Bryson Cale

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Astronomer, Software Engineer, & Data Scientist

Education

George Mason University — Fairfax, VA
Ph.D., Physics — 2017–2021
Dissertation: Retrieval and Applications of Precise Radial Velocities to Detect Exoplanets
Advisor: Dr. Peter Plavchan

Grinnell College — Grinnell, IA
Bachelor of Arts, Physics & Mathematics — 2012–2016
Advisors: Dr. Eliza Kempton, Dr. Karen Shuman

Employment

University of California San Diego — La Jolla, CA
Research Data Analyst — 2024–Current

- Building the data processing pipelines for Liger, IRIS, and HISPEC upcoming instruments for W. M. Keck Observatory and the Thirty Meter Telescope, and leading software-focused project meetings.
- Design, test, and implement new algorithms for calibrating and analyzing adaptive-optics fed instruments.
- Creating and running data simulators to characterize the on-sky capabilities for Liger & IRIS.
- Mentor to students, providing guidance in astronomy and physics concepts, code optimization, and best software practices for scientific computing.

NASA Jet Propulsion Laboratory — Pasadena, CA
NASA Postdoctoral Program (NPP) Fellow — 2021–2024

- Helped demonstrate the on-sky performance of PARVI, a next-generation spectrograph at Palomar observatory designed to characterize extrasolar planets.

George Mason University — Fairfax, VA
Graduate Research Assistant — 2017–2021

- Developed a set of Python codes to aid in the confirmation of > 10 extrasolar planets via the radial velocity technique with a variety of echelle spectrographs.
- Logged > 100 partial nights of observing with the iSHELL spectrograph on the NASA Infrared Telescope Facility.

George Mason University — Fairfax, VA
Academic Tutor — 2017–2021

- Tutored George Mason University student athletes in physics, math, and computer science courses.

Missouri State University Springfield, MO
Graduate Teaching Assistant 2016–2017

- Instructed three sections of an introductory astronomy lab course, including lecture preparation and grading.

Professional Service

- **Telescope Allocation Committees** - Evaluating proposals for observing time on a variety of telescopes.
- **Referee Manuscripts** - Regularly referee papers in the field of exoplanets and precision radial velocities for peer-reviewed journals.

Skills & Interests

- Math-modeling, statistics, & Bayesian inference, data pipelines, data-viz & dashboards.
- **Highly proficient**: Python & Julia, Numpy+SciPy, numba JIT, astropy, streamlit, matplotlib/plotly
- **Also experienced with:** C, JavaScript (React+JSX, THREE.js), HTML+CSS, Java, IDL, Matlab
- **Authored Packages:**
  - `IterativeNelderMead:` A robust Nelder-Mead solver for non-linear regression problems with support for bounded parameters. Implementations in Python and Julia.
    - https://astrobc1.github.io/IterativeNelderMead.jl/dev/
    - https://github.com/astrobc1/IterativeNelderMeadPython

    `Echelle.jl:` A set of Julia packages for extracting echelle spectra and generating precision radial velocities.
    - https://astrobc1.github.io/EchelleDocs/

    `AdaBeliefOptimization.jl:` An implementation of the AdaBelief solver in Julia.
    - https://github.com/astrobc1/AdaBeliefOptimization.jl

    `RVModelingToolkit.jl:` A Julia package to model radial velocity observations with Keplerian orbits + Gaussian processes to infer the existence of extrasolar planets.
    - https://astrobc1.github.io/RVModelingToolkitDocs/

Grants & Awards

- George Mason University Physics Department Summer Fellowship (2020).
- NASA Exoplanet Research Program (XRP) Fellowship (Co-I) (2019).
- George Mason University Physics Department Summer Fellowship (2018).

Publications

- ***Commissioning observations of HD 189733 with the PAlomar Radial Velocity Instrument.*** **First Author. Published in *Journal of Astronomical Telescopes, Instruments, and Systems*. 2023.**

- ***Diving Beneath the Sea of Stellar Activity: Chromatic Radial Velocities of the Young AU Mic Planetary System.*** **First Author. Published in *Astronomical Journal*. 2021.**
- ***Precise Radial Velocities of Cool Low Mass Stars With iSHELL.*** **First Author. Published in *Astronomical Journal*. 2019.**
- ***Precise Near-Infrared Radial Velocities with iSHELL.*** **First Author. White Paper submitted to the National Academies of Science. 2018.**
- *Accordion effect: a consequence of polarized light in precision radial velocity spectrometers.* Co-Author. Published in *SPIE*. 2024
- *Flares, Rotation, and Planets of the AU Mic System from TESS Observations. Co-Author. Published in Astronomical Journal. 2022.*
- *Orbital Dynamics and the Evolution of Planetary Habitability in the AU Mic System. Co-Author. Published in Astronomical Journal. 2022.*
- *Transit Timing Variations for AU Microscopii b and c* Co-Author. Published in *Astronomical Journal*. 2022.
- *TOI 560: Two Transiting Planets Orbiting a K Dwarf Validated with iSHELL, PFS, and HIRES RVs.* Co-Author. Published in *Astronomical Journal*. 2023.
- *Validating AU Microscopii d with Transit Timing Variations.* Co-Author. Published in *Astronomical Journal*. 2023.
- *Another Shipment of Six Short-Period Giant Planets from TESS*. Co-Author. Published in *Monthly Notices of the Royal Astronomical Society*. 2023.
- *Direct Imaging Explorations for Companions around Mid-Late M Stars from the Subaru/IRD Strategic Program*. Co-Author. Published in *Astronomical Journal*. 2023.
- *Characterizing and Mitigating the Impact of Telluric Absorption in Precise Radial Velocities.* Co-Author. Published in *Astronomical Journal*. 2022.
- *Characterizing and Mitigating Telluric Absorption in Precise Radial Velocities. II. A Study of an M2-type Star*. Co-Author. Published in *Astronomical Journal*. 2022.
- *The GAPS Programme at TNG. XXXVII. A precise density measurement of the young ultra-short period planet TOI-1807 b*. Co-Author. Published in *Astronomy & Astrophysics*. 2023.
- *A Close-in Puffy Neptune with Hidden Friends: The Enigma of TOI 620.* Co-Author. Published in *Astronomical Journal*. 2022.
- *HIP 70705: A multi-planet system with a near-USP super-Earth in the radius gap* Co-author. Published in *Astronomy & Astrophysics* Deeg et al. 2023
- *The Magellan-TESS Survey I: Survey Description and Mid-Survey Results.* Co-author. Published in *Astrophysical Journal*. Teske et al. 2021.
- *TOI-431/HIP 26013: A Super-Earth and a Sub-Neptune Transiting a Bright, Early K Dwarf, With a Third Planet Candidate.* Co-author. Published in *Monthly Notices of the Royal Astronomical Society*. Osborn et al. 2021.
- *Precise mass and radius of a transiting super-Earth planet orbiting the M dwarf TOI-1235: a planet in the radius gap?* Co-author. Published in *Astronomy & Astrophysics*. Bluhm et al. 2020.

- *A planet within the debris disk around the pre-main-sequence star AU Microscopii* Co-author. Published in *Nature*. Plavchan et al. 2020.
- *Magnetism and spin-orbit alignment in the young planetary system AU Mic* Co-author. Published in *Astronomy & Astrophysics*. Martioli et al. 2020.
- *The CARMENES search for exoplanets around M dwarfs Two planets on the opposite sides of the radius gap transiting the nearby M dwarf LP 72954*. Co-author. Published in *Astronomy & Astrophysics*. Nowak et al. 2020.
- *TOI 442: The CARMENES search for exoplanets around M dwarfs: TOI 442.01=LP714-47b: Populating the Neptune desert*. Co-author. Published in *Astronomy & Astrophysics*. Dreizler et al. 2020.
- *A Hot Saturn Orbiting an Oscillating Late Subgiant Discovered By TESS* Co-author. Published in *Astronomical Journal*. Huber et al. 2019
- *TOI 257: A Warm Sub-Saturn on a Moderately Eccentric Orbit*. Co-author. Published in *Monthly Notices of the Royal Astronomical Society*. Addison et al. 2021
- *EarthFinder Report*. NASA probe study report. Co-author. Plavchan et al. 2019
- *Exo-Transmit: An Open-Source Code for Calculating Transmission Spectra for Exoplanet Atmospheres of Varied Composition*. Co-author. Published in *Publications of the Astronomical Society of the Pacific*. Kempton et. al 2017.

Invited & Contributed Talks

- *PARVI*. Palomar Science Meeting. Pasadena, CA. June 2023.
- *PARVI Wavelength Calibration*. EPRV5. Santa Barbara, CA. March 2023.
- *Retreival and Applications of Precise Radial Velocities to Detect Exoplanets* IPAC Seminar. Pasadena, CA. February 2022.
- *2 Years of TESS Follow-up with iSHELL*. 22^{nd} TESS Science Team Meeting. Virtual. August 2020.
- *Precise NIR RVs of Cool Low Mass Stars with iSHELL*. Chesapeake Bay Area Exoplanet Meeting. Washington, D.C. January 2020.
- *iSHELL Data Analysis*. Extreme Precise Radial-Velocities. State College, Pennsylvania. August 2017.
- *Precise Radial Velocity First Light Observations With iSHELL*. 229^{th} American Astronomical Society Meeting. Grapevine, TX. January 2017

Awarded Telescope Time

- **2022B**: PARVI/Hale - Commissioning Science with the Palomar Radial Velocity Instrument (PARVI). Co-I.
- **2022A**: PARVI/Hale - Commissioning Science with the Palomar Radial Velocity Instrument (PARVI). Co-I.
- **2021B**: WIYN/NEID - Radial Velocity Follow Up of Exoplanet Candidates Orbiting Cool Low Mass Stars Identified With TESS. Co-I.

- **2021B**: IRTF/iSHELL - Radial Velocity Follow Up of Extrasolar Planet Candidates Orbiting Cool Low Mass Stars Identified With TESS. PI.
- **2021A**: IRTF/iSHELL - Radial Velocity Follow Up of Extrasolar Planet Candidates Orbiting Cool Low Mass Stars Identified With TESS. PI.
- **2020B**: HIRES/Keck - Measuring Stellar Activity with Chromatic Radial-Velocities in the Active and Planet-Bearing Nearby M dwarf AU Mic. Co-I.
- **2020B**: CHIRON/CTIO - Measuring Stellar Activity with Chromatic Radial-Velocities in the Active and Planet-Bearing Nearby M dwarf AU Mic. Co-I.
- **2020B**: IRTF/iSHELL - Radial Velocity Follow Up of Extrasolar Planet Candidates Orbiting Cool Low Mass Stars Identified With TESS. PI.
- **2020A**: IRTF/iSHELL - Radial Velocity Follow Up of Extrasolar Planet Candidates Orbiting Cool Low Mass Stars Identified With TESS. PI.
- **2019B**: CHIRON/CTIO - Measuring Stellar Activity with Chromatic Radial-Velocities in the Active and Planet-Bearing Nearby M dwarf AU Mic. Co-I.
- **2019B**: IRTF/iSHELL - RVx*TESS*: Spectral Studies of M Dwarfs with Simultaneous *TESS* and IRTF/iSHELL Observations. Co-I.
- **2019B**: IRTF/iSHELL - Radial Velocity Follow-up of Recently Discovered Transiting Planets Orbiting the Young and Active M Dwarf AU Mic. Co-I.
- **2019B**: IRTF/iSHELL - Radial Velocity Follow Up of Extrasolar Planet Candidates Orbiting Cool Low Mass Stars Identified With *TESS*. PI.
- **2019A**: IRTF/iSHELL - What Lies Beyond the TRAPPIST-1 Snow Line? Constraining Long Period Neptunes with iSHELL Radial Velocity Observations. Co-I.
- **2019A**: IRTF/iSHELL - Hidden Binaries in the Beta Pictoris Moving Group. Co-I.
- **2019A**: IRTF/iSHELL - Zodiacal Exoplanets In Time: Measuring the Masses of Young Exoplanets. PI.
- **2018B**: IRTF/iSHELL - Zodiacal Exoplanets In Time: Measuring the Masses of Young Exoplanets. PI.
- **2017A**: IRTF/iSHELL - What radial velocity precision is obtainable with iSHELL and the isotopic methane gas cell? Co-I.