Keefe Edward Alden Mitman

CONTACT
INFORMATION

Cornell University
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EMPLOYMENT

NASA Einstein Fellow, Cornell University

September 2024 - September 2027.

❏ Guest Researcher at the Flatiron Institute's Center for Computation Astrophysics.
❏ Guest Researcher at Princeton University's Gravity Initiative.

Postdoctoral Researcher, California Institute of Technology

June 2024 - August 2024.

EDUCATION

California Institute of Technology

Ph.D. in Physics, June 2024; GPA: 4.33/4.00.

❏ Dissertation:
Asymptotics with Numerical Relativity: Gravitational Memory, BMS Frames, and Nonlinearities.
❏ Dissertation Advisor: Professor Saul Teukolsky.

Columbia University in the City of New York

B.A. in Mathematics, B.A. in Physics, May 2019 (Cum Laude); GPA (Physics): 4.02/4.00

❏ Graduated with the Highest Honors in Physics.
❏ Dean's List — every semester.

HONORS/AWARDS

❏ NASA Hubble Fellowship.   *Sep. 2024 - Sep. 2027*
NASA Hubble Fellowship Program.
❏ Leadership Award (for "excellence in leadership and service to the Institute").   *Jun. 2024*
California Institute of Technology.
❏ Robert F. Christy Prize (for "an outstanding doctoral thesis in theoretical physics"),   *Jun. 2024*
California Institute of Technology.
❏ Everhart Lecturer (Lecture Video),   *May 2024*
California Institute of Technology.
❏ John S. Stemple Memorial Prize (for "outstanding progress in physics gresearch"),   *May 2022*
California Institute of Technology.
❏ APS Division of Gravitational Physics Best Student Presentation,   *Mar. 2022*
APS Division of Gravitational Physics.
❏ Rochus E. Vogt Graduate Fellowship,   *Sep. 2019 - Dec. 2019*
California Institute of Technology.
❏ Erwin H. Leiwant Scholarship,   *Sep. 2016 - May 2017*
Columbia University.
❏ Outstanding Achievement in German Language and Literature,   *Sep. 2015 - May 2016*
Columbia University, Department of Germanic Languages.

RESEARCH
INTERESTS

General relativity, numerical relativity simulations, black holes, gravitational waves, memory effects, the BMS group (and other symmetries of asymptotic infinity), ringdowns, surrogate models. Specifically, focusing on the improvement of waveform modeling for binary black hole mergers by matching the data of numerical simulations to that of analytic models using BMS frame fixing. Other interests include improving our understanding of black hole ringdowns and the way nonlinearities escape to infinity.

PUBLICATION SUMMARY	• A total of **32** short-author papers, **8 as lead author**.
	• Out of which, **2 covered by press release/educational programs**.
	• 2 other publications (notes, etc.)

REFEREED PUBLICATIONS

32. Emanuele Berti, Vitor Cardoso, Gregorio Carullo, *et al.* (66 authors w/ **Keefe Mitman**)
Black hole spectroscopy: from theory to experiment.
arXiv:2505.23895. (submitted to CQG). Jun. 2025.

31. Mark A. Scheel, Michael Boyle, **Keefe Mitman**, Nils Deppe, Leo C. Stein, *et al.*
The SXS Collaboration's third catalog of binary black hole simulations.
arXiv:2505.13378. (submitted to CQG). May 2025.

30. Scott E. Field, Vijay Varma, *et al.* (12 authors w/ **Keefe Mitman**)
GWSurrogate: A Python package for gravitational wave surrogate models.
J. Open Source Softw. 10 (2025) 107, 7073. Mar. 2025.

29. Guido Da Re, **Keefe Mitman**, Leo C. Stein, *et al.*
Modeling the BMS transformation induced by a binary black hole merger.
arXiv:2503.09569 Mar. 2025. (submitted to PRD).

28. **Keefe Mitman**, Isabella Pretto, Harrison Siegel, *et al.*
Probing the ringdown perturbation in binary black hole coalescences with an improved quasi-normal mode extraction algorithm.
arXiv:2503.09678. Mar. 2025. (submitted to PRD).

27. **Keefe Mitman**, Leo C. Stein, *et al.*
Length dependence of waveform mismatch: a caveat on waveform accuracy.
arXiv:2502.14025. Feb. 2025. (submitted to CQG).

26. Marina De Amicis *et al.* (20 authors w/ **Keefe Mitman**)
Late-time tails in nonlinear evolutions of merging black holes.
arXiv:2412.06887. Dec. 2024. (submitted to PRL).

25. Matt Giesler, Sizheng Ma, **Keefe Mitman**, *et al.*
Overtones and Nonlinearities in Binary Black Hole Ringdowns.
Phys. Rev. D 111, 084041. arXiv:2411.11269. Apr. 2025.

24. Geoffrey Lovelace, *et al.* (31 authors w/ **Keefe Mitman**)
Simulating binary black hole mergers using discontinuous Galerkin methods.
Class. Quantum Grav. 42 035001. arXiv:2410.00265. Jan. 2025.

23. Lorena Magaña Zertuche, Leo C. Stein, **Keefe Mitman**, *et al.*
High-Precision Ringdown Surrogate Model for Non-Precessing Binary Black Holes.
arXiv:2408.05300. Aug. 2024. (submitted to PRD).

22. Scott E. Field, *et al.* (12 authors w/ **Keefe Mitman**)
GWSurrogate: A Python package for gravitational wave surrogate models.
Journal of Open Source Software, 10(107), 7073. Jun. 2024.

21. **Keefe Mitman**, Leo C. Stein, Michael Boyle, *et al.*
A review of gravitational memory and BMS frame fixing in numerical relativity.
Class. Quantum Grav. 41 223001. arXiv:2405.08868. May 2024.
In Media: PBS Space Time (animation used at 3:47), SciShow (animation used at 2:27).

20. Yitian Chen, *et al.* (12 authors w/ **Keefe Mitman**)
Improved frequency spectra of gravitational waves with memory in a binary black hole simulation.
Phys. Rev. D 110, 064049. arXiv:2405.06197. Sep. 2024.

19. Dongze Sun, Michael Boyle, **Keefe Mitman**, *et al.*
Optimizing post-Newtonian parameters and fixing the BMS frame
for numerical relativity waveform hybridizations.
Phys. Rev. D 110, 104076. arXiv:2403.10278. Mar. 2024.

18. Luisa T. Buchman, *et al.* (7 authors w/ **Keefe Mitman**)
Numerical relativity multimodal waveforms using absorbing boundary conditions.
Class. Quantum Grav. 41 175011. arXiv:2402.12544. Feb. 2024.

17. Teagan Clarke, *et al.* (12 authors w/ **Keefe Mitman**)
Toward a self-consistent framework for measuring black hole ringdowns.
Phys. Rev. D 109, 124030. arXiv:2402.02819. Feb. 2024.

16. Hengrui Zhu, Justin Ripley, Frans Pretorius, Sizheng Ma, **Keefe Mitman**, Robert Owen, *et al.*
Nonlinear Effects In Black Hole Ringdown From Scattering Experiments I:
spin and initial data dependence of quadratic mode coupling.
Phys. Rev. D 109, 104050 (2024). arXiv:2401.00805. Jan. 2024.

15. Hengrui Zhu, Harrison Siegel, **Keefe Mitman**, Maximiliano Isi, Will Farr, *et al.*
Black Hole Spectroscopy for Precessing Binary Black Hole Coalescences.
arXiv:2312.08588. Dec. 2023. (submitted to PRD).

14. Alexander M. Grant, **Keefe Mitman**
Higher Memory Effects in Numerical Simulations of Binary Black Hole Mergers.
Class. Quantum Grav. 41 175003. arXiv:2312.02295. July. 2024.

13. Matteo Boschini, *et al.* (21 authors w/ **Keefe Mitman**)
Extending black-hole remnant surrogate models to extreme mass ratios.
arXiv:2307.03435. Jul. 2023.

12. Jooheon Yoo, **Keefe Mitman**, Vijay Varma, *et al.*
Numerical relativity surrogate model with memory effects and post-Newtonian hybridization.
Phys. Rev. D 108, 064027 (2023). arXiv:2306.03148. Sep. 2023.

11. Lorenzo Pompili, *et al.* (24 authors w/ **Keefe Mitman**)
Laying the foundation of the effective-one-body waveform models SEOBNRv5:
improved accuracy and efficiency for spinning non-precessing binary black holes.
arXiv:2303.18039. Mar. 2023.

10. **Keefe Mitman**, Macarena Lagos, Leo C. Stein, *et al.*
Nonlinearities in black hole ringdowns.
Phys. Rev. Lett. 130, 081402 (2023). arXiv:2208.07380. Feb. 2023.
Editors' Suggestion and Featured in Physics.
In Press: Caltech, Columbia, UMiss, JHU, APS Physics, Physics World, Space.com, etc.
In Media: Can gravitational waves INTERFERE with each other?

9. **Keefe Mitman**, Leo C. Stein, Michael Boyle, *et al.*
Fixing the BMS frame of numerical relativity waveforms with BMS charges.
Phys. Rev. D 106, 084029 (2022). arXiv:2208.04356. Oct. 2022.

8. Sizheng Ma, **Keefe Mitman**, Ling Sun, *et al.*
Quasinormal-mode filters:
a new approach to analyze the gravitational-wave ringdown of binary black-hole mergers.
Phys. Rev. D 106, 084036 (2022). arXiv:2207.10870. Oct. 2022.

7. Lorena Magaña Zertuche, **Keefe Mitman**, Neev Khera, Leo C. Stein, *et al.*
High precision ringdown modeling: mutlimode fits and BMS frames.
Phys. Rev. D 105, 104015 (2022). arXiv:2110.15922. May 2022.

6. **Keefe Mitman**, Neev Khera, Dante A. B. Iozzo, Leo C. Stein, *et al.*
Fixing the BMS frame of numerical relativity waveforms.
Phys. Rev. D 104, 024051 (2021). arXiv:2105.02300. Jul. 2021.

5. Dante A. B. Iozzo, Neev Khera, Leo C. Stein, **Keefe Mitman**, *et al.*
Comparing remnant properties from horizon data and asymptotic data in numerical relativity.
Phys. Rev. D 103, 124029 (2021). arXiv:2104.07052. Jun. 2021.

4. **Keefe Mitman**, Dante A. B. Iozzo, Neev Khera, *et al.*
Adding gravitational memory to waveform catalogs using BMS balance laws.
Phys. Rev. D 103, 024031 (2021). arXiv:2011.01309. Jan. 2021.

3. **Keefe Mitman**, Jordan Moxon, Mark A. Scheel, Saul A. Teukolsky, *et al.*
Computation of displacement and spin gravitational memory in numerical relativity.
Phys. Rev. D 102, 104007 (2020). arXiv:2007.11562. Nov. 2020.

UNREFEREED PUBLICATIONS

2. *Photo-nuclear dijet production in ultra-peripheral Pb+Pb collisions.*
ATLAS Collaboration, ATLAS-CONF-2017-011.

1. *Photo-nuclear dijet production in ultra-peripheral Pb+Pb collisions.*
ATLAS Collaboration, ATLAS-INT. July 2016.

INVITED TALKS/ WORKSHOPS

22. *Leveraging ringdown excitations as probes of astrophysics and tests of GR,* May. 2025
Workshop on Quasi Normal Mode and Black Hole Perturbation.
Institute for Basic Science (IBS CTPU-CGA), South Korea.

21. *Leveraging ringdown excitations as probes of astrophysics and tests of GR,* May. 2025
Astrophysics and Cosmological Relativity Seminar.
Albert Einstein Institute, Germany.

20. *Leveraging ringdown excitations as probes of astrophysics and tests of GR,* Apr. 2025
University of Massachusetts Dartmouth, CSCDR Physics Colloquium Series.

19. *Gravitational Wave Modeling in Light of next-Generation Detectors,* Oct. 2024
Princeton Gravity Initiative Fall Seminar Series.
Princeton Gravity Initiative.

18. *The Universe Never Forgets: pushing Einstein's theory to the limits,* Sep. 2024
NASA Hubble Fellowship Symposium.

17. *Asymptotics and Memory,* Sep. 2024
Ringdown Inside and Out,
Niels Bohr Institute.

16. *Simulating eXtreme Spacetimes Con 2024,* Aug. 2024
ICERM, Brown University.
Co-ran the session on "Waveform Extraction in Numerical Relativity".

15. *Physics and Astrophysics at the eXtreme 2024,* Jul. 2024
King's College London.
Part of the panel on "Waveform Challenges and Numerical Relativity".

14. *Gravitational Memory and BMS Frame Fixing in Numerical Relativity,* Jul. 2024
LISA FPWG Ringdown Meeting.

13. *Extracting Physics from Black Hole Simulations with Cauchy-characteristic Evolution,* Jun. 2024
NAHOMCon + NENAD,
Dartmouth College.

12. *The Universe Never Forgets: pushing Einstein's theory to the limits,* May 2024
Caltech Everhart Lecture.

11. *Gravitational-Wave Memory Effects in XG Observatories,* Jan. 2024
Cosmic Explorer Consortium Science Call.

10. *Gravitational Memory Effects: From Theory to Observation* (invited workshop), Jun. 2023
Queen Mary University of London.

9. *Nonlinearities in Black Hole Ringdowns*,   *Feb. 2023*
   APS DGRAV Seminar Series.
   APS DGRAV.

8. *The Future of Numerical Relativity: Gravitational Memory, BMS Frames, and More*, *Nov. 2022*
   Perimeter Institute Strong Gravity Seminar.
   Perimeter Institute.

7. *Holography and Gravitational Waves* (invited workshop),   *Jul. 2022*
   Institute for Fundamental Physics of the Universe.

6. *Black Holes and BMS Frames in Numerical Relativity*,   *Mar. 2022*
   Black Hole Initiative Colloquium.
   Black Hole Initiative at Harvard University.

5. *Ringdown Modeling: Multimode Fits and BMS Frames*,   *Nov. 2021*
   Caltech LIGO Seminar.
   Caltech LIGO.

4. *Gravitational Waves in Numerical Relativity and BMS Frames*,   *Nov. 2021*
   Princeton Gravity Initiative Fall Seminar Series.
   Princeton Gravity Initiative.

3. *Cauchy-characteristic Extraction and its Memorable Consequences*,   *Sep. 2021*
   Numerical Relativity Community Call Monthly Meeting (virtual),
   Numerical Relativity Community.

2. *Gravitational Memory and BMS Frames in Numerical Relativity*,   *Jun. 2021*
   LISA Waveform Working Group Monthly Meeting (virtual),
   LISA Waveform Working Group.

1. *Gravitational Memory in Numerical Relativity*,   *May 2021*
   Conference on Gravitational Scattering, Inspiral and Radiation (virtual),
   Galileo Galilei Institute.

CONTRIBUTED TALKS

9. *Modeling Ringdown Excitations for Precessing Binary Black Holes*   *Mar. 2025*
   APS Global Physics Summit.

8. *Nonlinearities in Black Hole Ringdowns*,   *Apr. 2023*
   APS April Meeting.

7. *Nonlinearities in Black Hole Ringdowns*,   *Mar. 2023*
   Pacific Coast Gravity Meeting.

6. *What Gravitational Waves Actually Look Like*,   *Oct. 2022*
   Astrophysics, Relativity, and Cosmology Seminar, California Institute of Technology.

5. *The Importance of BMS Frames for Gravitational Wave Modeling*,   *Apr. 2022*
   APS April Meeting.

4. *The Importance of BMS Frames for Gravitational Wave Modeling*,   *Mar. 2022*
   Pacific Coast Gravity Meeting. (Awarded DGRAV's Best Student Presentation).

3. *Thanks for the Memories*,   *Apr. 2021*
   Caltech Three Minute Thesis Competition.

2. *Gravitational Memory in Numerical Relativity*,   *Apr. 2021*
   APS April Meeting.

1. *Gravitational Memory in Numerical Relativity*,   *Mar. 2021*
   Pacific Coast Gravity Meeting.

ORGANIZED CONFERENCES

1. APS DGRAV Pacific Coast Gravity Meeting (at Caltech),   *Apr. 2023*

GRANTS	1. APS Division of Gravitational Physics Travel Grant, *Feb. 2022* APS Division of Gravitational Physics.

JOURNAL REFEREE Physical Review Letters, Physical Review D, Classical and Quantum Gravity,
European Physical Journal C, Astrophysics and Space Science.

GRANT REFEREE European Research Council Starting Grant.

TEACHING
EXPERIENCE

❏ TA for Ph205A (Quantum Field Theory) with Professor Sergei Gukov. *Sep. 2020 - Dec. 2020*
California Institute of Technology.
Pinned Review:

"Perfect. Best TA I've ever seen, would be a phenomenal professor. Problem sets were difficult, and would have been demoralizing in the extreme without help in TA sessions. Especially remarkable was the fact that Keefe knew the material and the problems (as well as the solutions) absolutely inside and out, so no matter where I was stuck he immediately had a helpful suggestion. Plus, the TA demonstrated extensive knowledge of the material beyond the course itself, and could adroitly field questions related to current research and applications of QFT, recommend other texts that addressed the problems differently, or offer a different approach when (as was usually the case) the course text's presentation was lacking.

Extremely approachable and available outside of organized office hours – genuinely concerned about the students in the class.

All things considered, HW troubles would have made this class an exceptionally unpleasant experience but for the excellent TA, thanks to whom I had a pretty good time overall."

❏ TA for Ph129C (Complex Analysis) with Professor Hiroshi Oguri. *Mar. 2020 - Jun. 2020*
California Institute of Technology.
❏ TA for GU4040 (General Relativity) with Professor Rachel Rosen. *Jan. 2019 - May 2019*
Columbia University.

Tutoring:
❏ Caltech Y – Rise Tutor. *Sep. 2019 - Jun. 2024*
❏ Columbia One-to-One Tutoring – One-to-One Tutor. *Sep. 2015 - May 2019*
❏ Mathematics and Physics Tutor (private). *Oct. 2016 - Sep. 2019*

OUTREACH

❏ Caltech Visiting Scientists Program –
Visiting Scientist at Madison Elementary School (Pasadena, CA). *Sep. 2019 - Nov. 2022*

ADDITIONAL
EXPERTISE

Languages: English (fluent), German (proficient), Spanish (elementary).
Computing: C/C++, Python (scipy, numpy), numerically solving PDEs, spectral methods, finite difference methods, ROOT, Matplotlib, Mathematica, LaTeX, Java/HTML.