

BENJAMIN HOROWITZ

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<https://bhorowitz.github.io>

Research Interests

Novel Astrophysical Simulation/Inference Methods and Machine Learning
The Cosmic Web and Galaxy-Halo/Environment Connection
Intergalactic and Intracluster Medium Physics

Education

University of California, Berkeley — Berkeley, CA *Fall 2014–Fall 2019*
MA, Physics (Dec. 2015), Ph.D. (Dec. 2019)
Thesis: *Optimal Reconstruction of Cosmological Density Fields* (Advisor: Prof. Uros Seljak)
NSF Graduate Research Fellowship (2014-2018)
DOE Science Graduate Student Research Award (2019)
Yale University — New Haven, CT *Fall 2010 – Spring 2014*
B.S. in Mathematics and Physics
NASA Connecticut Space Grant Consortium Fellowship (2012)

Academic Appointments

Kavli Institute for the Physics and Mathematics of the Universe — Kashiwanoha, JP *Spring 2024 – Present*
Kavli IPMU Fellow (2024 - current)
Working on machine learning-based approaches connecting large scale structure and hydrodynamics.
Lawrence Berkeley National Lab — Berkeley, CA *Spring 2023 – Fall 2023*
Postdoctoral Research Associate focused on intersection of machine learning and astrophysical analysis.
Princeton Astrophysical Sciences — Princeton, NJ *Spring 2020 – Fall 2022*
Postdoctoral Research Associate focused on statistical analysis and machine learning of large survey data.
Lawrence Berkeley National Lab — Berkeley, CA *Spring 2019 – Fall 2019*
Graduate Student Research Associate
Kavli Institute for the Physics and Mathematics of the Universe — Kashiwanoha, JP *Fall 2018*
NSF-JSPS Graduate Research Opportunities Worldwide Research Fellowship
Hosted by Prof. Khee Gan Lee and Prof. Masahiro Takada
Princeton Plasma Physics Lab — Princeton, NJ *Summer 2013*
Developed algorithms in Python and C++ for calculation of Thomson scattering spectrum for ongoing fusion experiments.

Student Projects Advised

Qi Guo — University of Tokyo, Japan (Graduate) *Spring 2024 – Current*
Constraints on Baryon Feedback from the 3d Ly- α forest power spectra (w/ Prof. Khee-Gan Lee)
Lillie Szemraj — Princeton University, NJ (Undergraduate) *Spring 2024 – Current*
Corrector-in-loop Models for Star Formation and Feedback
Lucas Mebille — École Polytechnique, France (Graduate) *Spring 2024 – Current*
Extracting Dynamic Information from Halo Formation
Chenze Dong — University of Tokyo, Japan (Graduate) *Spring 2023– Current*
Cosmic structure from low redshift galaxy surveys (w/ Prof. Khee-Gan Lee) : In Final Prep
Protocluster Detection in the CLAMATO Field (w/ Prof. Khee-Gan Lee): [2211.09331 \[astro-ph.CO\]](#)

Omar Yehia — University of Tokyo, Japan (Graduate)	<i>Spring 2024 – Fall 2025</i>
Diffusion Models for Baryon Painting	
Jupiter Ding — Princeton, NJ (Undergraduate)	<i>Summer 2021 – Summer 2022</i>
Differentiable Analysis of Ly- α Hydrodynamical Simulations: 2407.16009 [astro-ph.CO]	
Current Ph.D. Student at Northwestern	
Adam Rebei — Princeton, NJ (Undergraduate)	<i>Summer 2021 – Summer 2022</i>
Optimal Power Spectrum Estimation from Lyman Alpha Tomography	
Zihao Li — Sichuan University, China (Undergraduate)	<i>Summer 2019 – Summer 2021</i>
Optimal Void Reconstruction from Next Ly α Tomography : 2102.12306 [astro-ph.GA]	
Current Ph.D. Student at Niels Bohr Institute	
Nishant Misra — UC Berkeley, CA (Undergraduate)	<i>Summer 2019 – Fall 2021</i>
Gaussianization of the Lyman Alpha Forest (w/ Prof. Uros Seljak)	
Current Ph.D. Student at University of Michigan	
Max Dornfest — UC Berkeley, CA (Undergraduate)	<i>Summer 2019 – Fall 2021</i>
Surrogate Models for Ly α Forest : 2106.12675 [astro-ph.CO]	
Current Ph.D. Student at University of Hawaii	
Benjamin Zhang — UC Berkeley, CA (Undergraduate)	<i>Spring 2019 – Spring 2021</i>
Differentiable Pipelines for Cosmic Web Recovery: 2211.09331 [astro-ph.CO]	
Recovery of Intrinsic Alignment Signal from Next Generation Surveys (w/ Prof. KG Lee): 2007.15994 [astro-ph.CO]	
Current Ph.D. Student at University of Southern California	

Teaching Experience

Course	Institution	Role	Semester
Scientific Programming with Python	UC Berkeley	Instructor	Summer 2019
Cosmology and Relativistic Astrophysics	UC Berkeley	TA	Spring 2018
Physics for Future Presidents	UC Berkeley	TA	Fall 2018
Introduction to Cosmology	Stanford	Instructor	Summer 2016
Electricity and Magnetism	UC Berkeley	TA	Spring 2015
History of Mathematics	Yale	TA	Fall 2013
Calculus I	Yale	TA	Spring 2013

Service

Referee: Monthly Notices of The Royal Astronomy Society, Astrophysical Journal, Journal of Cosmology and Astroparticle Physics, Journal of Computational Mathematics

IPMU Astronomy Seminar Organizer — Kashiwanoha, JP *Fall 2024 – Present*

Center for Data Driven Discovery Group Meeting Leader — Kashiwanoha, JP *Fall 2025 – Present*

Learning Unlimited — Cambridge, MA *Spring 2013 – Present*
 Executive Director (2015-2023), Director of Development (2013-2015)
 Led volunteer organization to spread and support student-run educational enrichment programs ("Splash") to various colleges and universities around the United States. Programs reach over 12,000 secondary school students annually in twelve states.

Splash — Various *Fall 2010 – Present*
 Taught over 100 hours of educational outreach courses at Splash programs at Yale, MIT, Bard College, UC Berkeley, and Stanford. Topics taught include Physics of Black Holes, Introduction to Cosmology, Themes of Modern Physics, and Partial Differential Equations.

Splash at Yale — New Haven, CT *Spring 2011 – 2019*
 Executive Director (2011-2013), Board Member (2014 - 2019)

Cofounded educational outreach organization, registered as a 501(c)(3). Program reaches approximately 2,000 students annually.

Observing Proposals

Co-I on successful Subaru proposal S25A0117N for Spectroscopy of QUAsars in Subaru Hexagons (SQUASH)

Co-I on successful ALMA proposals 2025.1.01243.S, 2025.1.01615.S for Cosmic Himalayas

Co-I on successful UC-Keck proposals 2018B_U095, 2019A_U052, 2019B_U180 for CLAMATO DR2

Affiliations

Center for Data-Driven Discovery, University of Tokyo

Lawrence Berkeley National Lab, Center for Computational Cosmology

Prime Focus Spectrograph (PFS)

– Galaxy Evolution - Large Scale Structure Coordinator

COSMOS Lyman-Alpha Mapping And Tomographic Observations (CLAMATO)

Half-Dome collaboration

Large Synoptic Survey Telescope - Dark Energy Science Collaboration (LSST-DESC)

Selected Recent Talks

Kobayashi–Maskawa Institute Seminar (Invited) — Nagoya, JP	3/2026
Artificial Intelligence and High Energy Physics (AI+HEP) in East Asia (Invited) — Tsukuba, JP	1/2026
MockNYC 2026: Improving Galaxy Modeling for Cosmological Inference (Invited) — NYC, New York	1/2026
ASIAA workshop: Reconstructing the Universe — Taipei, Taiwan	12/2025
Putting the Cosmic Large-scale Structure on the Map (Invited) — Vienna, Austria	9/2025
New Strategies for Extracting Cosmology from Future Galaxy Surveys — Sexton, Italy	7/2025
ASIAA Colloquium (Invited) — Taipei, Taiwan	3/2025
Cosmology and galaxy astrophysics with simulations and machine learning — NYC, New York	12/2024
Yale Astrophysics Seminar — New Haven, CT	12/2024
Cosmology in the Adriatic – From PT to AI — Split, Croatia	7/2024
Baryons in the Universe — Kashiwanoha, Japan	4/2024
AI-driven discovery in physics and astrophysics — Kashiwanoha, Japan	1/2024
Future Science with CMB x LSS — Kyoto, Japan	4/2023
Nagoya Astronomy Colloquium (Invited) — Nagoya, Japan	4/2023
Vipolže Cosmology Conference 2022 — Smartno, Slovenia	7/2022
Cosmic Cartography 2022 (Invited) — Virtual	4/2022
CCA/NYU Cosmology X Machine learning Workshop — Virtual	9/2021
Dark Energy Spectroscopic Instrument Machine Learning Club — Virtual	6/2021
Bay Area Likelihood Free Inference Meeting — Berkeley Institute for Data Science, Berkeley, CA	12/2019
Thirty Meter Telescope Science Meeting 2019 — Xiamen University, Xiamen, China	11/2019
First Galaxies, First Structures — Paris Observatory, Paris, France	10/2019
Cosmic Web 2019 — Royal Observatory, Edinburgh, Scotland, UK	6/2019
COSMOS 2019 — Center for Computational Astrophysics, New York City, NY	5/2019
Interstellar Medium Program of Studies Seminar — UCSC, Santa Cruz, CA	5/2019
NYU-CCA Cosmology Seminar — New York City, NY	3/2019
Dark Universe Conference — Kyoto, Japan	2/2019

Led/Co-Led

- [1] **B. Horowitz** and A. Bayer. *jFoF: GPU Cluster Finding with Gradient Propagation*. To be submitted to MNRAS. Nov. 2025. arXiv: [2510.26851 \[astro-ph.CO\]](#).
- [2] **B. Horowitz** and Z. Lukić. “Differentiable Cosmological Hydrodynamics for Field Level Inference and High Dimensional Parameter Constraints”. In: MNRAS (Oct. 2025). DOI: [10.1093/mnras/staf1785](#). arXiv: [2502.02294 \[astro-ph.CO\]](#).
- [3] **B. Horowitz** and P. Melchior. “Joint cosmic density reconstruction from photometric and spectroscopic samples”. In: MNRAS 538.3 (Apr. 2025), pp. 2050–2057. DOI: [10.1093/mnras/staf390](#). arXiv: [2311.18738 \[astro-ph.CO\]](#).
- [4] **B. Horowitz**, R. de Belsunce, and Z. Lukić. “Maximum a posteriori Ly α estimator (MAPLE): band power and covariance estimation of the 3D Ly α forest power spectrum”. In: MNRAS 536.1 (Jan. 2025), pp. 845–850. DOI: [10.1093/mnras/stae2653](#). arXiv: [2403.17294 \[astro-ph.CO\]](#).
- [5] J. Ding*, **B. Horowitz**, and Z. Lukić. “TensorFlow Hydrodynamics Analysis for Ly- α Simulations”. In: *Astronomy and Computing* 48, 100858 (July 2024), p. 100858. DOI: [10.1016/j.ascom.2024.100858](#). arXiv: [2407.16009 \[astro-ph.CO\]](#).
- [6] **B. Horowitz**, C. Hahn, F. Lanusse, C. Modi, and S. Ferraro. “Differentiable stochastic halo occupation distribution”. In: MNRAS 529.3 (Apr. 2024), pp. 2473–2482. DOI: [10.1093/mnras/stae350](#). arXiv: [2211.03852 \[astro-ph.CO\]](#).
- [7] **B. Horowitz**, K.-G. Lee, M. Ata, T. Müller, A. Krolewski, J. X. Prochaska, J. F. Hennawi, M. White, D. Schlegel, R. M. Rich, P. E. Nugent, N. Suzuki, D. Kashino, A. M. Koekemoer, and B. C. Lemaux. “Second Data Release of the COSMOS Ly α Mapping and Tomography Observations: The First 3D Maps of the Detailed Cosmic Web at $2.05 < z < 2.55$ ”. In: ApJS 263.2, 27 (Dec. 2022), p. 27. DOI: [10.3847/1538-4365/ac982d](#). arXiv: [2109.09660 \[astro-ph.CO\]](#).
- [8] **B. Horowitz**, M. Dornfest*, Z. Lukić, and P. Harrington. “HYPHY: Deep Generative Conditional Posterior Mapping of Hydrodynamical Physics”. In: ApJ 941.1, 42 (Dec. 2022), p. 42. DOI: [10.3847/1538-4357/ac9ea7](#). arXiv: [2106.12675 \[astro-ph.CO\]](#).
- [9] Z. Li*, **B. Horowitz**, and Z. Cai. “Improved Ly α Tomography Using Optimized Reconstruction with Constraints on Absorption (ORCA)”. In: ApJ 916.1, 20 (July 2021), p. 20. DOI: [10.3847/1538-4357/ac044a](#). arXiv: [2102.12306 \[astro-ph.GA\]](#).
- [10] **B. Horowitz**, B. Zhang*, K.-G. Lee, and R. Kooistra. “TARDIS. II. Synergistic Density Reconstruction from Ly α Forest and Spectroscopic Galaxy Surveys with Applications to Protoclusters and the Cosmic Web”. In: ApJ 906.2, 110 (Jan. 2021), p. 110. DOI: [10.3847/1538-4357/abca35](#). arXiv: [2007.15994 \[astro-ph.CO\]](#).
- [11] **B. Horowitz**, K.-G. Lee, M. White, A. Krolewski, and M. Ata. “TARDIS. I. A Constrained Reconstruction Approach to Modeling the $z \sim 2.5$ Cosmic Web Probed by Ly α Forest Tomography”. In: ApJ 887.1, 61 (Dec. 2019), p. 61. DOI: [10.3847/1538-4357/ab4d4c](#). arXiv: [1903.09049 \[astro-ph.CO\]](#).
- [12] **B. Horowitz**, U. Seljak, and G. Aslanyan. “Efficient optimal reconstruction of linear fields and band-powers from cosmological data”. In: J. Cosmology Astropart. Phys. 2019.10, 035 (Oct. 2019), p. 035. DOI: [10.1088/1475-7516/2019/10/035](#). arXiv: [1810.00503 \[astro-ph.CO\]](#).
- [13] **B. Horowitz**, S. Ferraro, and B. D. Sherwin. “Reconstructing small-scale lenses from the cosmic microwave background temperature fluctuations”. In: MNRAS 485.3 (May 2019), pp. 3919–3929. DOI: [10.1093/mnras/stz566](#). arXiv: [1710.10236 \[astro-ph.CO\]](#).
- [14] **B. Horowitz** and U. Seljak. “Cosmological constraints from thermal Sunyaev-Zeldovich power spectrum revisited”. In: MNRAS 469.1 (July 2017), pp. 394–400. DOI: [10.1093/mnras/stx766](#). arXiv: [1609.01850 \[astro-ph.CO\]](#).
- [15] **B. Horowitz**. “Revisiting Primordial Black Holes Constraints from Ionization History”. In: *arXiv e-prints* (Dec. 2016). DOI: [10.48550/arXiv.1612.07264](#). arXiv: [1612.07264 \[astro-ph.CO\]](#).
- [16] R. Zinn, **B. Horowitz**, A. K. Vivas, C. Baltay, N. Ellman, E. Hadjiyska, D. Rabinowitz, and L. Miller. “La Silla QUEST RR Lyrae Star Survey: Region F”. In: ApJ 781.1, 22 (Jan. 2014), p. 22. DOI: [10.1088/0004-637X/781/1/22](#). arXiv: [1312.1602 \[astro-ph.GA\]](#).

Papers with Contribution

- [17] C. Byrohl, D. Nelson, **B. Horowitz**, K.-G. Lee, and A. Pillepich. “Introducing cosmosTNG: Simulating galaxy formation with constrained realizations of the COSMOS field”. In: A&A 698, A103 (June 2025), A103. DOI: [10.1051/0004-6361/202451970](#). arXiv: [2409.19047 \[astro-ph.GA\]](#).

* Students advised.

- [18] R. Momose, K.-G. Lee, M. Ata, **B. Horowitz**, and J. S. Kartaltepe. “The dependence of galaxy properties on the underlying three-dimensional matter density field at $2.0 < z < 2.5$ ”. In: PASJ 76.6 (Dec. 2024), pp. 1143–1157. DOI: [10.1093/pasj/psae076](https://doi.org/10.1093/pasj/psae076). arXiv: [2212.05984](https://arxiv.org/abs/2212.05984) [astro-ph.GA].
- [19] D. Lanzieri, F. Lanusse, C. Modi, **B. Horowitz**, J. Harnois-Déraps, J.-L. Starck, and LSST Dark Energy Science Collaboration (LSST DESC). “Forecasting the power of higher order weak-lensing statistics with automatically differentiable simulations”. In: A&A 679, A61 (Nov. 2023), A61. DOI: [10.1051/0004-6361/202346888](https://doi.org/10.1051/0004-6361/202346888). arXiv: [2305.07531](https://arxiv.org/abs/2305.07531) [astro-ph.IM].
- [20] B. Zhang*, K.-G. Lee, A. Krolewski, J. Shi, **B. Horowitz**, and R. Kooistra. “Alignments between Galaxies and the Cosmic Web at z 1-2 in the IllustrisTNG Simulations”. In: ApJ 954.1, 49 (Sept. 2023), p. 49. DOI: [10.3847/1538-4357/ace695](https://doi.org/10.3847/1538-4357/ace695). arXiv: [2211.09331](https://arxiv.org/abs/2211.09331) [astro-ph.CO].
- [21] C. Dong, K.-G. Lee, M. Ata, **B. Horowitz**, and R. Momose. “Observational Evidence for Large-scale Gas Heating in a Galaxy Protocluster at $z = 2.30$ ”. In: ApJ 945.2, L28 (Mar. 2023), p. L28. DOI: [10.3847/2041-8213/acba89](https://doi.org/10.3847/2041-8213/acba89). arXiv: [2303.07619](https://arxiv.org/abs/2303.07619) [astro-ph.GA].
- [22] J. Greene, R. Bezanson, M. Ouchi, J. Silverman, and the PFS Galaxy Evolution Working Group (including **B. Horowitz**). “The Prime Focus Spectrograph Galaxy Evolution Survey”. In: *arXiv e-prints*, arXiv:2206.14908 (June 2022), arXiv:2206.14908. DOI: [10.48550/arXiv.2206.14908](https://doi.org/10.48550/arXiv.2206.14908). arXiv: [2206.14908](https://arxiv.org/abs/2206.14908) [astro-ph.GA].
- [23] R. Kooistra, K.-G. Lee, and **B. Horowitz**. “Constraining the Fluctuating Gunn-Peterson Approximation using Ly α Forest Tomography at $z = 2$ ”. In: ApJ 938.2, 123 (Oct. 2022), p. 123. DOI: [10.3847/1538-4357/ac92e8](https://doi.org/10.3847/1538-4357/ac92e8). arXiv: [2201.10169](https://arxiv.org/abs/2201.10169) [astro-ph.CO].
- [24] A. Bennett, L. E. Condon, **B. Horowitz**, E. Leonarduzzi, R. M. Maxwell, P. Melchior, and H. Tran. “Surrogate modeling of the hydrologic cycle to advance on-demand seasonal prediction capabilities across the Continental United States”. In: *Frontiers in Hydrology 2022*. June 2022, 203-01, pp. 203–01.
- [25] P. Harrington, M. Mustafa, M. Dornfest, **B. Horowitz**, and Z. Lukić. “Fast, High-fidelity Ly α Forests with Convolutional Neural Networks”. In: ApJ 929.2, 160 (Apr. 2022), p. 160. DOI: [10.3847/1538-4357/ac5faa](https://doi.org/10.3847/1538-4357/ac5faa). arXiv: [2106.12662](https://arxiv.org/abs/2106.12662) [astro-ph.CO].
- [26] C. Baltay, D. Rabinowitz, E. Hadjiyska, E. S. Walker, P. Nugent, P. Coppi, N. Ellman, U. Feindt, R. McKinnon, **B. Horowitz**, and A. Effron. “The La Silla-QUEST Low Redshift Supernova Survey”. In: PASP 125.928 (June 2013), p. 683. DOI: [10.1086/671198](https://doi.org/10.1086/671198).
- [27] C. Baltay, D. Rabinowitz, E. Hadjiyska, M. Schwamb, N. Ellman, R. Zinn, S. Tourtellotte, R. McKinnon, **B. Horowitz**, A. Effron, and P. Nugent. “The La Silla-QUEST Southern Hemisphere Variability Survey”. In: *The Messenger* 150 (Dec. 2012), pp. 34–38.

Other Published Works

- [28] **B. Horowitz**, C. Cuesta-Lazaro, and O. Yehia. “BaryonBridge: Stochastic Interpolant Model for Fast Hydrodynamical Simulations”. In: *ICML2025 ml4astro Workshop*, arXiv:2510.19224 (Oct. 2025), arXiv:2510.19224. DOI: [10.48550/arXiv.2510.19224](https://doi.org/10.48550/arXiv.2510.19224). arXiv: [2510.19224](https://arxiv.org/abs/2510.19224) [astro-ph.CO].
- [29] **B. Horowitz** and P. Melchior. “Plausible Adversarial Attacks on Direct Parameter Inference Models in Astrophysics”. In: *NeurIPS ML4PS workshop*, arXiv:2211.14788 (Nov. 2022), arXiv:2211.14788. DOI: [10.48550/arXiv.2211.14788](https://doi.org/10.48550/arXiv.2211.14788). arXiv: [2211.14788](https://arxiv.org/abs/2211.14788) [astro-ph.CO].
- [30] A. Bennett, **B. Horowitz**, E. Leonarduzzi, Y. Ma, A. Triplett, R. Hull, L. E. Condon, R. M. Maxwell, and P. Melchior. “Towards calibration of physics-based integrated surface-groundwater models using deep-learning based surrogates and simulation based inference”. In: *AGU Fall Meeting Abstracts*. Vol. 2022. AGU Fall Meeting Abstracts. Dec. 2022, H35C-08, H35C-08.
- [31] B. Zhang, K. Lee, A. Krolewski, **B. Horowitz**, J. Primack, and D. Hellinger. “Forecasting High- z Galaxy-Cosmic Web Alignments for Subaru-PFS”. In: *American Astronomical Society Meeting Abstracts #237*. Vol. 237. American Astronomical Society Meeting Abstracts. Jan. 2021, 154.05, p. 154.05.
- [32] **B. Horowitz**, R. Zinn, B. Charles, P. S. Coppi, N. E. Ellman, G. Fowler, E. I. Hadjiyska, D. L. Rabinowitz, and K. Vivas. “Expanded RR Lyrae Search in the Southern Hemisphere with the La Silla-QUEST Survey”. In: *American Astronomical Society Meeting Abstracts #223*. Vol. 223. American Astronomical Society Meeting Abstracts. Jan. 2014, 156.07, p. 156.07.
- [33] **B. Horowitz**, A. Diallo, E. Feibush, and B. Leblanc. “Modular Python-based Code for Thomson Scattering System on NSTX-U”. In: *APS Division of Plasma Physics Meeting Abstracts*. Vol. 2013. APS Meeting Abstracts. Oct. 2013, JP8.018, JP8.018.

- [34] E. Hadjiyska, D. Rabinowitz, C. Baltay, N. Ellman, P. Nugent, R. Zinn, **B. Horowitz**, R. McKinnon, and L. R. Miller. “La Silla-QUEST Variability Survey in the Southern Hemisphere”. In: *New Horizons in Time Domain Astronomy*. Ed. by E. Griffin, R. Hanisch, and R. Seaman. Vol. 285. IAU Symposium. Apr. 2012, pp. 324–326. DOI: [10.1017/S1743921312000944](https://doi.org/10.1017/S1743921312000944). arXiv: [1210.1584](https://arxiv.org/abs/1210.1584) [[astro-ph.IM](#)].