# Simona J. Miller

*Curriculum Vitae*

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smiller@caltech.edu ⋆ ORCID: 0000-0001-5670-7046 ⋆ website: simonajmiller.github.io

I am a fifth-year Ph.D. candidate in the **Laser Interferometer Gravitational-wave Observatory** (LIGO) Data Analysis Group at the **California Institute of Technology** (Caltech). My broad research interests center answering how, when, and why we can infer properties of compact objects like black holes and neutron stars—from both a statistical and astrophysical standpoint. Additionally, I am passionate educator who prioritizes building a supportive, inclusive culture in physics academia that serves the public good. I am a member of the LIGO-Virgo-KAGRA (LVK) Scientific Collaboration, with contributions verified here.

## Education

2021–2026 **Ph. D in Physics, M.S. in Physics** – **Caltech**, Pasadena, CA, USA
Advised by Katerina Chatziioannou; Expected graduation June 2026
Thesis: (in prep.) *Robustly measuring the spins of binary black holes*

2016–2020 **B.A. in Physics, Minor in Mathematics** – **Smith College**, Northampton, MA, USA
Advised by Joyce Palmer-Fortune & Travis Norsen
Thesis: *Using Gravitational-wave Signals to Model the Distribution of Spin Across the Binary Black Hole Population*
Honors: *Summa cum laude*, Highest honors on thesis

## Academic Positions

Sept. 2023 – Dec. 2023 **Visiting Scientist** – **Flatiron Institute Center for Computational Astrophysics** (CCA) New York, NY, USA; Advised by Will Farr & Maximiliano Isi

Jan. 2021 – Aug. 2021 **Fulbright Research Scholar** – **Max Planck Institute for Gravitational Physics** Hannover, Germany; Advised by Maria Alessandra Papa & Reinhard Prix

June. 2020 – Dec. 2020 **Postbaccalaureate Researcher** – **Flatiron Institute CCA** New York, NY, USA; Advised by Will Farr & Thomas Callister

## Honors, Awards, & Fellowships

Graduate level:

2025 First-place prize for **best poster presentation** at LVK Collaboration Meeting

2024 **James A. Cullen Memorial Fellowship** (Caltech)

2022 Honorable Mention for National Science Foundation Graduate Research Fellowship Program

2021–2022 Named first-year Graduate Fellowship (Caltech)

Select undergraduate level:

2020 The **Adelaide Wilcox Bull Paganelli Prize** for exceptional achievement and service to the Smith College Department of Physics

2020 The **Frank A. Waterman Prize** for a senior who has done excellent work in the Smith College Department of Physics

2020 Elected to Phi Beta Kappa, National Academic Honor Society for Liberal Arts and Sciences

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| 2020 | Elected to Sigma Xi, National Scientific Research Honor Society |
| 2019 | **International Research Experience for Undergraduates** in Physics (University of Florida, Max Planck Institute for Gravitational Physics, and GEO 600) |
| 2018 | **LIGO Summer Undergraduate Research Fellowship** (Caltech) |
| 2016–2020 | **STRIDE Research Scholarship** (Educational Outreach Physics Laboratory, Smith College) |

## Publications

**Short author-list publications** (Author lists marked with "⋆" include one of S. J. Miller's undergraduate research mentees as first or second author):

[14] *Measuring spin precession from massive black hole binaries with gravitational waves: insights from time-domain signal morphology*
**S. J. Miller**, M. Isi, K. Chatziioannou, V. Varma, & S. Hourihane
Physical Review D, 112, 104046 (Nov. 2025), DOI, arXiv:2505.14573

[13] *Compact Binary Coalescence Sensitivity Estimates with Injection Campaigns during the LIGO-Virgo-KAGRA Collaborations' Fourth Observing Run*
R. Essick, M. W. Coughlin, M. Zevin, D. Chatterjee, T. A. Clarke, S. Colloms, U. Mali, **S. Miller**, N. Steinle, P. Baral, A. C. Baylor, G. Cabourn Davies, T. Dent, P. Joshi, P. Kumar, C. Messick, T. Mishra, A. Ouzriat, K. S. Phukon, L. Piccari, M. Pillas, M. Trevor, T. A. Callister, & M. Fishbach
Physical Review D, 112, 102001 (Nov. 2025), DOI, arXiv:2508.10638

[12] *Inferring the spins of merging black holes in the presence of data-quality issues*
R. Udall, S. Bini, K. Chatziioannou, D. Davis, S. Hourihane, J. McIver, Y. Lecoeuche, & **S. Miller**
With Physical Review D reviewers. Submitted Oct. 2025. arXiv:2510.05029

[11] *Mapping Parameter Correlations in Spinning Binary Black Hole Mergers*
⋆ K. Kang, **S. J. Miller**, K. Chatziioannou, & D. Ferguson
Physical Review D, 112, 064020 (Sept. 2025), DOI, arXiv:2502.17402

[10] *Evidence of the pair instability gap in the distribution of black hole masses*
H. Tong, M. Fishbach, E. Thrane, M. Mould, T. A. Callister, A. Farah, N. Guttman, S. Banagiri, D. Beltran-Martinez, B. Farr, S. Galaudage, J. Godfrey, J. Heinzel, M. Kalomenopoulos, **S. J. Miller**, & A. Vijaykumar *(Authors after Guttman are alphabetical)*
With Nature reviewers. Submitted Sept. 2025. arXiv:2509.04151

[9] *The anti-aligned spin of GW191109: glitch mitigation and its implications.*
R. Udall, S. Hourihane, **S. Miller**, D. Davis, K. Chatziioannou, M. Isi, & H. Deshong
Physical Review D, 111, 024046 (Jan. 2025), DOI, arXiv:2409.03912

[8] *Gravitational wave signals carry information beyond effective spin parameters*
⋆ **S. J. Miller**, Z. Ko, T. A. Callister, & K. Chatziioannou
Physical Review D, 109, 104036 (May 2024), DOI, arXiv:2401.05613

[7] *GW190521: tracing imprints of spin-precession on the most massive black hole binary*
**S. J. Miller**, M. Isi, K. Chatziioannou, V. Varma, & I. Mandel
Physical Review D, 109, 024024 (Jan. 2024), DOI, arXiv:2310.01544

[6] *No evidence that the majority of black holes in binaries have zero spin*
T. A. Callister, **S. J. Miller**, K. Chatziioannou, & W. Farr.
The Astrophysical Journal Letters, 937, L13 (Sept. 2022), DOI, arXiv:2205.08574

[5] *The Low Effective Spin of Binary Black Holes and Implications for Individual Gravitational-wave Events*
**S. Miller**, T. A. Callister, & W. Farr.
The Astrophysical Journal, 895, 128 (June 2020), DOI, arXiv:2001.06051

**LIGO-Virgo-KAGRA collaboration papers** to which I have made a **significant contribution**:

[4] *GW250114: testing Hawking's area law and the Kerr nature of black holes*
I was one of two **key analysts** who generated the data that lead to the first-ever high-confidence observational confirmation of Hawking's Area Law.
Physical Review Letters, 135, 111403 (Sept. 2025), DOI, arXiv:2509.08054

[3] *GWTC-4.0: Population Properties of Merging Compact Binaries*
I served on **paper writing team** and was a **key analyst**. I wrote and made figures for everything spin-related, and coordinated the production, result review, and synthesis of all spin analyses.
With Astrophysical Journal Letters reviewers. Submitted Aug. 2025. arXiv:2508.18083

[2] *GWTC-4.0: Updating the Gravitational-Wave Transient Catalog with Observations from the First Part of the Fourth LIGO-Virgo-KAGRA Observing Run*
I contributed the population-reweighted posterior distributions for the GWTC-4.0 catalog.
With Astrophysical Journal Letters reviewers. Submitted Aug. 2025. arXiv:2508.18082

[1] *Population Properties of Compact Objects from the Second LIGO-Virgo Gravitational-Wave Transient Catalog*
I developed spin population models and contributed corresponding analysis results.
Astrophysical Journal Letters, 913, L7 (May 2021), DOI, arXiv:2010.14533

**In preparation**:

- *Misinterpreting spins of heavy black holes: insights from time-domain morphology*
**S. J. Miller**, M. Isi, K. Chatziioannou, V. Varma, & S. Hourihane
In preparation; Expected Spring 2026
- *Improving Posterior Predictive Checks for Gravitational-wave Population Analyses*
⋆ S. Winney, **S. J. Miller**, K. Chatziioannou, & P. Meyers
In preparation; Expected January 2026
- *Coalescing Compact Binary Parameter Estimation with Gravitational Waves in the Presence of non-Gaussian Transient Noise*
Y. Lecoeuche, J. McIver, A. Knee, R. Udall, K. Rink, S. Hourihane, **S. J. Miller**, K. Chatziioannou, & T. J. Massinger
In preparation; Expected December 2025 (currently undergoing internal LVK review)

# Teaching & Mentoring

## Teaching Experience

Jan 2026 – March 2026 **Lecturer in Physics & Astronomy - Cosmology and Extragalactic Astrophysics**
Undergraduate level, Pomona College; Primary instructor for full course as a graduate student

Jan 2025 **Guest Lecturer – Mathematical Methods of Physics**
Graduate level, Caltech; Taught a single guest lecture about Complex Analysis; Class taught by Katerina Chatziioannou

April 2024 – June 2024 **Teaching Assistant – Computational Physics**
Undergraduate level, Caltech; Designed and wrote problem sets, often taught the class, hosted office hours, graded; Class taught by Rana Adhikari & Lee McCuller

Jan. 2024 – Mar. 2024 **Teaching Assistant – General Relativity II**
Graduate level, Caltech; Hosted office hours, graded; Class taught by Saul Teukolsky

Sept. 2019 – Dec. 2019 **Teaching Assistant – Advanced Introductory Physics**
Undergraduate level, Smith College; Helped develop course materials, in-class TA, hosted office hours; Class taught by Travis Norsen

Sept. 2018 – May 2020 **Teaching Assistant – Introductory Physics II**
Undergraduate level, Smith College; In-class TA, hosted office hours; Class taught by Travis Norsen & Joyce Palmer-Fortune

## Research Mentoring Experience

June 2025 – present
Serena Fink (University of Montana)
*Caltech LIGO SURF 2025; Continued work remotely during academic year (AY) 2025-26*
Project: *Measuring Spin Precession in the Ringdown*; co-mentored with Eliot Finch

Jan. 2024 – Aug. 2024
Andres Nava (Caltech)
*AY and Caltech LIGO SURF 2024*
Project: *Using Symbolic Regression to Characterize Degeneracies in Compact Binary Coalescence Parameter Space*; co-mentored with Aaron Johnson

June 2024 – present
Sophia Winney (University of Chicago)
*Caltech LIGO SURF 2024; Continued work remotely during AY 2024-25 & 2025-26*
Project: *Developing Better Posterior Predictive Checks for Gravitational-wave Population Analyses* → Currently preparing results for publication.

June 2023 – Sept. 2025
Karen Kang (Amherst College; Currently Churchill Scholar at Cambridge University)
*Caltech LIGO SURF program 2023; Continued work remotely during AY 2023-24 & 2024-25*
Project: *Mapping Parameter Correlations in Spinning Binary Black Hole Mergers* → Resulted in publication.

June 2022 – May 2023
Zoe Ko (University of California Berkeley; Currently PhD student at Johns Hopkins University)
*Caltech LIGO SURF program 2022; Continued work remotely during AY 2022-23*
Project: *Studying Effective and Component Spin Distributions of Binary Black Hole Mergers* → Resulted in publication.

## Tutoring Experience

Sept. 2022 – May. 2023 **RISE Tutor – High School Mathematics**
Caltech Y; Advised by Liz Jackman

Sept. 2019 – May 2020 **Physics Master Tutor – Mathematical Methods for Physics & Engineering**
Spinelli Center for Quantitative Learning, Smith College; Advised by Travis Norsen & Kat McCune

Sept. 2018 – May 2020 **Physics Master Tutor – Introductory Physics II**
Spinelli Center for Quantitative Learning, Smith College; Advised by Travis Norsen & Kat McCune

## Certificates & Professional Development

2026 **Certificate of Interest in University Teaching** (Caltech)

2025 Teaching Strategies That Work: APS/AAS Educator Workshop

2025 Fall Meeting of the Southern California Chapter of the American Association of Physics Teachers (SCAAPT, University of La Verne)

2025 Future Faculty Workshop (Caltech)

2024 **Certificate of Interest in Undergraduate Research Mentoring** (Caltech)

# Presentations

## *Invited* Talks, Colloquia, & Panels

A "⋆" indicates a predominantly undergraduate or high-school audience.

- *Using Gravitational Waves from Merging Black Holes to Test Fundamental Physics*
  (⋆ Talk) Pasadena City College, Pasadena, CA, USA. Nov. 2025.
- *Testing Hawking's Area Law on GW250114 with Time-domain Inference*
  (⋆ Talk) Pomona College, Pomona, CA, USA. Oct. 2025.
- *The Spin Distribution of Binary Black Hole Mergers through GWTC-4.0: Magnitude, Alignment with Orbital Angular Momentum, and Effective Spin*
  (Talk) High-Energy Astrophysics Division (HEAD) Meeting of the Americal Astronomial Society (AAS), St. Louis, MO, USA. Oct. 2025.
- *Testing Hawking's Area Law on GW250114 with Time-domain Inference*
  (⋆ Talk) Loyola Marymount College, Los Angeles, CA, USA. Oct. 2025.
- *Gravitational-wave Population Inference*
  (⋆ Talk) Caltech, LIGO Undergraduate Study Group, Pasadena, CA, USA. Feb. 2024.
- *Measuring the Spins of Binary Black Holes Using Gravitational Waves*
  (⋆ Colloquium) Amherst College, Amherst, MA, USA. Nov. 2023.
- *Mind the systematics: How is the assumed population model affecting our measurements of the binary black hole population?*
  (Talk + Panel Discussion) "GWPopulations What's Next?" Conference, Milan, Italy. July 2023.
- *Measuring the distribution of spin across the black hole population.*
  (⋆ Talk) FUTURE Conference for Undergraduate Women and Gender Minorities in Physics. Pasadena, CA, USA. Sept. 2022.
- *My Journey into Gravitational-wave Physics.*
  (⋆ Talk) Medford High School, Medford, MA (my alma mater). Virtual. June 2021.
- *Introduction to Gravitational Radiation.*
  (⋆ Lecture) Smith College, Advanced Introductory Physics class. Northampton, MA, USA. Nov. 2019.

## Select Contributed Presentations

(From 2020 onwards)

- *The distribution of spin across the population of merging binary black holes: Results and validation*
  (Talk) Gravitational Wave Physics and Astronomy Workshop (GWPAW), Atlanta, GA, USA. Dec. 2025.
- *Testing Hawking's Area Law on GW250114 with Time-domain Inference*
  (Poster, **won first-place prize for best poster**) LIGO-Virgo-KAGRA Collaboration Meeting, Fort Collins, CO, USA. Sept. 2025.
- *Improving Posterior Predictive Checks for Binary Black Hole Populations*
  (Talk) American Physical Society (APS) Global Summit, Anaheim, CA, USA. March 2025.
- *Dissecting Gravitational Waves from Precessing Heavy Binary Black Holes in the Time Domain*
  (Talk) April 2024 Meeting of the APS, Sacramento, CA, USA. April 2024.
- *How can we measure spin precession for heavy binary black holes using gravitational waves?*
  (Talk) April 2023 Meeting of APS, Minneapolis, MN, USA. April 2023.

- *No evidence that the majority of black holes in binaries have zero spin: Population measurements of the BBH spin after LIGO/Virgo's O3 observing run*
  (Talk) April 2022 Meeting of the APS, New York, NY, USA. April 2022.
- *The Natal Spins of Binary Black Holes After LIGO/Virgo's O3a Observing Run.*
  (Talk) 237th Meeting of the AAS. Virtual. Jan. 2021.
- *Using Gravitational-waves to Model the Distribution of Spin Across the Binary Black Hole Population.*
  (Talk) Smith College Physics Senior Honors Thesis Symposium. Virtual. May 2020.
- *The Low Effective Spin of BBHs and Implications for Individual GW Events.*
  (Poster) Conference for Undergraduate Women in Physics. Hartford, CT, USA. Jan. 2020.

## Code Releases

- `tdinf`*: time domain parameter estimation for gravitational-wave signals*
  S. .J. Miller, S. Hourihane, M. Isi, R. Udall, and K. Chatziioannou
  Git: `simonajmiller/tdinf`, Zenodo: 16865525

## Leadership, Outreach, & Volunteer Work

(From 2022 onwards)

May 2025 – present **Elected Union Steward for Physics, Math, & Astronomy (PMA)**
Caltech Graduate Student Workers and Postdocs United, UAW Local 2478
Help fellow graduate students with union contract interpretation and enforcement.

May 2024 – Feb. 2025 **Elected Collective Bargaining Team Member**
Caltech Graduate Student Workers and Postdocs United, UAW Local 2478
Bargained for the first-ever collective bargaining agreement for Graduate Students and Postdocs at Caltech; lead record-keeping and social-media communications about bargaining progress.

Sept. 2022 – Sept. 2024 **FUTURE Conference Co-chair (2022) and Volunteer (2023–2024)**
Caltech PMA
Played major role in organizing the FUTURE conference for undergraduate women and gender minorities in physics, including running program admissions, moderating several panels at the conference, giving talks and tours, leading and organizing over 30 graduate student volunteers, handling and administrative tasks; Advised by David Hsieh

Sept. 2022 – Sept. 2024 **Respect is a Part of Research (RPR) Facilitator**
Caltech PMA
Lead group discussion in this mandatory workshop in the Caltech PMA graduate student orientation about preventing sexual assault and creating a culture of respect in graduate school

Jan. 2022 – June 2023 **Graduate Student Advisory Board Member**
Caltech PMA
Liased between graduate students and administration, organized social activities, pushed for inclusive practices and a community-driven department culture; Advised by Nam Ung & Mika Walton

Jan. 2022 – June 2023 **Gender Minorities & Women in PMA (GWiPMA) Organizing Committee Member**
Caltech PMA
Pushed for equitable and inclusive practices in PMA (such as more gender-neutral bathrooms), organized community activities, hosted speakers.

### Science Communication

- Sept. 2025: Provided a **quote** for *"An Unimaginable Breakthrough": Loudest-Ever Gravitational Wave Collision Proves Stephen Hawking Correct* by Alfredo Carpineti, an IFL Science article about observationally confirming Hawking's Area Law with GW240114.
- Aug. 2025: Made the outreach **infographic** for the gravitational-wave detection, GW231123: the most massive binary black hole observed date. **Coordinated the graphic's translation into over 10 languages, enabling global circulation**, including appearances in Science News (USA), Coelum Astronomia (Italy), AstroArts (Japan), LIGO-India News (India), the LIGO magazine (international), and many more.
- June 2025: Featured in the AstroBites article *Uncovering Precession for GW190521: How the Last Cycle Cracked the Case* by Viviana Caceres

## Other Relevant Employment & Experience

- Jan. 2019–May 2019: Graded problem sets for Introductory Physics I at Smith College
- Sept. 2016–May 2018: Designed and constructed **pedagogical demonstrations for Introductory Physics classes**, e.g., a Faraday Motor as a Smith College STRIDE Research Scholar
- Sept. 2014–May 2016: Tested high-school curricula about elementary particle physics for **QuarkNet**
- Jan. 2014–Aug. 2016: Developed **robotics curricula for elementary school classrooms** with the Tufts University Center for Engineering Education & Outreach