

Dr. Kirk Stuart Simeon Barrow

Email: kbarrow@illinois.edu
Website: www.kirkbarrow.com

Expertise: computational astrophysics, radiative transfer, orbital mechanics, optimization, galaxy formation, mathematical and statistical modeling, instruction, atmospheric flight, unmanned aerial vehicle design

Citizenship: United States of America

CURRENT POSITIONS

Assistant Professor **2022-present**
Astronomy Department
University of Illinois at Urbana-Champaign

Affiliate Professor **2023-present**
Center for East Asian and Pacific Studies
University of Illinois at Urbana-Champaign

EDUCATION

Ph.D, Physics, Astrophysics Specialization **2013-2018**
Georgia Institute of Technology

M.S., Aerospace Engineering, Orbital Mechanics Specialization **2014-2016**
Georgia Institute of Technology

B.S., Aerospace Engineering, Space Specialization **2004-2009**
Georgia Institute of Technology

GRANTS, FELLOWSHIPS, AND AWARDS

2023 Illinois Space Grant REU Grant (Co-I)
2021 – 2024 NASA Hubble Fellowship at Center for Astrophysics | Harvard & Smithsonian
2021 University of Tokyo IPMU Visiting Research Fellowship
2019 – 2023 PI: XSEDE XRAC Research Allocation TG-AST190001 (Renewed 2020,2021,2022)
2019 Co-Organizer: KIPAC Workshop-Hosting Grant
2018 – 2019 PI: XSEDE Computing Startup Allocation TG-AST180052
2018 – 2021 Stanford University Porat Postdoctoral Fellowship
2018 Lavender Diploma for Academics and Contributions to the LGBTQIA Community
2018 Georgia Tech School of Physics Amelio Award for Research Excellence
2017 NASA Jet Propulsion Laboratory Year-Round Graduate Internship
2016, 2017 School of Physics Conference Travel Grant
2014 XSEDE Conference Grant
2013 – 2016 Southern Regional Education Board 3-Year Doctoral Fellowship

Certifications Earned or in Progress

- Stanford Postdoctoral Teaching Certificate (February 2021)
- Japanese Language Proficiency Test N2 (est. 2023)

REFEREED JOURNAL PUBLICATIONS

- 1) **Barrow, K. S. S.**, Robertson, B. E., Ellis, R. E., Nakajima, K. Saxena, A., Stark, D. P., Tang, M. (10/2020) *The Lyman Continuum Escape Survey: Connecting Time-Dependent [O III] and [O II] Line Emission with Lyman Continuum Escape Fraction in Simulations of Galaxy Formation*, The Astrophysical Journal Letters, 902 L39
- 2) Aykutalp, A, **Barrow, K. S. S.**, Wise, J. H., Johnson, J (7/2020) *Induced Metal-free Star Formation around a Massive Black Hole Seed*, The Astrophysical Journal Letters, 898 L53
- 3) **Barrow, K. S. S.** (11/2019) *Blue Galaxies: Modeling Nebular H α Emission in High Redshift Galaxies*, Monthly Notices of the Royal Astronomical Society, 491 (3): 4509-4522
- 4) **Barrow, K. S. S.**, Aykutalp, A, Wise, J. H. (9/2018) *Observational signatures of massive black hole formation in the early universe*, Nature Astronomy, 10.1038/s41550-018-0569-y
- 5) **Barrow, K. S. S.**, Wise, J. H., Aykutalp, A., O'Shea, B. W., Norman, M. L., Xu, H. (2/2018) *First Light II: Emission Line Extinction, Population III Stars, and X-ray Binaries*, Monthly Notices of the Royal Astronomical Society, 474 (2): 2614-2634
- 6) **Barrow, K. S. S.**, Wise, J. H., Norman, M. L., O'Shea, B. W., Xu, H. (8/2017) *First Light: Exploring the Spectra of High-Redshift Galaxies in the Renaissance Simulations*, Monthly Notices of the Royal Astronomical Society, 469 (4): 4863-4878
- 7) Barrow, J., Smalt, S., Brock, S., **Barrow, K. S. S.** (1/2009) *Learning Styles: Effective Tool for Deploying Finance Personnel in Changing Times*. Romanian Society for Quality Assurance, 10(104,2009),91-109

CONFERENCE PAPERS

- 8) **Barrow, K. S. S.**, Holzinger, M. J. (2/2017) *Recursive Multi-Objective Optimization of Mars-Earth-Venus Trajectories*, AIAA/AAS, 27th AAS/AIAA Space Flight Mechanics Meeting

SUBMITTED JOURNAL ARTICLES

- 9) **Lillian Santos-Olmsted, Kirk Barrow**, Tilman Hartwig (1/2023) *The Galaxy Assembly and Interaction Neural Networks (GAINN) for high-redshift JWST observations (submitted, The Astrophysical Journal)*
- 10) Tiger Yu-Yang Hsiao, Dan Coe, Abdurro'uf, Lily Whitler, Intae Jung, Gourav Khullar, Ashish Kumar Meena, Pratika Dayal, **Kirk S. S. Barrow, Lillian Santos-Olmsted, Adam Casselman**, Eros Vanzella, Mario Nonino, Yolanda Jimenez-Teja, Masamune Oguri, Daniel P. Stark, Lukas J. Furtak, Adi Zitrin, Angela Adamo, Gabriel Brammer, Larry Bradley, Jose M. Diego, Erik Zackrisson, Steven L. Finkelstein, Rogier A. Windhorst, Rachana Bhatawdekar, Taylor A. Hutchison, Tom Broadhurst, Paola Dimauro, Felipe Andrade-Santos, Jan J. Eldridge, Ana Acebron, Roberto J. Avila, Matthew B. Bayliss, Alex Benitez, Christian Binggeli, Patricia Bolan, Marusa Bradac, Adam C. Carnall, Christopher J. Conselice, Megan Donahue, Brenda Frye, Seiji Fujimoto, Alaina Henry, Bethan L. James, Susan Kassin, Lisa Kewley, Rebecca L. Larson, Tod Lauer, David Law, Guillaume Mahler, Ramesh Mainali, Stephan McCandliss, David Nicholls, Norbert Pirzkal, Marc Postman, Jane R. Rigby, Russell Ryan, Peter Senchyna, Keren Sharon, Ikko Shimizu, Victoria Strait, Mengtao Tang, Michele Trenti, Anton Vikaeus, Brian Welch, (11/2022) *JWST reveals a possible $z \sim 11$ galaxy merger in triply-lensed MACS0647-JD (accepted, Astrophysical Journal Letters)*

RESEARCH EXPERIENCE

Post-Graduate

NASA Hubble Postdoctoral Fellow

Harvard University | Smithsonian Center for Astrophysics
Harvard University

Fall 2021 – Summer 2022

- Developed a radiative transfer algorithm for particle-based mesh codes

Visiting Researcher and Professor

Kavli Institute for the Physics and Mathematics of the Universe
University of Tokyo

Summer and Fall 2021

- Investigated the time domain evolution of metallicity in merging galaxies
- Created observational calibration for detecting metallicity from cosmological simulations
- Developed JWST diagnostics for high redshift galaxies using machine learning

Porat Postdoctoral Fellow

Kavli Institute for Particle Astrophysics and Cosmology,
Stanford University and SLAC National Accelerator Laboratory

Fall 2018 – Fall 2021

- Developed advanced emission line radiative transfer and synthetic observation tools
- Studied high-cadence simulation outputs to determine the evolution of optical lines
- Reproduced observed relationships in observed galaxies with bespoke simulations

Graduate

NASA Graduate Internship – Research in Space Mission Design, Jet Propulsion Laboratory

May 2017 – July 2017

Mentor: Nathan Strange

- Developed trajectory tools for gravity assist leveraging
- Contributed code to an orbit optimizing software in development (Frost)
- Optimized a low-thrust tour from Titan to Enceladus (Malto)
- Found trajectories that reduced fuel cost by 80% to Enceladus compared to direct insertion

Aerospace Engineering – Research in Trajectory Optimization, Georgia Institute of Technology

January 2016 – May 2017

Mentor: Marcus Holzinger

- Developed a theoretical framework and algorithm to optimize Earth-Mars-Venus cycler trajectories on supercomputers
- Found new classes of trajectories that reduce round-trip times between Earth and Mars

Astrophysics – Research in Computational Cosmology, Georgia Institute of Technology

August 2013 – May 2018

Mentor: John Wise

- Developed a computational model to generate observables from simulated astrophysical data on the early Universe
- Found relationships between emission lines and bursts of star formation
- Found trends in the spectra and images of galaxies in the early universe
- Found identifying observational characteristics for the first generation of stars
- Found identifying observational characteristics for the formation of large black holes

Undergraduate

Astrophysics – Research in Computational Cosmology, Georgia Institute of Technology
August 2012 – August 2013

Mentor: John Wise

- Analyzed the rates of photo evaporation in cosmological simulations
- Developed a merger tree algorithm
- Found that large galaxies evacuate satellite halos and inhibit star formation

Aerospace Engineering – Research in Space Mission Design, Georgia Institute of Technology
January 2009 – June 2009

Mentor: David Spencer

- Developed an entry system for unmanned flight in Titan atmosphere
- Modeled and simulated entry, deployment, cruise, and landing for an extended multi-stage scientific study of Titan

Aerospace Engineering – Research in Uninhabited Aerial Vehicles, Georgia Institute of Technology
May 2008 – January 2009

Mentor: Eric Johnson

- Created a control program for use in testing of an uninhabited aerial vehicle
- Tested the control program on flight hardware

INVITED TALKS

- 1) Williams College, Williamstown, Massachusetts (5/6/2023) *The Benefits of Generalized Radiative Transfer Modelling of the ISM in the Time Domain* (**Colloquium**)
- 2) Harvard University, Cambridge, Massachusetts (4/20/2023) *The Benefits of Generalized Radiative Transfer Modelling of the ISM in the Time Domain* (**Seminar**)
- 3) University of California, Los Angeles, Los Angeles, California (3/2/2022) *High-Cadence Synthetic Observations and Neural Networks in the Era of JWST* (**Colloquium**)
- 4) Carnegie Observatories (2/1/22) *High-Cadence Synthetic Observations and Neural Networks in the Era of JWST* (**Colloquium**)
- 5) Kavli IPMU/University of Tokyo (8/19/21) *High-Cadence Synthetic Observations and Neural Networks in the Era of JWST* (**Seminar**)
- 6) Princeton University (7/27/21) *High-Cadence Synthetic Observations and Neural Networks in the Era of JWST* (**Colloquium**)
- 7) NRAO/GBO/University of Virginia (4/15/21) *Using High-Cadence Synthetic Observations to Unlock a New Era in Astrophysics* (**Colloquium**)
- 8) University of Florida (3/25/21) *Using High-Cadence Synthetic Observations to Unlock a New Era in Astrophysics* (**Colloquium**)
- 9) Johns Hopkins University (3/1/21) *Using High-Cadence Synthetic Observations to Unlock a New Era in Astrophysics* (**Seminar**)
- 10) University of Texas at Austin (2/8/2021) *Using High-Cadence Synthetic Observations to Unlock a New Era in Astrophysics* (**Astronomy Colloquium**)
- 11) Massachusetts Institute of Technology (12/7/2020) *Using High-Cadence Synthetic Observations to Unlock a New Era in Astrophysics*
- 12) University of Illinois at Urbana-Champaign (12/4/2020) *Using High-Cadence Synthetic Observations to Unlock a New Era in Astrophysics* (**Astrophysics Colloquium**)
- 13) University of Arizona (11/19/2020) *Using High-Cadence Synthetic Observations to Unlock a New Era in Astrophysics* (**Steward Observatory/NOIRLab Colloquium**)
- 14) Stanford University (8/27/2020) *Time-Dependent Trends in Radiative Transfer and Nebular Emission Lines* (**Astrophysics Colloquium**)
- 15) Harvard-Smithsonian Center for Astronomy (8/25/2020): *Time-Dependent Trends in Radiative Transfer and Nebular Emission Lines*

- 16) Harvard-Smithsonian Center for Astronomy, Cambridge, Massachusetts (11/12/2019): *Emission Line Modeling in the High-Redshift Universe* (**Seminar**)
- 17) University of California, Santa Cruz, Santa Cruz, California (12/14/2018): *Synthetic Observations of the High-Redshift Universe* (**Seminar**)
- 18) University of California, Davis, Davis, California (11/1/2018) *Caius: Synthetic Observables Using Monte Carlo Photon Simulations* (**Seminar**)
- 19) University of California, Berkeley, Berkeley, California (10/5/2018) *Synthetic Observables Using Monte Carlo Photon Simulations* (**Discussion Moderator**)
- 20) Stanford University, Stanford, California (10/9/2018) *Synthetic Observations of the High-Redshift Universe*
- 21) Los Alamos National Laboratory, Los Alamos, New Mexico (12/14/2017) *Caius: Synthetic Observables Using Monte Carlo Photon Simulations* (**Seminar**)
- 22) University of Arizona, Tucson, Arizona (11/6/2017) *Caius: Synthetic Observables Using Monte Carlo Photon Simulations* (**Seminar**)
- 23) Flatiron Institute, New York, New York (10/13/2017) *Caius: Synthetic Observables Using Monte Carlo Photon Simulations*
- 24) University of Maryland, College Park, Maryland (10/10/2017) *Caius: Synthetic Observables Using Monte Carlo Photon Simulations* (**Seminar**)
- 25) Jet Propulsion Laboratory, NASA, Pasadena, California (7/26/2017) *Astrodynamics, Astronomy, and Astrophysics* (**Seminar**)
- 26) Space Systems Design Laboratory, Georgia Institute of Technology (11/14/2016) *Multi-Objective Optimization of Mars-Earth-Venus Trajectories*
- 27) Duke TIP Program, Georgia Institute of Technology (7/13/15) *Gravity* (**Guest Lecture**)
- 28) Center for Relativistic Astrophysics, Georgia Institute of Technology (10/8/2014) *First Light: Exploring the Spectra of Galaxies in the Early Universe*

CONFERENCE PRESENTATIONS

- 1) SAZERAC-sip: First Stars, (10/23/2020) *Unraveling Time-Dependent Trends in Star Formation Using Cosmological Simulations* (**Talk**)
- 2) 235th American Astronomical Society Meeting, Honolulu, Hawaii (1/7/2020) *Blue Galaxies: Modeling Nebular Emission Lines in the Time Domain* (**Talk**)
- 3) Frank Bash Symposium, UT Austin, Austin, Texas (10/23/2019): *Blue Galaxies: Exploring Nebular Emission in the Early Universe* (**Invited Review Talk**)
- 4) Enzo Workshop, SLAC Linear Accelerator Center, Menlo Park, California, (6/11/2019) *Photometry and emission line modeling of high-redshift stellar clusters and H II regions* (**Talk**)
- 5) Formation of Stars and Massive clusters in Dwarf Galaxies over Cosmic Time, Leiden, Netherlands (2/22/2019) *Photometry and emission line modeling of high-redshift stellar clusters and H II regions* (**Invited Talk**)
- 6) Extremely Big Eyes on the Early Universe, Los Angeles, California (1/28/2019) *Synthetic Observations of the High-Redshift Universe* (**Talk**)
- 7) Stellar Archaeology as a Time Machine to the First Stars, Kashiwa, Japan (12/4/2018) *Synthetic Observations of the High-Redshift Universe* (**Talk**)
- 8) 2018 National Society of Black Physicists Conference, Columbus, Ohio, (11/5/2018) *Synthetic Observations of the High-Redshift Universe* (**Invited Talk**)
- 9) 231st American Astronomical Society Meeting, Washington, DC (1/11/2018) *Caius: Synthetic Observables Using Monte Carlo Photon Simulations* (**Dissertation Talk**)
- 10) Spectral Diagnostics to Explore the Cosmic Dawn with JWST, STScI, Baltimore, Maryland (8/1/2017) *First Light: Exploring the Spectra of Galaxies in the Early Universe* (**Talk**)
- 11) 27th AAS/AIAA Space Flight Mechanics Meeting, San Antonio, Texas (2/5/2017) *Multi-Objective Optimization of Mars-Earth-Venus Trajectories* (**Talk, Conference Paper**)
- 12) Exploring the Universe with JWST II Conference, Montreal, Canada (10/27/2016) *First Light: Exploring the Spectra of Galaxies in the Early Universe* (**Talk**)
- 13) 32nd Annual Institut d'Astrophysique de Paris Conference, Paris, France (6/19/2016) *First Light:*

- Exploring the Spectra of Galaxies in the Early Universe (Poster, Poster Talk)*
14) 224th American Astronomical Society Meeting, Seattle, Washington (1/5/2015) *First Light: Exploring the Spectra of Galaxies in the Early Universe (Poster)*

MENTORSHIP

Thinh Nguyen

Graduate Student, University of Illinois at Urbana-Champaign

Fall 2022 - present

- **Primary Ph.d Advisor**
- Investigating the interaction between galaxy mergers molecular hydrogen self-shielding, and reionization in detailed radiative-hydrodynamic simulations.
- Investigating major mergers as part of the AGORA simulation code comparison collaboration.

Zhongxing (Harry) Hu

Undergraduate, University of Illinois at Urbana-Champaign

Fall 2022 - Spring 2023

- Investigating the assembly, merger, and accretion of small seed black holes in cosmological simulations.
- Presented finding in a poster at the UIUC Astrofest

Adam Casselman

Undergraduate, University of Illinois at Urbana-Champaign

Fall 2022

- Investigating the interaction between galaxy mergers and nebular emission lines in galaxy simulations of the early Universe.
- Contributed to a JWST observation paper on merging galaxies.

Rithika Baskar

Undergraduate, University of Illinois at Urbana-Champaign

Winter 2022 – Spring 2022

- Investigating the effect of mergers on galaxy and star formation

Bryen Irving

Graduate Student, Stanford University

Spring 2020 – Fall 2021

- Secondary mentor along with Tom Abel and Roger Blandford. Developing models for massive black hole formation and evolution.

Lillian Santos-Olmsted

Undergraduate, University of California, Santa Cruz

Graduate Student, Stanford University

Spring 2020 – present

- Primary mentor. Student selected from a competitive, funded quarter-long Cal-Bridge Summer Research Program (CAMPARE). Developing diagnostic tools for observers from simulation synthetic observations.
- Submitted research findings in a paper in January 2022

Luz Ángela García Peñaloza

Postdoctoral Scholar, Universidad ECCI, Columbia

Winter 2020 – Summer 2020

- Host and research mentor for Luz Ángela García Peñaloza as part of the KIPAC Program for Astrophysics Visitor Exchange at Stanford (PAVES)

Other Mentorship Activities

- 2020-2021: Lead and organized weekly research group meetings with mentees
- 2018: American Physics Society Bridge Program and National Mentoring Community Conference panelist
- 2016-2017: Mentor and organizer for the Graduate Association of Physicists, Georgia Tech
- 2008-2018: Mentoring and tutoring of high school and undergraduate students

ENGAGEMENT, SERVICE, AND LEADERSHIP

Current Committees

- 2023: REU Committee
- 2023: Lecturer Search Committee
- 2023: Astronomy Graduate Application Committee
- 2022-2023: DEI Committee

Prior Service

- 2019-2020: Stanford KIPAC Cosmology Seminar committee member and speaker host
- 2019: SLAC Users Organization Congressional DC physics advocacy trip attendee, meetings with the office of 12 US Senators and Representatives
- 2018-2019: Co-organized the first interdisciplinary Space Sciences at Stanford conference
- 2018: Represented Stanford University at the National Society of Black Physicists Conference
- 2017-2018: Nominated to College of Sciences Graduate Student Diversity Council, Georgia Tech
- 2017: Represented Georgia Tech at the National Society of Black Physicists Conference
- 2015-2016: Led a startup competition group to build an automated solar energy pricing and permitting computer application
- 2007-2008: Primary and General Election Presidential Campaign Volunteer; organized a chapter within the Georgia Tech community. Created community outreach initiatives at community centers, churches, and with local businesses.
- 2006-2008: President, Georgia Tech Airsoft Club; built and organized membership from inactivity to an intercollegiate competitive level

Application, Proposal, and Journal Reviews

- NASA Astrophysics Theory Program
- NASA FINESST Graduate Student Fellowship
- NASA ADSPS Early Science Grant Program
- National Science Foundation Theory Grant Program
- Monthly Notices of the Royal Astronomical Society
- AAS Astrophysical Journal
- Stanford physics undergraduate summer research program

TEACHING EXPERIENCE

Professor, University of Illinois at Urbana Champaign

Spring 2023

- Graduate Physical Cosmology (ASTR 507) – Original lectures, assignments, projects, and sole class management of a highly specialized Ph.d course in cosmology

Lecturer, University of Illinois at Urbana Champaign

Fall Semester 2021, 2022

- Seminar in Astronomy (ASTR 496 RI) – Undergraduate and graduate student introduction to research hosting a cross section of the faculty

Guest Lecturer, University of Tokyo

Fall Semester 2021

- Graduate Machine Learning and Astronomy – Original lectures, class activities, projects and homework assignments
- Prepared content for a hybrid class format suited to overcoming language barriers

Lead Instructor, Stanford University

Summer Quarter 2020

- The Origin and Development of the Cosmos (Physics 16) – Lead a course of 52 students, planned syllabus, created course content (lectures, activities, assignments, exams, projects), coordinated with a co-instructor and two teaching assistants
- Managed migration of the course to online teaching with a heavy emphasis on active learning

Guest Lecturer, Stanford University

Winter Quarter 2020

- Graduate Modern Astrophysics (Physics 360) – Original lectures and assignments on star cluster physics and HII regions

Stanford Postdoctoral Teaching Certificate, Stanford University

May 2019 – February 2021

- 70 hours of pedagogy/andragogy and curriculum design course work and journal clubs
- A minimum of 5 hours of in-class original course material taught with teacher assessments

Physics Graduate Teaching Assistant, Georgia Institute of Technology

August 2013 – December 2014, May 2015 – August 2016

- Electricity and Magnetism (Physics II) - Taught 3-5 lecture-style recitation sections per week per semester, proctored, and graded exams and assignments
- Mechanics (Physics I) – Created online homework assignments for a MOOC
- Fundamentals of Astrophysics (Physics 4347) - Held office hours, graded exams and assignments

Professional Tutoring, Tech Tutors, ClubZ! Atlanta Tutors, In-Home Tutors, Atlanta and privately

November 2008 – September 2013, September 2016 – present

- Worked for tutoring agencies focused on enhancing individual math and science skills at the grade school and college level
- Tutored over three hundred students for thousands of hours
- Developed an intuitive knowledge of multiple disciplines and sciences

Education Research, Kennesaw State University

June 2009 – July 2009

- Analyzed statistical performance data in conjunction with learning tests to determine correlations for use in executive MBA applications, documented methods and findings

SKILLS

Creator

- CAIUS Radiative Transfer Pipeline

Highly Proficient

- Applied mathematical modeling of dynamic physical systems
- Enzo, yt, Hyperion, Cloudy, Malto
- Python, Linux, Mathematica, MATLAB, Cluster Computing
- Microsoft Office, LaTeX

Experienced

- Neural Networks
- Statistical modeling
- CAD, Solid Edge
- C++, FORTRAN, Julia
- Orbit optimization tool development