

Rajeev Vaisakh

PHD · PHYSICS · OBSERVATIONAL COSMOLOGY · LARGE-SCALE STRUCTURE

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Research and Technical Profile

Ph.D. in physics and astrophysics working across observational cosmology, large-scale structure, spectroscopic survey analysis, survey simulations, and time-domain astronomy. My research uses DESI galaxy and quasar clustering, mock catalogs, galaxy-halo connection modeling, redshift-failure studies, and observational-systematics analyses to connect large astronomical datasets to measurements of cosmic expansion and structure growth. I also work on Type Ib/c core-collapse supernova cosmology with ROTSE data, giving me experience across both high-redshift spectroscopic surveys and low-redshift transient observations. I am interested in developing survey-driven, simulation-based, and multi-probe approaches to cosmology using current and upcoming astronomical datasets.

Research Experience

Southern Methodist University, Department of Physics

Dallas, TX

ADVISOR: DR. ROBERT KEHOE

May 2021 – present

- Dissertation: “Measuring Cosmic Expansion from Early to Late Times using Quasars, Galaxies, and Local Supernovae”
- Developed DESI mock-catalog and clustering-validation workflows for QSO/ELG analyses using Uchuu and GLAM simulations.
- Modeled galaxy-halo connections, selection effects, redshift failures, and observational systematics in DESI large-scale structure analyses.
- Contributed to redshift-failure modeling studies relevant to $2 + 3$ pt statistics and primordial non-Gaussianity constraints.
- Produced and validated simulated survey products for reference mocks, covariance mocks, and cosmological clustering analyses.
- Analyzed ROTSE Type Ib/c supernova data for nearby-universe cosmology and time-domain systematics.

Indian Institute of Technology Hyderabad, Department of Physics

Sangareddy, Telangana, India

ADVISOR: DR. SHANTANU DESAI

2018 – 2019

- M.Sc. thesis: “Tests of Violation of Inverse Square Law on Radio Pulsar Fluxes”

Indian Institute of Astrophysics

Bengaluru, Karnataka, India

ADVISOR: DR. SIVARANI THIRUPATHI

May 2018 – Aug. 2018

- Summer research on galactic archaeology with metal-poor stars.

Professional Experience

- 2025-2026 **Moody Dissertation Fellow**, Southern Methodist University
- 2022-2026 **Graduate Research Assistant**, Southern Methodist University
- 2021-2026 **Support Observer**, Dark Energy Spectroscopic Instrument (DESI) at Kitt Peak National Observatory
- 2021-2022 **Graduate Teaching Assistant**, Southern Methodist University

Education

Southern Methodist University

Dallas, TX, USA

PH.D. PHYSICS

Aug. 2020 – present

- Expected graduation: July 2026

Southern Methodist University

Dallas, TX, USA

M.S. PHYSICS

Aug. 2020 – May 2022

- Completed en route to Ph.D.

Large-Scale Structure, Simulations, & Statistical Inference

- Developed DESI QSO/ELG mock-catalog and clustering-validation workflows using Uchuu and GLAM simulations for reference mocks, covariance mocks, and survey-systematics studies.
- Modeled the galaxy-halo connection of DESI tracers using simulation-based approaches, including halo occupation and subhalo-based modeling for quasars and emission-line galaxies.
- Quantified the impact of survey realism, redshift failures, selection effects, and observational systematics on two-point and higher-order clustering measurements.
- Contributed to DESI redshift-failure modeling studies relevant to $2 + 3$ pt statistics and primordial non-Gaussianity constraints.
- Compared simulated and observed clustering across redshift bins and tracer populations to validate mock catalogs and assess systematic uncertainties.
- Interested in extending these frameworks toward simulation-based inference, emulation, field-level analyses, and AI-driven approaches to large-scale structure cosmology.

Technical Skills & Scientific Computing

- **Large-Scale Structure:** DESI QSO/ELG clustering, galaxy-halo connection modeling, two-point and higher-order statistics, BAO/RSD context, primordial non-Gaussianity systematics.
- **Simulations & Mocks:** Uchuu and GLAM simulations; DESI reference mocks; covariance mocks; lightcone production; HOD/subhalo modeling; simulated-vs-observed clustering validation.
- **Statistical Inference:** covariance estimation, systematic-error propagation, likelihood-level validation, uncertainty quantification, forward modeling; developing interest in simulation-based inference and emulation.
- **Scientific Computing:** Python, NumPy, SciPy, pandas, Astropy, Matplotlib, Jupyter, Bash/Shell, $\LaTeX$; working familiarity with C/C++, SQL, and IDL.
- **Data & Workflows:** FITS, HDF5, Parquet, catalog-level analysis, HPC/SLURM workflows, Git/GitHub, validation scripts, reproducible workflows, large-scale data processing.

Programming, Software Tools, & Data Systems

- **Languages:** Python, Bash/Shell, $\LaTeX$; working familiarity with C/C++, IDL, and SQL.
- **Scientific Python:** NumPy, SciPy, pandas, Astropy, Matplotlib, Jupyter.
- **Software Practices:** Git/GitHub, collaborative development, documentation, reproducible workflows, validation scripts, and code review.
- **Computing:** HPC clusters, SLURM batch workflows, large-scale data processing, simulation workflows, and mock-catalog production.
- **Astronomical Data:** FITS, HDF5, Parquet, catalog-level analysis, DESI/ROTSE data products, and transient/survey data validation.
- **Reliability:** Regression checks, pipeline diagnostics, validation tests, and reproducibility checks.

Survey Collaboration, Operations, & Service

- DESI collaborator & **Builder** with 1500+ hours of service across observing operations, observing software maintenance, analysis infrastructure, and observational-systematics studies.
- DESI support observer for 50+ remote and in-person observing shifts, contributing to data collection and survey operations.
- Co-Chair of the DESI Early Career Scientists Committee and ECS liaison to the DESI Professional Development Committee.

Awards, Fellowships, & Grants

Aug. 2025	Moody Dissertation Fellowship , Southern Methodist University	\$31,500
2022–2025	DESI Early Career Scientist Travel Grants , Collaboration meetings: Cancun, Durham, Hawaii, Marseille, Berkeley, Tucson	\$7,500
Sep. 2024	In-Person Observing Travel Grant – Kitt Peak National Observatory, Arizona , DESI – Lawrence Berkeley National Laboratory	\$1,200
Mar. 2024	Best Poster Award – Graduate Poster Session , Southern Methodist University	\$250
Nov. 2022	People's Choice Award – Three Minute Thesis , Southern Methodist University	\$400
Sep. 2021	Charles W. Tittle Staring Line Award , Southern Methodist University	\$1,000
Dec. 2018	JENESYS 2018 Student Exchange Fellowship , INDO–Japan Student Exchange Program, Ministry of Foreign Affairs, Japan	\$3,000
June 2018	Summer Research Fellowship , Indian Academy of Sciences	\$300

Presentations

INVITED & OUTREACH TALKS

- Jan. 2026 – *Galaxy-Halo Connection Modeling: Producing High-Fidelity Lightcones for DESI*. Invited Talk, DESI Special Session, AAS Winter Meeting, Phoenix, Arizona, USA.
- Oct. 2025 – *Galaxy-Halo Connection Modeling: Producing High-Fidelity Lightcones for DESI*. Invited Talk, Theoretical Astroparticle and Cosmology Symposium in Texas (TACOS), Sam Houston State University, Huntsville, Texas, USA.
- May 2024 – *Probing the Expansion of the Universe using the Dark Energy Spectroscopic Instrument*. Invited Talk, IIT Hyderabad High Energy Physics Remote Seminar Series.
- Apr. 2024 – *Eclipses: Here's What They Are Hiding From You!* Outreach Talk, SMU Physics Totality Lecture Series.

SELECTED CONTRIBUTED PRESENTATIONS

- 2025 – *DESI Y3 Reference and Covariance Mock Production for QSO/ELG Clustering Analyses*. DESI Collaboration Meetings, Berkeley, California, and Tucson, Arizona, USA.
- 2024 – *High-Fidelity DESI QSO Lightcones, Uchuu-GLAM Simulations, and Halo Occupation Modeling*. DESI Collaboration Meeting, Marseille, France; TXAPS, Southern Methodist University; UNT TEXAS Symposium.
- 2023 – *DESI Quasar Lightcone Production and Galaxy-Halo Connection Modeling with Uchuu-GLAM Simulations*. DESI Collaboration Meetings, Durham, UK, and Hawaii, USA; TXAPS, Angelo State University.
- Mar. 2023 – *Probing the Cosmic Expansion of the Universe using DESI*. Poster, Graduate Poster Session, Southern Methodist University, Dallas, Texas, USA.
- Dec. 2022 – *Generating High-Fidelity Lightcones for DESI Quasars using Uchuu Simulations*. DESI Collaboration Meeting, Cancun, Mexico.
- Apr. 2019 – *Tests of Violation of Inverse Square Law on Radio Pulsar Fluxes*. Poster, RETCO: Recent Trends in Study of Compact Objects, Inter-University Centre for Astronomy and Astrophysics, Pune, India.

Mentoring

2021-2023	Amy Hermann , Undergrad, Southern Methodist University (<i>OH-filters / NIR astronomy</i>)	Dallas, TX
2023-2025	Christopher Cook , Undergrad, Southern Methodist University (<i>ROTSE Photometry</i>)	Dallas, TX
2023-	Antone Amalbert , 3rd year PhD, Southern Methodist University (<i>DESI & ROTSE science</i>)	Dallas, TX
2025-	Joshua Mendez , Undergrad, Southern Methodist University (<i>OH-filters / NIR astronomy</i>)	Dallas, TX
2025-	Hafiz Inamullah , 1st year PhD, Instituto Politécnico Nacional (<i>DESI science</i>)	Mexico

Teaching Experience

2021-2022	Introduction to Physics Lab: Electromagnetism (PHYS1106) , Graduate Teaching Assistant	SMU
Fall 2021	Introduction to Physics Lab: Mechanics (PHYS1105) , Graduate Teaching Assistant	SMU
Fall 2021	Introduction to Electromagnetism (PHYS1304) , Graduate Teaching Assistant	SMU
Fall 2021	Introduction to Mechanics (PHYS1303) , Graduate Teaching Assistant	SMU

Collaboration Leadership & Professional Service

2025– present	Early Career Scientist Committee , Co-chair	DESI Collaboration
2024– present	Early Career Scientist Committee , Member	DESI Collaboration
2024– present	Professional Development Committee , Early Career Scientist Liaison	DESI Collaboration
2024	Texas APS Conference , Local Organizing Committee Member	SMU Dedman College, SMU Dedman College, SMU
2024–2025	Dedman Graduate Student Assembly , Secretary	
2023–2025	Dedman Graduate Student Assembly , Physics Representative	
2022	TACOS Cosmology Conference , Local Organizing Committee Member	

SOCIETY MEMBERSHIPS

- American Physical Society (APS); American Astronomical Society (AAS); Sigma Xi.

Publications & Bibliography

SELECTED FIRST-AUTHOR/CO-AUTHOR PAPERS AND COLLABORATION PUBLICATIONS

- Vaisakh, R.**, Lasker, J., Kehoe, R., et al. 2026. *DESI Y3 Reference Mocks: Clustering Results from Uchuu QSO and ELG Lightcones*, arXiv:2606.28559.
- Vaisakh, R.**, Kehoe, R., et al. 2026. *Cosmological Distance Measurements from Stripped Core-Collapse Type Ib/c Supernovae*. Manuscript in preparation.
- Vaisakh, R.**, Krolewski, A., et al. 2026. *Revisiting Redshift-Failure Modelling and its Impact on $2 + 3pt$ Statistics and f_{NL} for DESI Y3*. Manuscript in preparation (to be submitted in August with DESI official release).
- Vaisakh, R.**, Khan, N. K., Amalbert, A., et al. 2026. *DESI DR2 GLAM–Uchuu Covariance Mocks: Clustering Results from ELGs and QSOs*. Manuscript in preparation (to be submitted in August with DESI official release).
- Prada, F., Fernández-García, E., **Vaisakh, R.**, et al. 2026. *DESI DR2 BAO Cosmology from GLAM–Uchuu N-body Covariance Matrices*. Manuscript in preparation (to be submitted in August with DESI official release).
- Fernández-García, E., Prada, F., **Vaisakh, R.**, et al. 2026. *DESI DR2 GLAM–Uchuu Covariance Mocks: Clustering Results from BGS-BRIGHT and LRG*. Manuscript in preparation (to be submitted in August with DESI official release).
- Li, Q., Dawson, K., Prada, F., Fernández-García, E., **Vaisakh, R.**, et al. 2026. *DESI DR2 GLAM–Uchuu Covariance Mocks: BAO Measurement with Mock-Based Covariance*. Manuscript in preparation (to be submitted in August with DESI official release).
- Fernández-García, E., Prada, F., Smith, A., et al., including **Vaisakh, R.** 2025. *DESI DR2 Reference Mocks: Clustering Results from Uchuu-BGS and LRG*. arXiv:2507.01593.

Prada, F., Ereza, J., Smith, A., Lasker, J., **Vaisakh, R.**, Kehoe, R., et al. 2025. *The DESI One-Percent Survey: Modelling the Clustering and Halo Occupation of All Four DESI Tracers with Uchuu*. *Astronomy & Astrophysics*, 698, A170.

Hermann, A., Lasker, J., **Vaisakh, R.**, et al. 2026. *Characterizing Photonic Ring Resonator Filters for OH-Suppressed Near-Infrared Astronomy*. Volume 54 number 1 (JAAVSO).

Bhattacharjee, A. B., Rai, M., Kashyap, K., Khurana, A., **Vaisakh, R.**, et al. 2018. *Effect of Annealing Temperature on the Structure and Optical Properties of ZnO Nanoparticles for Possible Anti-Bacterial Applications*. *Optik*, 158, 1006–1015.

MAJOR DESI COLLABORATION PAPERS (ALPHABETICAL AUTHOR LIST)

Karim, M. A., Adame, A. G., Aguado, D., Aguilar, J., Ahlen, S., Alam, S., et al. 2025. *Data Release 1 of the Dark Energy Spectroscopic Instrument*. arXiv:2503.14745.

Karim, M. A., Aguilar, J., Ahlen, S., Alam, S., Allen, L., Prieto, C. A., et al. 2025. *DESI DR2 Results II: Measurements of Baryon Acoustic Oscillations and Cosmological Constraints*. arXiv:2503.14738.

Andrade, U., Paillas, E., Mena-Fernández, J., Li, Q., Ross, A. J., Nadathur, S., et al. 2025. *Validation of the DESI DR2 Measurements of Baryon Acoustic Oscillations from Galaxies and Quasars*. arXiv:2503.14742.

Adame, A. G., Aguilar, J., Ahlen, S., Alam, S., Alexander, D. M., Alvarez, M., Alves, O., Anand, A., Andrade, U., Armengaud, E., et al. 2024. *DESI 2024 II: Sample Definitions, Characteristics, and Two-Point Clustering Statistics*. arXiv:2411.12020.

Adame, A. G., Aguilar, J., Ahlen, S., Alam, S., Alexander, D. M., Alvarez, M., Alves, O., Anand, A., Andrade, U., Armengaud, E., et al. 2024. *DESI 2024 V: Full-Shape Galaxy Clustering from Galaxies and Quasars*. arXiv:2411.12021.

Adame, A. G., Aguilar, J., Ahlen, S., Alam, S., Alexander, D. M., Prieto, C., Allende, Alvarez, M., Alves, O., Anand, A., Andrade, U., et al. 2024. *DESI 2024 VII: Cosmological Constraints from the Full-Shape Modeling of Clustering Measurements*. arXiv:2411.12022.

Adame, A. G., Aguilar, J., Ahlen, S., Alam, S., Alexander, D. M., Alvarez, M., Alves, O., Anand, A., Andrade, U., Armengaud, E., et al. 2024. *DESI 2024 III: Baryon Acoustic Oscillations from Galaxies and Quasars*. arXiv:2404.03000.

Adame, A. G., Aguilar, J., Ahlen, S., Alam, S., Alexander, D. M., Alvarez, M., Alves, O., Anand, A., Andrade, U., Armengaud, E., et al. 2025. *DESI 2024 VI: Cosmological Constraints from the Measurements of Baryon Acoustic Oscillations*. *Journal of Cosmology and Astroparticle Physics*, 2025(02), 021.

Adame, A. G., Aguilar, J., Ahlen, S., Alam, S., Alexander, D. M., Alvarez, M., Alves, O., Anand, A., Andrade, U., Armengaud, E., et al. 2025. *DESI 2024 IV: Baryon Acoustic Oscillations from the Lyman- α Forest*. *Journal of Cosmology and Astroparticle Physics*, 2025(01), 124.

Adame, A. G., Aguilar, J., Ahlen, S., Alam, S., Aldering, G., Alexander, D. M., Alfarsy, R., Prieto, C., Allende, Alvarez, M., Alves, O., et al. 2024. *The Early Data Release of the Dark Energy Spectroscopic Instrument*. *The Astronomical Journal*, 168(2), 58.

Adame, A. G., Aguilar, J., Ahlen, S., Alam, S., Aldering, G., Alexander, D. M., Alfarsy, R., Prieto, C., Allende, Alvarez, M., Alves, O., et al. 2024. *Validation of the Scientific Program for the Dark Energy Spectroscopic Instrument*. *The Astronomical Journal*, 167(2), 62.