ADRIAN E. BAYER

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📍 New York Metropolitan Area, USA

EDUCATION

University of California, Berkeley, USA — 2018–2023
Ph.D. Physics — Thesis adviser: Uroš Seljak

University of Cambridge, UK — 2017–2018
Master of Advanced Study, Mathematics

Imperial College London, UK — 2013–2017
MSci Physics with Theoretical Physics — Thesis adviser: Fay Dowker
Graduated top of the cohort (approx. 250 students)

ACADEMIC APPOINTMENTS

Princeton University, USA — 2023–
Postdoctoral Researcher

Simons Foundation, USA — 2023–
Guest Researcher

The University of Tokyo, Japan — 2022
Visiting Researcher (3 months)

Massachusetts Institute of Technology, USA — 2016
Undergraduate Researcher (2 months) — Adviser: Lindley Winslow

Imperial College London, UK — 2015
Undergraduate Researcher (3 months) — Adviser: Henrique Araújo

HONORS AND AWARDS

Outstanding Graduate Student Instructor Award, Univeristy of California, Berkeley, 2022

Berkeley Distinguished Graduate Fellows Video Prize ($1,000 grant), University of California, Berkeley, 2019

The Berkeley Fellowship, University of California, Berkeley, 2018

Abdus Salam Undergraduate Prize, Imperial College London, 2017

Governors' MSci Prize in Physics, Imperial College London, 2017

Ken Allen Prize, Imperial College London, 2016

Winton Capital Prize for Outstanding Performance in Second Year Physics, Imperial College London, 2015

EPSRC Summer Vacation Bursary (£2,200 grant), Engineering and Physical Sciences Research Council, 2015

BIBLIOGRAPHY

PRIMARY AUTHOR:

1. Golshan, M. and **A. E. Bayer**. "Massive νs through the CNN lens: interpreting the field-level neutrino mass information in weak lensing". In: (Oct. 2024). arXiv: 2410.00914 [astro-ph.CO]

2. Robnik, J., **A. E. Bayer**, M. Charisi, Z. Haiman, A. Lin, and U. Seljak. "Periodicity significance testing with null-signal templates: reassessment of PTF's SMBH binary candidates". In: MNRAS 534.2 (Oct. 2024), pp. 1609–1620. DOI: 10.1093/mnras/stae2220. arXiv: 2407.17565 [astro-ph.GA]

3. **Bayer, A. E.**, Y. Zhong, Z. Li, J. DeRose, Y. Feng, and J. Liu. "The HalfDome Multi-Survey Cosmological Simulations: N-body Simulations". In: (July 2024). arXiv: 2407.17462 [astro-ph.CO]

4. **Bayer, A. E.**, J. Liu, C. D. Kreisch, and A. Pisani. "Significance of void shape: Neutrino mass from Voronoi void halos?" In: Phys. Rev. D 110.6, L061305 (Sept. 2024), p. L061305. DOI: [10.1103/PhysRevD.110.L061305](). arXiv: [2405.12302 [astro-ph.CO]]().

5. **Bayer, A. E.**, U. Seljak, and C. Modi. "Field-Level Inference with Microcanonical Langevin Monte Carlo". In: *40th International Conference on Machine Learning*. July 2023. arXiv: [2307.09504 [astro-ph.CO]]().

6. **Bayer, A. E.**, C. Modi, and S. Ferraro. "Joint velocity and density reconstruction of the Universe with nonlinear differentiable forward modeling". In: J. Cosmology Astropart. Phys. 2023.6, 046 (June 2023), p. 046. DOI: [10.1088/1475-7516/2023/06/046](). arXiv: [2210.15649 [astro-ph.CO]]().

7. **Bayer, A. E.**, J. Liu, R. Terasawa, A. Barreira, Y. Zhong, and Y. Feng. "Super-sample covariance of the power spectrum, bispectrum, halos, voids, and their cross covariances". In: Phys. Rev. D 108.4 (2023), p. 043521. DOI: [10.1103/PhysRevD.108.043521](). arXiv: [2210.15647 [astro-ph.CO]]().

8. **Bayer, A. E.**, A. Banerjee, and U. Seljak. "Beware of fake ν 's: The effect of massive neutrinos on the nonlinear evolution of cosmic structure". In: Phys. Rev. D 105.12, 123510 (June 2022), p. 123510. DOI: [10.1103/PhysRevD.105.123510](). arXiv: [2108.04215 [astro-ph.CO]]().

9. **Bayer, A. E.**, U. Seljak, and J. Robnik. "Self-calibrating the look-elsewhere effect: fast evaluation of the statistical significance using peak heights". In: MNRAS 508.1 (Nov. 2021), pp. 1346–1357. DOI: [10.1093/mnras/stab2331](). arXiv: [2108.06333 [astro-ph.IM]]().

10. **Bayer, A. E.**, F. Villaescusa-Navarro, E. Massara, J. Liu, D. N. Spergel, L. Verde, B. D. Wandelt, M. Viel, and S. Ho. "Detecting Neutrino Mass by Combining Matter Clustering, Halos, and Voids". In: ApJ 919.1, 24 (Sept. 2021), p. 24. DOI: [10.3847/1538-4357/ac0e91](). arXiv: [2102.05049 [astro-ph.CO]]().

11. **Bayer, A. E.**, A. Banerjee, and Y. Feng. "A fast particle-mesh simulation of non-linear cosmological structure formation with massive neutrinos". In: J. Cosmology Astropart. Phys. 2021.1, 016 (Jan. 2021), p. 016. DOI: [10.1088/1475-7516/2021/01/016](). arXiv: [2007.13394 [astro-ph.CO]]().

12. **Bayer, A. E.** and U. Seljak. "The look-elsewhere effect from a unified Bayesian and frequentist perspective". In: J. Cosmology Astropart. Phys. 2020.10, 009 (Oct. 2020), p. 009. DOI: [10.1088/1475-7516/2020/10/009](). arXiv: [2007.13821 [physics.data-an]]().

CONTRIBUTING AUTHOR:

1. Zeghal, J., D. Lanzieri, F. Lanusse, A. Boucaud, G. Louppe, E. Aubourg, **A. E. Bayer**, and The LSST Dark Energy Science Collaboration. *Simulation-Based Inference Benchmark for LSST Weak Lensing Cosmology*. 2024. arXiv: [2409.17975 [astro-ph.CO]](). URL: [https://arxiv.org/abs/2409.17975]().

2. Pandey, S., C. Modi, B. D. Wandelt, D. J. Bartlett, **A. E. Bayer**, G. L. Bryan, M. Ho, G. Lavaux, T. L. Makinen, and F. Villaescusa-Navarro. "CHARM: Creating Halos with Auto-Regressive Multi-stage networks". In: (Sept. 2024). arXiv: [2409.09124 [astro-ph.CO]]().

3. Ding, Z., C.-H. Chuang, Y. Yu, L. H. Garrison, **A. E. Bayer**, Y. Feng, C. Modi, D. J. Eisenstein, M. White, A. Variu, C. Zhao, H. Zhang, J. Meneses Rizo, D. Brooks, K. Dawson, P. Doel, E. Gaztanaga, R. Kehoe, A. Krolewski, M. Landriau, N. Palanque-Delabrouille, and C. Poppett. "The DESI N-body Simulation Project - II. Suppressing sample variance with fast simulations". In: MNRAS 514.3 (Aug. 2022), pp. 3308–3328. DOI: [10.1093/mnras/stac1501](). arXiv: [2202.06074 [astro-ph.CO]]().

4. Kreisch, C. D., A. Pisani, F. Villaescusa-Navarro, D. N. Spergel, B. D. Wandelt, N. Hamaus, and **A. E. Bayer**. "The GIGANTES Data Set: Precision Cosmology from Voids in the Machine-learning Era". In: ApJ 935.2, 100 (Aug. 2022), p. 100. DOI: [10.3847/1538-4357/ac7d4b](). arXiv: [2107.02304 [astro-ph.CO]]().

5. Tomás, A., H. M. Araújo, A. J. Bailey, **A. Bayer**, E. Chen, B. López Paredes, and T. J. Sumner. "Study and mitigation of spurious electron emission from cathodic wires in noble liquid time projection chambers". In: *Astroparticle Physics* 103 (Dec. 2018), pp. 49–61. DOI: [10.1016/j.astropartphys.2018.07.001](). arXiv: [1801.07231 [physics.ins-det]]().

SELECTED TALKS

University of Chicago, Chicago IL, USA   July 2024
Simons Observatory Collaboration Meeting
"CMB x LSS with the HalfDome Simulations"

Mediterranean Institute for Life Sciences, Split, Croatia — July 2024
Cosmology in the Adriatic – From PT to AI
"Cosmology in the Adriatic with Adrian: from field-level inference to joint analyses"

Università degli Studi di Catania - Dipartimento di Fisica e Astronomia, Catania, Italy — July 2024
International Conference on Machine Learning for Astrophysics – 2nd Edition
"Extracting optimal information from cosmological surveys with field-level inference and joint analyses"

Sexten Center for Astrophysics, Sexten, Italy — July 2024
New Strategies For Extracting Cosmology From Future Galaxy Surveys Workshop – 2nd Edition
"The HalfDome CMB x LSS Simulations"

Aspen Center for Physics, Aspen CO, USA — June 2024
Fundamental Physics in the Era of Big Data and Machine Learning
"Physics-based sampling"

Grand Arsenal, Chania, Greece — May 2024
COSMO21: Statistical Challenges in 21st Century Cosmology
"Towards an Optimal Cosmological Detection of Neutrino Mass with Joint Analyses and Field-Level Inference"

Stanford University, Stanford CA, USA — April 2024
Cosmology Seminar
"Towards an Optimal Cosmological Detection of Neutrino Mass with Field-Level Inference"

Yale University, New Haven CT, USA — April 2024
Cosmology Seminar
"Towards an Optimal Cosmological Detection of Neutrino Mass with Field-Level Inference"

Center for Computational Astrophysics, Flatiron Institute, New York NY, USA — March 2024
Cosmology X Data Science Meeting
"The HalfDome CMB x LSS Simulations"

The Center for Cosmology and Particle Physics, New York University, NY, USA — March 2024
Astrophysics and Relativity Seminar
"Towards an Optimal Cosmological Detection of Neutrino Mass with Field-Level Inference"

Center for Data Driven Discovery (CD3), Kavli IPMU, University of Tokyo, Japan — January 2024
The CD3 x Simons Foundation workshop: AI-driven discovery in physics and astrophysics
"Cosmological Field-Level Inference with Microcanonical Langevin Monte Carlo"

High Energy Accelerator Research Organization (KEK), Tskuba, Japan — January 2024
ML at HEP workshop
"Extracting optimal information from upcoming cosmological surveys"

Center for Computational Astrophysics, Flatiron Institute, New York NY, USA — November 2023
Debating the potential of machine learning for astronomical surveys (#2) – IAP/CCA Conference
"Cosmological Field-Level Inference with Microcanonical Langevin Monte Carlo"

Imperial College London, London, UK — November 2023
Seminar
"Towards an Optimal Cosmological Detection of Neutrino Mass"

Monte Verità, Ascona, Switzerland — October 2023
Hamers & Nails, Frontiers in Machine Learning in Cosmology, Astro & Particle Physics
"Cosmological Field-Level Inference with Microcanonical Langevin Monte Carlo"

Hawaii Convention Center, Honolulu HI, USA — July 2023
International Conference on Machine Learning (ICML), Workshop on Machine Learning for Astrophysics
"Field-Level Inference with Microcanonical Langevin Monte Carlo"

Sexten Center for Astrophysics, Sexten, Italy — July 2023
New Strategies For Extracting Cosmology From Future Galaxy Surveys Workshop
"Field-Level Inference with Microcanonical Hamiltonian Monte Carlo"

Center for Computational Astrophysics, Flatiron Institute, New York NY, USA   May 2023
Cosmic Connections Symposium
"Field-Level Inference with Microcanonical Hamiltonian Monte Carlo"

Stanford University, Stanford CA, USA (zoom)   January 2023
LSST Higher-Order Statistics Meeting
"Super-Sample Covariance of Higher-Order Statistics"

Institute for Advanced Studies, Princeton NJ, USA   December 2022
Cosmology Lunch
"Towards Optimal Measurement of the Neutrino Mass using Large-Scale Structure"

Center for Computational Astrophysics, Flatiron Institute, New York NY, USA   December 2022
Cosmology X Data Science Meeting
"Towards Optimal Measurement of the Neutrino Mass using Large-Scale Structure"

University of Pennsylvania, Philadelphia PA, USA   December 2022
CMB Meeting
"Towards Optimal Measurement of the Neutrino Mass using Large-Scale Structure"

Université de Montréal, Montréal, Canada   November 2022
Astromerique Speaker Series
"Massive Neutrino Information in Large-Scale Structure and Field-Level Inference"

Vipolže, Slovenia   July 2022
Berkeley Center for Cosmological Physics Summer Workshop
"Massive Neutrino Information in Large-Scale Structure and Field-Level Inference"

The University of Tokyo (Hongo Campus), Tokyo, Japan   May 2022
GPU Workshop
"Cosmological simulations on GPU with tensorflow"

The University of Tokyo (Kavli IPMU), Kashiwanoha, Japan   April 2022
APEC Seminar
"Towards detecting neutrino mass using non-linear cosmic structure"

Kyoto University (Yukawa Institute for Theoretical Physics), Kyoto, Japan   April 2022
Cosmology with Weak Lensing: Beyond the 2-pt Statistics
"Detecting neutrino mass using nonlinear cosmic structure"

Institut d'Astrophysique de Paris, Paris, France   February 2022
Journal Club – Univers
"Detecting neutrino mass using nonlinear cosmic structure"

Center for Computational Astrophysics, Flatiron Institute, New York NY, USA   August 2021
Learn the Universe
"The Look-Elsewhere Effect"

Pennsylvania State University, State College PA, USA   June 2021
Statistical Challenges in Modern Astronomy VII
"The Look-Elsewhere Effect from a Unified Bayesian and Frequentist Perspective"

University of Cambridge (Kavli Institute for Cosmology), Cambrigde, UK   September 2019
KICC 10th Anniversary Symposium
"Look Elsewhere" (poster)

TEACHING

Astronomy
Lecturer, East Jersey State Prison, 2024

Bayesian Data Analysis and Machine Learning for Physical Sciences
Graduate Student Instructor, UC Berkeley, 2021

Python for Physics
Teaching Assistant, Imperial College London, 2016

MENTORING

Yue Pan (Graduate Student), Princeton University (2024–)
Project: Primordial non-Gaussianity with Voids

Veena Krishnaraj (Undergraduate Student), Princeton University (2024–)
Project: Beyond the Standard Model with Machine Learning

James Robinson (Undergraduate Student), Princeton University (2024–)
Project: Fast Algorithms for Computing the Kinetic Sunyaev-Zeldovich Effect

Arnab Lahiry (Undergraduate Student), Indian Institute of Science Education and Research, Tirupati (2024–)
Project: Interpreting the Source of Information in the Cosmic Web (co-advised with Francisco Villaescusa-Navarro)

Chenze Dong (Graduate Student), University of Tokyo (2024–)
Project: Field-Level Inference for Galaxies (co-advised with Ben Horowitz and KG Lee)

Akira Tokiwa (Graduate Student), University of Tokyo (2023–)
Project: Super-Sample Covariance for Weak Lensing (co-advised with Jia Liu and Masahiro Takada)

James Sunseri (Graduate Student), Princeton University (2023–)
Project: Information Content of the Cosmic Web (co-advised with Jia Liu)

Yici Zhong (Graduate Student), University of Tokyo (2022–2024)
Project: HalfDome Cosmological Simulations for Stage IV Surveys (co-advised with Jia Liu)

Malika Golshan (Undergraduate Student), UC Berkeley (2022–2024)
Project: Interpreting what AI learns about neutrino physics in cosmological simulations

OUTREACH TALKS

Neutrino Mass from Cosmology: Measuring the Mass of a Needle in a Haystack   August 2024
New Jersey State Museum, Planetarium, Trenton NJ, USA

Neutrino Mass from Cosmology: Measuring the Mass of a Needle in a Haystack   November 2023
Astronomy on Tap, Trenton NJ, USA

OUTREACH

Astronomy on Tap @ Trenton, Host and Organizer (2023, 2024)

Presenter at City College of New York STEM Career Fair (2024)

Media Representative at the Flatiron-Nomad Partnership and Simons Foundation Public Eclipse Party (2024)

Berkeley Compass Mentor (2022)

Adopt-a-Physicist Mentor (2020)

ACADEMIC SERVICES

Convener of **Numerical Cosmology and Artificial Intelligence** session at COSMO'24 [Japan] (2024)

Organizer of **Cosmology Lunch Meeting** at Princeton University (2024)

Organizer of **Cosmology and ML Meeting** at Simons Foundation (2024)

Organizer of **Debating the potential of machine learning for astronomical surveys (#2)** conference at IAP/CCA (2023)

REFEREEING

Astronomy & Astrophysics (A&A), The Astrophysical Journal (ApJ), Astrophysical Journal Letters (ApJL), International Conference on Machine Learning (ICML), Journal of Cosmology and Astroparticle Physics (JCAP), Monthly Notices of the Royal Astronomical Society (MNRAS), Neural Information Processing Systems (NeurIPS)

COLLABORATIONS

HalfDome (Leader), Simons Observatory, LSST, Learning the Universe

REFERENCES

Prof. Uroš Seljak
useljak@berkeley.edu
Departments of Physics and Astronomy, University of California, Berkeley

Prof. David Spergel
dspergel@simonsfoundation.org
Simons Foundation, New York City

Prof. Jia Liu
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Kavli Institute for the Physics and Mathematics of the Universe, University of Tokyo