

# Lily L. Zhao

FLATIRON RESEARCH FELLOW | CENTER FOR COMPUTATIONAL ASTROPHYSICS

## CONTACT INFORMATION

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162 5th Avenue  
New York, NY 10010

## EDUCATION

### Yale University

M.S., M.Phil., Astronomy

May 2018

Ph.D., Astronomy

Jun. 2021

Dissertation Title: *The Path to Extreme Precision Radial Velocity With EXPRES*

### University of Chicago

Jun. 2016

B.S. Mathematics

B.A. Physics

B.A. Biological Sciences

## RESEARCH POSITIONS

### Center for Computational Astrophysics, Flatiron Institute

New York, NY

*Flatiron Research Fellow*

Sep. 2021 - Present

*Research Analyst, Pre-Doctoral Fellow*

Sep. 2019 - Jan. 2020

### Yale Exoplanet Group

New Haven, CT

*EXPRES Team Member*

Sep. 2016 - Jun. 2021

### Bean Exoplanet Group

Chicago, IL

*Hubble STIS Transit Spectroscopy*

Jun. 2015 - Jun. 2016

### NASA Goddard Space Flight Center

Greenbelt, MD

*Joint Polar Satellite System 2 Tracking*

Jun. 2014 - Aug. 2014

### Argonne National Laboratory

Lemont, IL

*South Pole Telescope Polarization Calibration*

Jun. 2013 - Jun. 2015

## AWARDS

*Third Place, Three Minute Thesis Competition, Yale University*

2020

*Sheldon Wise Pre-Doctoral Fellowship, Yale University*

2018

*Graduate Research Fellow, National Science Foundation*

2016

*Google Earth Engine Scholarship, Google*

2015

## PUBLICATIONS

### First Author

8. **Zhao, L.L.**, Hogg, D.W., Bedell, M., Luger, R. "Capturing Stellar Surface Variations at the Spectral Level" in prep.
7. **Zhao, L.L.**, Dumusque, X., Ford, E., et al. "Comparison of Solar Data from HARPS, HARPS-N, EXPRES, and NEID" accepted
6. **Zhao, L.L.**, Kunovac-Hodzic, V., Brewer, J.M., et al. "Measured Spin-Orbit Alignment of Ultra-Short Period Super-Earth 55 Cnc e" 2023, *Nature Astronomy*, 7, 198
5. **Zhao, L.L.**, Fischer, D.A., Henry, G.W., et al. "The EXPRES Stellar-Signals Project II. State of the Field of Disentangling Photospheric Velocities" 2022, *AJ*, 163, 171
4. **Zhao, L.L.**, Hogg, D.W., Bedell, M., Fischer, D.A. "*Excalibur*: A Non-Parametric, Hierarchical Wavelength-Calibration Method for a Precision Spectrograph" 2021, *AJ*, 161, 80

3. **Zhao, L.L.**, Fischer, D.A., Ford, E., Henry, G.W., Rottenbacher, R.M., Brewer, J.M. "The EXPRES Stellar-Signals Project I. Description of Data" 2020, RNAAS, 4, 156
2. Petersburg, R.R., Ong, J.M.J., **Zhao, L.L.**, et al. "An Extreme-Precision Radial-Velocity Pipeline: First Radial Velocities from EXPRES" 2020, AJ, 159, 187  
(Contributions were equally split among the first three authors)
1. **Zhao, L.L.**, Fischer, D., Brewer, J., Giguere, M., & Rojas-Ayala, B. "Planet Detectability in the Alpha Centauri System" 2018, AJ, 155, 24

### Contributing Author

12. Savel, A.B., Bedell, M., Kempton, E.M-R., et al. [incl. **Zhao, L.L.**] "Peering into the black box: forward-modeling the uncertainty budget of high-resolution spectroscopy of exoplanet atmospheres" submitted
11. Korolik, M., Rottenbacher, R.M., Fischer, D.A., et al. [incl. **Zhao, L.L.**] "Refining the Stellar Parameters of  $\tau$  Ceti: a Pole-on Solar Analog" 2023, AJ, 166, 123
10. Brewer, J.M., **Zhao, L.L.**, Fischer, D.A., et al. "EXPRES IV. Two Additional Planets Orbiting  $\rho$  Corona Borealis Reveal Uncommon System Architecture" 2023, AJ, 166, 46
9. Rottenbacher, R.M., Cabot, S.H.C., Fischer, D.A., et al. [incl. **Zhao, L.L.**] "EXPRES. III. Revealing the Stellar Activity Radial Velocity Signature of  $\epsilon$  Eridani with Photometry and Interferometry" 2021, AJ, 163, 19
8. Luger, R., Bedell, M., Foreman-Mackey, D., et al. [incl. **Zhao, L.L.**] "Mapping Stellar Surfaces III: An Efficient, Scalable, and Open-Source Doppler Imaging Model" 2021, arXiv:2110.06271
7. Holzer, P., Cisewski-Keke, J., Fischer, D.A., **Zhao, L.L.** "A Hermite-Gaussian Based Radial Velocity Estimation Method" 2021, AnApS, 15, 527
6. Holzer, P.H., Cisewski-Keke, J., **Zhao, L.L.**, Fischer, D.A., Ford, E.B. "A Stellar Activity F-statistic for Exoplanet Surveys (SAFE)" 2021, AJ, 161, 272
5. Cabot, S.H.C., Rottenbacher, R.M., Henry, G.W., **Zhao, L.L.**, et al. "EXPRES. II. Searching for Planets Around Active Stars: A Case Study of HD 101501" 2020, AJ, 161, 26
4. Hoeijmakers, H.J., Cabot, S.H.C., **Zhao, L.L.**, et al. "High-Resolution Transmission Spectroscopy of MASCARA-2 b with EXPRES" 2020, A&A, 641, A120
3. Brewer, J.M., Fischer, D.A., Blackman, R.T., et al. [incl. **Zhao, L.L.**] "EXPRES I. HD 3651 an Ideal RV Benchmark" 2020, AJ, 160, 67
2. Blackman, R.T., Fischer, D.A., Jurgenson, C.A., et al. [incl. **Zhao, L.L.**] "Performance Verification of the EXtreme PREcision Spectrograph" 2020, AJ, 159, 238
1. Gaudi, S., Blackwood, G., Howard, A., et al. [incl. **Zhao, L.L.**] "Extreme Precision Radial Velocity Working Group" 2019, BAAS 51, 232

### Textbooks

- Astrobiology* (Pressbooks) target Feb. 2024  
Contributer
- Handbook of Exoplanets* (Springer) 2023  
55 Cancri (Copernicus): A Multi-planet System with a Hot Super-Earth and a Jupiter Analogue
- Origins and the Search for Life in the Universe* (CK-12) 2017  
Chapter 6: The Complexification of Chemistry  
Chapter 7: The Emergence of Life on Earth

SEMINARS &  
COLLOQUIA  
○: INVITED

- *Colloquium*, University of Maryland (Apr. 2023)
- *Exocoffee*, Max Planck Institute for Astronomy (Apr. 2023)
- *Astro Seminar*, Carnegie Earth and Planets Laboratory (Dec. 2022)

- *Colloquium*, Jet Propulsion Laboratory (Nov. 2022)
- *Colloquium*, EPRV Research Coordination Network (May. 2022)
- *Exo-Cam Seminar*, University of Cambridge (Nov. 2021)
- *Summer Seminar*, the Ohio State University (Jun. 2021)
- *Fall Seminar*, Columbia University (Nov. 2020)
- *Exoplanet Journal Club*, University of Chicago (Nov. 2020)
- *Center for Exoplanets and Habitable Worlds Seminar*, Pennsylvania State University (Nov. 2020)
- *Galaxies, Cosmology, Stars & Planets Seminar*, Harvard University (Oct. 2020)
- *ORIGINS Seminar*, University of Arizona (Sep. 2020)
- *Tuesday Seminar*, University of Delaware (Apr. 2020)

## MEETINGS

### Conference Talks (◦: Invited)

- "Solar to Stellar Observations" *Cool Stars* (Jun. 2024)
- "Excalibur" *Spectral Fidelity* (Sep. 2023)
- "The Extreme Stellar Signals Project" *EPRV V* (Mar. 2023)
- "Comparing Solar Data across Four Precision Instruments" *PoET* (Feb. 2023)
- "Improving Exoplanet Detection with Discriminative Linear Regression" *Flatiron-wide Algorithms and Mathematics* (Oct. 2022)
- "The EXPRES Stellar Signals Project (ESSP): Establishing the State of the Field in Disentangling Photospheric Velocities" *Exoplanets IV* (May 2022)
- "Discussion of the EXPRES Stellar Signals Project" *Gaussian Process Radial Velocities* (Apr. 2022)
- "The EXPRES Stellar Signals Project (ESSP): Establishing the State of the Field in Disentangling Photospheric Velocities" *The Star-Planet Connection* (Oct. 2021)
- "Machine Learning for Extreme Precision Spectrographs" *AAS 238; Machine Learning in Astronomy (MiM)* (Jun. 2021)
- "Planet Detectability with Next-Generation Spectrographs" *Exoplanets III* (Jul. 2020)
- "EXPRES" *Extreme Precision Radial Velocity IV* (Mar. 2019)
- "EXPRES, the Extreme Precision Spectrograph" *HoRSE: High Resolution Spectroscopy for Exoplanet atmospheres* (Oct. 2018)
- "EXPRES Precision and First Light Results" *Exoplanets II* (Jul. 2018)
- "EXPRES Precision and First Light Results" *Emerging Researchers in Exoplanet Science IV* (Jun. 2018)
- "Planet Detectability in the Alpha Centauri System" *European Week of Astronomy and Space Science* (Apr. 2018)
- "Observational Constraints on Planets in the Alpha Centauri Star System" *Emerging Researchers in Exoplanet Science III* (Jun. 2017)

### Workshops

- Sun-as-a-Star (Mar. 2023)
- Future of Astrophysical Data Infrastructure (Feb. 2023)
- Gaia DR3 Fête (Jun. 2022)
- Sagan Exoplanet Summer School: EPRV (Jul. 2019)
- Building Early Science with TESS (Mar. 2019)

## PROFESSIONAL ACTIVITIES

*Referee:* AAS Journals, A&A, MNRAS, PASJ  
*Proposal Reviewer:* NASA, NSF

### Community Organizing & Collaborations

Exoplanet Exploration Program Analysis Group (ExoPAG)

2023 - 2026

	<i>Executive Committee</i>	
	EPRV Research Coordination Network	2022 - Present
	<i>Steering Committee</i>	
	Extreme Stellar Signals Project (ESSP) Network	2021 - Present
	<i>Lead Organizer</i>	
	The Terra-Hunting Experiment	2021 - Present
	<i>Member</i>	
	Extreme PREcision Spectrograph (EXPRES) Team	2021 - Present
	<i>Science Lead</i>	
	<b>Scientific Organizing Committees</b>	
	Extreme Precision Radial Velocity V	2023
	Sun-as-a-Star Workshop	2023
	Emerging Researchers in Exoplanet Science (ERES)	
	ERES III, Yale	2017
	ERES V, Cornell	2019
	ERES VI, Princeton	2021
	<b>Diversity, Inclusion, &amp; Equity</b>	
	<i>Executive Board:</i> Yale Astronomy Climate and Diversity Committee	2020 - 2021
	<i>Fellow:</i> Yale Office of Graduate Student Diversity and Development	2018 - 2021
	<i>Founding Member:</i> Yale Astronomy Student Council	2018 - 2021
MENTORING	<i>Co-Mentor:</i> Chris Lam	Fall 2022
	Graduate Student, University of Florida	
	Paper in prep., Poster presentation at EPRV V	
	<i>Mentor:</i> Nusrat Jahan	Summer 2022
	Undergraduate Student, Hunter College	
	Poster presentation at AAS 241 and CUWiP	
	<i>Mentor:</i> Lianys Feliciano	Summer 2022
	Undergraduate Student, New York City College of Technology	
	Poster presentation at SACNAS and AAS 241	
TEACHING	<i>Guest Lecture:</i> Another Earth	Fall 2022
	Columbia University	
	<i>Research Project Lead:</i> Exoplanets	Summer 2021
	Warrior Scholars Project	
	<i>Certificate of College Teaching Preparedness</i>	2018
	Granted by the Yale Center for Teaching and Learning	
	<i>Co-Instructor:</i> Origins and the Search for Life in the Universe	Fall 2017
	Yale University	
	<i>Teaching Fellow:</i> Frontiers and Controversies in Astrophysics	Spring 2017
	Yale University	
	<i>Teaching Fellow:</i> Origins and the Search for Life in the Universe	Fall 2016
	Yale University	

## SELECT OUTREACH

<i>Scientist Speaker:</i> Skype a Scientist	2019 - 2021
<i>Docent:</i> the Peabody Museum	2018 - 2019
<i>Demonstrations, Group Leader:</i> Girls Science Investigation	2017 - 2019
<i>Guest Author:</i> Scientific American, Observations	2017
<i>Invited Speaker, Public Relations Committee:</i> Open Labs	2016 - 2020
<i>Observatory Volunteer:</i> Franklin Institute	2012 - 2016

## PROPOSALS

### Observing Proposals

*PI:* NEID, Awarded 5.8 hours of P2 time 2022B  
 "Measuring the Shortest Timescale Stellar Signals for a Range of Spectral Types"

*PI:* Gemini, Awarded 29.8 hours of Band 1 time 2022B  
 "Unveiling the Signatures of Starspots in MAROON-X Spectra with Simultaneous Interferometric Stellar Surface Mapping"

### Grant Proposals

While fully funded from 2021-2024, I contributed to the following successful proposals.

*Co-I:* NASA Extreme Precision Radial Velocity Foundation Science 2023

#### Awarded

"New Strategies for Combining EPRV Observations from Multiple Instruments" (PI: Eric Ford, Pennsylvania State University)

*Co-I:* NASA Extreme Precision Radial Velocity Foundation Science 2023

#### Awarded

"A community driven, modular data-pipeline architecture to push EPRV into the 1 cm/s era" (PI: Jennifer Burt, California Institute of Technology)

*Collaborator:* NSF Astronomical Sciences 2023 - 2025

#### Awarded \$510,000

"Unmasking Stellar Variability: Hierarchical Bayesian methods for characterization of low-mass planets with EPRV spectroscopy" (PI: Jessica Kehe, University of Wisconsin-Madison)

*Co-I:* NASA Exoplanets Research Program (XRP) 2023 - 2025

#### Awarded \$575,000

"Turn down the noise! Disentangling planetary and stellar signals by observing the Sun with EXPRES" (PI: Joe Llama, Lowell Observatory)

*Co-I:* Heising-Simons Foundation 2022 - 2025

#### Awarded \$950,000

"EXPRES 100 Earths Survey" (PI: Joe Llama, Lowell Observatory)

## REFERENCES

**Debra A. Fischer:** [debra.fischer@yale.edu](mailto:debra.fischer@yale.edu)

**David W. Hogg:** [david.hogg@nyu.edu](mailto:david.hogg@nyu.edu)

**Eric B. Ford:** [eford@psu.edu](mailto:eford@psu.edu)