# Benjamin James ("BJ") Fulton

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### **Education**

- Doctor of Philosophy in Astronomy from the Institute for Astronomy at the University of Hawaii, Manoa, July 2017
- Master of Science in Astronomy from the Institute for Astronomy at the University of Hawaii, Manoa, September 2014
- Bachelor of Science in Physics with a Minor in Astronomy and Planetary Science from the University of California, Santa Barbara, June 2009

#### **Publication statistics**

- Nine first author & major contributions in four second author refereed publications
- 132 total refereed publications
- Contributions to four Nature publications
- 4538 citations
- h-index = 35

# **Research Experience**

- Discovered a gap in the radius distribution of small planets found by Kepler. This has significant implications for our understanding of the formation and evolution of these planets (Fulton et al. 2017).
- Developed a highly extensible and open source software package for the analysis of radial velocity time-series data written in object-oriented Python (radvel.readthedocs.io)
- Significantly contributions to the development of the "Jump" target management and analysis database used by the California Planet Search team, which required skills in Django, Javascript, CSS, Haml, and Docker (jump.caltech.edu)
- Wrote software that allows the Automated Planet Finder (APF) telescope at Lick Observatory to be a fully operational and autonomous observatory. Thanks in large part to my automation and scheduling software, the telescope has been operating autonomously on a nightly basis collecting high-precision radial velocities for the last 5 years
- Developed a new technique to extract radial velocities from low signal-to-noise spectra which enabled the discovery of the Jupiter-size transiting exoplanet KELT-8b (<u>Fulton et al. 2015b</u>)
- Published two papers (<u>Fulton et al. 2015a, Fulton et al. 2016</u>) announcing the discovery of 5 new low-mass planets orbing four nearby stars. These discoveries were made possible, in large part, by the APF facility.
- Worked extensively with collaborators at the Space Telescope Science Institute on a project to revolutionize the way that
  radial velocities are calculated from gas absorption cell spectroscopy
- Published a paper (<u>Fulton et al., 2013</u>) for which I modeled the Rossiter-McLaughlin (R-M) effect to measure the stellar obliquity of HAT-P-17. I ported/adapted an existing Differential Evolution Markov Chain Monte Carlo code from IDL to Python, and wrote the model calculation code from scratch to take advantage of a new semi-analytical model of the R-M effect
- Developed an automated planet detection algorithm to search for Keplerian signals in heterogeneous radial velocity datasets and characterize pipeline completeness using injection-recovery tests (<u>Howard & Fulton 2016</u>)
- Published a paper for which we searched for transit timing variations in the HAT-P-13 planetary system and refined the system parameters (<u>Fulton et al. 2011</u>). This required me to become familiar with exoplanet transit light curve modeling, and the theory of transit timing variations.
- Contributed to a paper that appeared in Nature (<u>Howard et al. 2013</u>) in which we made the first mass measurement of an Earth-size exoplanet.
- Contributed to a paper led by Peter Nugent constraining the explosion time of the nearby supernova in M101 that appeared
  in Nature (Nugent et al. 2011).
- Transformed the Byrne Observatory at Sedgwick reserve from an unused and forgotten facility, into a fully operational and robotic observatory.
- Wrote a pipeline to search for and model the effects of ellipsoidal variations, reflection and relativistic beaming in Kepler
- Contributed observations for seven Minor Planet Circulars, and have been credited with the discovery of two new Marscrossing asteroids.
- I was previously involved with a project to measure the orbital motion of astrometric binaries using lucky imaging and speckle interferometry.

### **Teaching and Mentoring Experience**

- Mentored Caltech SURF summer students in 2018 and 2019
- Designed curriculum and instructed university-level "Introduction to Astronomy" summer course at the University of Hawaii at Manoa (2015)
- Three-time research advisor at the HISTAR program for gifted K-12 students (2012, 2013, 2015)

### **Observing Experience**

- ~100 full or partial nights using the HIRES instrument on the Keck I telescope located on Maunakea
- Nearly ~750 nights on the Automated Planet Finder Telescope at Lick Observatory (mostly robotic running on my software)
- Approximately 20 nights using the OPTIC imager on the University of Hawaii 2.2 m telescope located on Maunakea
- Approximately 7 nights on the Nickel 1.0 m at Lick Observatory
- Approximately 180 nights on the Sedgwick telescope of the Las Cumbres Observatory network (mostly robotic running on my software)

#### **Academic Awards**

- 2018 Robert J. Trumpler award for an outstanding PhD thesis
- Texaco prize postdoctoral fellowship at Caltech
- ARCS Foundation Honolulu 2016 Scholar of the Year
- 2016 Columbia ARCS Award in Astronomy
- Student Excellence in Research Award at the University of Hawaii at Manoa in 2015
- National Science Foundation Graduate Research Fellowship in 2014
- Physics Research Honors award upon graduation from UCSB in 2009

#### **Publications**

#### First Author

- Fulton, B.J. et al. (2018); The California Kepler Survey VII. Precise Planet Radii Leveraging Gaia DR2 Reveal the Stellar Mass Dependence of the Planet Radius Gap, AJ, 156, 264, (2018AJ....156..264F)
- Fulton, B.J. et al. (2018); RadVel: The Radial Velocity Modeling Toolkit, PASP, 130, 986, (2018PASP..130d4504F)
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- Fulton, B.J. et al. (2016); Three Temperate Neptunes Orbiting Nearby Stars, ApJ, 830, 46 (2015ApJ...830...1F)
- Fulton, B.J. et al. (2015b); KELT-8b: A Highly Inflated Transiting Hot Jupiter and a New Technique for Extracting Highprecision Radial Velocities from Noisy Spectra, ApJ, 810, 30 (2015ApJ...810...30F)
- Fulton, B.J. et al. (2015a); Three Planets Orbing HD 7924, ApJ, 805, 175 (2015ApJ...805..175F)
- Fulton, B.J. et al. (2014); A Search for Planetary Eclipses of White Dwarfs in the Pan-STARRS1 Medium-deep Fields, ApJ, 796, 114 (2014ApJ...796..114F)
- Fulton, B. J. et al. (2013); The Stellar Obliquity and the Long-period planet in the HAT-P-17 Exoplanetary System, ApJ, 772, 80 (2013ApJ...772...80F)
- Fulton, B. J. et al (2011); Long-term Transit Timing Monitoring and Refined Light Curve Parameters of HAT-P-13b, 2011, AJ, 142, 84 (2011AJ...142...84F)

#### Significant Contributions

- Howard, A. W., and Fulton, B. J. (2016); Limits on Planetary Companions from Doppler Surveys of Nearby Stars, PASP, 128, 969, (2016PASP..128k4401H). Performed all analysis, produced all plots, and wrote most of the methods section
- Street, R. A., Fulton, B. J. et al (2015); Extended Baseline Photometry of Rapidly Changing Weather Patterns on the Brown Dwarf Binary Luhman-16, ApJ, 812, 161, (2015ApJ...812..161S) Extracted the photometry in an initial reduction (the photometry was eventually superseded in the referee process)
- Knutson, H., Fulton, B. J. et al (2014); Friends of Hot Jupiters. I. A Radial Velocity Search for Massive, Long-period Companions to Close-in Gas Giant Planets, ApJ, 785, 126, (2014ApJ...785..126K) – Performed all radial velocity analysis, and wrote some of the methods section
- Sinukoff, E.; Fulton, B. J.; Scuderi, L.; Gaidos, E. (2013); Below One Earth The Detection, Formation, and Properties of Subterrestrial Worlds, Space Science Reviews, 10.1007 (<a href="http://dx.doi.org/10.1007/s11214-013-0019-1">http://dx.doi.org/10.1007/s11214-013-0019-1</a>) – Performed analysis and wrote text for one of the major sections of the paper involving Kepler photometry

#### **High Impact Journals**

- Benneke et al. (2019); A sub-Neptune exoplanet with a low-metallicity methane-depleted atmosphere and Mie-scattering clouds, Nature Astronomy, Volume 3, Issue 813B (2019NatAs...3..813B)
- Gaudi et al. (2017); A giant planet undergoing extreme-ultraviolet irradiation by its hot massive-star host, Nature, Volume 546, Issue 7659 (2017Natur.546..514G)
- Howard et al. (2013); A rocky composition for an Earth-sized exoplanet, Nature, Volume 503, Issue 7476 (2013Natur.503..381H)
- Nugent et al. (2011); Supernova SN 2011fe from an exploding carbon-oxygen white dwarf star, Nature, Volume 480, Issue 7377 (2011Natur.480..344N)

#### Other Publications

- Gaidos et al. (2019); Planetesimals around stars with TESS (PAST) I. Transient dimming of a binary solar analogue at the
  end of the planet accretion era, MNRAS, 488, 4465 (2019MNRAS.488.4465G)
- Hey et al. (2019); Six new rapidly oscillating Ap stars in the Kepler long-cadence data using super-Nyquist asteroseismology, MNRAS, 488, 18H (2019MNRAS, 488...18H)
- Vanderburg et al. (2019); TESS Spots a Compact System of Super-Earths around the Naked-eye Star HR858, ApJ, 881L, 19V (2019AJ...158...79D)
- David et al. (2019); A Warm Jupiter-sized Planet Transiting the Pre-main-sequence Star V1298 Tau, AJ, 158, 79D (2019AJ...158...79D)
- Johns et al. (2019); KELT-23Ab: A Hot Jupiter Transiting a Near-solar Twin Close to the TESS and JWST Continuous Viewing Zones, AJ, 158, 78J (2019AJ....158...78J)
- Yahalomi et al. (2019); The Mass of the White Dwarf Companion in the Self-lensing Binary KOI-3278: Einstein versus Newton, ApJ, 880, 33Y (2019ApJ...880...33Y)
- Hirsch et al. (2019); Discovery of a White Dwarf Companion to HD 159062, ApJ, 878, 50H (2019ApJ...878...50H)
- Huber et al. (2019); A Hot Saturn Orbiting an Oscillating Late Subgiant Discovered by TESS, AJ, 157, 245H (2019AJ....157...245H)
- Mills et al. (2019); The California-Kepler Survey. VIII. Eccentricities of Kepler Planets and Tentative Evidence of a Highmetallicity Preference for Small Eccentric Planets, AJ, 157, 198M (2019AJ....157..198M)
- Berardo et al. (2019); Revisiting the HIP 41378 System with K2 and Spitzer, AJ, 157, 185B (2019AJ....157..185B)
- Dragomir et al. (2019); TESS Delivers Its First Earth-sized Planet and a Warm Sub-Neptune, AJ, 875, 7D (2019ApJ...875L...7D)
- Mills et al. (2019); Long-period Giant Companions to Three Compact, Multiplanet Systems, AJ, 157, 145M (2019AJ....157...145M)
- Kosiarek et al. (2019); K2-291b: A Rocky Super-Earth in a 2.2 day Orbit, AJ, 157, 116K (2019AJ....157..116K)
- Livingston et al. (2019); Spitzer Transit Follow-up of Planet Candidates from the K2 Mission, AJ, 157, 102L (2019AJ....157..102L)
- Kosiarek et al. (2019); Bright Opportunities for Atmospheric Characterization of Small Planets: Masses and Radii of K2-3b, c, and d and GJ3470 b from Radial Velocity Measurements and Spitzer Transits, AJ, 157, 97K (2019AJ....157...97K)
- Bryan et al. (2019); An Excess of Jupiter Analogs in Super-Earth Systems, AJ, 157, 52B (2019AJ....157...52B)
- Wang et al. (2019); HD 202772A: A Transiting Hot Jupiter around a Bright, Midly Evolved Star in a Visual Binary Discovered by TESS, AJ, 157, 51W (2019AJ....157...51W)
- Labadie-Bartz et al. (2019); KELT-22Ab: A Massive, Short-Period Hot Jupiter Transiting a Near-solar Twin, ApJS, 240, 13L (2019ApJS..240...13L)
- Mawet et al. (2019); Deep Exploration of Eps Eridani with Keck Ms-band Vortex Coronagraphy and Radial Velocities: Mass and Orbital Parameters of the Giant Exoplanet, AJ, 157, 33M (2019AJ....157...33M)
- David et al. (2018); Discover of a Transiting Adolescent Sub-Neptune Exoplanet with K2, AJ, 156, 302D (2018AJ....156..302D)
- Livingston et al. (2018); Sixty Validated Planets from K2 Campaigns 5–8, AJ, 156, 277L (2018AJ...156..277L)
- Weiss et al. (2018); The California-Kepler Survey. VI. Kepler Multis and Singles Have Similar Planet and Stellar Properties Indicating a Common Origin, AJ, 156, 254W (2018AJ....156..254W)
- Crossfield et al. (2018); A TESS Dress Rehearsal: Planetary Candidates and Variables from K2 Campaign 17, ApJS, 239, 5C (2018ApJS..239...5C)
- Peterson et al. (2018); A 2 R⊕ Planet Orbiting the Bright Nearby K Dwarf Wolf 503, AJ, 156, 188P (2018AJ...156..188P)
- Van Eylen et al. (2018); An asteroseismic view of the radius valley: stripped cores, not born rocky, MNRAS, 479, 4786V (2018MNRAS, 479, 4786V)
- Brady et al. (2018); Kepler-1656b: A Dense Sub-Saturn with an Extreme Eccentricity, AJ, 156, 147B (2018AJ....156..147B)
- Liang et al. (2018); Two Warm, Low-density Sub-Jovian Planets Orbiting Bright Stars in K2 Campaigns 13 and 14, AJ, 156, 127 (2018AJ....156..127Y)
- Petigura et al. (2018); Dynamics and Formation of the Near-resonant K2-24 System: Insights from Transit-timing Variations

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- Liang et al. (2018); Planetary Candidates from K2 Campaign 16, AJ, 156, 22 (2018AJ....156...22Y)
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- Bowler et al. (2018); Orbit and Dynamical Mass of the Late-T Dwarf GL 758 B, AJ, 155, 159B (2018AJ...155..159B)
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- Johnson et al. (2018); KELT-21b: A Hot Jupiter Transiting the Rapidly Rotating Metal-poor Late-A Primary of a Likely Hierarchical Triple System, AJ, 155, 100J (2018AJ....155..100J)
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- Weiss et al. (2018); The California-Kepler Survey. V. Peas in a Pod: Planets in a Kepler Multi-planet System Are Similar in Size and Regularly Spaced, AJ, 155, 48W (2018AJ...155...48W)
- Petigura et al. (2018); Planet Candidates from K2 Campaigns 5–8 and Follow-up Optical Spectroscopy, AJ, 155, 21P (2018AJ...155...21P)
- Ciardi et al. (2018); K2-136: A Binary System in the Hyades Cluster Hosting a Neptune-sized Planet, AJ, 155, 10C (2018AJ....155...10C)
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- Dressing et al. (2017); Characterizing K2 Candidate Planetary Systems Orbiting Low-mass Stars. II. Planetary Systems
   Observed During Campaigns 1–7, AJ, 154, 207 (2017AJ....154..207D)
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- Shporer et al. (2017); Three Statistically Validated K2 Transiting Warm Jupiter Exoplanets Confirmed as Low-mass Stars, ApJ, 847, 18 (2017ApJ...847L...18S)
- Christiansen et al. (2017); Three's Company: An Additional Non-transiting Super-Earth in the Bright HD 3167 System, and Masses for All Three, AJ, 154, 122 (2017AJ....154..122C)
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- Sinukoff, E., et al. (2017); K2-66b and K2-106b: Two Extremely Hot Sub-Neptune-size Planets with High Densities, AJ, 153, 271 (2017AJ....153..271S)
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- McLeod, K., et al. (2017); KELT-18b: Puffy Planet, Hot Host, Probably Perturbed, AJ, 153, 263 (2017AJ....153..263M)
- Crossfield, I., et al. (2017); Two Small Transiting Planets and a Possible Third Body Orbiting HD 106315, AJ, 153, 255 (2017AJ....153..255C)
- Rappaport, S., et al. (2017); EPIC 220204960: A Quadruple Star System Containing Two Strongly Interacting Eclipsing Binaries, MNRAS, 467, 2 (2017MNRAS, 467, 2160R)
- Zheng, W., et al. (2017); Discovery and Follow-up Observations of the Young Type Ia Supernova 2016coj, ApJ, 841, 64Z (2017ApJ...841...64Z)
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- Oberst, T., et al. (2017); KELT-16b: A Highly Irradiated, Ultra-short Period Hot Jupiter Nearing Tidal Disruption, AJ, 153, 97 (2017AJ...153...970)
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- Samuel, K., et al. (2016); K2-97b: A (Re-?)Inflated Planet Orbiting a Red Giant Star, AJ, 152, 185 (2016AJ....152..185G)
- Hartman, J., et al. (2016); HAT-P-65b and HAT-P-66b: Two Transiting Inflated Hot Jupiters and Observational Evidence for the Reinflation of Close-in Giant Planets, AJ, 152, 182 (2016AJ....152..182H)
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- Buhler, P. B. et al. (2016); Dynamical Constraints on the Core Mass of Hot Jupiter HAT-P-13b, ApJ, 821, 26 (2016ApJ...821...26B)
- Weiss, L. et al. (2016); Revised Masses and Densities of the Planets around Kepler-10, ApJ, 819, 83 (2016ApJ...819...83W)
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- Shporer, A. et al. (2010); Ground-based Multisite Observations of Two Transits of HD 80606b, ApJ, 722, 880 (2010ApJ...722..880S)

### **Invited Talks**

- Colloquium speaker at Lowell Observatory in Flagstaff, Arizona (2018)
- Center for Space and Habitability Colloquium speaker at Universitat, Bern, Switzerland (2018)
- Planetary Science / IPLEX seminar speaker at the University of California, Los Angeles (2018)
- Panelist on occurrence rate panel at the 2017 ExoPAG16 meeting
- FLASH seminar speaker at the University of California at Santa Cruz (2017)
- Seminar speaker at the Center for Habitable Worlds at Penn State University (2016)
- Public talk at a conference of The American Congress of Obstetricians and Gynecologists (2013)

### **Conferences and Meetings**

- Contributed talk at the Extreme Solar Systems conference in Reykjavik, Iceland (2019)
- Contributed talk at the Extreme Precision Radial Velocity Conference in Grindelwald, Switzerland (2019)
- Contributed talk at the Kepler and K2 Science Meeting in Pasadena, California (2019)
- Attended the Telluric Hackathon in New York City, New York (2019)

- Contributed talk at the Keck Science Meeting in Pasadena, California (2018)
- Contributed talk at the ExSoCal 2018 conference in Pasadena, California (2018)
- Contributed talk at the Exoplanets II conference in Cambridge, UK (2018)
- Co-Chair of "observing strategy" breakout session at the Extremely Precise Radial Velocities III conference at Penn State (2017)
- Poster at the Extremely Precise Radial Velocities III conference at Penn State (2017)
- Contributed talk at the Kepler & K2 SciCon IV (2017)
- Contributed talk at the 2017 Aspen Winter Conference: Formation and Dynamical Evolution of Exoplanets
- Poster at the Exoplanets I conference in Davos, Switzerland (2016)
- Poster at the Extreme Solar Systems III conference in Waikaloa, HI (2015)
- Poster at the Sagan Workshop in Pasadena, CA (2015)
- Poster at the Extreme Precision Radial Velocity workshop in New Haven, CT (2015)
- Poster at the Toward Other Earths II conference in Porto, Potugal (2014)
- Poster at the Sagan Workshop in Pasadena, CA (2014)
- Poster at the Exoplanetary Science conference in Quy Nhon, Vietnam (2014)
- Poster at the Kepler Science Conference II in Mountain View, CA (2013)
- Poster at the American Astronomical Society Winter Meeting in Long Beach, CA (2013)

# **Work History**

NASA Exoplanet Science Research Scientist / NN-EXPLORE April 2018 - present Institute / Caltech **Deputy Project Scientist** California Institute of **Texaco Postdoctoral Fellow** August 2017 - April 2018 Technology Institute for Astronomy, **National Science Foundation** August 2014 - August 2017 University of Hawaii **Graduate Research Fellow** Institute for Astronomy, **Graduate Research Assistant** August 2012 - August 2014 University of Hawaii Research Associate (Astronomy) LCOGT, Goleta, CA March 2009 - August 2012

# **Hobbies and Interests**

- Auto racing SCCA Hawaii Region Solo class champion 2016, and 2017 SCCA Cal Club region class champion, 2018 SCCA San Diego Match tour STU class win
- Digital photography, including astrophotography (Astronomy Picture of the Day, 2011/08/26 http://apod.nasa.gov/apod/ap110826.html)
- Amateur astronomy