

# Lily L. Zhao

NASA SAGAN FELLOW | UNIVERSITY OF CHICAGO

## CONTACT

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## 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

### University of Chicago

Chicago, IL

*NASA Sagan Fellow*

Oct. 2024 - Present

### Center for Computational Astrophysics, Flatiron Institute

New York, NY

*Flatiron Research Fellow*

Sep. 2021 - Sep. 2024

*Pre-Doctoral Fellow*

Sep. 2019 - Jan. 2020

### Yale Exoplanet Group

New Haven, CT

*NSF Graduate Research Fellow*

Sep. 2016 - Jun. 2021

## AWARDS

*Dirk Brouwer Memorial Prize for Outstanding PhD Thesis, Yale University* 2024

*Hubble Fellowship, NASA* 2024

*Third Place, Three Minute Thesis Competition, Yale University* 2020

*Sheldon Wise Pre-Doctoral Fellowship, Yale University* 2018

*Graduate Research Fellowship, National Science Foundation* 2016

## PUBLICATIONS

### First Author

10. **Zhao, L.L.**, Al Moulla, K., Faria, J., et al. "The Extreme Stellar-Signals Project IV. State of the Field of Disentangling Solar Signals" in prep.
9. **Zhao, L.L.**, Fischer, D.A., Szymkowiak, A.E., et al. "Uncovering Hidden Systematics in Extreme-Precision Radial Velocity Measurements" submitted
8. **Zhao, L.L.**, Bedell, M., Hogg, D.W., Luger, R. "A Compact, Coherent Representation of Stellar Surface Variation in the Spectral Domain" 2024, *ApJ*, 977, 140
7. **Zhao, L.L.**, Dumusque, X., Ford, E., et al. "The Extreme Stellar-Signals Project III. Combining Solar Data from HARPS, HARPS-N, EXPRES, and NEID" 2023, *AJ*, 166, 173
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 (\*: Student Paper)

24. Luhn, J., Rubenzahl, R.A., Halverson, S., **Zhao, L.L.** "An Exposure-averaged Gaussian Process Framework to Recover Stellar Variability in Combined Radial Velocity Data Sets" submitted
23. Ellworth, M., Llama, J., **Zhao, L.L.**, et al. "The He I D3 Line as a Proxy for Magnetic Activity using EXPRES Solar Observations" arXiv, 2510.27059
22. Brady, M., Bean, J.L., Basant, R., et al. [incl. **Zhao, L.L.**] "An Earth-like Density for the Temperate Earth-sized Planet GJ 12b" accepted
- \*21. Komori, C., Brewer, J.M., **Zhao, L.L.** "The Effects of Sunspots on Spectral Line Shapes in the Visible" 2025, AJ, 170, 209
20. Salzer, J., Cisewski-Kehe, J., Ford, E.B., **Zhao, L.L.** "Searching for Low-Mass Exoplanets Amid Stellar Variability with a Fixed Effects Linear Model of Line-by-Line Shape Changes" 2025, AJ, 170, 179
19. Freckelton, A.V., Mortier, A., Bedell, M., et al. [incl. **Zhao, L.L.**] "gr8stars – I. A homogeneous spectroscopic study of bright FGKM dwarfs and a public library of their high-resolution spectra" 2025, MNRAS, 540, 1786
18. Basant, r., Luque, R., Bean, J.L., et al. [incl. **Zhao, L.L.**] "Four sub-Earth planets orbiting Barnard's Star from MAROON-X and ESPRESSO" 2025, ApJ, 982, 1
17. Vieytes, M., **Zhao, L.L.**, Bedell, M. "The Influence of Chromospheric Activity on Line Formation" 2025, ApJ, 981, 4
16. 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" 2025, AJ, 169, 135
- \*15. Lam, C., Bedell, M., **Zhao, L.L.**, Gupta, A. "Gasperry: Optimized Scheduling of Radial Velocity Follow-Up Observations for Active Host Stars" 2024, AJ, 168, 200
14. Llama, J., **Zhao, L.L.**, Brewer, J.M., et al. "The Lowell Observatory Solar Telescope: a fiber feed into the Extreme Precision Spectrometer" 2024, SPIE, 13094, 20L
13. Siegel, J., Halverson, S., Luhn, J.K., **Zhao, L.L.**, et al. "Quiet Please: Detrending Radial Velocity Variations from Stellar Activity with a Physically Motivated Spot Model" 2024, AJ, 168, 158
12. Eisner, N.L., Grunblat, S.K., Barragán, O., et al. [incl. **Zhao, L.L.**] "Planet Hunters TESS. V. A Planetary System Around a Binary Star, Including a Mini-Neptune in the Habitable Zone" 2024, AJ, 167, 241
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-Kehe, J., Fischer, D.A., **Zhao, L.L.** "A Hermite-Gaussian Based Radial Velocity Estimation Method" 2021, AnApS, 15, 527

6. Holzer, P.H., Cisewski-Kehe, 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., Roettenbacher, 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

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

### INVITED TALKS

#### Colloquia

- UC Berkeley (Feb. 2025)
- Rochester Institute of Technology (Dec. 2024)
- University of Toronto (Feb. 2024)
- University of Maryland (Apr. 2023)
- Jet Propulsion Laboratory (Nov. 2022)
- EPRV Research Coordination Network (May 2022)

Not listed: 12 seminars (9 invited)

#### Invited Conference Talks

- "Advancing Precision Radial Velocity Towards Detecting Earth Analogs" *Frank N. Bash Symposium* (Sep. 2025)
- "Advancing Precision Radial Velocity Towards Detecting Earth Analogs" *TDLI: Post-doctoral Frontier Symposium in Physics and Astronomy* (Sep. 2025)
- Life Beyond Earth: The Missing Links *ISSI Breakthrough Workshop* (Jun. 2025)
- "Solar to Stellar Observations" *Cool Stars* (Jun. 2024)
- "Excalibur" *Spectral Fidelity* (Sep. 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)
- "Machine Learning for Extreme Precision Spectrographs" *AAS 238; Machine Learning in Astronomy (MiM)* (Jun. 2021)
- "EXPRES" *Extreme Precision Radial Velocity IV* (Mar. 2019)

Not listed: 21 contributed conference talks

## PROFESSIONAL ACTIVITIES

*Referee:* AAS Journals, A&A, MNRAS, PASP, PASJ  
*Proposal Reviewer:* NASA APRA, NSF AAG, NSF ATI

### **Community Leadership & Collaborations**

Exoplanet Exploration Program Analysis Group (ExoPAG) 2023 - 2026  
*Executive Committee Member*

EPRV Research Coordination Network 2022 - Present  
*Steering Committee Member*

The Terra-Hunting Experiment 2021 - Present  
*Member*

Extreme Stellar Signals Project (ESSP) 2020 - Present  
*Founder; Executive Committee Member*

Extreme Precision Spectrograph (EXPRES) Team 2016 - Present  
*Project Scientist*

### **Scientific Organizing Committees**

EPRV VI Splinter Session "Accessing and Working with EPRV Solar Datasets" 2025

EPRV VI Splinter Session "Benchmarking Stellar Variability Mitigation Methods" 2025

EPRV V 2023

EPRV V Splinter Session "From Solar to Stellar" 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

### **Diversity, Inclusion, & Equity**

*Executive Board:* Yale Astronomy Climate and Diversity Committee 2020 - 2021

*Fellow:* Yale Office of Graduate Student Diversity and Development 2018 - 2021

*Founding Member:* Yale Astronomy Student Council 2018 - 2021

### **Invited Panels**

*Interview Preparation Panel,* Guide to Applying for Astronomy Postdocs (GAAP) (Jul. 2025)

*Career Panel,* Emerging Researchers in Exoplanet Science IX (Jul. 2024)

## MENTORING

*Co-Mentor:* Claire Komori 2023-2025  
 Masters Student, State University of San Francisco  
 First-author publication

*Co-Mentor:* Chris Lam Fall 2022  
 Graduate Student, University of Florida  
 First-author publication, Poster presentation at EPRV V

*Mentor:* Nusrat Jahan Summer 2022  
 Undergraduate Student, Hunter College  
 Poster presentation at AAS 241 and CUWiP

*Mentor:* Lianys Feliciano Summer 2022  
 Undergraduate Student, New York City College of Technology  
 Poster presentation at SACNAS and AAS 241

TEACHING	<i>Guest Lecture: Another Earth</i> Columbia University	Fall 2022
	<i>Research Project Lead: Exoplanets</i> Warrior Scholars Project	Summer 2021
	<i>Certificate of College Teaching Preparation</i> Granted by the Yale Center for Teaching and Learning	Awarded 2018
	<i>Co-Instructor: Origins and the Search for Life in the Universe</i> Yale University	Fall 2017
	<i>Teaching Fellow: Frontiers and Controversies in Astrophysics</i> Yale University	Spring 2017
	<i>Teaching Fellow: Origins and the Search for Life in the Universe</i> Yale University	Fall 2016
SELECT OUTREACH	<i>Astronomy Conversations Presenter: Adler Planetarium</i>	2025 - Present
	<i>Mentor: AMP-UP</i>	2024 - 2025
	<i>Reviewer: NHFP App Feedback Program</i>	2024
	<i>Speaker: Skype a Scientist</i>	2019 - 2021
	<i>Docent: the Peabody Museum</i>	2018 - 2019
	<i>Demonstrations, Group Leader: Girls Science Investigation</i>	2017 - 2019
	<i>Guest Author: Scientific American, Observations</i>	2017
	<i>Invited Speaker, Public Relations Committee: Open Labs</i>	2016 - 2020
PROPOSALS	<i>Observatory Volunteer: Franklin Institute</i>	2012 - 2016
	<b>Observing Proposals</b>	
	<i>PI: NEID, 2022B</i>	
	<b>Awarded 5.8 hours of P2 time</b>	
	"Measuring the Shortest Timescale Stellar Signals for a Range of Spectral Types"	
	<i>PI: Gemini, 2022B</i>	
	<b>Awarded 29.8 hours of Band 1 time</b>	
	"Unveiling the Signatures of Starspots in MAROON-X Spectra with Simultaneous Interferometric Stellar Surface Mapping"	
	<b>Grant Proposals</b>	
	While fully funded from 2021-2027, I contributed to the following successful proposals.	
	<i>Co-I: NASA Exoplanet Mass Measurement Program</i>	2024
	<b>Selectable</b> "A Star-as-the-Sun: applying solar EPRV techniques to stellar spectra" (PI: Drake Demming, University of Maryland)	
	<i>Co-I: NASA Exoplanet Mass Measurement Program</i>	2024
	<b>Selectable</b> "Development of a community data reduction framework to advance EPRV towards the cm/s precision era" (PI: Daniel Krolikowski, University of Arizona)	
	<i>Co-I: NASA Extreme Precision Radial Velocity Foundation Science</i>	2022
	<b>Awarded \$450,000</b> "New Strategies for Combining EPRV Observations from Multiple Instruments" (PI: Eric Ford, Pennsylvania State University)	

*Co-I:* NASA Extreme Precision Radial Velocity Foundation Science 2022  
**Awarded \$480,000**  
 "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)