Lily L. Zhao NASA Sagan Fellow | University of Chicago

Contact

Email: lilylingzhao@uchicago.edu
Website: https://lilylingzhao.github.io/
ORCHID: 0000-0002-3852-3590

Mailing Address
5640 S Ellis Ave.
Chicago, IL 60637

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

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, LL..**, Fischer, D., Brewer, J., Giguere, M., & Rojas-Ayala, B. "Planet Detectability in the Alpha Centauri System" 2018, AJ, 155, 24

Contributing Author ($\star$: Student Paper)

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" in prep
19. 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" submitted
$\star$18. Komori, C., Brewer, J.M., **Zhao, L.L.** "The Effects of Sunspots on Spectral Line Shapes in the Visible" in review
17. Vieytes, M., **Zhao, L.L.**, Bedell, M."The Influence of Chromospheric Activity on Line Formation" accepted
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" accepted
$\star$15. Lam, C., Bedell, M., **Zhao, L.L.**, Gupta, A. "*Gaspery*: 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 τ 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 ρ 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 ϵ 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-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

Astrobiology (Pressbooks) 2024
Co-author

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

SELECTED TALKS
○: INVITED

Seminars & Colloquia

- ○ *Colloquium*, Rochester Institute of Technology (Dec. 2024)
- ○ *Career Panel*, Emerging Researchers in Exoplanet Science IX (Jul. 2024)
- ○ *Colloquium*, University of Toronto (Feb. 2024)
- ○ *Observers Lunch*, CIERA (Jan. 2024)
- ○ *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)

Conferences

- • "The Extreme Stellar Signals Project" *MIT Stellar Contamination* (Sep. 2024)
- ○ "Solar to Stellar Observations" *Cool Stars* (Jun. 2024)
- • "The Extreme Stellar Signals Project" *Extreme Solar Systems V* (Mar. 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)
- "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, PASP, PASJ
Proposal Reviewer: NASA, NSF

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 and Executive Committee Member

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

Scientific Organizing Committee

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

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

Mentoring

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

Guest Lecture: Another Earth — Fall 2022
Columbia University

Research Project Lead: Exoplanets — Summer 2021
Warrior Scholars Project

Certificate of College Teaching Preparation — Awarded 2018
Granted by the Yale Center for Teaching and Learning

Co-Instructor: Origins and the Search for Life in the Universe — Fall 2017
Yale University

Teaching Fellow: Frontiers and Controversies in Astrophysics — Spring 2017
Yale University

Teaching Fellow: Origins and the Search for Life in the Universe — Fall 2016
Yale University

SELECT OUTREACH

Mentor: AMP-UP — 2024 - 2025
Speaker: Skype a Scientist — 2019 - 2021
Docent: the Peabody Museum — 2018 - 2019
Demonstrations, Group Leader: Girls Science Investigation — 2017 - 2019
Guest Author: Scientific American, Observations — 2017
Invited Speaker, Public Relations Committee: Open Labs — 2016 - 2020
Observatory Volunteer: Franklin Institute — 2012 - 2016

PROPOSALS

Observing Proposals

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

PI: Gemini, 2022B
Awarded 29.8 hours of Band 1 time
"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
David W. Hogg: david.hogg@nyu.edu
Eric B. Ford: eford@psu.edu