# CHRISTIAN R. HAYES

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## OBJECTIVE

Experienced with analyzing large, high-dimensional data sets, utilizing a variety of techniques, including modeling and machine learning, and adept at reporting results to both expert and general audiences; seeking a position to aid in the analysis and interpretation of data through creative problem solving.

## WORK EXPERIENCE

**Research Scientist**, University of Washington                                          2020 - present
- Serve as a data processing specialist with the APOGEE-2 data reduction pipeline team to generate survey data products and vet their quality prior to public release.
- Develop physically-motivated, non-linear models of the evolution of dwarf galaxies and develop techniques to fit sparse observations of real systems.
- Oversee and coordinate with the APOGEE-2 survey's targeting team personnel to ensure that the science team's plans are executed, develop modifications to the survey's targeting plan, and assess and communicate the status of the survey to the APOGEE team.

**Research Assistant**, University of Virginia                                          2015 - 2020
- Manipulated databases of 100s of thousands to 100s of millions of stars in Python using a variety of analysis and machine learning techniques.
- Developed data visualization methods in matplotlib to interpret and analyze databases with 30-300 dimensions.
- Developed non-linear models of the spatial and velocity distributions of star clusters in Python to detect their orientation and rotation from samples of thousands of stars.
- Using clustering and non-linear models, identified that 0.5% of a 150,000 star sample of the Milky Way originated in dwarf galaxies that were accreted into the Milky Way.
- Discovered that the stellar disk of the Milky Way is about twice the size through the classification of stars and justification with regression techniques.

**Cox Research Scholar**, Indiana University                                          2011 - 2015
- Performed image and spectral analysis to identify stars and measure their properties.
- Cataloged archived data and studied the time evolution of systems of star clusters.
- Awarded the Provost's Award for Undergraduate Research and Creative Activity (2014) for research published in a peer-reviewed publication and the Barry M. Goldwater Scholarship (2014).

**NSF REU Research Assistant**, University of Rochester                                          2014
- Analyzed images from the *Spitzer Space Telescope* and performed spectral modeling and decomposition.

## TEAMWORK, LEADERSHIP, AND VOLUNTEER EXPERIENCE

**APOGEE-2 Team Member**, APOGEE Survey                                          2016 - present
- Contributed to targeting and planning of the APOGEE survey and led the evaluation of survey progress for individual programs as a part of yearly survey wide reviews (2018, 2019).
- Vetted databases of 100s of thousands of stars and assisted with documentation for the public data releases of the APOGEE survey.

**Dark Skies, Bright Kids Volunteer**, Charlottesville, Virginia                                          2015 - present

- Planned and ran astronomy outreach programs for elementary school students particularly those who are underserved or from under-represented minorities in the STEM fields (8 after-school programs and 4 summer camps).
- After-school program coordinator for two years and summer camp coordinator for one year.
- Member and lead of the "DSBK Assessments Team" (2017 - 2020) that evaluates the goals of the program.

**Volunteer Presenter**, Fan Mountain Observatory Public Nights                    2015 - present
- Gave presentations and demonstrations of astronomical principles, techniques, and instruments to the general public at eight Fan Mountain Observatory Public Nights.
- Taught other volunteers how to set-up demonstrations and what to present to public night tours.

**Telescope Operator**, Leander McCormick Observatory Public Nights                    2015 - 2019
- Operated both modern and antique telescopes to show astronomical objects to the general public.
- Trained volunteers how to use telescopes and how to run telescope viewings for the public.

**Graduate Admissions Committee Member**, UVA Astronomy Department                    2019
- Participated in the selection process and managed the list of candidates and their qualifications.
- Organized, scheduled, and conducted interviews of candidates.
- Planned and coordinated prospective student visits to UVA.

**Qualifying Exam Committee Member**, UVA Astronomy Department                    2017 - 2018
- Developed the astronomy graduate qualifying exam with the other committee members.
- Designed questions for the astronomy graduate qualifying exam.

**Head Teaching Assistant**, UVA Astronomy Department                    2016 - 2017
- Organized and decided the graduate student teaching assistant assignments for the Astronomy department and scheduled lab assignments.
- Archived department teaching assistant resources for ease of future use.

## HONORS AND AWARDS

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|---|---|
| **Raven Society Inductee**, Raven Society, UVA | 2018 |
| **C. Mark Pirrung Family Jefferson Fellow**, Jefferson Scholars Foundation | 2017 |
| **Laurence W. Fredrick Teaching Award**, UVA Astronomy | 2017 |
| **National Science Foundation Graduate Research Fellow**, NSF | 2017 |
| **Graduate STEM Research Fellow**, Virginia Space Grant Consortium | 2016 |
| **Astronomy/Observatory Scholarship**, IU Astronomy | 2015 |
| **Barry M. Goldwater Scholar** | 2014 |
| **Provost's Award for Undergraduate Research and Creative Activity**, IU | 2014 |
| **Hollis & Greta Johnson Research Scholarship**, IU Astronomy | 2013, 2014, 2015 |
| **Chambliss Astronomy Achievement Student Award**, AAS | 2013 |
| **Edward C. McCreery Undergraduate Research Travel Award**, IU Astronomy | 2013 |
| **Summer Research Partnership Scholarship**, Hutton Honors College, IU | 2012 |
| **Cox Research Scholar**, IU | 2011 - 2015 |

## RESEARCH GRANTS

**NSF/AST Grant #1908331**, Collaborator ($351,297)                    Sept 2019 - Sept 2022

Wrote the scientific justification for the successful competitive NSF/AST grant proposal titled *The Evolution of Dwarf Galaxies – A Comprehensive View of the Magellanic Clouds*, which was led by the Principal-Investigators, Drs. David Nidever and Steven Majewski.

**GSASC Research Grant**, Principal-Investigator ($1,000)                    2019

Wrote a successful application for the Graduate School of Arts and Sciences Council competitive research grant to fund research or travel opportunities.

## TEACHING EXPERIENCE

### Undergraduate Research Mentor

- **Yara Yousef**, University of Virginia      2017 - 2018

### Course Instructor

- ASTR 1270: Unsolved Mysteries in the Universe, University of Virginia      Summer 2017

### Teaching Assistant, University of Virginia

- ASTR 1230: Introduction to Astronomical Observation      Spring 2017
- ASTR 1270: Unsolved Mysteries in the Universe      Spring 2017
- ASTR 1559: Black Holes      Fall 2016
- ASTR 1270: Unsolved Mysteries in the Universe      Spring 2016
- ASTR 1230: Introduction to Astronomical Observation      Fall 2015
- ASTR 1220: Introduction to Stars, Galaxies, and the Universe      Fall 2015
- Night Lab Instructor      2015 - 2017

### Miscellaneous Teaching Experiences:

- Course grader for ASTR 5610: Galactic Structure and Stellar Populations (graduate course)      Spring 2018
- Session Facilitator at the UVA Center for Teaching Excellence (CTE) Teaching As a Graduate Student (TAGS) Workshop.      2017, 2018, 2019
- Ran an IRAF tutorial for graduate students      Fall 2017

## REFEREED PUBLICATIONS

*Summary: 27 total, 7 first author, 4 second or third author*

27. A. A. Sheffield, A. Z. Subrahimovic, M. Refat, R. L. Beaton, S. Hasselquist, **et al.** 2021 "*Chemodynamically Characterizing the Jhelum Stellar Stream with APOGEE-2*," The Astrophysical Journal, submitted. (2021)

26. F. A. Santana, R. L. Beaton, K. R. Covey, J. E. O'Connell, P. Longa-Peña, **et al.** 2021 "*Final Targeting Strategy for the SDSS-IV APOGEE-2S Survey*," The Astronomical Journal, submitted. (2020)

25. R. L. Beaton, R. J. Oelkers, R. J., **C. R. Hayes**, K. R. Covey, S. D. Chojnowski, et al. 2021 "*Final Targeting Strategy for the SDSS-IV APOGEE-2N Survey*," The Astronomical Journal, submitted. (2020)

24. A. M. Price-Whelan, D. W. Hogg, K. V. Johnston, M. K. Ness, H.-W. Rix, **et al.** 2021 "*Orbital Torus Imaging: Using Element Abundances to Map Orbits and Mass in the Milky Way*," The Astrophysical Journal, accepted. (2020)

23. Cheng, X., Anguiano, B., Majewski, S. R., **Hayes, C. R.**, Arras, P., et al. 2020 "*Exploring the Galactic Warp Through Asymmetries in the Kinematics of the Galactic Disk*," The Astrophysical Journal, 905, 49. (2020)

22. R. Ahumada, C. Allende Prieto, A. Almeida, F. Anders, S. F. Anderson, **et al.** 2020 "*The Sixteenth Data Release of the Sloan Digital Sky Surveys: First Release from the APOGEE-2 Southern Survey and Full Release of eBOSS Spectra*," The Astrophysical Journal Supplements, 249, 3. (2020)

21. B. Anguiano, S. R. Majewski, **C. R. Hayes**, C. Allende Prieto, X. Cheng, et al. 2020 "*The Stellar Velocity Distribution Function in the Milky Way Galaxy*," The Astrophysical Journal, 160, 43. (2020)

20. **C. R. Hayes**, A. M. Matthews, Y. Song, S. T. Linden, S. E. Liss, et al. 2020 "*First Results from the Dark Skies, Bright Kids Astronomy Club Draw-A-Scientist Test*," Physical Review Physics Education Research, 16, 010131. (2020)

19. D. L. Nidever, S. Hasselquist, **C. R. Hayes**, K. Hawkins, S. R. Majewski, et al. 2020 "*The Lazy Giants: APOGEE Abundances Reveal Low Star Formation Efficiencies in the Magellanic Clouds*," The Astrophysical Journal, 895, 88. (2020)

18. **C. R. Hayes**, S. R. Majewski, S. Hasselquist, B. Anguiano, M. Shetrone, et al. 2020 "*Metallicity and $\alpha$-element Abundance Gradients along the Sagittarius Stream as Seen by APOGEE*," The Astrophysical Journal, 889, 63. (2020)

17. R. Guerço, K. Cunha, V. V. Smith, **C. R. Hayes**, C. Abia, et al. 2019 "*Fluorine Abundances in the Galactic Disk*," The Astrophysical Journal, 885, 139. (2019)

16. D. H. Weinberg, J. A. Holtzman, S. Hasselquist, J. C. Bird, J. A. Johnson, **et al.**, 2019, "*Chemical Cartography with APOGEE: Multi-element abundance ratios*," The Astrophysical Journal, 874, 102. (2019)

15. D. S. Aguado, R. Ahumada, A. Almeida, S. F. Anderson, B. Andrews, **et al.**, 2019, "*The Fifteenth Data Release from the Sloan Digital Sky Surveys: First Release of MaNGA Derived Quantities, Data Visualization Tools and Stellar Library*," The Astrophysical Journal Supplement Series, 240, 23. (2019)

14. S. Hasselquist, J. L. Carlin, J. A. Holtzman, M. Shetrone, **C. R. Hayes** , et al., 2019, "*Tracing the Sagittarius Stream using APOGEE Chemical Abundances*," The Astrophysical Journal, 872, 58. (2019)

13. J. T. Mackereth, R. P. Schiavon, J. Pfeffer, **C. R. Hayes**, J. Bovy, et al., 2019, "*The origin of accreted stellar halo populations in the Milky Way using APOGEE, Gaia, and the EAGLE simulations*," Monthly Notices of the Royal Astronomical Society, 482, 3426. (2019)

12. J. J. Andrews, B. Anguiano, J. Chanamé, M. A. Agüeros, H. M. Lewis, **et al.**, 2019 "*Using APOGEE Wide Binaries to Test Chemical Tagging with Dwarf Stars*," The Astrophysical Journal, 871, 42. (2019)

11. **C. R. Hayes**, D. R. Law, S. R. Majewski, 2018 "*Constraining the Solar Reflex Velocity Using Gaia Observations of the Sagittarius Stream*," The Astrophysical Journal Letters, 867L, 20H. (2018)

10. **C. R. Hayes**, S. R. Majewski, S. Hasselquist, R. L. Beaton, K. Cunha, et al., 2018, "*Disk-Like Chemistry of the Triangulum-Andromeda Overdensity as Seen by APOGEE*," The Astrophysical Journal Letters, 859, L8. (2018)

9. B. Abolfathi, D. S. Aguado, G. Aguilar, C. Allende Prieto, A. Almeida, **et al.**, 2018 "*The Fourteenth Data Release of the Sloan Digital Sky Survey: First Spectroscopic Data from the extended Baryon Oscillation Spectroscopic Survey and from the second phase of the Apache Point Observatory Galactic Evolution Experiment*," The Astrophysical Journal Supplement Series, 235, 42. (2018)

8. E. Fernández-Alvar, L. Carigi, W. J. Schuster, **C. R. Hayes**, N. Ávila-Vergara, et al., 2018, "*Disentangling the Galactic Halo with APOGEE: II. Chemical and Star Formation History for the Two Distinct Populations*," The Astrophysical Journal, 852, 50. (2018)

7. **C. R. Hayes**, S. R. Majewski, M. Shetrone, E. Fernández-Alvar, C. Allende Prieto, et al., 2018, "*Disentangling the Galactic Halo with APOGEE: I. Chemical and Kinematical Investigation of Distinct Metal-Poor Populations*," The Astrophysical Journal, 852, 49. (2018)

6. D. L. Nidever, K. Olsen, A. R. Walker, A. K. Vivas, R. D. Blum, **et al.**, 2017, "*SMASH - Survey of MAgellanic Stellar History*," The Astronomical Journal, 154, 199. (2017)

5. F. D. Albareti, C. Allende Prieto, A. Almeida, F. Anders, S. Anderson, **et al.**, 2017, "*The Thirteenth Data Release of the Sloan Digital Sky Survey: First Spectroscopic Data from the SDSS-IV Survey MApping Nearby Galaxies at Apache Point Observatory*," The Astrophysical Journal Supplement Series, 233, 25. (2017)

4. J. G. Fernández-Trincado, O. Zamora, D. A. García-Hernández, D. Souto, F. Dell'Agli, **et al.**, 2017, "*Atypical Mg-poor Milky Way Field Stars with Globular Cluster Second-generation-like Chemical Patterns*," The Astrophysical Journal Letters, 846, 2. (2017)

3. S. T. Linden, M. Pryal, **C. R. Hayes**, N. W. Troup, S. R. Majewski, et al., 2017, "*Timing the Evolution of the Galactic Disk with NGC 6791: An Open Cluster with Peculiar High-$\alpha$ Chemistry as Seen by APOGEE*," The Astrophysical Journal, 842, 49. (2017)

2. **C. R. Hayes**, E. D. Friel, T. J. Slack, & O. M. Boberg, 2015, "*Properties of the Old Open Cluster Czernik 30*," The Astronomical Journal, 150, 69. (2015)

1. **C. R. Hayes** & E. D. Friel, 2014, "*Radial Velocities of Three Poorly Studied Clusters and the Kinematics of Open Clusters*," The Astronomical Journal, 147, 69. (2014)

## ORAL PRESENTATIONS

**Dwarf Galaxy Accretion in the Milky Way:** — January 2020
**Viewing Dwarf Galaxy Accretion through the Eyes of Large Surveys**
235th Meeting of the American Astronomical Society, Honolulu, HI — Contributed Talk

**Tracing the Sagittarius Stream with APOGEE** — June 2019
SDSS-IV/V Collaboration Meeting, Ensenada, Mexico — Contributed Talk

**How Do We Know What Stars Are Made of?** — March 2019
**And What Are They Made of Anyway?**
Jefferson Fellow's Symposium, Charlottesville, Virginia — Public Talk

**The Chemical Abundance Profile of the Milky Way's Accreted Halo** — November 2018
CENAG 2018, Heidelberg Germany — Contributed Talk

**Chemistry of the Triangulum-Andromeda Overdensity as Seen by APOGEE** — June 2018
232nd Meeting of the American Astronomical Society, Denver, CO — Contributed Talk

**Chemical Evolution of Metal-Poor Stars in the Milky Way** — April 2018
Virginia Space Grant Consortium Student Research Conference, Norfolk, VA — Invited Talk

**Chemistry of the Triangulum-Andromeda Overdensity** — March 2018
APOGEE-2 Winter Workshop, Besançon, France — Contributed Talk

**Extended Kinematic Structure of the Large Magellanic Cloud** — April 2017
Virginia Space Grant Consortium Student Research Conference, Williamsburg, VA — Invited Talk

**Distinct Metal-Poor Populations in the Milky Way Seen by APOGEE** — November 2016
Southeastern Section American Physical Society Conference, Charlottesville, VA — Contributed Talk

**Metal-Poor Stars Seen by APOGEE** — June 2016
SDSS-IV Collaboration Meeting, Madison WI — Contributed Lightning Talk

**Metal-Poor Stars Seen by APOGEE** — June 2016
APOGEE-2 Team Meeting, Madison, WI — Contributed Talk

**A Photometric Study of the Open Cluster Czernik 30**                    March 2015
Undergraduate Honors Thesis Presentation, Indiana University                Talk

**Dust Mineralogy of T Tauri Stars in NGC 1333**                    August 2014
University of Rochester                                                Talk

**Kinematics of Open Clusters**                                      April 2014
Indiana University                                                    Talk

## PROFESSIONAL MEMBERSHIPS

**Raven Society**                                               Inducted 2018

**APOGEE Team**                                                 2016 - present

**Phi Beta Kappa Honor Society**                                Inducted 2014

**American Astronomical Society**

## SOFTWARE PROFICIENCY

**Languages (Proficiency)**: Python (Advanced), IDL (Intermediate), SQL (Basic), C (Basic)
**Packages**: scikit-learn, numpy, scipy, matplotlib, astropy, FlexCE
**Tools/Programs**: TOPCAT, IRAF, LaTeX, Unix, SM, Google/MS Suites, MOOG, BACCHUS

## EDUCATION

**Ph.D., Astronomy**, University of Virginia                         May 2020
Advisor: Dr. Steven R. Majewski
GPA: 4.0 (4.0 scale)

**M.S., Astronomy**, University of Virginia                          May 2017
GPA: 4.0 (4.0 scale)

**B.S., Astronomy/Astrophysics, and B.S., Physics**, Indiana University     May 2015
Minor: Mathematics
With Departmental Honors and Highest Distinction
GPA: 3.991 (4.0 scale)

*Last Updated February 21, 2021*