Simona J. Miller

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 Ph.D research focuses the measurability of the spins of binary black holes through their gravitational-wave emission for individual systems and their astrophysical population. I am broadly interested in how, when, and why we can infer properties of objects like black holes and neutron stars, from both a statistical and astrophysical standpoint, as well as in building a supportive, inclusive culture in physics academia that serves the public good. My thesis advisor is Professor Katerina Chatziioannou, and my contributions to the LIGO Scientific Collaboration are verified here.

Education

Sept. 2021 **Ph.D in Physics, M.S. in Physics**
June 2026 Caltech, Pasadena, CA, USA

Sept. 2016 **B.A. in Physics**, Minor in Mathematics
May 2020 Smith College Northampton, MA, USA
Thesis: *Using Gravitational-wave Signals to Model the Distribution of Spin Across the Binary Black Hole Population*

Honors, Awards, & Fellowships

Graduate level:

2025 Prize for **best poster presentation** in data analysis (LIGO-Virgo-KAGRA Collaboration Meeting, Fort Collins, CO)

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

2021-22 Named first-year Graduate Fellowship (Caltech)

2020-21 **Fulbright Research Scholarship** (Fulbright Germany and the Albert Einstein Institute)

Select undergraduate level:

2020 Graduated **Summa Cum Laude** (Smith College)

2020 **Highest Honors on Undergraduate Honors Thesis** in Physics (Smith College)

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

2019 **International Research Experience for Undergraduates** in Physics (University of Florida, the Albert Einstein Institute, and GEO 600)

2018 **LIGO Summer Undergraduate Research Fellowship** (California Institute of Technology)

2016-20 **STRIDE Research Scholarship** (Smith College)

Research Experience

Sept. 2021 – Present **LIGO Laboratory, Caltech**, Pasadena, CA, USA
Graduate Research Assistant, Advised by Katerina Chatziioannou

Sept. 2023 – Dec. 2023 **Center for Computational Astrophysics, Flatiron Institute**, New York, NY, USA
Guest Researcher, Advised by Will Farr & Maximiliano Isi

Jan. 2021 – Aug. 2021 **Albert Einstein Institute** (Max Planck Institute for Gravitational Physics), Hannover, Germany
Fulbright Award, Advised by Maria Alessandra Papa & Reinhard Prix

June. 2020 – Dec. 2020 **Center for Computational Astrophysics, Flatiron Institute**, New York, NY, USA
Postbaccalaureate Visiting Scholar, Advised by Will Farr & Thomas Callister

Sept. 2019 – May 2020 **Smith College**, Northampton MA & LIGO Laboratory, Pasadena CA, USA
Senior Honors Thesis in Physics, Advised by Thomas Callister & Travis Norsen

May 2019 – Aug. 2019 **GEO 600, Albert Einstein Institute**, Hannover, Germany
Participant in University of Florida's International REU Program, Advised by James Lough & Nikhil Mukund

Sept. 2018 – Sept. 2019 **LIGO Laboratory, Caltech**, Pasadena, CA, USA (remotely)
Undergraduate Research Assistant, Advised by Thomas Callister

June 2018 – Aug. 2018 **LIGO Laboratory, Caltech**, Pasadena, CA, USA
Summer Undergraduate Research Fellow, Advised by Alan Weinstein, Jonah Kanner, & Thomas Callister

Feb. 2018 – Feb. 2019 **Theoretical Condensed Matter Physics Lab, Smith College**, Northampton, MA, USA
Undergraduate Research Assistant, Advised by Courtney Lannert

Publications

Short author-list publications (**10** total; author lists marked with "⋆" include an undergraduate mentee):

- *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. Oct. 2025. ArXiv:2510.05029

- *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
  With Physical Review D reviewers. Oct. 2025. ArXiv:2505.14573

- *Evidence of the pair instability gap in the distribution of black hole masses*
  H. Tong, et. al., incl. **S. J. Miller**
  With Nature reviewers. Sept. 2025. ArXiv:2509.04151

- *Compact Binary Coalescence Sensitivity Estimates with Injection Campaigns during the LIGO-Virgo-KAGRA Collaborations' Fourth Observing Run*
  R. Essick, et. al., incl. **S. Miller**
  With Physical Review D reviewers. Aug. 2025. ArXiv:2508.10638

- *Mapping Parameter Correlations in Spinning Binary Black Hole Mergers*
  ⋆ K. Kang, **S. J. Miller**, K. Chatziioannou, & D. Ferguson
  Physical Review D. Sept. 2025 ArXiv:2502.17402

- *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. Jan. 2025 ArXiv:2409.03912

- *Gravitational wave signals carry information beyond effective spin parameters.*
  ⋆ **S. J. Miller**, Z. Ko, T. A. Callister, & K. Chatziioannou
  Physical Review D. May 2024 ArXiv:2401.05613

- *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. Jan. 2024 ArXiv:2310.01544

- *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. Sept. 2022 ArXiv:2205.08574

- *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. June 2020 ArXiv:2001.06051

LIGO-Virgo-KAGRA collaboration papers to which I have made a **significant contribution** (**4** total):

- *GW250114: testing Hawking's area law and the Kerr nature of black holes*
  I was a **key analyst**. I generated all measurements of the black hole properties from the signal's inspiral data, which lead to the high-confidence confirmation of Hawking's area law shown in Figures 5 and 8.
  Physical Review Letters, Sept. 2025 ArXiv:2509.08054

- *GWTC-4.0: Population Properties of Merging Compact Binaries*
  I served on **paper writing team**–an invited position–and was a **key analyst**. I wrote and made figures for everything spin-related in the paper, as well as coordinated the production, result review, and synthesis of all spin analyses contributed by tens of LVK members, myself included.
  With reviewers. Aug. 2025. ArXiv:2508.18083

- *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 individual-event posterior distributions for the full set of O4a events shown in Figure 2.
  With reviewers. ArXiv:2508.18082.. Aug. 2025

- *Population Properties of Compact Objects from the Second LIGO–Virgo Gravitational-Wave Transient Catalog*
  I contributed the spin analysis results shown in Figures 11 and 12.
  Astrophysical Journal Letters. May 2021 ArXiv:2010.14533

In preparation (**2** total):

- *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 February 2026 – March 2026

- *Improving Posterior Predictive Checks for Gravitational-wave Population Analyses*
  ⋆ S. Winney **S. J. Miller**, K. Chatziioannou, & P. Meyers
  In preparation; Expected December 2025 – January 2026.

Presentations

Invited Presentations

- *The Spin Distribution of Binary Black Hole Mergers through GWTC-4.0: Magnitude, Alignment with Orbital Angular Momentum, and Effective Spin*
  (**Invited** 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*
  (**Invited** Talk) Loyola Marymount College, Senior Physics Seminar Course, Los Angeles, CA, USA. Oct. 2025.

- *Gravitational-wave Population Inference*
  (**Invited** Talk) Caltech, LIGO Undergraduate Study Group, Pasadena, CA, USA. Feb. 2024.

- *Measuring the Spins of Binary Black Holes Using Gravitational Waves*
  (**Invited** 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?*
  (**Invited** Talk + Panel Discussion) GWPopulations What's Next Conference, Milan, Italy. July 2023.

- *Measuring the distribution of spin across the black hole population.*
  (**Invited** Talk) Graduate student research presentation at FUTURE Conference for Undergraduate Women and Gender Minorities in Physics. Pasadena, CA, USA. Sept. 2022.

- *My Journey into Gravitational-wave Physics.*
  (**Invited** Talk) Presentation to high school physics classes at my alma mater, Medford High School, Medford, MA. Virtual. June 2021.

- *Introduction to Gravitational Radiation.*
  (**Invited** Talk) Smith College, Advanced Introductory Physics class. Northampton, MA, USA. Nov. 2019.

Select Contributed Presentations

- *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.
- *Improved Whitening of the Readout Signal for GEO 600.* (Talk) Smith College Physics Student Summer Research Symposium. Northampton, MA, USA. Sept. 2019.
- *Modeling and Measuring Eccentricity in Binary Black Hole Inspirals.* (Poster) Conference for Undergraduate Women in Physics. Amherst, MA, USA. Jan. 2019.

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

Teaching, Mentoring, & Outreach

Certificates

2024 **Certificate of Interest in Undergraduate Research Mentoring** (Caltech)
2026 **Certificate of Interest in University Teaching** (Caltech)

Research Mentoring Experience

June 2025 present Serena Fink (University of Montana)
Mentor for Caltech LIGO SURF program 2025
Project: *Measuring Spin Precession in the Ringdown*; co-mentored with Eliot Finch

Jan. 2024 Aug. 2024 Andres Nava (Caltech)
Mentor during academic year and Caltech LIGO SURF program 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)
Mentor for Caltech LIGO SURF program 2024
Project: *Developing Better Posterior Predictive Checks for Gravitational-wave Population Analyses*; Continued work remotely for the 2024-25 academic year to prepare results for publication

June 2023 Sept. 2025 Karen Kang (Amherst College; Currently Churchill Scholar at Cambridge University)
Mentor for Caltech LIGO SURF program 2023
Project: *Mapping Parameter Correlations in Spinning Binary Black Hole Mergers*; Continued work remotely for the 2023-24 and 2024-25 academic years to prepare results for publication

June 2022 May 2023 Zoe Ko (University of California Berkeley; Currently Ph.D student at Johns Hopkins University)
Mentor for Caltech LIGO SURF program 2022
Project: *Studying Effective and Component Spin Distributions of Binary Black Hole Mergers*; Continued work remotely for the 2022-23 academic year to prepare results for publication

Teaching Experience

Jan 2025 Caltech, Pasadena, CA, USA
Guest Lecture – Graduate Level Mathematical Methods for Physics (Complex Analysis Section)

Class taught by by Katerina Chatziioannou

April 2024 Caltech, Pasadena, CA, USA
June 2024 *Teaching Assistant – Undergraduate Computational Physics Laboratory*

Designed problem sets, often taught the class, hosted office hours, graded; Advised by Rana Adhikari and Lee McCuller; 1 semester

Jan. 2024 Caltech, Pasadena, CA, USA
Mar. 2024 *Teaching Assistant – Graduate Level General Relativity II*

Hosted office hours, graded; Advised by Saul Teukolsky; 1 semester

Sept. 2018 Smith College Physics Department, Northampton, MA, USA
May 2020 *Teaching Assistant – Introductory Physics II, Advanced Introductory Physics*

In-class TA, hosted office hours; Advised by Travis Norsen & Joyce Palmer-Fortune; 2 semesters

Tutoring Experience

Sept. 2022 Caltech Y, Caltech, Pasadena, CA, USA
May. 2023 *RISE Tutor for High School Mathematics*, Advised by Liz Jackman

Sept. 2018 Spinelli Center for Quantitative Learning, Northampton, MA, USA
May 2020 *Physics Master Tutor – Introductory Physics II, Math. Methods of Physics & Engineering*, Advised by Travis Norsen & Kat McCune; 4 semesters

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, from the most massive binary black hole observed date. Coordinated translation of this graphic into over 10 languages, enabling global circulation. It appears in many articles about the historic detection, including those in Science News (USA), Coelum Astronomia (Italy), AstroArts (Japan), LIGO-India News (India), the LIGO magazine (international), and more.
- **June 2025**: Featured in the AstroBites article *Uncovering Precession for GW190521: How the Last Cycle Cracked the Case* by Viviana Caceres

Other Relevant Volunteer Work

May 2025 Caltech Graduate Student Workers and Postdocs United, UAW Local 2478
present *Elected Union Steward for Physics, Math, & Astronomy Division*

Help fellow graduate students with union contract interpretation and enforcement.

May 2024 Caltech Graduate Student Workers and Postdocs United, UAW Local 2478
Feb. 2025 *Elected Collective Bargaining Team Member for Graduate Student Union*

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. 2023 Caltech Division of Physics, Math, & Astronomy
Sept. 2024 *Volunteer at FUTURE conferences; 2023, 2024*

Invited panelist and volunteer for FUTURE conference; see entry below

Sept. 2022 Caltech Division of Physics, Math, & Astronomy
Graduate student Co-Chair of FUTURE conference

Played major role (60+ hours) in organizing the FUTURE conference for undergraduate women and gender minorities in physics, including serving on the admissions panel, moderating several panels at the conference, giving talks and tours, being in charge of 30+ graduate student volunteers, and lots of administrative work; Advised by David Hsieh

Sept. 2022 Caltech Division of Physics, Math, & Astronomy
Sept. 2024 *Respect is a Part of Research Facilitator; 2022, 2023, 2024*

Facilitator for workshop about preventing sexual assault and creating a culture of respect in graduate school, as part of the physics, math, & astronomy Caltech graduate student orientation

Jan. 2022 Caltech Division of Physics, Math, & Astronomy
June 2023 *Member of Physics, Math, & Astronomy Graduate Student Advisory Board*

Liased between graduate students and administration, organized social activities; Advised by Nam Ung and Mika Walton

Other Relevant Employment

Jan. 2019 Smith College Department of Physics
May 2019 *Grader – Introductory Physics I* , Advised by Travis Norsen; 1 semester

Sept. 2016 Smith College Educational Outreach Physics Laboratory
May 2018 *Designed and constructed demonstrations to use in Introductory Physics classrooms*, STRIDE research project, Advised by Joyce Palmer-Fortune; 4 semesters

Jan. 2014 Tufts University Center for Engineering Education & Outreach
Aug. 2016 *Elementary Curriculum Development Intern; LEGO Robotics Summer Camp Instructor*