

ADRIAN E. BAYER

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📍 New York Metropolitan Area, USA

EDUCATION

University of California, Berkeley, USA

Ph.D. Physics

2018–2023

Thesis adviser: Uroš Seljak

University of Cambridge, UK

Master of Advanced Study, Mathematics

2017–2018

Imperial College London, UK

MSci Physics with Theoretical Physics

Graduated top of the cohort (approx. 250 students)

2013–2017

Thesis adviser: Fay Dowker

ACADEMIC APPOINTMENTS

Flatiron Institute, Simons Foundation, USA

Flatiron Research Fellow

2023–

Princeton University, USA

Postdoctoral Researcher

2023–

The University of Tokyo, Japan

Visiting Researcher (3 months)

2022

Massachusetts Institute of Technology, USA

Undergraduate Researcher (2 months)

2016

Adviser: Lindley Winslow

Imperial College London, UK

Undergraduate Researcher (3 months)

2015

Adviser: Henrique Araújo

HONORS AND AWARDS

Outstanding Graduate Student Instructor Award, University 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

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

Liam Parker (Graduate Student), UC Berkeley (2024–)

Project: Field-Level Inference using CNNs (co-supervised with Uroš Seljak)

Paper: [arXiv: 2504.01092](#) ([astro-ph.CO](#))

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 (2024–5)

Project: Interpreting the Information in the Cosmic Web (co-supervised with Francisco Villaescusa-Navarro)

Paper: [arXiv: 2504.17839](#) ([astro-ph.CO](#))

Chenze Dong (Graduate Student), University of Tokyo (2024–)

Project: Field-Level Inference for Galaxies (co-supervised with Ben Horowitz and KG Lee)

Akira Tokiwa (Graduate Student), University of Tokyo (2023–5)

Project: Super-Sample Covariance for Weak Lensing (co-supervised with Jia Liu and Masahiro Takada)

James Sunseri (Graduate Student), Princeton University (2023–)

Project: Information Content of the Cosmic Web (co-supervised with Jia Liu)

Paper: [arXiv: 2503.11778](#) ([astro-ph.CO](#))

Yici Zhong (Graduate Student), University of Tokyo (2022–4)

Project: HalfDome Cosmological Simulations for Stage IV Surveys (co-supervised with Jia Liu)

Paper: [arXiv: 2407.17462](#) ([astro-ph.CO](#))

Malika Golshan (Undergraduate Student), UC Berkeley (2022–4)

Project: Interpreting what AI learns about neutrino physics in cosmological simulations

Paper: [arXiv: 2410.00914](#) ([astro-ph.CO](#))

ACADEMIC SERVICES

SOC of **MOCK NYC** at New York (2026)

Organizer of **Astrophysics x ML Meeting** at Flatiron Institute (2025–)

Organizer of **Dark Cosmos Seminar** at Princeton University (2025)

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

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

Convener of **Numerical Cosmology and Artificial Intelligence** session at COSMO'24 [Japan] (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), Physical Review D (PRD), Physical Review Letters (PRL)

COLLABORATIONS

HalfDome (Leader)

Simons Observatory (Leader of Foreground / Sky Modeling Working Group)

LSST DESC

Learning the Universe

OUTREACH

Astronomy on Tap @ Jersey Shore, Organizer (Summer 2025)

Astronomy on Tap @ Trenton, Host and Organizer (2023-2025)

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)

OUTREACH TALKS

Neutrino Mass from Cosmology: Measuring the Mass of a Needle in a Haystack New Jersey State Museum, Planetarium, Trenton NJ, USA	August 2024
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Neutrino Mass from Cosmology: Measuring the Mass of a Needle in a Haystack Astronomy on Tap, Trenton NJ, USA	November 2023
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SELECTED ACADEMIC TALKS

Center for Computational Astrophysics, Flatiron Institute, New York NY, USA Exoplanet Meeting “Detecting astronomical signals in large and noisy spaces”	June 2025
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Center for Computational Astrophysics, Flatiron Institute, New York NY, USA Cosmology X Data Science Meeting “What’s the Likelihood? Field-Level Cosmology x Detecting Signals in Large and Noisy Places”	May 2025
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Center for Astrophysics, Harvard University, Cambridge MA, USA AstroAI Seminar “Why a tiny neutrino particle inspired me to reconstruct the initial conditions of the Universe”	April 2025
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Center for Astrophysics, Harvard University, Cambridge MA, USA ITC Luncheon Talk “Field-Level Reconstruction of the Cosmological Initial Conditions”	April 2025
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Massachusetts Institute of Technology, Cambridge MA, USA TESS Science Talk “Detecting astronomical signals in large and noisy spaces”	April 2025
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University of Pennsylvania, Philadelphia PA, USA Astro Seminar “Why a tiny neutrino particle inspired me to simulate and reconstruct the entire Universe”	April 2025
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Tokyo University, Tokyo, Japan Astronomy Seminar “Towards an Optimal Cosmological Detection of Neutrino Mass with Field-Level Inference and Joint Analyses”	November 2024
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Kyoto University, Kyoto, Japan COSMO'24 "Introduction to Numerical Cosmology and Artificial Intelligence"	October 2024
University of Chicago, Chicago IL, USA Simons Observatory Collaboration Meeting "CMB x LSS with the HalfDome Simulations"	July 2024
Mediterranean Institute for Life Sciences, Split, Croatia Cosmology in the Adriatic – From PT to AI "Cosmology in the Adriatic with Adrian: from field-level inference to joint analyses"	July 2024
Università degli Studi di Catania - Dipartimento di Fisica e Astronomia, Catania, Italy International Conference on Machine Learning for Astrophysics – 2nd Edition "Extracting optimal information from cosmological surveys with field-level inference and joint analyses"	July 2024
Sexten Center for Astrophysics, Sexten, Italy New Strategies For Extracting Cosmology From Future Galaxy Surveys Workshop – 2nd Edition "The HalfDome CMB x LSS Simulations"	July 2024
Aspen Center for Physics, Aspen CO, USA Fundamental Physics in the Era of Big Data and Machine Learning "Physics-based sampling"	June 2024
Grand Arsenal, Chania, Greece COSMO21: Statistical Challenges in 21st Century Cosmology "Towards an Optimal Cosmological Detection of Neutrino Mass with Joint Analyses and Field-Level Inference"	May 2024
Stanford University, Stanford CA, USA Cosmology Seminar "Towards an Optimal Cosmological Detection of Neutrino Mass with Field-Level Inference"	April 2024
Yale University, New Haven CT, USA Cosmology Seminar "Towards an Optimal Cosmological Detection of Neutrino Mass with Field-Level Inference"	April 2024
Center for Computational Astrophysics, Flatiron Institute, New York NY, USA Cosmology X Data Science Meeting "The HalfDome CMB x LSS Simulations"	March 2024
The Center for Cosmology and Particle Physics, New York University, NY, USA Astrophysics and Relativity Seminar "Towards an Optimal Cosmological Detection of Neutrino Mass with Field-Level Inference"	March 2024
Center for Data Driven Discovery (CD3), Kavli IPMU, University of Tokyo, Japan The CD3 x Simons Foundation workshop: AI-driven discovery in physics and astrophysics "Cosmological Field-Level Inference with Microcanonical Langevin Monte Carlo"	January 2024
High Energy Accelerator Research Organization (KEK), Tsukuba, Japan ML at HEP workshop "Extracting optimal information from upcoming cosmological surveys"	January 2024
Center for Computational Astrophysics, Flatiron Institute, New York NY, USA Debating the potential of machine learning for astronomical surveys (#2) – IAP/CCA Conference "Cosmological Field-Level Inference with Microcanonical Langevin Monte Carlo"	November 2023
Imperial College London, London, UK Seminar "Towards an Optimal Cosmological Detection of Neutrino Mass"	November 2023

Monte Verità, Ascona, Switzerland Hamers & Nails, Frontiers in Machine Learning in Cosmology, Astro & Particle Physics “Cosmological Field-Level Inference with Microcanonical Langevin Monte Carlo”	October 2023
Hawaii Convention Center, Honolulu HI, USA International Conference on Machine Learning (ICML), Workshop on Machine Learning for Astrophysics “Field-Level Inference with Microcanonical Langevin Monte Carlo”	July 2023
Sexten Center for Astrophysics, Sexten, Italy New Strategies For Extracting Cosmology From Future Galaxy Surveys Workshop “Field-Level Inference with Microcanonical Hamiltonian Monte Carlo”	July 2023
Center for Computational Astrophysics, Flatiron Institute, New York NY, USA Cosmic Connections Symposium “Field-Level Inference with Microcanonical Hamiltonian Monte Carlo”	May 2023
Stanford University, Stanford CA, USA (zoom) LSST Higher-Order Statistics Meeting “Super-Sample Covariance of Higher-Order Statistics”	January 2023
Institute for Advanced Studies, Princeton NJ, USA Cosmology Lunch “Towards Optimal Measurement of the Neutrino Mass using Large-Scale Structure”	December 2022
Center for Computational Astrophysics, Flatiron Institute, New York NY, USA Cosmology X Data Science Meeting “Towards Optimal Measurement of the Neutrino Mass using Large-Scale Structure”	December 2022
University of Pennsylvania, Philadelphia PA, USA CMB Meeting “Towards Optimal Measurement of the Neutrino Mass using Large-Scale Structure”	December 2022
Université de Montréal, Montréal, Canada Astromerique Speaker Series “Massive Neutrino Information in Large-Scale Structure and Field-Level Inference”	November 2022
Vipolže, Slovenia Berkeley Center for Cosmological Physics Summer Workshop “Massive Neutrino Information in Large-Scale Structure and Field-Level Inference”	July 2022
The University of Tokyo (Hongo Campus), Tokyo, Japan GPU Workshop “Cosmological simulations on GPU with tensorflow”	May 2022
The University of Tokyo (Kavli IPMU), Kashiwanoha, Japan APEC Seminar “Towards detecting neutrino mass using non-linear cosmic structure”	April 2022
Kyoto University (Yukawa Institute for Theoretical Physics), Kyoto, Japan Cosmology with Weak Lensing: Beyond the 2-pt Statistics “Detecting neutrino mass using nonlinear cosmic structure”	April 2022
Institut d’Astrophysique de Paris, Paris, France Journal Club – Univers “Detecting neutrino mass using nonlinear cosmic structure”	February 2022
Center for Computational Astrophysics, Flatiron Institute, New York NY, USA Learn the Universe “The Look-Elsewhere Effect”	August 2021

BIBLIOGRAPHY

PRIMARY AUTHOR:

1. Thiele, L., **A. E. Bayer**, and N. Takeishi. “Simulation-Efficient Cosmological Inference with Multi-Fidelity SBI”. in: (July 2025). arXiv: [2507.00514 \[astro-ph.CO\]](#)
2. **Bayer, A. E.**, F. Villaescusa-Navarro, S. Sharief, R. Teyssier, L. H. Garrison, L. Perreault-Levasseur, G. L. Bryan, M. Gatti, and E. Visbal. “Field-Level Comparison and Robustness Analysis of Cosmological N-Body Simulations”. In: (May 2025). arXiv: [2505.13620 \[astro-ph.CO\]](#)
3. Lahiry, A., **A. E. Bayer**, and F. Villaescusa-Navarro. “Interpreting Cosmological Information from Neural Networks in the Hydrodynamic Universe”. In: (Apr. 2025). arXiv: [2504.17839 \[astro-ph.CO\]](#)
4. Parker, L., **A. E. Bayer**, and U. Seljak. “Initial Conditions from Galaxies: Machine-Learning Subgrid Correction to Standard Reconstruction”. In: (Apr. 2025). arXiv: [2504.01092 \[astro-ph.CO\]](#)
5. Sunseri, J., **A. E. Bayer**, and J. Liu. “The Power of the Cosmic Web”. In: (Mar. 2025). arXiv: [2503.11778 \[astro-ph.CO\]](#)
6. Golshan, M. and **A. E. Bayer**. “Massive ν s through the CNN lens: interpreting the field-level neutrino mass information in weak lensing”. In: *JCAP* 05 (2025), p. 024. DOI: [10.1088/1475-7516/2025/05/024](#). arXiv: [2410.00914 \[astro-ph.CO\]](#)
7. 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 \[astro-ph.GA\]](#)
8. **Bayer, A. E.**, Y. Zhong, Z. Li, J. DeRose, Y. Feng, and J. Liu. “The HalfDome multi-survey cosmological simulations: N-body simulations”. In: *JCAP* 05 (2025), p. 016. DOI: [10.1088/1475-7516/2025/05/016](#). arXiv: [2407.17462 \[astro-ph.CO\]](#)
9. **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 \[astro-ph.CO\]](#)
10. **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 \[astro-ph.CO\]](#)
11. **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 \[astro-ph.CO\]](#)
12. **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 \[astro-ph.CO\]](#)
13. **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 \[astro-ph.CO\]](#)
14. **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 \[astro-ph.IM\]](#)

15. **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](https://doi.org/10.3847/1538-4357/ac0e91). arXiv: [2102.05049](https://arxiv.org/abs/2102.05049) [[astro-ph.CO](#)]
16. **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](https://doi.org/10.1088/1475-7516/2021/01/016). arXiv: [2007.13394](https://arxiv.org/abs/2007.13394) [[astro-ph.CO](#)]
17. **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](https://doi.org/10.1088/1475-7516/2020/10/009). arXiv: [2007.13821](https://arxiv.org/abs/2007.13821) [[physics.data-an](#)]

CONTRIBUTING AUTHOR:

1. Xu, L., M. Sarkar, A. I. Lonappan, Í. Zubeldia, P. Villanueva-Domingo, S. Casas, C. Fidler, C. Amancharla, U. Tiwari, **A. Bayer**, C. A. Ekiou, M. Cranmer, A. Dimitrov, J. Fergusson, K. Gandhi, S. Krippendorf, A. Laverick, J. Lesgourgues, A. Lewis, T. Meier, B. Sherwin, K. Surrao, F. Villaescusa-Navarro, C. Wang, X. Xu, and B. Bolliet. “Open Source Planning Control System with Language Agents for Autonomous Scientific Discovery”. In: (2025). arXiv: [2507.07257](https://arxiv.org/abs/2507.07257) [[cs.AI](#)]. URL: <https://arxiv.org/abs/2507.07257>
2. Huang, N., R. Stiskalek, J.-Y. Lee, **A. E. Bayer**, C. C. Margossian, C. K. Jespersen, L. A. Perez, L. K. Saul, and F. Villaescusa-Navarro. “CosmoBench: A Multiscale, Multiview, Multitask Cosmology Benchmark for Geometric Deep Learning”. In: (2025). arXiv: [2507.03707](https://arxiv.org/abs/2507.03707) [[cs.LG](#)]. URL: <https://arxiv.org/abs/2507.03707>
3. 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”. In: (2024). arXiv: [2409.17975](https://arxiv.org/abs/2409.17975) [[astro-ph.CO](#)]. URL: <https://arxiv.org/abs/2409.17975>
4. Pandey, S., C. Modi, B. D. Wandelt, D. J. Bartlett, **A. E. Bayer**, G. L. Bryan, M. Ho, G. Lavaux, T. L. Mäkinen, and F. Villaescusa-Navarro. “CHARM: Creating Halos with Auto-Regressive Multi-stage networks”. In: (Sept. 2024). arXiv: [2409.09124](https://arxiv.org/abs/2409.09124) [[astro-ph.CO](#)]
5. 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](https://doi.org/10.1093/mnras/stac1501). arXiv: [2202.06074](https://arxiv.org/abs/2202.06074) [[astro-ph.CO](#)]
6. 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](https://doi.org/10.3847/1538-4357/ac7d4b). arXiv: [2107.02304](https://arxiv.org/abs/2107.02304) [[astro-ph.CO](#)]
7. 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](https://doi.org/10.1016/j.astropartphys.2018.07.001). arXiv: [1801.07231](https://arxiv.org/abs/1801.07231) [[physics.ins-det](#)]

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