James M. Sullivan

Center for Theoretical Physics
6C-405
Cambridge, MA 02139 USA

Email: jms3@mit.edu
Website: https://jmsull.github.io
ORCiD: 0000-0003-1964-0836

Current Position

Brinson Prize Fellow, Hosted at the Center for Theoretical Physics
Massachusetts Institute of Technology (MIT)

Research Interests

Large-scale structure, primordial non-gaussianity, computational methods, Bayesian statistics, differentiable forward models.

Education

2018-2024	PhD in Astrophysics, UC Berkeley
2018-2019	MA in Astrophysics, UC Berkeley
2014-2018	BS in Physics, UT Austin
	BS in Pure Mathematics, UT Austin
	BS in Astronomy[1], UT Austin

Grants, honors & awards

2024	Brinson Prize Fellowship [$360,000]
	Graduate:
2023	Department of Energy Office of Science Graduate Student Research (SCGSR) Award (HEP) [∼$43,000]
2023,2024	PI of DOE Mission Science (HEP) ERCAP Award (2x renewal/doubling of "Data-driven Differentiable Linear Cosmology")
2022	PI of NERSC ASCR ERCAP Exploratory Award ("Data-driven Differentiable Linear Cosmology")
2018-2022	Department of Energy Computational Sciences Graduate Fellowship (CSGF) [∼$200,000]
2018	National Science Foundation Graduate Research Fellowship (GRFP, *declined*) [∼$150,000]
	Undergraduate:

---

[1] with Certificate in Scientific Computing & Data Science

Publications & talks

Journal articles (lead author)

2023   **JMS**, Tijan Prijon, Uroš Seljak, "Learning to Concentrate: Multi-tracer Forecasts on Local Primordial Non-Gaussianity with Machine-Learned Bias", *JCAP*, 8, 4, arXiv:2303.08901

JMS, JD Emberson, Salman Habib, Nicholas Frontiere, "Improving initialization and evolution accuracy of cosmological neutrino simulations", *JCAP*, 6, 3, arXiv:2302.09134

2021   **JMS**, Uroš Seljak, Sukhdeep Singh, "An Analytic Hybrid Halo + Perturbation Theory Model for Small-scale Correlators: Baryons, Halos, and Galaxies", *JCAP*, 11, 26, arXiv:2104.10676

2020   **JMS**, Sarafina Nance, J. Craig Wheeler, "The Betelgeuse Project III: Constraints from Rotation", *ApJ*, 905, 128

2019   **JMS**, Alexander Wiegand, Daniel Eisenstein, "The clustering of galaxies in the SDSS-III Baryon Oscillation Spectroscopic Survey: evolution of higher-order correlations demonstrated with Minkowski functionals", *MNRAS*, 485, 2

2018   **JMS**, Shingo Hirano, Volker Bromm, "Minimum star-forming halo mass in axion cosmology", *MNRAS Letters*, 481L, 69

JMS, Collin Weir, Austin Reichert, R. Todd Evans, W. Cyrus Proctor, Nicholas Thorne, "Student Cluster Competition 2017, Team University of Texas at Austin/Texas State University: Reproducing Vectorization of the Tersoff Multi-Body Potential on the Intel Skylake and NVIDIA V100 Architectures", *Special edition of Parallel Computing*

Journal articles (other author)

2023   Jaime Ruiz-Zapatero et al. (inc. **JMS**), "Limberjack.jl", arXiv:2310.08306

Andrina Nicola et al. (inc. **JMS** & LSST DESC Collaboration), "Galaxy bias in the era of LSST: perturbative bias expansions", arXiv:2307.03226

2018   Sarafina Nance, **JMS**, Manuel Diaz, J. Craig Wheeler, "The Betelgeuse Project II: asteroseismology", MNRAS, 479, 1

2017   Shingo Hirano, **JMS**, & Volker Bromm, "First star formation in ultralight particle dark matter cosmology", MNRAS Letters, 473, 1

J. Craig Wheeler et al. (inc. **JMS**), "The Betelgeuse Project: constraints from rotation", MNRAS, 465, 3

Submitted

2023   **JMS**, Uroš Seljak "Deterministic Langevin Optimization", (Submitted to the Journal of Global Optimization), arXiv:2310.00745

Selected Talks

(⋆ = invited talks)

2024:

- Cosmology on the Adriatic: From PT to AI, "Split Gong Session: 2 Points on Local PNG"
- Sexten Conference on New Strategies for Extracting Cosmology From Future Galaxy Surveys: 2nd edition, "Field level bias modeling, time evolution, and local primordial non-Gaussianity"
- Higgs Centre for Theoretical Physics meeting on Theoretical Modeling of Large-Scale Structure of the Universe, "Field level bias modeling, assembly bias, and primordial non-Gaussianity"
- Fundamental Physics from Future Spectroscopic Surveys, "Leveraging the b_ϕ dimension of multi-tracer"
- BCCP Seminar, "Local Primordial Non-Gaussianity in Galaxy Surveys"

2023:

- NYU CCPP Informal Astro Seminar, "Galaxies Remember Inflation: New Aspects of Local Primordial Non-Gaussianity in Galaxy Surveys"
- IAP/CCA Debate 2, "Embedding Neural Networks in ODEs to Learn Linear Cosmological Physics"
⋆ Yale Cosmology Seminar, "Galaxies Remember Inflation: Early Universe Physics with Large-scale Structure"
- KICC CMB/LSS Meeting, "Galaxies Remember Inflation: New Aspects of Local Primordial Non-Gaussianity in Galaxy Surveys"
⋆ MPA Cosmology Seminar, "Galaxies Remember Inflation: New Aspects of Local Primordial Non-Gaussianity in Galaxy Surveys"
⋆ IAS/Princeton Cosmology Lunch, "New Aspects of Local Primordial Non-Gaussianity in Galaxy Surveys"
⋆ KICP Astro Series, "Galaxies Remember Inflation: Early Universe Physics with Large-scale Structure"
- Columbia Cosmology Group, "New Bias Methods for Local Primordial Non-Gaussianity in Galaxy Surveys"
- CCA Cosmology Meeting, "New Bias Methods for Local Primordial Non-Gaussianity in Galaxy Surveys"
⋆ Stanford KIPAC Cosmology Seminar, "Large-scale Structure Remembers Inflation: New Aspects of Local Primordial Non-Gaussianity in Galaxy Surveys"
⋆ CfA Seminar, "New Aspects of Local Primordial Non-Gaussianity in Galaxy Surveys"
⋆ CMB-S4 Collaboration Meeting, parallel session, "Fast exploration of BSM models with Bolt.jl"
- Benasque Understanding Cosmological Observations, organized session on PNG + Large-scale Systematics, and High-dimensional Data Analysis (also gave flash talk)
⋆ SPHEREx Cosmology Group, "Learning to Concentrate: Multi-tracer Forecasts on Local Primordial Non-Gaussianity with Machine-Learned Bias"
- Sexten Conference on New Strategies for Extracting Cosmology From Future Galaxy Surveys, "Bias Methods for Primordial non-Gaussianity"
- Cosmology from Home 2023, "Learning Linear Cosmological Physics"
- SIAM OP23, "Deterministic Langevin Optimization"

2022:

⋆ Montreal Astromerique Speaker Series, "Accelerating Cosmological Inference with Gradients and Surrogate Models"
- Vipolže, "Deterministic Langevin Optimization"

- DoE CSGF Program Review, "Computational Aspects of Computational Cosmology" (Exiting fellow talk)
- Cosmology From Home, "Bolt.jl - the Differentiable Boltzmann Solver"
2021:
⋆ DESI GGL Telecon, "Halo-Zel'dovich Perturbation Theory"
⋆ ANL CPAC Journal Club, "Halo-Zel'dovich Perturbation Theory"
⋆ University of Arizona Cosmology group meeting (TACOS), "Halo-Zel'dovich Perturbation Theory"
- Stanford 'Lensing is Low' workshop (lightning talk), "Halo-Zel'dovich Perturbation Theory"

Posters

- Flatiron Institute Cosmic Connections Workshop 2023 (New York, NY), "Learning to Concentrate: Multi-tracer Forecasts on Local Primordial Non-Gaussianity with Machine-Learned Bias"
- Computational Science Graduate Fellowship Program Review 2021 (virtual), "Halo-Zel'dovich Perturbation Theory"
- 2021 NeurIPS Differentiable Programming workshop, "Gradients of the Big Bang: Solving the Einstein-Boltzmann Equations with Automatic Differentiation"
- Computational Science Graduate Fellowship Program Review 2019 (Arlington, VA), "Neutrinos in HACC"
- American Astronomical Society Meeting 2018 (Washington, D.C.), "Redshift Evolution of Non-Gaussianity in Cosmic Large-scale Structure"

Teaching & Advising

Courses

2024	Berkeley Physics Directed Reading Program (Mentee: Lea Zhang), Inflationary Cosmology
2022-2023	STEM Faculty at Mount Tamalpais College (Accredited Associate degree-granting institution in San Quentin State Prison)
	- [Spring 2023 Statistics Co-instructor]
	- [Fall 2022 Physics I with Lab Co-instructor]
	- [Spring 2022 Intermediate Algebra Co-instructor]
2018	UCB Graduate Student Instructor (ASTRON C10)
2016-2018	UT Freshman Research Initiative (FRI) Mentor
2016	UT Physical Sciences Learning Assistant

Students Advised

Undergraduates:
- Ben Pennell (U Toronto, CITA SURF) - Summer 2023 → (w. Zack Li)
Project: *Cosmological Ionization History with Neural Ordinary Differential Equations*

- Tijan Prijon (U Lubljanja, BCCP) - Fall 2022 - Spring 2023 (w. Uroš Seljak)
Project: *Machine-Learned Bias for Local Primordial Non-Gaussianity*

Leadership & Outreach

- Berkeley Cosmology Journal Club Organizer (2024)

- Berkeley Physics Directed Reading Program Mentor (2024)

- Reviewer for the Berkeley Scientific Journal (Undergraduate-run science journalism publication, 2024)

- UC Berkeley Astronomy Department Faculty Search Graduate Representative (2023)

- Astrobites Author (2019-21, 14 articles), and Editorial co-chair (2021, edited 100+ submissions).

- UC Berkeley Astronomy Department Representative for facilitating the Respect is a Part of Research Sexual Violence and Sexual Harassment prevention training (2022,2023)

- UC Berkeley Prospective Graduate Student Visit Committee Chair (2022) [3/3 admitted students attending accepted offer that year]

- Math & Physical Sciences Scholars Undergraduate Mentor (2022)

- POWER Bay Area Outreach Mentor (2021)

- Teacher for SPLASH Berkeley (2021,2022,2023,2024)

- Astronomy Scholars Undergraduate Mentor (2021)

- Berkeley Racial Justice Book Club Facilitator (2020)

- Compass Undergraduate Mentor (2019)

- Compass Lecture "Fuzzy Dark Matter" (2019)

References

Uroš Seljak: UC Berkeley & Lawrence Berkeley National Laboratory
Salman Habib: Argonne National Laboratory, UChicago, & Northwestern
Martin White: UC Berkeley & Lawrence Berkeley National Laboratory