Ryan Rubenzahl

Education

2018– **Doctor of Philosophy**, *California Institute of Technology*, Pasadena, CA
Astrophysics. Advisor: Andrew Howard
Thesis: *From the Sun to the Stars: A Solar Calibrator for the Keck Planet Finder And New Frontiers in Exoplanet Obliquities*. Anticipated May 2024 defense.

2021 **Master of Science**, *California Institute of Technology*, Pasadena, CA
Astrophysics

2014–2018 **Bachelor of Science**, *University of Rochester*, Rochester, NY
Physics and Astronomy, *Magna cum laude* with highest distinction. Minor: Math.
Senior thesis (Advisor: Segev BenZvi): *Identifying Type Ia Supernovae in Extragalactic Spectra*

Academic Employment

2018– **Graduate Researcher**, *California Institute of Technology*, Astronomy Department
Built an autonomous solar feed to measure Sun-as-a-star EPRV spectra, characterized exoplanet masses with radial velocities and obliquities using the classical and reloaded Rossiter-McLaughlin technique, and developed a hierarchical Bayesian probabilistic mass-radius relation for exoplanets < 8 $R_\oplus$.

2014–2018 **Undergraduate Researcher**, *University of Rochester*, Physics & Astronomy Department
Simulated type-Ia supernova spectra and built a random forest classifier to estimate DESI yield, searched for and analyzed TeV phenomena with HAWC, including possible "Fermi Bubbles" in M31 and galactic TeV binaries, and simulated water-Cherenkov tanks for HAWC outrigger expansion project.

Awards and Honors

2018 NSF Graduate Research Fellowship, National Science Foundation
2018 Stoddard Prize, *best senior thesis in Physics & Astronomy*, U. of Rochester
2018 Janet Fogg Prize, *awarded to one senior for dedicated departmental service*, U. of Rochester
2018 Undergraduate Teaching Award, U. of Rochester
2017 Barry M. Goldwater Scholarship, Goldwater Foundation
2017 Award for Excellence in Programming, *for "Earth Hour"*, U. of Rochester
2016, 2017 Continuing Student Scholarship, U. of Rochester
2014 Bausch and Lomb Honorary Science Award & Scholarship, U. of Rochester

Skills and Training

- Proficiency with advanced statistical techniques including Bayesian methods, WAIC/lppd, MCMC, Gaussian Processes, mixture models, neural networks, and random forests
- Familiarity with EPRV spectrographs, testing during commissioning, assessing detectors, drift, calibration sources, and wavelength solutions
- Experience in design, construction, alignment, and testing of opto-mechanical systems
- Observing on professional astronomical telescopes: 50 nights on Keck (48 HIRES, 2 KPF), 1 night on the Palomar 200" (WIRC+Pol/TripleSpec), 8 nights at C.E.K. Mees Observatory
- Managing big surveys: I scheduled $\sim 10^4$ HIRES radial velocity observations for 104 stars in the TESS-Keck Survey across 298 Keck nights during 2019–2022
- Experience leading tours and stargazing events at observatories (~ 40 nights at C.E.K. Mees Observatory) and in the public (sidewalk astronomy, CaltechAstro outreach lecture series)
- Software: Python (proficient), Mathematica, SQL, Java, UNIX shell scripting (Bash), Docker, SLURM, SAOImage DS9, TheSky6, CCDSoft, CCDStack

1200 E. California Blvd., MC 249-17 – Pasadena, CA 91125 – USA
rrubenza@caltech.edu • *rrubenza.github.io* • *rrubenza*
0000-0003-3856-3143

Student Mentorship

2023 **Xuezhen Li**, Undergraduate, *Pasadena City College*
As part of the Caltech Connection program, Xuezhen researched the exoplanet measurement techniques, learned Python, and explored fitting real radial velocity and transit data to discover an exoplanet.

2021 **Jared Siegel**, Undergraduate, *University of Chicago*, (currently PhD student at Princeton)
As a Caltech SURF student, Jared wrote a line-by-line radial velocity pipeline and derived a novel activity indicator based on the depth of individual spectral lines which outperformed traditional activity indicators in reducing the RMS of αCenB HARPS RVs.

2020 **Aanica Gonzales-Rogers**, Undergraduate, *California Institute of Technology*
As a Caltech SURF student, Aanica explored the detectability of exoplanets in wide orbits using `orbitize!` and simulated astrometric measurements anticipated in future Gaia data releases.

TA Positions

Astronomy Department, California Institute of Technology

2020 Ay 124: Structure and Evolution of Galaxies, Ay 105: Optical Instrumentation Lab (remote)

2019 Ay 122a: Optical/IR Measurements and Instrumentation

Physics and Astronomy Department, University of Rochester

2018 AST 142: Elementary Astrophysics (Honors)

2017 AST 111: The Solar System & Its Origin, AST 142: Elementary Astrophysics

2016 PHY 141 Lab: Mechanics (Honors), AST 102: Relativity, Black Holes, and the Big Bang

2015 AST 106: Cosmic Origins of Life, AST 104: The Solar System

Service

2021–2023 Organizer/facilitator, *Respect is a Part of Research*, California Institute of Technology
Presented material and facilitated group discussions for a peer-lead sexual harassment/sexual assault prevention workshop for incoming first year graduate students during orientation.

2021–2022 Teaching Assistant, *Code/Astro*
Assisted students with writing their Python packages throughout the software development workshop.

2019–2021 Volunteer, *FUTURE*, California Institute of Technology
Co-ran a CV/SoP writing workshop for undergraduate women and nonbinary students

2019–2020 Teaching Assistant, *Intro2Astro*
Presented lessons on Bayesian statistics, model fitting, and model comparison.

2018 Peer Advisor, *College Center for Advising Services*, University of Rochester
Advised students with their majors, course selection, research opportunities, networking, independent study, study abroad, applying for grad school, and more.

2015–2018 Tour Guide, *C.E.K. Mees Observatory*, University of Rochester
Presented the history of the observatory, current research at UR, and operated the 24-inch telescope.

Telescope Time

2023 Keck-I Telescope: KPF (5.75 nights, PI[†], 2 nights co-I)
[†]Functionally PI, but officially "PI: Howard" as Caltech grad students cannot PI Keck proposals

Selected Presentations

2023 Keck Science Meeting, Berkeley, CA (contributed talk)

2023 Exoplanets Seminar, Princeton University (invited talk)

2023 Dix Planetary Science Seminar, Caltech (talk)

2023 EPRV 5, Santa Barbara, CA (poster)

2023 Sun-as-a-star workshop, Flatiron Institute/CCA (invited talk)

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2023 AAS 241, Seattle, WA (contributed talk #323.01)
2022 ERES VII, The Pennsylvania State University (contributed talk)
2020 AAS 235, Honolulu, HI (talk)
2019 Keck Science Meeting, UCLA (contributed talk)
2019 Extreme Solar Systems IV, Reykjavik, Iceland (poster #309.08)
2018 AAS 231, National Harbor, MD (poster #250.05)
2016, 2017 Rochester Symposium for Physics Students (talk)

Press and Public Media

2023 "Is there life beyond Earth? The Keck Planet Finder could tell us." Interviewed for article on KPF and the Solar Calibrator for Dell (**Rubenzahl**+23, submitted to PASP)

2021 "The Strange Case of the Misplaced Cotton Candy World" Interviewed for article on WASP-107 b for supercluster.com (**Rubenzahl**+21, AJ; Piaulet, Benneke, **Rubenzahl**+21, AJ)

2020 "Measuring the Speed of Stars" Presented a public talk for CaltechAstro outreach on YouTube

Publications

Refereed **2 first author**, 2 second/third author, 32 nth author

Non-Refereed **1 first author**, 1 second author, 2 nth author

Selected peer-reviewed journal publications

2023 **R. A. Rubenzahl**, S. Halverson, J. Walawender, G. M. Hill, A. W. Howard, M. Brown, E. Ida, J. Tehero, B. J. Fulton, S. R. Gibson, et al., "Staring at the Sun with the Keck Planet Finder: An Autonomous Solar Calibrator for High Signal-to-Noise Sun-as-a-Star Spectra", *accepted to Publications of the Astronomical Society of the Pacific*

2022 J. C. Siegel, **R. A. Rubenzahl**, S. Halverson, & A. W. Howard, "Into the Depths: A New Activity Metric for High-precision Radial Velocity Measurements Based on Line Depth Variations", *The Astronomical Journal*, 163, 260

2022 A. Chontos, J. M. A. Murphy, M. G. MacDougall, T. Fetherolf, J. Van Zandt, **R. A. Rubenzahl**, C. Beard, D. Huber, N. M. Batalha, I. J. M. Crossfield, et al., "The TESS-Keck Survey: Science Goals and Target Selection", *The Astronomical Journal*, 163, 297

2021 **R. A. Rubenzahl**, F. Dai, A. W. Howard, A. Chontos, S. Giacalone, J. Lubin, L. J. Rosenthal, H. Isaacson, N. M. Batalha, I. J. M. Crossfield, et al., "The TESS-Keck Survey. IV. A Retrograde, Polar Orbit for the Ultra-low-density, Hot Super-Neptune WASP-107b", *The Astronomical Journal*, 161, 119

2021 C. Piaulet, B. Benneke, **R. A. Rubenzahl**, A. W. Howard, E. J. Lee, D. Thorngren, R. Angus, M. Peterson, J. E. Schlieder, M. Werner, et al., "WASP-107b's Density Is Even Lower: A Case Study for the Physics of Planetary Gas Envelope Accretion and Orbital Migration", *The Astronomical Journal*, 161, 70

2020 A. Albert, R. Alfaro, C. Alvarez, J. C. Arteaga-Velázquez, K. P. Arunbabu, D. Avila Rojas, H. A. Ayala Solares, E. Belmont-Moreno, S. Y. BenZvi, C. Brisbois, et al. (including **R. A. Rubenzahl**), "Constraints on the Emission of Gamma-Rays from M31 with HAWC", *The Astrophysical Journal*, 893, 16

Selected conference proceedings/abstracts

2020 S. R. Gibson, A. W. Howard, K. Rider, A. Roy, J. Edelstein, M. Kassis, J. Grillo, S. Halverson, M. M. Sirk, C. Smith, et al. (including **R. Rubenzahl**), "Keck Planet Finder: design updates", *Society of Photo-Optical Instrumentation Engineers (SPIE) Conference Series*, 11447, 1144742

2019 **R. Rubenzahl**, A. Howard, & E. Sinukoff, "The Sub-Saturn Mass-Radius Relationship from K2 and a NASA-Keck Key Project", *AAS/Division for Extreme Solar Systems Abstracts*, 51, 309.08

2017 C. D. Rho, **R. Rubenzahl**, S. BenZvi, & HAWC Collaboration, "Searching for TeV Gamma-ray Emission from Binary Systems with HAWC", *35th International Cosmic Ray Conference (ICRC2017)*, 301, 742

2017 **R. Rubenzahl**, S. BenZvi, J. Wood, & HAWC Collaboration, "Limits on the Emission of Gamma Rays from M31 (The Andromeda Galaxy) with HAWC", *35th International Cosmic Ray Conference (ICRC2017)*, 301, 594

TESS-Keck Survey peer-reviewed publications

I contributed substantially to the TKS infrastructure by co-developing the sample construction algorithm (Chontos+22, AJ), constructing the nightly target lists (298 calendar nights), and co-leading the RV fitting of the HIRES/APF data for all TKS systems (Polanski+ in prep).

2023 J. M. Akana Murphy, N. M. Batalha, N. Scarsdale, et al., "The TESS-Keck Survey. XVI. Mass Measurements for 12 Planets in Eight Systems", *The Astronomical Journal*, 166, 153

2023 M. G. MacDougall, E. A. Petigura, G. J. Gilbert, et al., "The TESS-Keck Survey. XV. Precise Properties of 108 TESS Planets and Their Host Stars", *The Astronomical Journal*, 166, 33

2023 J. Van Zandt, E. A. Petigura, M. MacDougall, et al., "TESS-Keck Survey. XIV. Two Giant Exoplanets from the Distant Giants Survey", *The Astronomical Journal*, 165, 60

2022 M. G. MacDougall, E. A. Petigura, T. Fetherolf, et al., "The TESS-Keck Survey. XIII. An Eccentric Hot Neptune with a Similar-mass Outer Companion around TOI-1272", *The Astronomical Journal*, 164, 97

2022 E. V. Turtelboom, L. M. Weiss, C. D. Dressing, et al., "The TESS-Keck Survey. XI. Mass Measurements for Four Transiting Sub-Neptunes Orbiting K Dwarf TOI-1246", *The Astronomical Journal*, 163, 293

2022 J. Lubin, J. Van Zandt, R. Holcomb, et al., "TESS-Keck Survey. IX. Masses of Three Sub-Neptunes Orbiting HD 191939 and the Discovery of a Warm Jovian plus a Distant Substellar Companion", *The Astronomical Journal*, 163, 101

2022 P. A. Dalba, S. R. Kane, D. Dragomir, et al., "The TESS-Keck Survey. VIII. Confirmation of a Transiting Giant Planet on an Eccentric 261 Day Orbit with the Automated Planet Finder Telescope", *The Astronomical Journal*, 163, 61

2021 M. G. MacDougall, E. A. Petigura, I. Angelo, et al., "The TESS-Keck Survey. VI. Two Eccentric Sub-Neptunes Orbiting HIP-97166", *The Astronomical Journal*, 162, 265

2021 N. Scarsdale, J. M. A. Murphy, N. M. Batalha, et al., "TESS-Keck Survey. V. Twin Sub-Neptunes Transiting the Nearby G Star HD 63935", *The Astronomical Journal*, 162, 215

2021 F. Dai, A. W. Howard, N. M. Batalha, et al., "TKS X: Confirmation of TOI-1444b and a Comparative Analysis of the Ultra-short-period Planets with Hot Neptunes", *The Astronomical Journal*, 162, 62

2021 L. M. Weiss, F. Dai, D. Huber, et al., "The TESS-Keck Survey. II. An Ultra-short-period Rocky Planet and Its Siblings Transiting the Galactic Thick-disk Star TOI-561", *The Astronomical Journal*, 161, 56

2020 F. Dai, A. Roy, B. Fulton, et al., "The TESS-Keck Survey. III. A Stellar Obliquity Measurement of TOI-1726 c", *The Astronomical Journal*, 160, 193

2020 P. A. Dalba, A. F. Gupta, J. E. Rodriguez, et al., "The TESS-Keck Survey. I. A Warm Sub-Saturn-mass Planet and a Caution about Stray Light in TESS Cameras", *The Astronomical Journal*, 159, 241

Peer-reviewed publications contributed to as observer

2023 A. Householder, L. M. Weiss, J. E. Owen, et al., "Investigating the Atmospheric Mass Loss of the Kepler-105 Planets Straddling the Radius Gap", *arXiv e-prints*, arXiv:2309.11494

2023 F. Dai, K. C. Schlaufman, H. Reggiani, et al., "A Mini-Neptune Orbiting the Metal-poor K Dwarf BD+29 2654", *The Astronomical Journal*, 166, 49

2023 E. Knudstrup, D. Gandolfi, G. Nowak, et al., "Radial velocity confirmation of a hot super-Neptune discovered by TESS with a warm Saturn-mass companion", *Monthly Notices of the Royal Astronomical Society*, 519, 5637

2023 F. Dai, K. Masuda, C. Beard, et al., "TOI-1136 is a Young, Coplanar, Aligned Planetary System in a Pristine Resonant Chain", *The Astronomical Journal*, 165, 33

2023 M. El Mufti, P. P. Plavchan, H. Isaacson, et al., "TOI 560: Two Transiting Planets Orbiting a K Dwarf Validated with iSHELL, PFS, and HIRES RVs", *The Astronomical Journal*, 165, 10

2022 O. Barragán, D. J. Armstrong, D. Gandolfi, et al., "The young HD 73583 (TOI-560) planetary system: two 10-$M_\oplus$ mini-Neptunes transiting a 500-Myr-old, bright, and active K dwarf", *Monthly Notices of the Royal Astronomical Society*, 514, 1606

2022 M. C. Johnson, T. J. David, E. A. Petigura, et al., "An Aligned Orbit for the Young Planet V1298 Tau b", *The Astronomical Journal*, 163, 247

2022 J. G. Winters, R. Cloutier, A. A. Medina, et al., "A Second Planet Transiting LTT 1445A and a Determination of the Masses of Both Worlds", *The Astronomical Journal*, 163, 168

2022 N. Heidari, I. Boisse, J. Orell-Miquel, et al., "HD 207897 b: A dense sub-Neptune transiting a nearby and bright K-type star", *Astronomy and Astrophysics*, 658, A176

2021 M. El Mufti, P. P. Plavchan, H. Isaacson, et al., "TOI 560 : Two Transiting Planets Orbiting a K Dwarf Validated with iSHELL, PFS and HIRES RVs", *arXiv e-prints*, arXiv:2112.13448

2021 M. Rice, S. Wang, A. W. Howard, et al., "SOLES I: The Spin-Orbit Alignment of K2-140 b", *The Astronomical Journal*, 162, 182

2021 J. Llop-Sayson, J. J. Wang, J.-B. Ruffio, et al., "Constraining the Orbit and Mass of epsilon Eridani b with Radial Velocities, Hipparcos IAD-Gaia DR2 Astrometry, and Multiepoch Vortex Coronagraphy Upper Limits", *The Astronomical Journal*, 162, 181

2021 J. Zhang, L. M. Weiss, D. Huber, et al., "Long-period Jovian Tilts the Orbits of Two sub-Neptunes Relative to Stellar Spin Axis in Kepler-129", *The Astronomical Journal*, 162, 89

2021 L. J. Rosenthal, B. J. Fulton, L. A. Hirsch, et al., "The California Legacy Survey. I. A Catalog of 178 Planets from Precision Radial Velocity Monitoring of 719 Nearby Stars over Three Decades", *The Astrophysical Journal Supplement Series*, 255, 8

2021 B. J. Fulton, L. J. Rosenthal, L. A. Hirsch, et al., "California Legacy Survey. II. Occurrence of Giant Planets beyond the Ice Line", *The Astrophysical Journal Supplement Series*, 255, 14

2021 M. R. Kosiarek, D. A. Berardo, I. J. M. Crossfield, et al., "Physical Parameters of the Multiplanet Systems HD 106315 and GJ 9827", *The Astronomical Journal*, 161, 47