

Christopher Cain

2235 W. Spur Dr., Phoenix, AZ, 85085

clcain3@asu.edu • +1 (909) 802-4637

Website: <https://clcain3.wixsite.com/christopher-cain>

EMPLOYMENT	Beus Prize Postdoctoral Research Fellow <ul style="list-style-type: none">Arizona State University Sep 2023-Present
EDUCATION	University of California, Riverside , Riverside, California, USA <ul style="list-style-type: none">Ph.D. in Physics (Advisor: Dr. Anson D'Aloisio)Jan 2020 – Jul 2023M.S. in PhysicsSep 2018 - Jan 2020 Azusa Pacific University , Azusa, California, USA <ul style="list-style-type: none">B.S. in Physics, B.S. in MathematicsSep 2014 - Dec 2017<ul style="list-style-type: none">Graduated Summa Cum Laude
PUBLICATIONS	Total published papers: 22 (+5 submitted, +5 in prep., 32 tot.) First-author papers: 10 (+3 submitted, +1 in prep., 14 tot.) Student papers: 1 (+3 in prep., 4 tot.) Co-Author papers: 11 (+2 submitted, +1 in prep., 14 tot.) Total (first-author) citations: 439 (148) h-index (first-author): 10 (6) Source: NASA ADS

First-Author

- Christopher Cain, Anson D'Aloisio, et. al., "Introducing *SAGUARO* - SimulAting IGM EvolUtion and Environments At High ResOLution: Simulation Setup and First Results", in prep.
- Christopher Cain, Alexander V. Engelen, et. al., "The CMB optical depth constrains the duration of reionization", submitted to ApJL, pending review.
- Christopher Cain, Matthew McQuinn, et. al., "Kiloparsec-scale turbulence driven by reionization may grow intergalactic magnetic fields", submitted to PRL, pending review.
- Christopher Cain, Anson D'Aloisio, et. al., "New constraints on the galactic ionizing efficiency and escape fraction at $2.5 < z < 6$ based on quasar absorption spectra", submitted to PASA, favorable review received
- Christopher Cain, "Towards an accurate treatment of the reduced speed of light approximation in parameterized radiative transfer simulations of reionization", *Journal of Cosmology and Astroparticle Physics*, vol. 2024, no. 12, Dec. 2024
- Christopher Cain, Garrett Lopez, et. al., "Chasing the beginning of reionization in the JWST era", *The Astrophysical Journal*, vol. 980, no. 1, pp. 83, Feb 2025.
- Christopher Cain & Anson D'Aloisio, "FlexRT - A fast and flexible cosmological radiative transfer code for reionization studies I: Code validation", *Journal of Cosmology and Astroparticle Physics*, vol. 2024, no. 12, Dec. 2024
- Christopher Cain, Evan Scannapieco, et. al., "The hydrodynamic response of small-scale structure to reionization drives large IGM temperature fluctuations that persist to $z = 4$ ", *Monthly Notices of the Royal Astronomical Society Letters*, vol. 533, no. 1, pp. L100, Sept. 2024
- Christopher Cain, Anson D'Aloisio, et. al., "On the rise and fall of galactic ionizing output at the end of reionization", *Monthly Notices of the Royal Astronomical Society*, vol. 531, no. 1, pp. 1951, Jun 2024
- Christopher Cain, Anson D'Aloisio, et. al., "The Morphology of Reionization in a Dynamically Clumpy Universe", *Monthly Notices of the Royal Astronomical Society*, vol. 522, no. 2, pp. 2047, Jun 2023
- Christopher Cain, Anson D'Aloisio, et. al., "Small-scale clumping of dark matter and the mean free path of ionizing photons at $z = 6$ ", *Journal of Cosmology and Astroparticle Physics*, vol. 2023, no. 1, Jan. 2023

- Christopher Cain, Anson D'Aloisio, et. al., "A Short Mean Free Path at $z = 6$ Favors Late and Rapid Reionization by Faint Galaxies", *The Astrophysical Journal Letters*, vol. 917, no. 2, pp. 37, Aug 2021.
- Christopher Cain, Anson D'Aloisio, et. al., "A Model-Insensitive Baryon Acoustic Oscillation Feature in the 21 cm Signal from reionization", *The Astrophysical Journal*, vol. 898, no. 2, pp. 168, Aug 2020.
- * Christopher Cain, E. Baron, et al., "Investigating the Unusual Spectroscopic Time-Evolution in SN 2012fr," *The Astrophysical Journal*, vol. 869, no. 2, pp. 162, Dec 2018.

Student Papers

- Aloha Das, Christopher Cain, et. al., "Dynamics of the halo-opacity connection during reionization", in prep.
- Alexandra Nelander, Christopher Cain, et. al., "Can high-redshift AGN observed by JWST explain the EDGES absorption signal?", in prep.
- Joshua Cohon, Christopher Cain, et. al., " $\text{Ly}\alpha$ emission in JADES-GS-z13-1-LA at $z = 13$: a signpost of early reionization?", in prep.
- Joshua Roth, Anson D'Aloisio, Christopher Cain, et. al., "The effect of reionization on direct measurements of the mean free path", *Monthly Notices of the Royal Astronomical Society*, vol. 530, no. 4, pp. 5209, Jun 2024

Co-Author

- Garrett Lopez, ..., Christopher Cain, et. al., "Predicting the patchy kSZ signal in light of recent QSO absorption results", in prep.
- Yongda Zhu, ..., Christopher Cain, et. al., "Nuclear Winds Drive Large-Scale Cold Gas Outflows in Quasars during the Reionization Epoch", submitted to Nature Astronomy
- Darby Kramer, ..., Christopher Cain, et. al., "Cross-correlating the patchy screening and kinetic Sunyaev-Zel'dovich effects as a new probe of reionization", submitted to ApJ, in review
- Nakul Gangolli, ..., Christopher Cain, et. al., "The correlation between galaxy density and $\text{Ly}\alpha$ forest transmission in late reionization models", *Journal of Cosmology and Astroparticle Physics*, vol. 2025, no. 3, pp. 69, Mar. 2025
- Bayu Wilson, ..., Christopher Cain, et. al., "Imaging reionization's last phases with I-front Lyman- α emissions", *Journal of Cosmology and Astroparticle Physics*, vol. 2025, no. 1, pp. 66, Jan. 2025
- Yongda Zhu, ..., Christopher Cain, et. al., "Discovery of a Unique Close Quasar-DSFG Pair Linked by a [C II] Bridge at $z = 5.63$ ", *Research Notes of the American Astronomical Society*, vol. 8, no. 11, pp. 284, Nov. 2024
- Bayu Wilson, ..., Christopher Cain, et. al., "Quantifying Lyman- α emissions from reionization fronts", *Journal of Cosmology and Astroparticle Physics*, vol. 2025, no. 1, pp. 65, Jan. 2025
- Yongda Zhu, ..., Christopher Cain, et. al., "Damping Wing-Like Features in the Stacked $\text{Ly}\alpha$ Forest: Potential Neutral Hydrogen Islands at $z < 6$ ", *Monthly Notices of the Royal Astronomical Society Letters*, vol. 533, no. 1, pp. L49, Sept. 2024
- Geoff G. Murphy, ..., Christopher Cain, et. al., "Bayesian estimation of cross-coupling and reflection systematics in 21cm array visibility data", *Monthly Notices of the Royal Astronomical Society*, vol. 534, no. 3, pp. 2653, Nov. 2024
- Piyanat Kittiwisit, ..., Christopher Cain, et. al., "matvis: A matrix-based visibility simulator for fast forward modelling of many-element 21 cm arrays", *RAS Techniques and Instruments*, vol. 4, pp. rzaf001, Jan. 2025
- Yongda Zhu, ..., Christopher Cain, et. al., "Probing Ultra-late Reionization: Direct Measurements of the Mean Free Path over $5 < z < 6$ ", *The Astrophysical Journal*, vol. 955, no. 2, pp. 161, Aug 2023.

* Completed as an undergraduate.

- Fahad Nasir, Christopher Cain, et. al., “Hydrodynamic Response of the Intergalactic Medium to Reionization II: Physical Characteristics and Dynamics of Ionizing Photon Sinks”, *The Astrophysical Journal*, vol. 923, no. 2, pp. 161, Dec 2021.
- Anson D’Aloisio, ..., Christopher Cain, et. al., “Hydrodynamic Response of the Intergalactic Medium to Reionization”, *The Astrophysical Journal*, vol. 898, no. 2, pp. 149, Aug 2020.
- * Carlos Contreras, ..., Christopher Cain et. al., “SN 2012fr: Ultraviolet, Optical, and Near-Infrared Light Curves of a Type Ia Supernova Observed Within a Day of Explosion,” *The Astrophysical Journal*, vol. 859, no. 1, pp. 1–24, May 2018.

TALKS

- “Measuring the average escape fraction with high- z quasar data + HST/JWST”, lightning talk at Cosmic Frontier Center conference at UT Austin May 2025
- “The effect of reionization on small-scale structure in the intergalactic medium”, invited talk at IGM-Galaxy workshop in Trieste, Italy May 2025
- “Revealing the physics of reionization with high-redshift quasars, JWST observations, & simulations of the IGM”, DUSC Seminar at the University of Washington Apr 2025
- “Chasing the beginning of reionization in the JWST era”, contributed talk at 40th IAP Symposium, Paris, France Dec 2024
- “A tale of three histories: distinguishing reionization scenarios in the JWST Era”, lightning talk at Kalvi Institute, UC Santa Barbara. Aug 2024
- “A tale of three histories: distinguishing reionization scenarios in the JWST Era”, talk at *Cosmic Dawn at High Latitudes Conference*, Stockholm, Sweden Jun 2024
- “Ending Reionization Gracefully: Properties of the ionizing photon sources at the end of reionization”, talk at *Reionisation in the Summer Conference*, Heidelberg, Germany Jun 2023
- “Modeling Reionization from Small to Large Scales”, Lunch talk at UCLA Apr 2023
- “Small-scale clumping of dark matter and the mean free path of ionizing photons at $z = 6$ ”, talk at UCLA Dark Matter 2023 conference Mar 2023
- “Modeling Reionization from Small to Large Scales”, Lunch talk at UC Santa Cruz Mar 2023
- “Modeling Reionization from Small to Large Scales”, Lunch talk at UC Santa Barbara Mar 2023
- Lightning talk at *Reionization on a Blackboard Workshop* at Flatiron Institute, NYC Sep 2022
- “The optically thick IGM at $z \geq 6$: Improved modeling techniques and implications for observations”, talk at *Reionization and Cosmic Dawn: Looking Forward to the Past* at UC Berkeley, CA Mar 2022
- “A short mean free path at $z = 6$: implications for reionization”, Live online talk at *SAZERAC Reionization Conference* Jun 2021
- “A Model-Insensitive Baryon Acoustic Oscillation Feature in the 21 cm Signal from reionization,” Recorded talk at *SAZERAC Reionization Conference* Jun 2020
- * “Analysis of Unusual Si II Features of SN2012fr Using SYNOW and W7,” Talk at *Carnegie Supernova Project Fall Meeting*, Pasadena, California, USA Oct 2017.

PROPOSALS & ALLOCATIONS

- NSF ACCESS Accelerate Compute Allocation (PHY240332, PI)
An accurate parameter study of reionization to constrain the ionizing properties of the first galaxies
• ≈ 2.5 million CPU hours + 450 TB storage Jan 2025-Present
- NSF ACCESS Accelerate Compute Allocation (PHY230158, PI)
A comprehensive treatment of the intergalactic ionizing opacity for studies of reionization
• ≈ 3 million CPU hours + 400 TB storage, est. value \$92,720 Oct 2023-Dec 2024
- NSF ACCESS Explore Compute Allocation (PHY230063, PI)
Accurate simulations of reionization for studies of the Lyman alpha forest and other high-redshift observables
• $\approx 400K$ CPU hours May 2023-May 2024
- George Becker, ...Christopher Cain, et. al., “The Mean Free Path at $z = 5.6$: Insights into How Reionization Ends”, ESI proposal 2024A U281 Sep 2023

	<ul style="list-style-type: none"> Yongda Zhu, ...Christopher Cain, et. al., “The Mean Free Path of Ionizing Photons at $z = 5.6$: A Robust Constraint on Reionization”, ALMA proposal 2022.1.00662.S Apr 2022 George Becker, ...Christopher Cain, et. al., “The Mean Free Path at $z = 5.6$: Insights into Ultra-Late Reionization”, Keck proposal 2021A_U039 Mar 2020
SELECTED AWARDS, SCHOLARSHIPS & FELLOWSHIPS	<ul style="list-style-type: none"> Beus Prize Postdoctoral Fellowship Beus Center for Cosmic Foundations School of Earth & Space Exploration, Arizona State University Jun 2023 Robert T. Poe Memorial Scholarship for Outstanding PhD Graduate Dept. of Physics and Astronomy, University of California Riverside Jun 2023 Beus Prize Postdoctoral Fellowship, School of Earth & Space Exploration, Arizona State University Feb 2023 Senior Graduate Student of the Year Award, Dept. of Physics and Astronomy, University of California Riverside Jun 2022 Junior Graduate Student of the Year Award, Dept. of Physics and Astronomy, University of California Riverside Jun 2020 1st Year Graduate Student of the Year Award, Dept. of Physics and Astronomy, University of California Riverside Jun 2019 Provost Research Fellowship, University of California Riverside Apr 2018
COMMUNITY & PROFESSIONAL SERVICE	<p>Academic Journals</p> <ul style="list-style-type: none"> Referee for <i>The Astrophysical Journal</i>, <i>Monthly Notices of the Royal Astronomical Society</i>, <i>Journal of Astropartical Physics & Cosmology</i> <ul style="list-style-type: none"> Papers refereed: 12 <p>Computational Resources</p> <ul style="list-style-type: none"> Reviewer for computer time proposals for the DiRAC Resource Allocation Committee. <p>Committees</p> <ul style="list-style-type: none"> ASU School of Earth & Space Exploration Internal Research Symposium Jun 2024 – Aug 2024 Beus Center for Cosmic Foundations Seminar Series Sep 2023 – Present <p>Outreach</p> <ul style="list-style-type: none"> Contributor to <i>Astronomy Magazine</i> (https://www.astronomy.com) Student Volunteer, <i>Dept. of Mathematics and Physics</i>, Azusa Pacific University Jan 2015 – Dec 2017 <ul style="list-style-type: none"> Assisted various department activities and community outreach programs.
STUDENTS ADVISED	<ul style="list-style-type: none"> Joshua Cohon Oct 2024 – Present <ul style="list-style-type: none"> ASU undergraduate researcher in his freshman year. His project addresses the implications of a recent detection of a $\text{Ly}\alpha$ emitting galaxy by JWST at $z = 13$. Alexandra Nelander Jun 2024 – Present <ul style="list-style-type: none"> ASU undergraduate researcher working on her senior thesis. Her project is about the relationship between high-redshift AGN and the EDGES cosmological 21 cm detection. Esteban Moreno Oct 2023 – Present <ul style="list-style-type: none"> ASU undergraduate researcher. He is studying the $\text{Ly}\alpha$ transmission properties of the intergalactic medium during reionization. Aloha Das Sep 2023 – Present <ul style="list-style-type: none"> ASU Undergraduate researcher. He is studying the relationship between ionizing photon absorbers and dark matter halos during reionization. Joshua Roth Jun 2022 – Jul 2023 <ul style="list-style-type: none"> UCR Undergraduate researcher. He presented results in January 2023 at AAS and is published a first-author paper in June, 2024 and was accepted to Princeton for grad school. Andrew Caruso Jan 2023 – Jun 2023 <ul style="list-style-type: none"> UCR undergraduate who completed his senior thesis at the end of Spring 2024 under my supervision. Sanya Dharmi Jun 2021 – Mar 2022 <ul style="list-style-type: none"> UCR Undergraduate researcher during the summer and academic year. She contributed significantly to and was co-author on my paper “Small-scale clumping of dark matter and the mean free path of ionizing photons at $z = 6$”.
TEACHING EXPERIENCE	<p>University of California, Riverside, Riverside, California, USA</p> <ul style="list-style-type: none"> Teacher’s Assistant, Department of Physics and Astronomy Sep 2019 – Jun 2020 <ul style="list-style-type: none"> Courses Taught: PHYS 2LA, 2LB, 2LC (undergraduate physics labs) <p>Azusa Pacific University, Azusa, California, USA</p>

- Tutor, Dept. of Mathematics and Physics Sep 2015 – Dec 2017
- Teacher's Assistant, Dept. of Mathematics and Physics Jan 2016 – Dec 2017
 - Courses taught: PHYS 151 (Introductory Physics), MATH 280 (Discrete Math & Proof)

Other

- Private Math & Physics Tutor
 - Over 1200 hours of private tutoring experience logged independently and on platforms such as Wyzant and Chegg.

SKILLS

C/C++, Fortran, Python, Bash Script, MATLAB, Mathematica, R, Java, L^AT_EX, Microsoft Office, LibreOffice, Linux, Windows

ORIGINAL SOFTWARE

3D Cosmological Radiative Transfer Code (C++)
1D Radiative Transfer & Hydrodynamics Code (C++)

REFERENCES

Prof. Anson D'Aloisio (Ph.D. Advisor)

Associate Professor of Physics & Astronomy
University of California, Riverside
900 University Ave, Riverside, CA 92521
ansond@ucr.edu • (951) 827-4940

Prof. Rogier Windhorst

Regents' Professor, School of Earth & Space
Exploration
Arizona State University
1151 S Forest Ave, Tempe, AZ
Marisol.J.Diaz@asu.edu • (480)-965-7143

Prof. Judd Bowman

Professor, School of Earth & Space Exploration
Arizona State University
1151 S Forest Ave, Tempe, AZ
judd.bowman@asu.edu • (480)-965-8880

Prof. George Becker

Associate Professor of Physics & Astronomy
University of California, Riverside
900 University Ave, Riverside, CA 92521
georgeb@ucr.edu • (951) 827-5268

Prof. Matthew McQuinn

Associate Professor of Physics & Astronomy
University of Washington
University 1900 Commerce St., Seattle, WA 98195
mcquinn@uw.edu