Jacob Lustig-Yaeger

Astronomy & Astrobiology, PhD

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Education

PhD in Astronomy & Astrobiology (dual-titled PhD) (2014 – 2020)
MS in Astronomy (2016)
University of Washington, Seattle, WA
Thesis: "The Detection, Characterization, and Retrieval of Terrestrial Exoplanet Atmospheres"
Advisor: Professor Victoria Meadows

BS in Physics (Honors), Minor in Mathematics (2009 – 2013)
University of California, Santa Cruz, CA
Advisor: Professor Jonathan Fortney

Research Interests

— Characterizing terrestrial exoplanets for habitability and signs of life
— Retrieving terrestrial planet atmospheres using Bayesian inference
— Modeling telescope sensitivity to motivate future exoplanet science cases
— Developing novel methods to detect exoplanet habitability and biosignatures

Research Experience

Post Doctoral Fellow: The Johns Hopkins Applied Physics Laboratory (2020 – present)
Terrestrial exoplanet atmospheres, theory & observation, mission concepts

Graduate Research Assistant: Virtual Planetary Laboratory (2014 – 2020)
Terrestrial exoplanets, their atmospheres, habitability & biosignatures

Undergraduate & Postbaccalaureate Researcher: University of California, Santa Cruz (2012 – 2014)
Hot Jupiter & brown dwarf atmospheres, opacity sources, and atmospheric retrieval

Teaching Experience

Research Mentor: Department of Astronomy, University of Washington (Sept 2016 – Present)
Advising undergraduate students in exoplanet astronomy and astrobiology research

Teaching Assistant: Department of Astronomy, University of Washington (Sept 2014 – June 2015)
Led two biweekly sections for undergraduate students
— ASTR 101 (Spring 2015; Autumn 2014)
— ASTR 150 (Winter 2015)

Math & Writing Tutor: Learning Support Services, UCSC (Sept 2010 – June 2012)
Instructed students in college level mathematics and writing as a group and drop-in tutor

Honors, Awards, & Funded Proposals

— **NASA Exoplanet Research Program PI:** "Venus as an Exoplanet: Constructing a Venus Transmission Spectrum from Venus Express Solar Occultation Measurements" (2022)
— **JWST Cycle 1 Co-PI:** "Tell Me How I'm Supposed To Breathe With No Air: Measuring the Prevalence and Diversity of M-Dwarf Planet Atmospheres" (2021)
— **NASA Group Achievement Award:** LUVOIR Mission Concept Study Team (2019)
— Honors undergraduate thesis in physics (2013)
— University Honor, *cum laude* at University of California, Santa Cruz (2013)

Technical Skills

— Programming in Python, Julia, IDL, & Fortran
— Packaging Python code for open-source distribution
— Bayesian parameter inference and model selection
— Version control and collaboration with Git & GitHub
— Data visualization with Matplotlib, Tableau, & Bokeh
— Writing and typesetting with LaTeX and Overleaf
— Extensive experience with MS Office Suite

Community Service

— Member of the Exoplanet Science Metrics Working Group (May 2023 - present)
— Science Organizing Committee: STScI 2023 Spring Symposium (Aug 2022 – present)
— Section Co-Editor: "Handbook of Exoplanets, Second Edition" (Mar 2022 – present)
— Participating Member and Task Co-Lead: ExoPAG SAG 22 (Oct 2020 – Dec 2021)
— Reviewer for AAS Journals, MNRAS, Nature Astronomy (2017 - present)

Publications

First Authored

8. **Lustig-Yaeger, J.**, Meadows, V. S., Crisp, D., Line, M. R., & Robinson, T. D. (2023). "Earth as a Transiting Exoplanet: A Validation of Transmission Spectroscopy and Atmospheric Retrieval Methodologies for Terrestrial Exoplanets". *The Planetary Science Journal*, 4(9), 170.
7. **Lustig-Yaeger, J.** & Fu, G., May, E. M., Ceballos, K. N., Moran, S. E., Peacock, S., Stevenson, K. B., Kirk, J., López-Morales, M., MacDonald, R. J., Mayorga, L. C., Sing, D. K., et al. (2023). "A JWST transmission spectrum of the nearby Earth-sized exoplanet LHS 475 b". *Nature Astronomy*, 1-12. https://doi.org/10.1038/s41550-023-02064-z
6. **Lustig-Yaeger, J.**, Sotzen, K. S., Stevenson, K. B., Luger, R., May, E. M., Mayorga, L. C., Mandt, K., & Izenberg, N. R. (2022). "Hierarchical Bayesian Atmospheric Retrieval Modeling for Population Studies of Exoplanet Atmospheres: A Case Study on the Habitable Zone". *The Astronomical Journal*, 163(3), 140.
5. **Lustig-Yaeger, J.**, Stevenson, K. B., Mayorga, L. C., Sotzen, K. S., May, E. M., Izenberg, N. R., & Mandt, K. (2021). "Retrieving Exoplanet Atmospheres using Planetary Infrared Excess: Prospects for the Night side of WASP-43 b and other Hot Jupiters". *The Astrophysical Journal Letters*, 921(1), L4.
4. **Lustig-Yaeger, J.**, Meadows, V. S., & Lincowski, A. P. (2019). "A Mirage of the Cosmic Shoreline: Venus-like Clouds as a Statistical False Positive for Exoplanet Atmospheric Erosion". *The Astrophysical Journal Letters*, 887(1), L11.
3. **Lustig-Yaeger, J.**, Robinson, T. D., & Arney, G. (2019). "`coronagraph`: Telescope Noise Modeling for Exoplanets in Python". *Journal of Open Source Software*, 4(40), 1387.
2. **Lustig-Yaeger, J.**, Meadows, V. S., & Lincowski, A. P. (2019). "The Detectability and Characterization of the TRAPPIST-1 Exoplanet Atmospheres with JWST". *The Astronomical Journal*, 158(1), 27.
1. **Lustig-Yaeger, J.**, Meadows, V. S., Tovar Mendoza, G., Schwieterman, E. W., Fujii, Y., Luger, R., & Robinson, T. D. (2018). "Detecting Ocean Glint on Exoplanets Using Multiphase Mapping". *The Astronomical Journal*, 156(6), 301.

Co-Authored

31. Mayorga, L. C., **Lustig-Yaeger, J.**, & Stevenson, K. B. (2023). "On the Effectiveness of the Planetary Infrared Excess (PIE) Technique to Retrieve the Parameters of Multiplanet Systems around M Dwarfs: A Case Study on the TRAPPIST-1 System". *The Astrophysical Journal*, 956(2), 74.
30. Meadows, V. S., Lincowski, A. P., & **Lustig-Yaeger, J.** (2023). "The Feasibility of Detecting Biosignatures in the TRAPPIST-1 Planetary System with JWST". *The Planetary Science Journal*, 4(10), 192.
29. Chouqar, J., **Lustig-Yaeger, J.**, Benkhaldoun, Z., Szentgyorgyi, A., Jabiri, A., & Soubkiou, A. (2023). "Surface pressure impact on nitrogen-dominated USP super-Earth atmospheres". *Monthly Notices of the Royal Astronomical Society*, 522(1), 648-659.

28. Schlawin, E., Challener, R., Mansfield, M., Rauscher, E., Adams, A., & **Lustig-Yaeger, J.** (2023). "Planet Eclipse Mapping with Long-term Baseline Drifts". *The Astronomical Journal*, 165(5), 210.

27. Moran, S. E., Stevenson, K. B., Sing, D. K., MacDonald, R. J., Kirk, J., **Lustig-Yaeger, J.**, Peacock, S., Mayorga, L. C., Bennett, K. A., López-Morales, M., May, E. M., et al. (2023). "High Tide or Riptide on the Cosmic Shoreline? A Water-Rich Atmosphere or Stellar Contamination for the Warm Super-Earth GJ 486b from JWST Observations". *The Astrophysical Journal Letters*, 948(1), p.L11.

26. Ahrer, E. M., Stevenson, K. B., Mansfield, M. et al. (2023). "Early Release Science of the exoplanet WASP-39b with JWST NIRCam". *Nature* 614, 653-658.

25. Rustamkulov, Z., Sing, D. K., Mukherjee, S. et al. (2023). "Early Release Science of the exoplanet WASP-39b with JWST NIRSpec PRISM". *Nature* 614, 659-663.

24. JWST Transiting Exoplanet Community Early Release Science Team (2023). "Identification of carbon dioxide in an exoplanet atmosphere". *Nature* 614, 649-652.

23. Limbach, M. A., Vanderburg, A., Stevenson, K. B., Blouin, S., Morley, C., **Lustig-Yaeger, J.**, Soares-Furtado, M. and Janson, M., (2022). "A new method for finding nearby white dwarfs exoplanets and detecting biosignatures". *Monthly Notices of the Royal Astronomical Society*, 517(2), pp.2622-2638.

22. Mandell, A. M., **Lustig-Yaeger, J.**, Stevenson, K., & Staguhn, J. (2022). "MIRECLE: Science Yield for a Mid-IR Explorer-Class Mission to Study Non-Transiting Rocky Planets Orbiting the Nearest M-Stars Using Planetary Infrared Excess". *The Astronomical Journal*, 164, 176.

21. Mandt, K., Luspay-Kuti, A., **Lustig-Yaeger, J.**, Felton, R., & Domagal-Goldman, S. (2022). "TRAPPIST-1h as an Exo-Titan. I. The Role of Assumptions about Atmospheric Parameters in Understanding an Exoplanet Atmosphere". *The Astrophysical Journal*, 930(1), 73.

20. Wood, B. E., Hess, P., **Lustig-Yaeger, J.**, Gallagher, B., Korwan, D., Rich, N., et al. (2022). "Parker Solar Probe imaging of the night side of Venus". *Geophysical Research Letters*, 49(3), e2021GL096302.

19. Hinkel, N. R., Pepper, J., Stark, C. C., Burt, J. A., Ciardi, D. R., Hardegree-Ullman, K. K., **Lustig-Yaeger, J.**, Kopparapu, R., Mishra, L., Molaverdikhani, K., Pascucci, I., et al. (2021). "Final Report for SAG 22: A Target Star Archive for Exoplanet Science". *arXiv preprint arXiv*:2112.04517.

18. Komacek, T. D., Kang, W., **Lustig-Yaeger, J.**, & Olson, S. L. (2021). "Constraining the Climates of Rocky Exoplanets". *Elements*, 17, 4.

17. Mayorga, L. C., **Lustig-Yaeger, J.**, May, E. M., Sotzen, K. S., Gonzalez-Quiles, J., et al. (2021) "Transmission Spectroscopy of the Earth-Sun System to Inform the Search for Extrasolar Life". *The Planetary Science Journal*, 2(4), 140.

16. Kopparapu, R., Arney, G., Haqq-Misra, **J., Lustig-Yaeger**, J., & Villanueva, G. (2021). "Nitrogen dioxide pollution as a signature of extraterrestrial technology". *The Astrophysical Journal*, 908(2), 164.

15. Mansfield, M., Schlawin, E., **Lustig-Yaeger, J.**, et al. (2020). "Eigenspectra: A Framework for Identifying Spectra from 3D Eclipse Mapping". *Monthly Notices of the Royal Astronomical Society*.

14. Leung, M., Meadows, V. S., & **Lustig-Yaeger, J.** (2020). "High-Resolution Spectral Discriminants of Ocean Loss for M Dwarf Terrestrial Exoplanets". *The Astronomical Journal*, 160(1), 11.

13. Chouqar, J., Zouhair, B., Jabiri, A., **Lustig-Yaeger, J.**, Soubkiou, A., & Szentgyorgyi, A. (2020). "Properties of Sub-Neptune Atmospheres: TOI-270 System". *Monthly Notices of the Royal Astronomical Society*, 495(1), 962-970.

12. Guzewich, S. D., **Lustig-Yaeger, J.**, Davis, C. E., Kopparapu, R. K., Way, M. J., & Meadows, V. S. (2020). "The Impact of Planetary Rotation Rate on the Reflectance and Thermal Emission Spectrum of Terrestrial Exoplanets Around Sun-like Stars". *The Astrophysical Journal*, 893, 140.

11. Lincowski, A. P., **Lustig-Yaeger, J.**, & Meadows, V. S. (2019). "Observing Isotopologue Bands in Terrestrial Exoplanet Atmospheres with the James Webb Space Telescope—Implications for Identifying Past Atmospheric and Ocean Loss". *The Astronomical Journal*, 158(1), 26.
10. Luger, R., Agol, E., Foreman-Mackey, D., Fleming, D. P., **Lustig-Yaeger, J.**, & Deitrick, R. (2019). "STARRY: Analytic Occultation Light Curves". *The Astronomical Journal*, 157(2), 64.
9. Lincowski, A. P., Meadows, V. S., Crisp, D., Robinson, T. D., Luger, R., **Lustig-Yaeger, J.**, & Arney, G.N. (2018). "Evolved Climates and Observational Discriminants for the TRAPPIST-1 Planetary System". *The Astrophysical Journal*, 867(1), 76.
8. Meadows, V. S., Reinhard, C. T., Arney, G. N., Parenteau, M. N., Schwieterman, E. W., Domagal-Goldman, S. D., Lincowski, A. P., Stapelfeldt, K. R., Rauer, H., DasSarma, S., Hegde, S., Narita, N., Deitrick, R., **Lustig-Yaeger, J.**, Lyons, T. W., & Siegler, N. (2018). "Exoplanet Biosignatures: Understanding Oxygen as a Biosignature in the Context of Its Environment". *Astrobiology*, 18, 630-662.
7. Meadows, V. S., Arney, G. N., Schwieterman, E. W., **Lustig-Yaeger, J.**, Lincowski, A. P., Robinson, T., Domagal-Goldman, S. D., Barnes, R. K., Fleming, D. P., Deitrick, R., Luger, R., Driscoll, P. E., Quinn, T. R., Crisp, D. (2018). "The Habitability of Proxima Centauri b: Environmental States and Observational Discriminants". *Astrobiology*, 18, 133-189.
6. Luger, R., **Lustig-Yaeger, J.**, & Agol, E. (2017). "Planet-Planet Occultations in TRAPPIST-1 and Other Exoplanet Systems". *The Astrophysical Journal*, 851(2), 94.
5. Fujii, Y., **Lustig-Yaeger, J.**, & Cowan, N. B. (2017). "Rotational Spectral Unmixing of Exoplanets: Degeneracies between Surface Colors and Geography". *The Astronomical Journal*, 154(5), 189.
4. Luger, R., **Lustig-Yaeger, J.**, Fleming, D. P., Tilley, M. A., Agol, E, Meadows, V. S., Deitrick, R., & Barnes, R. (2017). "The Pale Green Dot: A Method to Characterize Proxima Centauri b using Exo-Aurorae". *The Astrophysical Journal*, 837, 63.
3. Barnes, R., Deitrick, R., Luger, R., Driscoll, P. E., Quinn, T. R., Fleming, D. P., Arney, G., Crisp, D., Domagal-Goldman, S. D., Lincowski, A. P., **Lustig-Yaeger, J.**, & Schwieterman, E. (2017). "The Habitability of Proxima Centauri b I: Evolutionary Scenarios". *arXiv preprint arXiv:1608.06919.*
2. Greene, T. P., Line, M. R., Montero, C., Fortney, J. J., **Lustig-Yaeger, J.**, & Luther, K. (2016). "Characterizing transiting exoplanet atmospheres with JWST". *The Astrophysical Journal*, 817(1), 17.
1. Freedman, R. S., **Lustig-Yaeger, J.**, Fortney, J. J., Lupu, R. E., Marley, M. S., & Lodders, K. (2014). "Gaseous Mean Opacities for Giant Planet and Ultracool Dwarf Atmospheres over a Range of Metallicities and Temperatures". *The Astrophysical Journal Supplement Series*, 214(2), 25.

Presentations *Invited Talks*

6. **Lustig-Yaeger, J.** (2023). "Advancing the Study of Rocky Planets by Leveraging Connections Between Exoplanet and Solar System Science". Johns Hopkins Earth and Planetary Sciences Department, Bromery Seminar, MD, Sept. 14
5. **Lustig-Yaeger, J.** (2022). "Rocky Exoplanet Characterization on the Path Towards Habitability and Biosignatures". University of Maryland Planetary Astronomy Lunch Seminar Series, MD, Feb. 21
4. **Lustig-Yaeger, J.** & Meadows, V. S. (2019). "The Era of Terrestrial Exoplanet Characterization". AGU, Joint AGU-AAS Session on Frontiers in Exoplanets, San Francisco, CA, 10 Dec. *Watch it on YouTube!*
3. **Lustig-Yaeger, J.**, Meadows, V. S., & Lincowski, A. P. (2019). "Prospects for Biosignatures for Rocky Planets in the Era of JWST". SEEC Symposium 2019, "Rocky Exoplanets in the Era of JWST: Theory and Observation", NASA Goddard, Greenbelt, MD, 5 Nov.
2. **Lustig-Yaeger, J.**, Meadows, V. S., & Lincowski, A. P. (2019). "The Detectability and Characterization of the TRAPPIST-1 Exoplanet Atmospheres with JWST". ExoPAG 20, Bellevue, WA, 23 Jun.

1. **Lustig-Yaeger, J.**, Meadows, V., Tovar, G., Schwieterman, E., & Fujii, Y. "Prospects for Mapping Terrestrial Exoplanets with LUVOIR". Goddard Space Flight Center, October 25, 2017

Contributed Talks

7. **Lustig-Yaeger, J.**, Meadows, V. S., & Lincowski, A. P. (2019). "TRAPPIST-1 and Beyond: Strategies for Characterizing Terrestrial Exoplanets and their Habitability". Abstract [202-7] presented at 2019 Astrobiology Science Conference, Bellevue, WA, 24-28 June.
6. **Lustig-Yaeger, J.**, Meadows, V. S., & Lincowski, A. P. (2019). "Detecting and Characterizing Terrestrial Atmospheres in the TRAPPIST-1 System with JWST". TRAPPIST-1 Conference, Liège, Belgium, 11-14 Jun.
5. **Lustig-Yaeger, J.**, Meadows, V. S., & Lincowski, A. P. (2019). "Simulating the Detectability and Characterization of the TRAPPIST-1 Exoplanet Atmospheres with JWST". American Astronomical Society Meeting Abstracts, 233, #103.03
4. **Lustig-Yaeger, J.**, Meadows, V. S., Tovar, G., Schwieterman, E., W., Fujii, Y., Luger, R., & Robinson, T. D. (2018). "Detecting Oceans on Exoplanets with Next-Generation Telescopes". 2018 AGU Fall Meeting, Washington, D.C., 10-14 Dec. P51B-09
3. **Lustig-Yaeger, J.**, Luger, R., & Agol, E. (2017). "Probing the Orbital Dynamics and Atmospheric Properties of the TRAPPIST-1 Planets with JWST". Habitable Worlds 2017, #4100
2. **Lustig-Yaeger, J.**, Tovar, G., Fujii, Y., Schwieterman, E., & Meadows, V. (2017). "Mapping Surfaces and Clouds on Terrestrial Exoplanets Observed with Next-Generation Coronagraph-Equipped Telescopes". Astrobiology Science Conference, #3558
1. **Lustig-Yaeger, J.**, Line, M. R., & Fortney, J. J. (2015). "On the Confidence of Molecular Detections in the Atmospheres of Exoplanets from Secondary Eclipse Spectra". American Astronomical Society Meeting Abstracts, 225, #124.03

Posters

8. **Lustig-Yaeger, J.**, Lincowski, A. P., & Meadows, V. S. (2017). "Extending Atmospheric Characterization to Earth-Sized Exoplanets with JWST: Transits, Eclipses, and the TRAPPIST-1 System". Habitable Worlds 2017, Laramie, WY #4098
7. **Lustig-Yaeger, J.**, Tovar, G., Schwieterman, E. W., Fujii, Y., & Meadows, V. S. (2017). "Detecting Oceans on Exoplanets Using Phase-Dependent Mapping with Next-Generation Coronagraph-Equipped Telescopes". Habitable Worlds 2017, Laramie, WY #4110
6. **Lustig-Yaeger, J.**, Schwieterman, E., Meadows, V., & Fujii, Y. (2016). "Modeling Earth's Disk-Integrated, Time-Dependent Spectrum: Applications to Directly Imaged Habitable Planets". AAS/Division for Planetary Sciences Meeting Abstracts, 48, #122.34
5. **Lustig-Yaeger, J.**, Meadows, V., Schwieterman, E. W., & Robinson, T. (2016). "Modeling Earths Disk-Integrated Spectrum through a Lunar Month: Applications to Directly Imaged Habitable Exoplanets". Exoplanets I
4. **Lustig-Yaeger, J.**, Meadows, V., Line, M., & Crisp, D. (2015). "A Novel Approach to Atmospheric Retrieval for Small Exoplanets". AAS/Division for Planetary Sciences Meeting Abstracts, 47, #416.10
3. **Lustig-Yaeger, J.**, Line, M., Fortney, J. J., & Meadows, V. (2015). "Detecting Molecules in Exoplanet Atmospheres: Lessons Learned from Hot Jupiters". Astrobiology Science Conference, #7558
2. **Lustig-Yaeger, J.**, Line, M. R., & Fortney, J. J. (2014). "On the Detection Significance of Molecules in Exoplanets from Secondary Eclipse Observations". Cool Stars, 18, #267
1. **Lustig-Yaeger, J.**, Fortney, J. J., Freedman, R., Marley, M. S., & Lupu, R. E. (2014). "Gaseous Mean Opacities for Giant Planet and Brown Dwarf Atmospheres". American Astronomical Society Meeting Abstracts #223, #347.04

Public Talks

— "How Astronomers are Searching for Life on Planets Outside of the Solar System" Western Institute for Lifelong Learning, Silver City, NM. November 10, 2022.

— "Proxima Centauri b: A World of Possibilities" and panel discussion with Guillem Anglada-Escude, Rory Barnes, & Olivier Guyon, UW Astrobiology & the NASA Astrobiology Institute Lecture Series, Seattle, WA. May 3, 2017.

— "BREAKING: Terrestrial Exoplanet Discovered in the Habitable Zone of Proxima Centauri" Astronomy on Tap, Peddler Brewing Company, Seattle, WA. August 24, 2016.

Press

— Johns Hopkins Applied Physics Lab, Laurel, MD. (2023, January 11). "NASA's Webb Identifies Its First Exoplanet And It's the Size of Earth" [Press release].

— University of Washington, Seattle. (2019, August 13). "James Webb Space Telescope could begin learning about TRAPPIST-1 atmospheres in a single year, study indicates" [Press release].

Last updated on October 30, 2023