Curriculum Vitae

Richard Jude Anantua

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EDUCATION

2011-2016 **Stanford University,** Ph.D. Physics, Sep. 2016,
Thesis: "Towards Multiwavelength Observations of Relativistic Jets from General Relativistic Magnetohydrodynamic Simulations"
Advisor: Roger Blandford, Ph.D., Sc.D., FRS

2013-2014 **Harvard University,** Ed.M. Education Policy and Management, May 2014,
Cross-registered for courses at the Harvard-Smithsonian Center for Astrophysics and Harvard Business School

2011-2013 **Stanford University,** M.S. Physics, Jan. 2013

2006-2010 **Yale University,** B.S. (Physics and Philosophy) and (Economics and Mathematics), May 2010, Distinction in the (Physics and Philosophy) major

ACADEMIC APPOINTMENTS

UNIVERSITY OF TEXAS AT SAN ANTONIO, SAN ANTONIO, TX

Jan. 2022- **Assistant Professor, UTSA College of Sciences**

- Lead first research group in Texas focused on Event Horizon Telescope applications

HARVARD UNIVERSITY, CAMBRIDGE, MA

Jan. 2019-Dec. 2021 **Postdoctoral Fellow, Center for Astrophysics | Harvard & Smithsonian /Black Hole Initiative/Event Horizon Telescope**

- Conducted computational research at Institute for Theory & Computation
- Conducted high-energy astrophysics research in Avi Loeb Group
- Modeled jet/accretion flow/black hole emission for Event Horizon Telescope Collaboration
- Served as Outreach Working Group Coordinator for EHT

FLATIRON INSTITUTE, NEW YORK, NY

Nov. 2020-Jan. 2021 **Visiting Scholar, Center for Computational Astrophysics**

- Conducted theoretical and computational research in high-energy astrophysics and dark matter phenomenology

U.C. BERKELEY, BERKELEY, CA

Nov. 2016-Jan. 2019 **Postdoctoral Fellow, U.C. Berkeley Department of Astronomy**

- Conducted high-energy astrophysics research on near-horizon emission modeling of accretion disks and outflows in Eliot Quataert Group
- Advised and collaborated with graduate and undergraduate students

MAJOR COLLABORATIONS

- Event Horizon Telescope (2020-)
- Fermi Large Area Telescope (2014-2016)

EXPERIENCE

U.C. BERKELEY, BERKELEY, CA

Jul. 2018-Aug. 2018 **Instructor, U.C. Berkeley Department of Astronomy**

- Served as co-instructor for Astron 9 "Order of Magnitude Physics," devising original PowerPoint lectures, problem sets, projects and exams

Jul. 2017-Aug. 2017 **Instructor, U.C. Berkeley Department of Astronomy**

- Created Astron 9 "Relativity of Space and Time in Popular Science," devising original PowerPoint lectures, problem sets, projects and exams
- Served as Astron 9 Instructor of Record

STANFORD UNIVERSITY, STANFORD, CA

Sep. 2015-Dec. 2015 **Teaching Assistant, Stanford Department of Physics**

- Led discussion section, graded problem sets and worked on course design with Senior Staff Scientist Grzegorz Madejski in the graduate course Ph 216 Back of the Envelope Physics

Apr. 2013-Jun. 2013 **Teaching Assistant, Stanford Department of Physics**

- Led discussion section, graded problem sets and guest lectured for Prof. Stefan Funk in the undergraduate course Ph 17 Black Holes

Sep. 2012-Dec. 2012 **Teaching Assistant, Stanford Department of Physics**

- Led discussion section, graded problem sets and tutored students for Prof. Giorgio Gratta in the undergraduate course Ph 45 Light and Heat

Jun. 2012-Aug. 2012 **GRE Coach, Stanford Humanities and Sciences Early Identification Program**

- Served as a math GRE coach for students of diverse backgrounds
- Created all instructional material and homework

SELF-EMPLOYED, NEW YORK CITY, NY

Aug. 2010-May 2011 **Private Tutor**

- Advertised and performed tutoring services in chemistry, physics and math for middle and high school students in NYC

YALE UNIVERSITY, NEW HAVEN, CT

Sep. 2008-Apr. 2011 **Undergraduate Quantitative Reasoning Tutor**

- Tutored for Yale undergraduates in astronomy, economics, mathematics and physics courses

May 2009-Aug. 2009 **Research Associate, Jack Harris Lab**

- Modeled using Python code an optomechanical cavity that strongly couples the oscillation of an SiN membrane to cavity electric field modes via radiation pressure in order to lay groundwork for quantum non-demolition measurement of membrane ground state phonon number

Jun. 2008-Aug. 2008 **Researcher, Science, Technology and Research Scholars**

- Participated in a selective research and presentation program in which I created novel models of the graviton energy per frequency spectrum of Hawking radiating post-inflationary primordial black holes, a newly theorized source of stochastic gravitational wave background (confer Anantua et al., 2009)

GRANTS & COMPUTING ALLOCATIONS

- TACC Dell/Intel Knights Landing, Skylake System (Stampede2): 1,600.0 Node Hours (2022)
- TACC Long-term tape Archival Storage (Ranch): 2,000.0 GB (2022)

FELLOWSHIPS, AWARDS & HONORS

- Nature Astronomy Vol. 5 cover story (cf. Janssen et al., 2021) https://media.springernature.com/w440/springer-static/cover-hires/journal/41550/5/10?as=webp&q=95
- Royal Astronomical Society – 2021 Group Achievement Award (Astronomy) (Awarded to the Event Horizon Telescope Collaboration)
- Harvard Future Faculty Leaders Fellowship (2018)
- Galaxies Vol. 6 Issue 1 cover story (cf. Anantua et al., 2018) http://www.mdpi.com/2075-4434/6/1
- Diversifying Academia, Recruiting Excellence (DARE) (2014) Fellowship awarded to ~20% of Stanford doctoral applicants for this fellowship
- Achievement Rewards for College Scientists (ARCS) (2013) (I declined this award to attend Harvard)
- Harvard University Leadership in Education Award (2013), awarded to top 10-15% of Harvard Graduate School of Education applicants
- Stanford University Humanities and Sciences Fellowship (2010)
- Yale College Dean's Research Fellowship (2009)
- AP Scholar with Distinction at Stuyvesant High School (2006) (the most selective NYC Specialized High School Admission Test school (~3% admission rate for Class of '06))
- Prep for Prep Les Pierre Medal (2001), awarded to 1 top male and 1 top female in >100-member cohort at the end of 14-month preparatory component

PUBLICATIONS

29. B. Curd, R. Emami, R. Anantua, D. Palombo, S. Doeleman and R. Narayan, "Jets from SANE Super-Eddington Accretion Flows: Morphology, Spectra and Their Potential as Targets for ngEHT," [https://arxiv.org/abs/2206.06358], Submitted to MNRAS (2022)
28. A. Broderick **et al.,** "Characterizing and Mitigating Intraday Variability: Reconstructing Source Structure in Accreting Black Holes with mm-VLBI," ApJL **930,** L21 (2022)
27. B. Georgiev **et al.,** "A Uniform Power-law Prescription of Variability from Synthetic Images of Black Hole Accretion Flows," ApJL **930,** L20 (2022)
26. M. Wielgus **et al.,** "Millimeter Light Curves of Sagittarius A* Observed during the 2017 Event Horizon Telescope Campaign," ApJL **930,** L19 (2022)
25. J. Farrah **et al.,** "Selective Dynamical Imaging of Interferometric Data," ApJL **910,** L18 (2022)
24. **EHT Collaboration et al.,** "First Sagittarius A* Event Horizon Telescope Results. VI., Testing the Black Hole Metric," ApJL **930,** L17 (2022)
23. **EHT Collaboration et al.,** "First Sagittarius A* Event Horizon Telescope

Results. V., Testing Astrophysical Models of the Galactic Center Black Hole," ApJL **930,** L16 (2022)
22. **EHT Collaboration et al.,** "First Sagittarius A* Event Horizon Telescope Results. IV., Variability, Morphology and Black Hole Mass," ApJL **930,** L15 (2022)
21. **EHT Collaboration et al.,** "First Sagittarius A* Event Horizon Telescope Results. III., Imaging of the Galactic Center Supermassive Black Hole," ApJL **930,** L14 (2022)
20. **EHT Collaboration et al.,** "First Sagittarius A* Event Horizon Telescope Results. II., EHT Multiwavelength Observations, Data Processing and Calibration," ApJL **930,** L13 (2022)
19. **EHT Collaboration et al.,** "First Sagittarius A* Event Horizon Telescope Results. I., The Shadow of the Supermassive Black Hole in the Center of the Milky Way," ApJL **930,** L12 (2022)
18. K. Satapathy **et al.,** "The Variability of the Black-Hole Image in M87 at the Dynamical Time Scale," ApJ **925,** 13 (2022)
17. R. M. Emami, **R. J. Anantua,** A. A. Chael and A. Loeb, "Positron Effects on Polarized Images and Spectra from Jet and Accretion Flow Models of M87* and Sgr A*," ApJ **932,** 272 (2021)
16. M. Janssen **et al.**, "Event Horizon Telescope observations of the jet launching and collimation in Centaurus A" Nature Astronomy **5,** 1017-1028 (2021)
15. P. Kocherlakota **et al.,** "Constraints on Black-Hole Charges with the 2017 EHT Observations of M87*," PRD **103,** 104047 (2021)
14. R. Narayan **et al.,** "The Polarized Image of a Synchrotron-Emitting Ring of Gas Orbiting a Black-Hole," ApJ **912,** 35 (2021)
13. J. C. Algaba **et al.,** "Broadband Multi-Wavelength Properties of M87 During the 2017 Event Horizon Telescope Campaign," ApJL **911,** L11 (2021)
12. C. Goddi **et al.,** "Polarimetric Properties of Event Horizon Telescope Targets from ALMA," ApJL **910,** L14 (2021)
11. **EHT Collaboration et al.,** "First M87 Event Horizon Telescope Results. VIII., Magnetic Field Structure near The Event Horizon," ApJL **910,** L13 (2021)
10. **EHT Collaboration et al.,** "First M87 Event Horizon Telescope Results. VII. Polarization of the Ring," ApJL **910,** L12 (2021)
9. **R. J. Anantua,** R. M. Emami, A. Loeb and A. A. Chael, "Determining the Composition of Relativistic Jets from Polarization Maps," ApJ **896,** 30 (2020)
8. **R. J. Anantua,** S. M. Ressler and E. Quataert, "On the Comparison of AGN with GRMHD Simulations, I. Sgr A*," MNRAS **493,** 1404 (2020)
7. T. K. Fowler, H. Li and **R. J. Anantua,** "A Quasi-Static Hyper-Resistive Model of Ultra High Energy Cosmic Ray Acceleration by Magnetically Collimated Jets Created by Active Galactic Nuclei," ApJ **885,** 4 (2019)
6. **R. J. Anantua,** R. D. Blandford and A. Tchekhovskoy, "Multiwavelength Observations of Relativistic Jets from General Relativistic

Magnetohydrodynamic Simulations," Galaxies **6,** 31 (2018)

5. R. D. Blandford and **R. J. Anantua,** "The Future of Black Hole Astrophysics in the LIGO-VIRGO-LPF Era," J. Phys.: Conf. Ser. **840,** 012023 (2017)
4. M. Ackermann **et al.** (Fermi-LAT Collaboration), "Minute-Timescale >100 MeV Gamma-Ray Variability During the Giant Outburst of Quasar 3C 279 Observed by Fermi -LAT in 2015 June," ApJL **824,** L20 (2016)
3. **R. J. Anantua,** Sean A. Hartnoll, Victoria L. Martin and David M. Ramirez, "The Pauli Exclusion Principle at Strong Coupling: Holographic Matter and Momentum space," JHEP **3,** 104 (2013)
2. **R. J. Anantua** and O. K. Baker, "TeV Gamma Rays from Distant BL Lacs and Photon-Paraphoton Kinetic Mixing," Phys. Lett. B **690,** 25-28 (2010)
1. **R. J. Anantua,** R. Easther and J. T. Giblin Jr., "Grand Unification Scale Primordial Black Holes: Consequences and Constraints," Phys. Rev. Lett. **103,** 111303 (2009)

PUBLICATIONS IN PREP

- **R. J. Anantua,** A. Ricarte, R. D. Blandford, A. Tchekhovskoy, G. N. Wong, R. M. Emami, and A. A. Chael, "On the Comparison of AGN with GRMHD Simulations, II. M87," MNRAS (2022)
- **R. J. Anantua,** S. S. Alexander, D. Spergel and K. V. Tilberg, "Axion Couplings to the Kerr Metric as Sources of Positron Production," JHEP (2023)
- **R. J. Anantua,** "Inductive Slowing of Relativistic Jets in GRMHD Simulations," ApJ (2023)

PUBLICATIONS IN PRESS

- UTSA Today: "Groundbreaking image of the black hole Sagittarius A* enhance by physics professor Richard Anantua," (May 2022), Retrieved Jun 8, 2022 from: https://www.utsa.edu/today/2022/05/story/eht-black-hole-richard-anantua.html
- KHOU 11 Houston: "First photo shows a massive black hole in the Milky way that is 4 million times the mass of the Sun," (May 2022), Retrieved Jun 8, 2022 from: https://www.khou.com/article/tech/science/space/first-photo-black-hole-milky-way-galaxy-sagittarius-star/285-8fa35c71-c429-4a52-a0ef-b7ae40f2dda4
- Yale News: "Snapping a Cosmic Selfie – First Image of the Milky Way's Black Hole," (May 2022), Retrieved Jun 8, 2022 from: https://news.yale.edu/2022/05/13/snapping-cosmic-selfie-first-image-milky-ways-black-hole
- Harvard Crimson: "Harvard Astrophysicists Help Make Discovery in Understanding Black Hole's Magnetic Fields," (Apr. 2021), Retrieved Apr. 22, 2021 from: https://www.thecrimson.com/article/2021/4/12/black-hole-polarization/
- Gizmodo: "See a Black Hole's Magnetic Fields in a New Image from the Event Horizon Telescope," (Mar. 2021), Retrieved Apr. 22, 2021 from: https://gizmodo.com/see-a-black-holes-magnetic-fields-in-new-image-from-the-1846542592?fbclid=IwAR3lmy77huJRZgWzci2boXjbW8o2ke0NN0e4Cu0wHarLd9GJbEzzS1eQXlY
- American Astronomical Society: "Program Opens Research Pathways for Underrepresented Young Astrophysicists," (Sep. 2020), Retrieved Apr.

22, 2021 from: https://aas.org/posts/news/2020/09/program-opens-new-research-pathways-underrepresented-young-astrophysicists

- R. J. Anantua, "Seeing and Believing: 'Observing' Simulations of Relativistic Jets," (Mar. 2017), Retrieved Dec. 12, 2017 from: https://kipac.stanford.edu/highlights/seeing-believing-observing-simulations-relativistic-jets
- R. J. Anantua, "Why Are We Here in the Universe?" (Feb. 2017), Retrieved May 7, 2017 from: http://magazine.ivy.com/2017/02/why-are-we-here-in-the-universe/

INVITED TALKS

- GRAPPA University of Amsterdam Colloquium (Apr. 2022)
- Institute for Advanced Study Astrophysics Seminar (Oct. 2021)
- University of Virginia Colloquium (Sep. 2021)
- Vanderbilt Physics & Astronomy Seminar (Sep. 2021)
- University of Florida Special Colloquium on "Horizon-Scale Physics Using Movies and Polarization Maps" (Mar. 2021)
- Amherst College Colloquium on EHT M87* Polarization Papers VII & VIII (Mar. 2021)
- Okanagan College talk on EHT M87* Polarization Papers VII & VIII (Mar. 2021)
- Flatiron Institute Center for Computational Astrophysics, New York, NY, Galaxy Formation Group Meeting (Mar. 2021)
- University of Texas at Austin Physics Colloquium on "Horizon-Scale Physics Using Movies and Polarization Maps" (Mar. 2021)
- MIT Haystack talk on NSBP/SAO EHT Scholars initiative (Mar. 2021)
- Reed College (Feb. 2021)
- NASA Goddard (Jan. 2021)
- Cornell Astronomy Colloquium (Dec. 2020)
- Flatiron Institute Center for Computational Astrophysics, New York, NY, Compact Objects Group Meeting (Dec. 2020)
- University of Illinois at Urbana-Champaign Astrophysics Colloquium, "Imaging and Beyond: Understanding Near-Horizon Physics. Using Movies and Polarization Maps" (Dec. 2020)
- SUNY Stony Brook Colloquium (Nov. 2020)
- SUNY Stony Brook Astro Open Night "Relativity of Space and Time in Popular Science" (Nov. 2020)
- University of Chicago seminar on "Towards Understanding Near-Horizon Physics of Sgr A* from Movies and Polarization Maps" (Oct. 2020)
- Joint IAS/Princeton University Astrophysics Colloquium (Aug. 2020)
- Brown Astrophysics Seminar Series, Providence, RI talk on "'Observing' JAB Simulations – Towards Understanding Jet/Accretion Flow/Black Hole Systems in Sgr A* and M87" (Nov. 2019)
- "Understanding the Multiwavelength Blazar Variability – Workshop at Stanford" talk on cosmic ray acceleration in jets (Aug. 2019)
- Harvard Quasar Tea talk on "'Observing' JAB Simulations – Probing Near Horizon Scales in AGN" (Feb. 2019)

- Diversifying Academia Recruiting Excellence (DARE) 10th Reunion, Stanford, CA talk on "'Observing' JAB Simulations" (Nov. 2018)
- Harvard Black Hole Initiative talk on "'Observing' JAB Simulations" (Jun. 2018)
- City College of San Francisco talk on "Sgr A* Emission Parametrizations from GRMHD Simulations" (Feb. 2018)

SELECTED CONFERENCES

- American Astronomical Society 235th Meeting, Honolulu, HI talk on "Beyond Imaging: Probing Near-Horizon Physics from Movies and Polarization Maps based on GRMHD Simulations" (Jan. 2020)
- National Society of Black Physicists Conference, Providence, RI talk on "Discovering the Composition of Jets from Polarization Maps" (Nov. 2019)
- Tracing Cosmic Evolution with Clusters of Galaxies, Sexten, Italy poster on "Observing JAB Simulations— Probing Near Horizon Scales in Simulations" (Jul. 2019)
- 22nd International Conference on General Relativity and Gravitation, Valencia, Spain talk on "Observing JAB Simulations— Probing Near Horizon Scales in Simulations" (Jul. 2019)
- American Astronomical Society 234th Meeting, St. Louis, MO talk on "Cosmic Ray Acceleration in Jets by Accretion Disk Dynamo" (Jun. 2019)
- American Astronomical Society 233rd Meeting, Seattle, WA talk on "Observing JAB Simulations— Probing Near-Horizon Scales in Simulations" (Jan. 2019)
- American Astronomical Society 232nd Meeting, Denver, CO talk on "Observing JAB Simulations" (Jun. 2018)
- California Alliance Conference at U.C. Berkeley, poster presentation on "Observing Jet/Accretion Disk/Black Hole Simulations" (Mar. 2018)
- Polarized Emission from Astrophysical Jets, Ierapetra, Greece talk on "Observing Jet Simulations" (Jun. 2017)
- California Alliance Conference at UCLA, Los Angeles, CA poster presentation on "Observing Jet Simulations" (Feb. 2017)
- NSF Theoretical and Computational Astrophysical Network at U.C. Berkeley talk on "Observing Jet Simulations" (Jan. 2017)
- ASIAA M87 Workshop: Towards the 100th Anniversary of the Discovery of Cosmic Jets, Taipei, Taiwan oral presentation on "Observing Jet Simulations" (May 2016)
- American Astronomical Society 226th Meeting, Kissimmee, FL poster presentation on "Observing Jet Simulations" (Jan. 2016)
- California Alliance Conference at Caltech, Pasadena, CA poster presentation on "'Observing' Jet Simulations" (Apr. 2015)
- National Society of Black Physicists Conference, Baltimore, MD (Feb. 2015)

- Fermi Bubbles Theory and Observations Conference, Menlo Park, CA (SLAC) poster presentation on Parametric Modeling of Fermi Bubbles (Apr. 2013)
- American Physical Society Conference, Anaheim, CA oral presentation on (Anantua & Baker, 2010) (Apr. 2011)

MENTORSHIP

- Fisk-Vanderbilt student Elon Price for master's thesis and Summer 2020 GRMHD project at Smithsonian Astrophysical Observatory (co-mentor: Christian Fromm)
- Undergraduate intern Nicholas Conroy for Summer 2020 EHT Outreach at Smithsonian Astrophysical Observatory (co-mentor: Shep Doeleman)
- U.C. Berkeley undergraduate Jeremy Wayland (2017-18), including Summer Undergraduate Research Fellowship (SURF) 2018

OUTREACH & SERVICE

- TV appearance Nov. 2021 on BBC/NOVA Universe Ep. 4: Black Holes
- Served as NASA FINESST grant reviewer Mar. 2021
- Founded NSBP/SAO EHT Scholars Program, a paid summer internship at the Smithsonian Astronomical Observatory for undergraduate and graduate students affiliated with the National Society of Black Physicists
- Founded STEM Club, an organization uniting postdocs of color (PoC's) at Harvard through a monthly series of skill-building workshops and networking dinners starting March 2019
- Served on the American Astronomical Society Diversity and Inclusion Task Force – Data Collection and Metrics for Success Working Group, contributing to the 2018 Final Report: https://aas.org/files/aas_diversity_and_inclusion_task_force_final_report.pdf

SKILLS

- *C++, Mathematica, Matlab, Python, R, STATA, UNIX*
- National Strength and Conditioning Association: Certified Personal Trainer (2011)
- Five years of formal instruction in Latin; conversational in French and Haitian Creole

ACTIVITIES

Jun. 2000-Present **Prep for Prep,** NEW YORK, NY
A highly selective leadership development program that incorporates a rigorous 14-month academic component to prepare students for placement in leading independent schools and continues to work closely with the students through high school graduation and beyond

Sep. 2008-Dec. 2011 **Powerlifting**
Trained for powerlifting competitions, best squat/bench/deadlift (lbs.) 358/309/573 (in competition, 220lbs. class, raw, no wraps), 365/350/600 (in training at ~210lbs., raw, no wraps, lifetime drug-free)

Oct. 2007-May 2010 **Klib Kreyòl (Haitian Students Alliance)**
Served as vice president, publicizing club history, visiting Haiti for outreach, and coordinating alumni-student events

Sep. 2006-Sep. 2009 **Yale Rugby**
Played flanker, center