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) *Spring 2024 – Fall 2025*

Diffusion Models for Baryon Painting

Jupiter Ding — Princeton, NJ (Undergraduate) *Summer 2021 – Summer 2022*

Differentiable Analysis of Ly-α Hydrodynamical Simulations: 2407.16009 [astro-ph.CO]

Current Ph.D. Student at Northwestern

Adam Rebei — Princeton, NJ (Undergraduate) *Summer 2021 – Summer 2022*

Optimal Power Spectrum Estimation from Lyman Alpha Tomography

Zihao Li — Sichuan University, China (Undergraduate) *Summer 2019 – Summer 2021*

Optimal Void Reconstruction from Next Lyα Tomography : 2102.12306 [astro-ph.GA]

Current Ph.D. Student at Niels Bohr Institute

Nishant Misra — UC Berkeley, CA (Undergraduate) *Summer 2019 – Fall 2021*

Gaussianization of the Lyman Alpha Forest (w/ Prof. Uros Seljak)

Current Ph.D. Student at University of Michigan

Max Dornfest — UC Berkeley, CA (Undergraduate) *Summer 2019 – Fall 2021*

Surrogate Models for Lyα Forest : 2106.12675 [astro-ph.CO]

Current Ph.D. Student at University of Hawaii

Benjamin Zhang — UC Berkeley, CA (Undergraduate) *Spring 2019 – Spring 2021*

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)

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 Lyα 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 Lyα 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 Lyα 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 ∼ 2.5 Cosmic Web Probed by Lyα 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 I". 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].

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* 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. arXiv: 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. arXiv: 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. arXiv: 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. arXiv: 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. arXiv: 2206.14908 [astro-ph.GA].

[23] R. Kooistra, K.-G. Lee, and **B. Horowitz**. "Constraining the Fluctuating Gunn-Peterson Approximation using Lyα Forest Tomography at z = 2". In: ApJ 938.2, 123 (Oct. 2022), p. 123. DOI: 10.3847/1538-4357/ac92e8. arXiv: 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 Lyα Forests with Convolutional Neural Networks". In: ApJ 929.2, 160 (Apr. 2022), p. 160. DOI: 10.3847/1538-4357/ac5faa. arXiv: 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.

[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. arXiv: 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. arXiv: 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. arXiv: 1210.1584 [astro-ph.IM].