Dr. Kirk Stuart Simeon Barrow

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

Citizenship: United States of America

Career Goal: Professor, Research Scientist, Engineer

CURRENT POSITION

Porat Postdoctoral Fellow **2018-present**
Kavli Institute for Particle Astrophysics and Cosmology,
Stanford University and SLAC National Accelerator Laboratory

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

2019 – 2021 **PI: XSEDE XRAC Research Allocation TG-AST190001 (Renewed 2020)**
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**

Grants Under Review

- Brant Robertson, **Kirk Barrow**, Mengtao Tang, Richard Ellis & Aayush Saxena, "*Understanding How Ionizing Photons Escape from Early Star-Forming Galaxies"* Keck, MOSFIRE
- Wilkins et al., "*Wide Area First Light Survey"* James Webb Space Telescope

Certifications in Progress

- Stanford Postdoctoral Teaching Certificate (est. February 2021)
- Japanese Language Proficiency Test N3 ~~(est. December 2020)~~ (TBD: US Testing Postponed)

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 HeII 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

RESEARCH EXPERIENCE

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 2014 – 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

Astrophysics – Research in Computational Cosmology, Georgia Institute of Technology
August 2012 – August 2014
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

Undergraduate

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) Massachusetts Institute of Technology (12/7/2020) *Using High-Cadence Synthetic Observations to Unlock a New Era in Astrophysics*
2) University of Illinois at Urbana-Champaign, Champaign, Illinois (12/4/2020) *Using High-Cadence Synthetic Observations to Unlock a New Era in Astrophysics* **(Astrophysics Colloquium)**
3) University of Arizona, Tucson, Arizona (11/19/2020) *Using High-Cadence Synthetic Observations to Unlock a New Era in Astrophysics* **(Steward Observatory/NOIRLab Colloquium)**
4) Stanford University, Stanford, California (8/27/2020) *Time-Dependent Trends in Radiative Transfer and Nebular Emission Lines* **(Astrophysics Colloquium)**
5) Harvard-Smithsonian Center for Astronomy, Cambridge, Massachusetts (8/25/2020): *Time-Dependent Trends in Radiative Transfer and Nebular Emission Lines*
6) Harvard-Smithsonian Center for Astronomy, Cambridge, Massachusetts (11/12/2019): *Emission Line Modeling in the High-Redshift Universe* (**Seminar**)
7) University of California, Santa Cruz, Santa Cruz, California (12/14/2018): *Synthetic Observations of the High-Redshift Universe* (**Seminar**)
8) University of California, Davis, Davis, California (11/1/2018) *Caius: Synthetic Observables Using Monte Carlo Photon Simulations* (**Seminar**)
9) University of California, Berkeley, Berkeley, California (10/5/2019) *Synthetic Observables Using Monte Carlo Photon Simulations* (**Discussion Moderator**)
10) Stanford University, Stanford, California (10/9/2018) *Synthetic Observations of the High-Redshift Universe*
11) Los Alamos National Laboratory, Los Alamos, New Mexico (12/14/2017) *Caius: Synthetic Observables Using Monte Carlo Photon Simulations* (**Seminar**)
12) University of Arizona, Tucson, Arizona (11/6/2017) *Caius: Synthetic Observables Using Monte Carlo Photon Simulations* (**Seminar**)
13) Flatiron Institute, New York, New York (10/13/2017) *Caius: Synthetic Observables Using Monte Carlo Photon Simulations*
14) University of Maryland, College Park, Maryland (10/10/2017) *Caius: Synthetic Observables Using Monte Carlo Photon Simulations* (**Seminar**)
15) Jet Propulsion Laboratory, NASA, Pasadena, California (7/26/2017) *Astrodynamics, Astronomy, and Astrophysics* (**Seminar**)

16) Space Systems Design Laboratory, Georgia Institute of Technology (11/14/2016) *Multi-Objective Optimization of Mars-Earth-Venus Trajectories*
17) Duke TIP Program, Georgia Institute of Technology (7/13/15) *Gravity* (**Guest Lecture**)
18) 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, online, (10/23/2020) *Unraveling Time-Dependent Trends in Star Formation Using Cosmological Simulations* (**Talk**)
2) 235st 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

Bryen Irving, Graduate Student, Stanford University
Spring 2020 – present

- 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
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.

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: 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

- 2019-2020: Stanford KIPAC Cosmology Seminar committee member and speaker host
- 2019: NASA Astrophysics Theory Program grant review panelist
- 2019: SLAC Users Organization Congressional DC physics advocacy trip attendee, meetings with the office of 12 US Senators and Representatives
- 2019, 2020, 2021: Stanford physics undergraduate summer research program applicant reviewer
- 2019: Proposal reviewer for the NASA FINESST graduate student fellowship
- 2018-2019: Journal peer reviewer for the Monthly Notices of the Royal Astronomical Society
- 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 initiates 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

TEACHING EXPERIENCE

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 (est.)

- 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 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

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