James M. Sullivan

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Current Position

Astrophysics PhD Candidate, Berkeley Center for Cosmological Physics (BCCP)
University of California, Berkeley
Advisor: Uroš Seljak

Research Interests

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

Education

2018→ PhD in Astrophysics, UC Berkeley (in progress, expected May 2024)
2018-2019 MSc 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

Graduate:
2023 Department of Energy Office of Science Graduate Student Research (SCGSR) Award (HEP)
2023 PI of DOE Mission Science (HEP) ERCAP Award (renewal 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)
2018 National Science Foundation Graduate Research Fellowship (declined)
Undergraduate:

[1] with Certificate in Scientific Computing & Data Science

2018 Dean's Honored Graduate
2017-2018 Astronaut Scholar

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", arXiv:2303.08901
JMS, JD Emberson, Salman Habib, Nicholas Frontiere, "Improving initialization and evolution accuracy of cosmological neutrino simulations", 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 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 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)

Talks

(⋆ = invited talks)
⋆ 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"
- Berkeley Lunch Talks, "Local Primordial non-Gaussianity with Machine-learned Bias"
⋆ Montreal Astromerique Speaker Series 2022, "Accelerating Cosmological Inference with Gradients and Surrogate Models"
- Berkeley Lunch Talks, "Gradient-based Linear Cosmology with Julia"
- Vipolže 2022, "Deterministic Langevin Optimization"
- DoE CSGF Program Review, "Computational Aspects of Computational Cosmology" (Exiting fellow talk)
- Cosmology From Home 2022, "Bolt.jl - the Differentiable Boltzmann Solver"
⋆ 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"
- Berkeley Lunch Talks, "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

Courses

2022→ 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

Advising

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) - 11/22-5/23 (w. Uroš Seljak)
Project: *Machine-Learned Bias for Local Primordial Non-Gaussianity*

Professional Service & Outreach

- 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)
- Astronomy Scholars Undergraduate Mentor (2021)
- Berkeley Racial Justice Book Club Facilitator (2020)
- Compass Undergraduate Mentor (2019)
- Compass Lecture "Fuzzy Dark Matter" (2019)

Relevant Graduate Coursework

Mathematics: Mathematical Methods for the Physical Sciences (224A), Numerical Solution of Differential Equations (228A)
Computer Science: Applications of Parallel Computing (267), Statistical Learning Theory (281A)
Physics & Astronomy: Advanced Cosmology, Astrophysical Fluids, Radiative Processes, High-energy Astrophysics, Bayesian Statistics for Physical Sciences

Tools & Software

Languages/Frameworks ranked descending by (nonzero) proficiency :
Python, Julia, C/C++, jax, MPI, CUDA, OpenMP, FORTRAN, Matlab, R
Software Contributions: HACC, Bolt.jl, DLO, gzpt