

Samuel Halverson

Education

- 2016 **Doctor of Philosophy**, *The Pennsylvania State University*, University Park, PA.
Astronomy & Astrophysics, Advisor: Suvrath Mahadevan
- 2013 **Master of Science**, *The Pennsylvania State University*, University Park, PA.
Astronomy & Astrophysics
- 2009 **Bachelor of Arts**, *The University of California, Berkeley*, Berkeley, CA.
Physics and Astrophysics (double major), Advisor: Jerry Edelstein
- 2006 **Associate of Arts**, *City College of San Francisco*, San Francisco, CA.
Chinese (Mandarin)

Appointments

- 2016 – **Sagan Postdoctoral Fellow**, *University of Pennsylvania*, Physics & Astronomy Department.
Developing ultra-stable, high resolution Doppler spectrometers in the optical and near-infrared to search for terrestrial-mass planets orbiting nearby stars.
- 2010 – 2016 **Graduate Research Assistant**, *The Pennsylvania State University*, Astronomy Department.
Developed photonic subsystems to improve the radial velocity measurement precision of near-infrared and optical spectrometers for exoplanet surveys.
- 2010 **Department Researcher**, *University of California Berkeley*, Astronomy Department.
Combined stellar radial velocity and astrometric data to constrain masses of low-mass companions orbiting nearby Sun-like stars.
- 2007 – 2009 **Undergraduate Researcher**, *University of California Berkeley*, Space Sciences Laboratory.
Developed optomechanical hardware, control software, and data reduction software for an infrared externally dispersed Doppler interferometer.
- 2005 – 2007 **Volunteer Tutor**, *City College of San Francisco*, Mathematics Library.
Undergraduate mathematics tutor

Skills & training

- Experience in design, construction, alignment, and testing of high resolution optical and near-infrared spectrometers
- Experience in deriving realistic instrument performance and error budgets for astronomical spectrometers, systems engineering of multifaceted optical systems
- Development, assembly and performance verification of microscopic and macroscopic photonic systems, including miniature optical fiber devices and sensors for high precision spectroscopy, compact microscope devices
- Development of spectroscopic frequency standards for radial velocity spectrometers, such as stabilized Fabry-Perot cavities, broadband optical frequency combs
- Experience in the use and characterization of large-format CMOS and CCD detectors in both the visible and near-infrared
- Extensive experience in the testing and characterization of specialized single-mode and multi-mode optical fibers
- Observing on large astronomical telescopes, including the 200" at Palomar Observatory & 120" at Lick Observatory
- Software: IDL (data processing and image analysis), Zemax (optical design), TFCalc (optical coating simulations), GSolver (diffraction grating simulations)

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Awards

- 2016 NASA SAGAN POSTDOCTORAL FELLOWSHIP, NASA Exoplanet Science Institute
- 2016 LAB BENCH TO COMMERCIALIZATION GRANT (Co-I), Penn State
- 2015 DOWNSBROUGH GRADUATE FELLOWSHIP, Penn State University
- 2013, 2015 RESEARCH GRANT-IN-AID AWARD, Sigma-Xi
- 2013 BRUMBACH FELLOWSHIP, Penn State University
- 2010 – 2013 BUNTON-WALLER FELLOWSHIP, Penn State University
- 2012 – 2013 ZACCHEUS DANIEL AWARD, Penn State University
- 2012 NSF GRADUATE FELLOWSHIP HONORABLE MENTION, National Science Foundation
- 2010 – 2012 BRADDOCK-ROBERTS FELLOWSHIP, Penn State University
- 2009 GROUP ACHIEVEMENT AWARD, NASA SIM Planet Finding Capability Study Team
- 2009 PHYSICS UNDERGRADUATE RESEARCH SCHOLARSHIP, UC Berkeley Physics Department
- 2006 HONORS CERTIFICATE, City College of San Francisco
- 2005 KERKHOF MEMORIAL MATHEMATICS SCHOLARSHIP, City College of San Francisco

Collaborations contributed to

- 2014 – THE EXTREME PRECISION DOPPLER SPECTROMETER (NEID), a NASA high resolution, ultra-stable optical spectrometer for the 3.5 meter WIYN telescope (Co-I)
- 2011 – THE HABITABLE-ZONE PLANET FINDER, a high resolution, near-infrared spectrometer for the 10 meter Hobby-Eberly Telescope (Co-I)
- 2016 – THE KECK PLANET FINDER, an ultra-stable, high resolution optical spectrometer for Keck Observatory (collaborator).
- 2016 – THE MINIATURE EXOPLANET RADIAL VELOCITY ARRAY - RED (MINERVA-RED), a high resolution, diffraction-limited, near-infrared spectrometer on a 0.7 meter telescope (collaborator)
- 2016 – EARTH FINDER, A space-borne precision radial velocity mission concept study (collaborator).
- 2011 – 2015 THE APACHE POINT OBSERVATORY GALACTIC EVOLUTION EXPLORER, a near-infrared, multi-object spectrometer part of the Sloan Digital Sky Survey
- 2007 – 2010 TRIPLESPEC EXOPLANET DISCOVERY INSTRUMENT, a near-infrared, externally dispersed interferometer used as a Doppler velocimeter
- 2008 THE SPACE INTERFEROMETER MISSION, a former NASA astrometric observatory
- 2008 THE ATTEMPT TO OBSERVE OUTER-PLANETS IN NON-SINGLE-STELLAR ENVIRONMENTS, a ground-based radial-velocity survey designed to detect low-mass companions in multi-star systems

Professional talks

- 2017 ‘NEXT GENERATION EXOPLANET DISCOVERY INSTRUMENTS IN THE OPTICAL AND NEAR-INFRARED’, JPL Astrophysics Colloquium (invited)
- 2017 ‘THE HABITABLE-ZONE PLANET FINDER INSTRUMENT’, 3rd Workshop on Extremely Precise Radial Velocities (invited)
- 2017 ‘NEXT GENERATION DOPPLER VELOCIMETERS IN THE OPTICAL AND NEAR-INFRARED’, Precision Spectroscopy: Towards Earth 2.0 workshop
- 2017 ‘TOWARDS THE DISCOVERY OF EXO-EARTHS AND HABITABLE WORLDS’, Lockheed Martin Advanced Technology Center seminar (invited)
- 2016 ‘NEXT GENERATION PLANET HUNTERS IN THE OPTICAL AND NEAR-INFRARED’, Notre Dame astrophysics seminar (invited)

- 2016 ‘PHOTONIC SYSTEMS FOR HIGH PRECISION RADIAL VELOCITY INSTRUMENTS’, American Astronomical Society meeting 2016 dissertation talk
- 2015 ‘HIGH PRECISION DOPPLER SPECTROSCOPY IN THE NEAR-INFRARED’, Yale Exoplanet group lunch talk (invited)
- 2015 ‘NEAR-INFRARED FABRY-PEROT ETALONS FOR RADIAL VELOCITY INSTRUMENTS’, Pathways towards habitable planets 2015 satellite meeting (invited)
- 2015 ‘THE PATH TOWARDS 1 M/S RADIAL VELOCITY PRECISION IN THE NEAR-INFRARED’, UC Berkeley Space Sciences Laboratory Colloquium (invited)
- 2013 ‘THE HABITABLE-ZONE PLANET FINDER’, NASA GSFC Exoplanet Seminar (invited)
- 2011 ‘A FIBER FABRY-PEROT AS A DOPPLER CALIBRATION SOURCE’, SDSS-III annual meeting

Service

Referee: Proceedings of Astronomical Society of the Pacific (PASP), The Astrophysical Journal (ApJ)
 Panelist: NASA XRP grants program

Patents

Pending S. Mahadevan, **S. Halverson**, A. Roy, *Optical fiber scramblers*. U.S. Patent Application 62/204,206, filed August 2015.

Professional memberships

SPIE, The Optical Society (OSA), American Astronomical Society (AAS)

Publications

Peer-reviewed journal publications

Temporal Variations of Telluric Water Vapor Absorption at Apache Point Observatory, Li, D.; Blake, C.; Nidever, D.; **Halverson, S.**, PASP accepted, 2017

A Low-cost Environmental Control System for Precise Radial Velocity Spectrometers, Sliski, D.; Blake, C.; **Halverson, S.**, PASP accepted, 2017

Towards Space-like Photometric Precision from the Ground with Beam Shaping Diffusers, Stefansson, G.; Mahadevan, S.; Hebb, L.; Wisniewski, J.; Huehneroff, J.; Morris, B.; **Halverson, S.**; Zhao, M.; Wright, J.; O’rourke, J.; Knutson, H.; Hawley, S.; Kanodia, S.; Li, Y.; Hagen, L.; Lio, L.; Bender, C.; Robertson, P.; Dembicky, J.; Gray, C.; Ketzbeck, W.; McMillan, R.; & Rudyk, T, ApJ, 848, 1, 2017

The Impact of Charge Transfer Inefficiency on Extreme Precision Doppler Measurements, Blake, C.; **Halverson, S.**; Roy, A, Journal of Instrumentation, 12, C04003, 2017

A Versatile Technique to Enable Sub-milli-Kelvin Instrument Stability for Precise Radial Velocity Measurements: Tests with the Habitable-zone Planet Finder, Stefansson, G.; Hearty, F.; Robertson, P.; Mahadevan, S.; Anderson, T.; Levi, E.; Bender, C.; Nelson, M.; Monson, A.; Blank, B.; **Halverson, S.**, Henderson, C.; Ramsey, L.; Roy, A.; Schwab, C.; & Terrien, R., ApJ, 833, 175, 2016

‘Modal-noise’ in single-mode fibers: A cautionary note for high precision radial velocity instruments, **Halverson, S.**; Roy, A.; Mahadevan, S.; & Schwab, C, ApJ, 814, L22, 2015

An Efficient, Compact, and Versatile Fiber Double Scrambler for High Precision Radial Velocity Instruments, **Halverson, S.**; Roy, A.; Mahadevan, S.; Ramsey, L.; Levi, E.; Schwab, C.; Hearty, F.; & MacDonald, N., *ApJ*, 806, 61, 2015

Development of Fiber Fabry-Perot Interferometers as Stable Near-infrared Calibration Sources for High Resolution Spectrographs, **Halverson, S.**; Mahadevan, S.; Ramsey, L.; Hearty, F.; Wilson, J.; Holtzman, J.; Redman, S.; Nave, G.; Nidever, D.; Nelson, M.; Venditti, N.; Bizyaev, D.; & Fleming, S., *PASP*, 126, 939, 2014

Suppression of Fiber Modal Noise Induced Radial Velocity Errors for Bright Emission-line Calibration Sources, Mahadevan, S.; **Halverson, S.**, Ramsey, & Venditti, N. *ApJ*, 786, 18, 2014

The Tenth Data Release of the Sloan Digital Sky Survey: First Spectroscopic Data from the SDSS-III Apache Point Observatory Galactic Evolution Experiment, Ahn, Christopher P.; Alexandroff, Rachael, Allende Prieto, Carlos, Anders, Friedrich, Anderson, Scott F.; Anderton, Timothy.; **Halverson, S. (85th author)** *ApJS*, 211, 17, 2014

Spectro-interferometric Observations of Classical Nova V458 Vul 2007, Rajabi, S.; Muterspaugh, M. W.; Lane, B.; Sirk, M.; Browne, S.; Ghasempour, A.; **Halverson, S.**; Kelly, J.; & Williamson, M., *ApJ*, 786, 18, 2012

Precise Stellar Radial Velocities of an M Dwarf with a Michelson Interferometer and a Medium-Resolution Near-Infrared Spectrograph, Muirhead, P.; Edelstein, J.; Erskine, D. J.; Wright, J. T.; Muterspaugh, M. W.; Covey, K.; Wishnow, E.; Hamren, K.; Andelson, P.; Kimber, D.; Mercer, T.; **Halverson, S.**, Vanderburg, A.; Mondo, D.; Czeszumka, A.; & Lloyd, J. P., *PASP*, 123, 709, 2011

A Prograde, Low-inclination Orbit for the Very Hot Jupiter WASP-3b, Tripathi, A.; Winn, J.; Johnson, J. A.; Howard, A.; **Halverson, S.**; Marcy, G. W.; Holman, M.; de Klerk, K.; Carter, J.; Esquerdo, G.; Everett, M.; & Cabrera, N., *ApJ*, 715, 421, 2010

Conference proceedings

A comprehensive radial velocity error budget for next generation Doppler spectrometers, Halverson, S.; Terrien, R.; Mahadevan, S.; Roy, A.; Bender, C.; Stefansson, G.; Monson, A.; Levi, E.; Hearty, F.; Blake, C.; McElwain, M.; Schwab, C.; Ramsey, L.; Wright, J.; Wang, S.; Gong, Q.; Roberston, P., *Proceedings of the SPIE*, Volume 9908, 99086P, 2016

Measuring extended red sensitivity in a 1.7 μ m-cutoff HgCdTe detector array, Terrien, R.; Monson, A.; Mahadevan, S.; Bender, C.; **Halverson, S.**; Ramsey, L., *Proceedings of the SPIE*, Volume 9915, 99151Q, 2016

The instrument control software package for the Habitable-Zone Planet Finder spectrometer, Bender, C.; Robertson, P.; Stefansson, G.; Monson, A.; Anderson, T.; **Halverson, S.**; Hearty, F.; Levi, E.; Mahadevan, S.; Nelson, M.; Ramsey, L.; Roy, A.; Schwab, C.; Shetrone, M.; & Terrien, R., *Proceedings of the SPIE*, Volume 9913, 991338, 2016

Design of NEID, an extreme precision Doppler spectrograph for WIYN, Schwab, C.; Rakich, A.; Gong, Q.; Mahadevan, S.; **Halverson, S.**; Roy, A.; Terrien, R.; Robertson, P.; Hearty, F.; Levi, E.; Monson, A.; Wright, J.; McElwain, M.; Bender, C.; Blake, C.; Sturmer, J.; Gurevich, Y. V.; Chakraborty, A.; & Ramsey, L., Proceedings of the SPIE, Volume 9908, 99087H, 2016

A system to provide sub-milliKelvin temperature control at T 300K for extreme precision optical radial velocimetry, Robertson, P.; Hearty, F.; Anderson, T.; Stefansson, G.; Levi, E.; Bender, C.; Mahadevan, S.; **Halverson, S.**; Monson, A.; Ramsey, L.; Roy, A.; Schwab, C.; Terrien, R.; Nelson, M.; & Blank, B., Proceedings of the SPIE, Volume 9908, 990862, 2016

Measuring the thermal sensitivity of a fiber Fabry-Perot interferometer, Jennings, J.; **Halverson, S.**; Diddams, S.; Terrien, R.; Ycas, G.; & Mahadevan, S., Proceedings of the SPIE, Volume 9907, 99072G, 2016

Adaptive optics fed single-mode spectrograph for high-precision Doppler measurements in the near-infrared, Schwab, C.; Jovanovic, N.; Feger, T.; Bakovic, M.; Gurevich, Y. V.; Sturmer, J.; Apodaca, R.; Vanzi, L.; Rukdee, S.; Lawrence, J. S.; Coutts, D. W.; Cvetojevic, N.; Mahadevan, S.; Stefansson, G. K.; **Halverson, S.**; & Guyon, O., Proceedings of the SPIE, Volume 9912, 991274, 2016

Ultra-stable temperature and pressure control for the Habitable-zone Planet Finder spectrograph, Stefansson, G.; Hearty, F.; Robertson, P.; Levi, E.; Mahadevan, S.; Anderson, T.; Monson, A.; Bender, C.; **Halverson, S.**, Li, Y.; Ramsey, L.; Roy, A.; Schwab, C.; Terrien, R.; Nelson, M.; & Blank, B., Proceedings of the SPIE, Volume 9908, 990871, 2016

The Habitable-zone Planet Finder Calibration System, **Halverson, S.**; Mahadevan, S.; Ramsey, L. W.; Terrien, R.; Roy, A.; Schwab, C.; Bender, C.; Hearty, F.; Levi, E.; Osterman, S.; Ycas, G.; Diddams, S., Proceedings of the SPIE, Volume 9147, 91477Z, 2014

Developments in simulations and software for a near-infrared precision radial velocity spectrograph, Terrien, R.; Bender, C.; Mahadevan, S.; **Halverson, S.**; Ramsey, L. W.; Hearty, F., Proceedings of the SPIE, Volume 9152, 915226, 2014

Scrambling and modal noise mitigation in the Habitable Zone Planet Finder fiber feed, Roy, A.; **Halverson, S.**; Mahadevan, S.; Ramsey, L. W., Proceedings of the SPIE, Volume 9147, 91476B, 2014

Environmental control system for Habitable-zone Planet Finder (HPF), Hearty, F.; Levi, E. Nelson, M.; Mahadevan, S.; Burton, A.; Ramsey, L.; Bender, C.; Terrien, R.; **Halverson, S.**; Robertson, P.; Roy, A.; Blank, B.; Blanchard, K.; Stefansson, G., Proceedings of the SPIE, Volume 9147, 914752, 2014

The Habitable-zone Planet Finder: A status update on the development of a stabilized fiber-fed near-infrared spectrograph for the for the Hobby-Eberly telescope, Mahadevan, S.; Ramsey, L. W.; Terrien, R.; **Halverson, S.**; Roy, A.; Hearty, F.; Levi, E.; Stefansson, G.; Robertson, P.; Bender, C.; Schwab, C.; Nelson, M., Proceedings of the SPIE, Volume 9147, 91471G, 2014

A Fiber Fabry-Perot Interferometer as Stable Wavelength Reference for High-resolution Astronomical Spectrographs, **Halverson, S.**; Mahadevan, S.; Ramsey, L., OSA Workshop on Specialty Optical Fibers and their Applications, W3.3, 2013

Optical fiber modal noise in the 0.8 to 1.5 micron region and implications for near infrared precision radial velocity measurements, McCoy, K. S.; Ramsey, L.; Mahadevan, S.; **Halverson, S.**; Redman, S. L., Proceedings of the SPIE, Volume 8446, 84468J, 2012

Development of a New, Precise Near-infrared Doppler Wavelength Reference: A Fiber Fabry-Perot Interferometer, **Halverson, S.**; Mahadevan, S.; Ramsey, L.; Redman, S.; Nave, G.; Wilson, J. C.; Hearty, F.; Holtzman, J., Proceedings of the SPIE, Volume 8446, 84468Q, 2012

Performance of the Apache Point Observatory Galactic Evolution Experiment (APOGEE) high-resolution near-infrared multi-object fiber spectrograph, Wilson, J. C.; Hearty, F.; Skrutskie, M. F.; Majewski, S. R.; Schiavon, R. et al. **Halverson, S. (80th author)**, Proceedings of the SPIE, Volume 8446, 84460H 2012

Predicting migration system dynamics with conditional and posterior probabilities, Andris, C. ; **Halverson, S.** ; Hardisty, F., Spatial Data Mining and Geographical Knowledge Services (ICSDM), 2011 IEEE International Conference, pg 192 - 197

Infrared radial velocimetry with TEDI: performance development, Edelstein, J.; Muirhead, P.; Wright, J. T.; Covey, K.; Erskine, D.; Muterspaugh, M.; Lloyd, J.; **Halverson, S.**; Marckwordt, M.; Mondo, D., Proceedings of the SPIE, Volume 7735, 773583, 2010

Precise infrared radial velocimetry with the Triplespec Exoplanet Discovery Instrument: current performance and results, Muirhead, P.; Edelstein, J.; Wright, J. T.; Erskine, D. J.; Muterspaugh, M. W.; Covey, K. R.; Marckwordt, M. R.; **Halverson, S.**; Mondo, D.; Lloyd, J. P., Proceedings of the SPIE, Volume 7735, 77357X, 2010

Precision Radial Velocities in the Near Infrared with TEDI, Lloyd, J. P.; Czeszumka, A.; Edelstein, J.; Erskine, D.; Feuerstein, M.; **Halverson, S.**; Marckwordt, M.; Mercer, T.; Muirhead, P.; Schwehr, J.; Muterspaugh, M.; Wishnow, E.; Wright, J., Transiting Planets, Proceedings of the International Astronomical Union, IAU Symposium, Volume 253, p. 157-161

Dispersed interferometry for infrared exoplanet velocimetry, Edelstein, J.; Muterspaugh, M.; Erskine, D.; Marckwordt, M.; Feuerstein, M. Mercer, T.; Czeszumka, A.; Schwer, J.; Halverson, S.; Lloyd, J.; Muirhead, P.; Wright, J.; Herter, T., Proceedings of the SPIE, Volume 7014, 70147F, 2008

[Non-refereed materials](#)

The Habitable-zone Planet Finder (HPF): Achieving high precision radial velocities and mitigating stellar activity noise, Mahadevan, S.; Ramsey, L. W.; Terrien, R.; Robertson, P.; Marchwinski, R. C.; Hearty, F.; Levi, E.; Stefansson, G.; Bender, C. F.; **Halverson, S.**; Roy, A.; Nelson, M.; Schwab, C., American Astronomical Society, AAS Meeting 225, #258.23

V458 Vul 2007: A Fast Varying Nova In The Early Phase Of Evolution, Rajabi, S.; Muterspaugh, M. W.; Lane, B. F.; Sirk, M. M.; Browne, S.; Ghasempour, A.; **Halverson, S.**; Kelly, J. G.; Williamson, M., American Astronomical Society, AAS Meeting 219, #436.16, 2010

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Preliminary Data Reduction Methods for TEDI: The Triplespec Exoplanet Discovery Instrument, **Halverson, S.**; Muirhead, P.; Muterspaugh, M.; Edelstein, J., Bulletin of the American Astronomical Society, Vol. 42, p.287, 2010

The SIM Exoplanet Analysis Experiment, an Undergraduate Perspective, **Halverson, S.**; Muterspaugh, M.; Howard, A.; Wright, J.; Sirk, M., Bulletin of the American Astronomical Society, Vol. 41, p.357, 2009

Refereed tinyurl.com/RefereedHalverson (3 first author articles, 1 second author, 8 total)

Non-Refereed tinyurl.com/NonRefereedHalverson (6 first author articles, 3 second author, 26 total)