, ArcGIS, Docker, Rancher, IRAF/PyRAF
- Analysis Experience: Image analysis, Monte Carlo Markov Chains, Maximum Likelihood Analysis (Chi-squared minimization), Parallel Computing (OpenMP, Multiprocessing, Beowulf Cluster Computing), Robotic Telescope Operations, Data Visualization, Fourier analysis, Neural Networks, Principle Component Analysis, Gaussian Processes

Collaborations

- CLASH/CANDELS: Supernova Search Team. Developed an image subtraction pipeline to facilitate SN search. Lens modeling to constrain the magnification of SNe.
- Frontier Fields: Supernova Search Team. Updated image subtraction pipeline used by CLASH and CANDELS. Initial lens modeling of SN Refsdal.
- LSST/DESC: Member of Strong Lensing and Supernova Working Groups.
- iPTF: Data reduction and analysis in support of the LCO Supernova Key Project.
- PESSTO/ePESSTO: Data reduction and analysis in support of the LCO Supernova Key Project.
- BUFFALO with HST: Supernova Search Team.

Graduate Mentorship

- 2014– Present Griffin Hosseinzadeh (UCSB/LCO): Has recently published a paper on the early light curve of a Type Ia SN with implications for their progenitor systems. Also published a paper on a sample of type Ibn SNe. Currently working on faint SN IIP that showed evidence for circumstellar material.
- 2017– Daichi Hiramatsu (UCSB/LCO): Gemini Spectroscopy data reduction and analysis
- 2017– Jamison Burke (UCSB/LCO): Gemini Spectroscopy data reduction and analysis

Undergraduate Mentorship

- 2017– Megan Newsome (UF): LCO Summer Intern working on LSST cadence studies for Tidal Disruption Events
- 2017– Haley Bowden (UCSB): Eureka Fellow working on LSST cadence studies for supernovae
- 2015–2016 David Guevel (UCSB): Worster Fellowship 2016
- 2013–2014 Viraj Pandya (Rutgers): AAS poster, Post-Baccalaureate Program in Astrophysics, Princeton University
- Summer 2013 Yssavo Camacho (Lehigh, Rutgers REU): AAS poster, Accepted to Rutgers University Physics and Astronomy Graduate Program 2015
- 2011–2013 Tom Holoien (Rutgers): AAS poster, Accepted to Ohio State Astronomy Graduate Program for Fall 2013
- 2010–2012 Samia Bouzid (Rutgers): AAS poster, Outstanding Senior Honors Thesis Prize

Teaching

- Fall 2009 Teaching Assistant (Rutgers): Extended Analytical Physics 115. Introductory physics for under-prepared engineering students. Average Teaching Effectiveness Rating 4.70 out of 5. Student Evaluations available upon request.
- Spring 2010 Teaching Assistant (Rutgers): Extended Analytical Physics 116. Introductory physics for under-prepared engineering students. Average Teaching Effectiveness Rating 4.72 out of 5. Student Evaluations available upon request.

Service

- 2016– LCO Science Seminar Coordinator
- 2014– Referee for MNRAS and ApJ
- 2015–2016 LCO Journal Club Coordinator
- 09,11,13,14 Rutgers Graduate Student Life Committee Student Representative
- 2012 Rutgers Telescope Allocation Committee for the Southern African Large Telescope
- 2012 Rutgers Astrophysics Graduate Student Journal Club Coordinator

Outreach

- 2016– LCO Public Seminar Coordinator
- 2016– Astronomy on Tap Coordinator/Presenter
- 2013 4-H Science Saturday Presenter
- 09,11,12** New Jersey Regional Science Fair Judge