Leah Fulmer

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Research Interests

I broadly explore the intersection between Astronomy and Data Science, with particular interest in anomaly detection among variable objects. I value software and pipeline development, as well as open source practices.

Education

Doctor of Philosophy in Astronomy **September 2018 - Present**
University of Washington Seattle, WA
Advisor: Dr. Daniela Huppenkothen

Bachelor of Science in Astronomy and Spanish **September 2013 - May 2017**
University of Wisconsin-Madison Madison, WI
Advisor: Professor John S. Gallagher, III

University of Chile and Pontifical Catholic University of Chile Santiago, Chile
Council on International Educational Exchange Study Abroad

Graduated with Distinction and Cumulative Grade Point Average 3.82 / 4.00

Employment

Data Reduction Specialist **October 2017 - July 2018**
National Optical Astronomy Observatory
Advisors: Dr. Stephanie Juneau, Dr. Knut Olsen and Dr. Mark Dickinson

Scientific Publications

Link to publications in Astrophysics Data System

[1] **Leah M. Fulmer**, John S. Gallagher, III, Wolf-Rainer Hamann, Lida M. Oskinova, Varsha Ramachandran, *Star formation and feedback at low metallicity: I. Photometry of stellar populations associated with the SMC-SGS 1*, 2018, A&A, in preparation. Data set and computation available through GitHub.

[2] **Leah M. Fulmer**, John S. Gallagher, III, Ralf Kotulla, *NGC 5523: An isolated product of soft galaxy mergers?*, 2017, A&A, 598, A119.

Selected Honors & Awards

- Jacobsen Fund Travel Grant : *University of Washington Department of Astronomy* 2018
- AAS Education and Professional Development Mini-Grant : *American Astronomical Society* 2018
- Achievement Rewards for College Scientists Fellowship : *ARCS Foundation, Inc.* 2018
- Chambliss Astronomy Achievement Award Honorable Mention : *American Astronomical Society* 2018
- Doherty Award for Excellence in Astronomy : *UW-Madison Department of Astronomy* 2017
- Jay C. Halls Scholarship : *UW-Madison College of Letters & Science* 2016
- Hilldale Undergraduate Research Fellowship : *UW-Madison* 2016
- WSGC Undergraduate Research Fellowship : *Wisconsin Space Grant Consortium* 2016
- WSGC Undergraduate Scholarship : *Wisconsin Space Grant Consortium* 2016
- Fay Ajzenberg-Selove Award : *UW-Madison Department of Physics* 2016
- University Book Store Academic Excellence Award : *UW-Madison* 2016
- International Academic Programs Study Abroad Scholarship : *UW-Madison* 2015
- Kemper K. Knapp Scholarship : *UW-Madison* 2013

Research Experience

University of Washington **September 2018 - Present**
Graduate Research Assistant Seattle, WA
Advisor: Dr. Daniela Huppenkothen

- Exploring unsupervised classification of variable objects in order to accurately detect anomalous objects and efficiently access valuable data products among massive datasets (Data Source: Zwicky Transient Facility).

University of Wisconsin-Madison, Department of Astronomy **January 2014 - Present**
Undergraduate Research Assistant Madison, WI
Advisor: Professor John (Jay) Gallagher, III

Ongoing September 2016 - Present:

- Investigated the stellar evolution in the Wing of the Small Magellanic Cloud, which curiously exhibits active star formation despite low ambient mass and gas densities.
- Revealed evidence for a significant star-forming event that occurred ∼30 Myr ago, creating ∼10^4 $M_\odot$ of new stars and initiating a pattern of sequential star formation that continues into the present. Scientific article in preparation (Fulmer et. al., MNRAS, in preparation).
- Performed photometric, clustering, and spatial analyses of ∼1000 stars in this region that collectively support this scenario of sequential star formation (Data Source: Galaxy Evolution Explorer, ESO 1.54m Telescope, ESO Very Large Telescope).
- **Technical Skills: Python** (intermediate), stellar photometry (IRAF Daophot), source matching (TOPCAT), archival data extraction (MAST, VizieR), kernel density estimate clustering analysis.

Completed January 2014 - October 2016 :

- Studied the evolution of the isolated galaxy NGC 5523, which demonstrates a paradoxical combination of global isolation (no massive companions) and asymmetrical features indicative of past interactions.
- Found that the asymmetrical features in NGC 5523 most likely arose from one or more non-disruptive mergers between it and former companion galaxies (Fulmer, Gallagher, & Kotulla, 2017, A&A, 598, A119).
- Performed multi-wavelength photometry on the various asymmetrical features within NGC 5523 (Data Source: Sloan Digital Sky Survey, Spitzer Space Telescope, WIYN 3.5m Telescope) in order to quantify the stellar masses, colors, and physical positions of those features within the host galaxy.
- **Technical Skills: IRAF** (intermediate), galactic photometry (IRAF Apphot, Ellipse, GALFIT), FITS imaging analysis (DS9), optical observation (WIYN).

National Optical Astronomy Observatory **October 2017 - July 2018**
Data Reduction Specialist Tucson, AZ
Research Advisors: Dr. Stephanie Juneau, Dr. Mark Dickinson
NOAO Data Lab Advisors: Dr. Stephanie Juneau, Dr. Knut Olsen

- Investigated how galactic star-formation rates evolve with redshift ($z < 1.5$), internal galactic properties, and environmental conditions in order to understand the physical causes responsible for the decline of the cosmic star formation history.
- Performed multi-object spectroscopic data reduction using an interactive graphical interface pipeline in order to produce a catalog of redshifts for our sample (Data Source: Visible Imaging Multi-Object Spectrograph, ESO Very Large Telescope).
- Initiated development of Python-based tools for spectral visualization and analysis with the NOAO Data Lab, thus enhancing the versatility of the Data Lab as a data center.
- Created public-facing scientific and technical tutorials that outline the functionality of the Data Lab archive.
- **Technical Skills: Python** (intermediate), spectroscopic data reduction and analysis, tutorial synthesis in a Jupyter Notebook environment.

Space Telescope Science Institute **June - August 2017**
Space Astronomy Summer Program Intern Baltimore, MD
Advisor: Dr. Mark Giuliano

- Created a dynamic visualization tool for the efficient analysis of Hubble Space Telescope and James Webb Space Telescope scheduling constraints, ultimately streamlining the process of space-based data acquisition.
- Designed the tool to be lightweight (fast, computationally inexpensive), interactive (supporting zooming, scrolling, dynamic time information displays), and independent (producing a stand-alone web page) for optimized functionality and communication among users.
- Communicated closely with potential users and adapted the tool quickly to user feedback.
- Incorporated the tool into both the Hubble and James Webb SPIKE observation scheduling systems.
- **Technical Skills: LISP** (intermediate), **JavaScript** (intermediate), **HTML** (beginner), software development, user communication and collaboration, incorporation of wrappers.

University of Chile, Department of Astronomy **March - September 2016**
Undergraduate Research Assistant Santiago, Chile
Advisor: Professor Monica Rubio

- Characterized the size, temperature, luminosity and mass of molecular clouds within the Magellanic Bridge in order to probe stellar evolution under low-metallicity conditions.
- Analyzed sub-millimeter CO emission via Gaussian fit distribution modeling (Data Source: Atacama Large Millimeter Array, Atacama Pathfinder Experiment), then completed a comparative analysis between the resulting data sets to check for mutual reliability.
- **Technical Skills: Class** (intermediate), **CASA** (beginner), spectroscopic analysis (ALMA, APEX), radio observations (APEX), spectroscopic data reduction using a template reduction script (APEX).

Yale University, Department of Astronomy **June 2015 - July 2016**
Dorrit Hoffleit Undergraduate Research Scholar New Haven, CT
Advisor: Professor Jeffrey (Jeff) Kenney

- Studied systematic trends in the star formation rates of Virgo Cluster galaxies in order to explore fundamental processes in galaxy cluster evolution.
- Concluded that in the mass range 10^9-10^{10} $M_\odot$, the galaxies with the highest specific star formation rates were all HI-rich, subject to ongoing gas accretion, and located at the outskirts of the cluster, thus revealing HI accretion as a potentially significant stage of infalling galaxy evolution.
- Extracted archival multi-wavelength photometric data of 50 Virgo galaxies (Data Source: Sloan Digital Sky Survey, Two Micron All-Sky Survey, Spitzer Space Telescope, Herschel Space Observatory), then modeled the discrete observational data with theoretical spectral energy distributions (Modeling Program: Magphys).
- **Technical Skills: IDL** (intermediate), SED modeling (Magphys), archival data extraction and quality assurance (SDSS, 2MASS, SST, HSO).

Selected Presentations

Oral Presentations

- *The NOAO Data Lab: Scientific Applications with Gaia Data Release 2*, Tucson Tutorial hosted by the National Optical Astronomy Observatory, May 2018, Tucson, AZ.
- *The NOAO Data Lab: Overview, Applications, Future*, DECam Community Science Workshop, May 2018, Tucson, AZ and Python in Astronomy, May 2018, New York, NY.
- *A Dynamic Visualization Tool for the Analysis of SPIKE Scheduling Constraints*, 2017 Space Telescope Science Institute Space Astronomy Summer Program Symposium, August 2017, Baltimore, MD. Link to presentation, see 55:15 - 1:04:35.
- *Stellar Evolution of the Star Cluster NGC 602 and its Surroundings in the Low-Density Wing of the Small Magellanic Cloud*, University of Wisconsin-Madison Senior Honors Thesis Symposium April 2017, Madison, WI **and** Undergraduate Research Symposium, April 2017, Madison, WI.

- *Investigating Physical Properties of the Magellanic Bridge via Submillimeter Emission*, University of Valparaíso, August 2016, Valparaíso, Chile.
- *Physical Properties and Submillimeter Excess in Low Metallicity Clouds in the Magellanic Bridge*, University of Chile Workshop for Astronomy Students, May 2016, Santiago, Chile.
- *NGC 5523: An Isolated Product of Soft Galaxy Mergers?*, WIYN 3.5m Telescope Board of Directors Meeting Invited Speaker, September 2015, Madison, WI.

Poster Presentations

- *Skyscrapers in a Desert: Observing Ongoing, Active Star Formation in the Low-Density Wing of the Small Magellanic Cloud*, 231^{st} AAS Meeting, January 2018, Washington, D.C.
- *Stellar Evolution of the Star Cluster NGC 602 and Massive Star Formation in the Low-Density Wing of the SMC*, 229^{th} AAS Meeting, January 2017, Grapevine, TX.
- *SED Fitting of Virgo Cluster Galaxies and Evidence for Enhanced Star Formation due to Accretion*, 227^{th} AAS Meeting, January 2016, Kissimmee, FL.
- *NGC 5523: An Isolated Product of Soft Galaxy Mergers?*, 225^{th} AAS Meeting, January 2015, Seattle, WA.

Professional Development

Graduate Teaching Assistant **September 2018 - Present**
Astronomy 101 Seattle, WA

- Guided students through online lectures, group discussions, and assignments regarding a broad range of astronomical topics from orbital dynamics to cosmological expansion.

Python in Astronomy Conference **April 2018**
Selected Participant New York, NY

- Engaged in a series of tutorials, "unconference" sessions, and programming sprints intended to communicate and actively develop Python usage within a variety of astronomical contexts.
- Lead the selected unconference session "Getting Started with the NOAO Data Lab", in which participants were introduced to Data Lab functionality, created personal accounts, and explored potential science cases.
- Pursued software development for spectroscopic visualization and analysis tools within the Data Lab.

La Serena School for Data Science **August 2017**
Selected Participant La Serena, Chile

- Participated in intensive lectures regarding fundamental techniques for data-driven science: linear and logistic regression, supervised and unsupervised classification, Bayesian statistics, Gaussian mixture models.
- Gained experience with key Python-based methods for machine learning and statistical analysis: decision trees, bagging, random forest, boosting techniques.
- Explored dynamic visualization tools for advanced photometric queries and analysis: Aladin, TOPCAT, Glue, the Virtual Observatory.
- Examined hardware systems for large data analysis and storage: high-performance computing, databases.
- Engaged in a collaborative project on the automatic classification of light curves: Accessed time series data from the Optical Gravitational Lensing Experiment (OGLE) On-line Photometric Databases, determined light curve features using the Feature Analysis for Time Series (FATS) library from the Harvard Institute for Applied Computational Science, extracted individual features for 45,000 light curves using a remote supercomputing cluster and the Slurm Workload Manager, explored several clustering, visualization, and classification methods in the analysis of our data set (K-means, t-SNE, random forest).

Observing Experience

- Mayall 4m Telescope : *Mosaic-3* : Kitt Peak National Observatory
- Atacama Pathfinder Experiment (APEX) : *SHeFI* : Llano de Chajnantor Observatory
- WIYN 3.5m Telescope : *HEXPAK, ODI* : Kitt Peak National Observatory

Societies

- American Astronomical Society Graduate Student Member 2018
- Iron Cross Society : *Recognizing significant leadership and service at UW-Madison* 2016
- Phi Beta Kappa 2016

Community

- Know Your Power : 233^{rd} AAS Meeting Special Session January 2018
  Understanding the distribution of power throughout the academic ecosystem into order to bolster inclusion.
- How to Build & Publish a Website : 233^{rd} AAS Meeting Workshop January 2018
  Developing crucial web development skills to meet professional and academic needs in the digital age.
- Data-Driven Astronomy in the 2020s and Beyond : Astronomy on Tap Talk July, September 2018
  With new types of astronomical data come new ways of solving problems and new ways of asking questions.
- Seeking Out Mentors and Surviving Disappointment : Podcast Interview May 2018
  Shared my experiences building mentor relationships, communicating goals, and practicing self-compassion.
- Questions to Ask when Considering a Graduate Program : AstroBetter Wiki Publication April 2018
  Consolidated a comprehensive list of questions that prospective students are advised to ask graduate programs.
- How to Land a Post-Baccalaureate Research Experience : AstroBetter Wiki Publication April 2018
  Lead an effort to collect resources on how post-baccalaureate scholars find research positions in astronomy.
- Tips for Landing a Post-Baccalaureate Research Experience : University of Arizona March 2018
  Presented advice to undergraduate students, including resources for networking, applications, and resilience.
- Teen Astronomy Café Program : NOAO December 2017
  Co-wrote and co-lead a Jupyter Notebook activity regarding spectroscopy, redshift, and large-scale structure.
- Expanding Your Horizons Conference : UW-Madison November 2016
  Engaged middle school-age girls in a discussion about infrared light and the importance of infrared telescopes.
- Astronomy Department Code of Conduct : UW-Madison February 2016
  Offered undergraduate representation and feedback that would most effectively encourage a safe environment.
- Creating Inclusive Environments in Astronomy : UW-Madison February 2016
  Presented key concepts for promoting equity within the Astronomy Department (privilege, microaggressions).
- Women of Wisconsin Strengthening Astronomy : UW-Madison September 2015 - May 2017
  Empowered women pursuing Astronomy and other STEM fields through peer mentorship and outreach events.

Professional References

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