Patrick McCreery

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Education

University of Colorado, Denver 2017-2018
Dual-Enrollment
University of Colorado, Boulder 2018-2022
B.A., Astrophysics, Planetary Science emphasis, May 2022
Minor, Applied Mathematics, Statistics emphasis
Cumulative GPA, Astronomy/Physics GPA: 3.99/4.0, 4.0/4.0, Summa Cum Laude
Thesis: *Generating Synthetic Solar Granulation using Machine Learning Techniques*
The Johns Hopkins University Fall 2022-
Physics & Astronomy Ph.D. Candidate

Research Interests

Stellar characterization
Exoplanet formation and evolution
High-resolution ground-based spectroscopy
Exoplanet atmosphere characterization
Exoplanet demographics
Archival analyses

Computer and Technical Skills

Computer Languages	Python, IDL, R, HTML, JavaScript
Software & Tools	LaTeX, Git/GitHub, Mathematica, MATLAB, Microsoft Suite

Research Positions and Projects

Exoplanet Host Star Characterization

One of the biggest obstacles to the accomplishment of the Worlds and Suns in Context theme of the Astro2020 Decadal Survey is the lack of accurate, precise, and homogeneous host star parameters and elemental abundances for both exoplanet host stars and stars searched for exoplanets. The fifth phase of the Sloan Digital Sky Survey (SDSS-V) is currently collecting high-resolution, high signal-to-noise ratio Apache Point Observatory Galactic Evolution Experiment (APOGEE) spectrograph H-band spectra for all known exoplanet host stars, as well as all stars searched for exoplanets using the astrometric, direct imaging, and Doppler techniques across both the northern and southern skies. The significant dispersion in SDSS-V exoplanet host star C/O, C/N, and N/O abundance ratios in proprietary DR20 data emphasizes the importance of accounting for non-solar abundance ratios in analyses of exoplanet atmospheric abundances. I have built upon the methods of Reggiani et al 2021 to self-consistently characterize the parameters and abundances of JWST exoplanet host stars accurately and precisely. Produced McCreery et al (2025b, in prep) and non-first author publications.

Atmospheric Escape

The near-infrared (NIR) helium triplet line is a marker that can be used investigate atmospheric escape of evaporating exoplanets, meaning observations of the triplet line are theorized to be effecting in providing insight to outstanding questions regarding atmospheric escape, such as if small planets can retain an atmosphere when highly irradiated by their host star. To date, the analysis of observations of the triplet line has been done inconsistently, motivating this project, to perform a uniform analysis of the helium observations. This project involved learning a plethora of skills, including nested sampling algorithms, Gaussian processes, and multiprocessing techniques. Produced McCreery et al 2025a and non-first author publications.

PandExo 2.0

Building upon the instrument simulator, PandExo, developed by the Space Telescope Science Institute, I ran simulations of transit lightcurves in an effort to better understand the impact of limb darkening on the transit depth error. PandExo currently uses a flat-bottom light curve to simulate depth errors, however, this project explores methods to provide depth errors that takes limb darkening into account while not significantly increasing the instrument simulator's computation time. Will produce a short paper and significant upgrade to PandExo to aid future JWST proposals. Produced McCreery et al (2025c, in prep)

Generating Synthetic Data Sets - Honors Thesis & LASP

Building upon the work of McClure, Rast, and Pillet, I used Fourier Transforms to resolve solar acoustic oscillations and separate these from the surface granulation. Instead of using expensive time series to perform the Fourier Filter, we proposed using machine learning (ML) techniques to directly separate the modes. Due to data scarcity for training the ML algorithm, we instead used convolutional variational auto-encoders to generate novel images of the solar surface as a method to enlarge the data sets for future training and projects.

Relevant Coursework

Physics
Classical Mechanics I/II
Electricity and Magnetism I/II
Quantum Mechanics I/II
Thermodynamics and Statistical Mechanics
Experimental Physics I/II
*Radiative Astrophysics**

Mathematics
Calculus, Differential Equations Sequences
Matrix Methods and Applications
*Fourier Series and Boundary Value Problems (PDEs)**
Applied Probability & Statistics Sequences
Matrix Methods and Linear Algebra

Astronomy Courses
Planetary Atmospheres and Geology
Plasma and Space Physics
*Planetary Surfaces and Interiors**
Astrophysics I
Data Analysis and Research Methods in Astronomy
*Stellar Structures and Interiors**

† indicates current enrollment
* indicates a graduate level course

Leadership, Volunteer, and Other Positions

CU STARs (2019-2022)

The Astrophysical and Planetary Sciences describe CU-STARs (Science, Technology and Astronomy Recruits) as "a University of Colorado program to support students from all backgrounds interested in space." I began loosely participating in 2019 as part of a program to host a campus wide star party, where I helped put together and use telescopes at the star party, as well as explain the object(s) in view and answer questions that attendees might have. In 2020, I began attending meetings more regularly, helping plan, develop, and present topics in astronomy to underrepresented and rural schools in Colorado.

Resident Advisor (2019-2020)

For the 2019-2020 school year, I worked as a resident advisor in the CU dorms, helping incoming freshman transition into college life. Work duties involved keeping in touch with each resident, putting on programs that kept students engaged in the communities, and being "on-call" for potential issues and crises that may arise in the residence halls. I left the position in 2020 due to concerns regarding COVID-19.

Applied Mathematics Writer (2019-)

In 2019, I joined the Applied Mathematics Department at CU, writing columns and news articles that post to the applied math website (amath.colorado.edu). I created and edited the yearly newsletter, maintained portions of the applied math website, and helped the IT specialist, office manager, and undergraduate coordinator.

CubeSat Project Member – Colorado Space Grant Consortium (2019)

For the spring semester of 2019, the Colorado Space Grant Consortium brought together students from all STEM fields to work on CubeSat projects that would ascend through Earth's atmosphere on a weather ballon. As part of the project, we designed, built, tested, and launched a project relevant to an ascending ballon. The team chose a project analyzing pressure, temperature, and solar flux with altitude in the atmosphere. I helped conceptualize the project, build the structure of the cube, test the GoPro fixed to the cube, and analyze the collected data.

Department of Astrophysics and Planetary Science Grader

During the summer of 2019, I graded for an introductory astronomy course, then in the fall of 2021, I graded for a course in data analysis in astronomy. Currently grading for a planetary atmospheres course (spring 2022).