

# Lily L. Zhao

NASA SAGAN FELLOW | UNIVERSITY OF CHICAGO

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| EDUCATION          | <b>Yale University</b><br>M.S., M.Phil., Astronomy<br>Ph.D., Astronomy<br>Dissertation Title: <i>The Path to Extreme Precision Radial Velocity With EXPRES</i>  | May 2018<br>Jun. 2021  |
|                    | <b>University of Chicago</b><br>B.S. Mathematics<br>B.A. Physics<br>B.A. Biological Sciences  | Jun. 2016  |
| RESEARCH POSITIONS | <b>University of Chicago</b><br><i>NASA Sagan Fellow</i>  | Chicago, IL<br>Oct. 2024 - Present                               |
|                    | <b>Center for Computational Astrophysics, Flatiron Institute</b><br><i>Flatiron Research Fellow</i><br><i>Pre-Doctoral Fellow</i>   | New York, NY<br>Sep. 2021 - Sep. 2024<br>Sep. 2019 - Jan. 2020   |
|                    | <b>Yale Exoplanet Group</b><br><i>NSF Graduate Research Fellow</i>  | New Haven, CT<br>Sep. 2016 - Jun. 2021                           |
| AWARDS             | <i>Dirk Brouwer Memorial Prize for Outstanding PhD Thesis</i> , Yale University<br><i>Hubble Fellowship</i> , NASA<br><i>Third Place</i> , Three Minute Thesis Competition, Yale University<br><i>Sheldon Wise Pre-Doctoral Fellowship</i> , Yale University<br><i>Graduate Research Fellowship</i> , National Science Foundation   | 2024<br>2024<br>2020<br>2018<br>2016                             |
| PUBLICATIONS       | <b>First Author</b><br><ol style="list-style-type: none"><li>10. <b>Zhao, L.L.</b>, Al Moulla, K., Faria, J., et al. "The Extreme Stellar-Signals Project IV. State of the Field of Disentangling Solar Signals" in prep.</li><li>9. <b>Zhao, L.L.</b>, Fischer, D.A., Szymkowiak, A.E., et al. "Uncovering Hidden Systematics in Extreme-Precision Radial Velocity Measurements" accepted.</li><li>8. <b>Zhao, L.L.</b>, Bedell, M., Hogg, D.W., Luger, R. "A Compact, Coherent Representation of Stellar Surface Variation in the Spectral Domain" 2024, ApJ, 977, 140</li><li>7. <b>Zhao, L.L.</b>, 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</li><li>6. <b>Zhao, L.L.</b>, 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</li><li>5. <b>Zhao, L.L.</b>, 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</li><li>4. <b>Zhao, L.L.</b>, Hogg, D.W., Bedell, M., Fischer, D.A. "Excalibur: A Non-Parametric, Hierarchical Wavelength-Calibration Method for a Precision Spectrograph" 2021, AJ, 161, 80</li></ol> |  |

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. Ellsworth, 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. Freckleton, 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. “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  $\tau$  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-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

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

### INVITED TALKS

#### Colloquia

- Columbia University (Feb. 2026)
- University of Toledo (Feb. 2026)
- University of Texas at Austin (Feb. 2026)
- 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)

Seminars 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

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| PROFESSIONAL ACTIVITIES                   | <i>Referee:</i> AAS Journals, A&A, MNRAS, PASP, PASJ<br><i>Proposal Reviewer:</i> NASA APRA, NSF AAG, NSF ATI                              |                |
|   | <b>Community Leadership &amp; Collaborations</b>   |                |
|   | Exoplanet Exploration Program Analysis Group (ExoPAG)<br><i>Executive Committee Member</i>   | 2023 - 2026    |
|   | EPRV Research Coordination Network<br><i>Steering Committee Member</i>   | 2022 - Present |
|   | The Terra-Hunting Experiment<br><i>Member</i>  | 2021 - Present |
|   | Extreme Stellar Signals Project (ESSP)<br><i>Founder; Executive Committee Member</i>   | 2020 - Present |
|   | Extreme Precision Spectrograph (EXPRES) Team<br><i>Project Scientist</i>   | 2016 - Present |
|   | <b>Scientific Organizing Committees</b>  |                |
|   | 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           |
| <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    |
| <b>Invited Panels</b>                     |  |                |
|   | <i>Interview Preparation Panel</i> , Guide to Applying for Astronomy Postdocs (GAAP) (Jul. 2025)   |                |
|   | <i>Career Panel</i> , Emerging Researchers in Exoplanet Science IX (Jul. 2024)   |                |
| MENTORING                                 | <i>Co-Mentor:</i> Claire Komori<br>Masters Student, State University of San Francisco<br>First-author publication                          | 2023-2025      |
|   | <i>Co-Mentor:</i> Chris Lam<br>Graduate Student, University of Florida<br>First-author publication, Poster presentation at EPRV V          | Fall 2022      |
|   | <i>Mentor:</i> Nusrat Jahan<br>Undergraduate Student, Hunter College<br>Poster presentation at AAS 241 and CUWiP                           | Summer 2022    |
|   | <i>Mentor:</i> Lianys Feliciano<br>Undergraduate Student, New York City College of Technology<br>Poster presentation at SACNAS and AAS 241 | Summer 2022    |

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

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| <i>Co-I:</i> NASA Extreme Precision Radial Velocity Foundation Science<br><b>Awarded \$480,000</b><br>"A community driven, modular data-pipeline architecture to push EPRV into the 1 cm/s era" (PI: Jennifer Burt, California Institute of Technology)          | 2022        |
| <i>Collaborator:</i> NSF Astronomical Sciences<br><b>Awarded \$510,000</b><br>"Unmasking Stellar Variability: Hierarchical Bayesian methods for characterization of low-mass planets with EPRV spectroscopy" (PI: Jessica Kehe, University of Wisconsin-Madison) | 2023 - 2025 |
| <i>Co-I:</i> NASA Exoplanets Research Program (XRP)<br><b>Awarded \$575,000</b><br>"Turn down the noise! Disentangling planetary and stellar signals by observing the Sun with EXPRES" (PI: Joe Llama, Lowell Observatory)                                       | 2023 - 2025 |
| <i>Co-I:</i> Heising-Simons Foundation<br><b>Awarded \$950,000</b><br>"EXPRES 100 Earths Survey" (PI: Joe Llama, Lowell Observatory)   | 2022 - 2025 |

## REFERENCES

**Debra A. Fischer:** debra.fischer@yale.edu  
**David W. Hogg:** david.hogg@nyu.edu  
**Eric B. Ford:** eford@psu.edu