

Dr. Derek Davis

Senior Postdoctoral Scholar Research Associate in Physics

California Institute of Technology - LIGO Laboratory

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Overview

California Institute of Technology Senior Postdoctoral Scholar of Physics, Member of LIGO Collaboration and Cosmic Explorer Consortium, LIGO Management Team Member, Chair of LIGO Detector Characterization Group, Research Specialization in Data Science with Large Gravitational-wave Data Sets and High Throughout Computing, Experience in Mentoring and Teaching Data Science

Education

Syracuse University

- Ph.D. in Physics - 2019
- Research Advisor - Dr. Peter Saulson
- Dissertation - *The Impact of Detector Characterization on Gravitational Wave Astrophysics*

University of Chicago

- B.A. in Physics, Specialization in Astrophysics - 2015
- B.S. in Mathematics - 2015

Appointments

Simons Scientific Software Research Faculty Award Fellow

Starting 2025

- Funded faculty fellowship to conduct research and scientific computing development for next-generation gravitational-wave observatories

Senior Postdoctoral Scholar

Aug 2019 - present

California Institute of Technology, LIGO Laboratory

- LIGO Scientific Collaboration Management Team member and Co-chair of the LIGO Detector Characterization group

- Lead coordinator of the GWTC-4 catalog of gravitational-wave signals detected by the LIGO-Virgo-KAGRA collaboration
- Primary developer and organizer for the Data Quality Report software suite used to investigate the potential impact of instrumental artifacts on the detection and analysis of all gravitational-wave events
- Leader in efforts to increase the cross-compatibility of detector characterization software across the global network of ground-based gravitational-wave detectors
- Principal investigator at Caltech for the Gravity Spy project that combines machine learning and citizen science to analyze LIGO data

Doctoral Research Assistant

Aug 2015 - Aug 2019

Syracuse University, Physics Department

- Developed the GWsubtract Python package that was used to increase the sensitivity of the LIGO gravitational-wave detector network by 25%
- Lead analyst for the PyCBC search for gravitational-wave signals in LIGO's second observing run
- Research focuses in data science, signal processing, high-throughput computing, and gravitational-wave astrophysics

Funding and Grant Experience

- Scientific Software Research Faculty Award - Simons Foundation - 5-year award of approximately \$800,000 - 2024
- Intelligent support for non-experts to navigate large information spaces - Currently managing NSF-funded award of \$45,000 - 2023
- LIGO Operations and Management - Contributed to proposal and reporting for NSF-funded award for FY24-FY28 - 2023

Awards and Fellowships

- LIGO Laboratory Award for Excellence in Detector Characterization and Calibration - 2018
- Physics World Breakthrough of the Year awarded to the international team of astronomers and astrophysicists that contributed to the first multi-messenger observation involving gravitational waves -2017
- Princess of Asturias Award for Technical and Scientific Research awarded to the LIGO Scientific Collaboration - 2017
- Bruno Rossi Prize awarded by the High Energy Astrophysics Division of the American Astronomical Society to the LIGO Scientific Collaboration - 2017

- UK Royal Astronomical Society Group Achievement Award in Astronomy awarded to the LIGO team - 2017
- Henry Levenstein Fellowship - 2016

Formal Mentoring Experience

Bri Aleman - CSU Northridge undergraduate - Summer 2024

- Supervised research into new machine-learning techniques to identify the sources of transient noise in the LIGO detectors.
- Bri was awarded Victor M Blanco fellowship in recognition of their work during the Summer 2024 SURF program.

Sasha Lukina - University of South Dakota undergraduate - Summer 2023

- Supervised research into new statistical methods to combine the results of multiple searches for gravitational-wave signals.
- Sasha is currently a PhD student at MIT

Aislinn McCann - CSU Northridge undergraduate - Summer 2023

- Supervised research into new methods to model and mitigate instrumental artifacts that pollute LIGO data.
- Aislinn is currently a PhD student at the University of Oregon

Leah Vazsonyi - Caltech undergraduate - Autumn 2019 through Spring 2023

- Supervised research into the impact of higher order modes on GW cosmology measurements. Leah presented this work at the NCUR 2021 meeting and has published an article based on this work.
- Leah is currently a PhD Student at UNC Chapel Hill

Kelsie Taylor - Caltech undergraduate - Autumn 2019 through Autumn 2022

- Supervised research into the detectability of higher order modes. Kaden presented this work at the NCUR 2021 meeting and is preparing a publication.
- Kelsie is currently a PhD Student at UT Austin.

Viviana Caceres - University of Puerto Rico undergraduate - Summer 2022

- Supervised research into new methods to mitigate glitches in gravitational-wave source parameter estimation.
- Viviana was awarded Victor M Blanco fellowship in recognition of her work during the Summer 2022 SURF program. She is currently a PhD student at Pennsylvania State University.

Maggie Huber - University of Michigan undergraduate - Summer 2021

- Supervised research into new methods to improve the precision of sky localization for gravitational wave events. Maggie presented this work at a LIGO meeting and has published an article based on this work.
- Maggie is currently a PhD Student at UC Boulder.

Makenzi Fischbach - Wellesley College undergraduate - Summer 2021

- Supervised research into new methods to increase the sensitivity of Stochastic searches, which is planned to be used in the next LIGO observing run.

Brina Martinez - UTRGV undergraduate - Summer 2020

- Supervised research into new methods to increase the sensitivity of CBC searches, which is part of planned upgrade to PyCBC. Brina presented this work at SACNAS 2020.
- Brina was awarded Victor M Blanco fellowship in recognition of her work during the Summer 2020 SURF program. Brina is currently a PhD student at the University of Arizona in physics

Rikako Hatoya - UCLA undergraduate - Autumn 2019 through Spring 2020

- Supervised research into the precision of machine-learning classification techniques for GW astronomy. Rikako presented this work at a LIGO Detchar virtual meeting.
- Rikako is currently a graduate student at UCLA in electrical engineering

Laurel White - Syracuse University undergraduate - Autumn 2016 through Spring 2018

- Supervised research into the impact of glitches on the PyCBC pipeline, resulting in a published paper and authorship on GWTC-1. Laurel presented this work at a LIGO Detchar meeting at LIGO Hanford and at April APS 2018.
- Based on research promise, Laurel was named Astronaut scholar, Goldwater scholar, and Meredith scholar. Laurel is currently a PhD student at MIT in astronomy

I have extensive experience informally mentoring graduate and undergraduate students as part of my management roles at Caltech and in the LIGO Scientific Collaboration

Formal Teaching Experience

General Physics I - Instructor - Summer 2016

- Instructor of record for an introductory mechanics course aimed at science students covering kinematics, Newton's laws of motion, energy, gravity, and basic special relativity.
- Developed personalized syllabus, wrote daily lectures, and created weekly problem sets.
- Supervised a teaching assistant who guided daily recitations based on the course.

Our Corner of the Universe - Autumn 2016

- Teaching assistant for an introductory astronomy laboratory course aimed at students in the humanities.

General Physics I - Autumn 2015 and Spring 2016

- Teaching assistant for an introductory mechanics course aimed at students in the sciences.

Software development

I have contributed to the following software packages and projects:

- **GWsubtract - lead developer** - Pipeline to measure and subtract noise contributions that limit the sensitivity of the LIGO interferometers; my contributions were recognized in the 2018 LIGO Laboratory Award for Excellence in Detector Characterization and Calibration
- **DQR-tasks - lead developer** - Suite of analysis tools to identify data quality issues in gravitational-wave interferometer data that may impact the detection of gravitational-wave signals; is actively used to analyze all detected signals in LIGO data.
- **DCHgate - lead developer** - Software package to remove loud transients from LIGO data in as a first step in searches for gravitational waves from pulsars and other persistent sources; will be used for all such analyses of LIGO data in the ongoing observing run.
- **Stochmon - lead developer** - Monitoring software of LIGO data to identify sources of correlated noise between multiple gravitational-wave interferometers that could impact searches for stochastic sources of gravitational-wave signals; currently in use.
- **Gwpy** - Package for easy analysis of data from ground-based gravitational-wave detectors; is a key dependency of many other python packages for gravitational-wave data analysis.
- **GwDetchar** - Suite of tools for characterization of gravitational-wave detectors and data; tools have been actively used since the first LIGO observing run.
- **GwSumm** - Package designed to support exhaustive monitoring of the many subsystems that make up ground-based gravitational-wave interferometers; has been in use in multiple collaborations since 2015.
- **PyCBC** - Software to detect coalescing compact binaries; was used in the first detection of gravitational waves and is actively used to search for new signals in LIGO-Virgo data.
- **PyGWB** - Library to enable searches for a stochastic gravitational-wave background; will be the primary analysis tool used in the current LIGO observing run to search for this signal.
- **Gravity Spy** - Suite of machine-learning-based classification tools for analysis of different instrumental artifacts in LIGO data; is the primary method used by the collaboration to investigate the sources of these problematic artifacts.
- **Bilby** - Library for a wide array of Bayesian analyses, with particular support for analysis of gravitational-wave data; is the primary package used to estimate the source properties of all signals detected in LIGO-Virgo data.
- **Hierarchical Veto** - Package for identifying correlations between different data streams recorded at gravitational-wave observatories; is the primary tool used to identify such correlations in LIGO data.

I have experience in general software development with Python, C, and Shell in scientific settings and working with large-scale computing clusters managed by HTCondor and Slurm.

Community Leadership

- LIGO Caltech SURF Program - since Summer 2020 - Lead mentor for the summer undergraduate research program, guiding student projects in gravitational-wave astrophysics and advising graduate students on mentoring students
- LIGO Caltech outreach coordinator - since Spring 2020 - Served as outreach coordinator, organizing outreach events in the local community hosted by members of the LIGO Laboratory at Caltech
- LVC Allies - since Autumn 2017 - Volunteered as a confidential resource for LVC members and worked to foster an inclusive and harassment-free environment
- Early Queer Scholarship Series - Autumn 2018 through Spring 2019 - Organized and acquired funding for a monthly talk series at Syracuse University focusing on showcasing the work of queer graduate students
- Embody Group Facilitator - Autumn 2017 through Spring 2019 - Co-facilitated a discussion group for transgender and gender nonconforming students at the Syracuse University LBGT resource center
- Open Doors - Autumn 2017 through Spring 2019 - Co-managed and acquired funding for the Open Doors graduate student organization for queer graduate students at Syracuse University

Education and Outreach Experience

- Marshall Fundamental School Science Night - Spring 2024 - Participated in outreach event targeted to support local middle school students
- LIGO Hanford Second Saturday Tours - Spring 2023 - Led tours of the LIGO Hanford observatory for members of the general public
- Hamilton Elementary's SMArt Night & Science Fair - Spring 2023 - Participated in outreach event targeted to support local elementary school students
- Gender Minorities & Women in PMA, Caltech - Autumn 2022 - Participated in panel discussing the postdoctoral application process
- Future of Physics Workshop - Autumn 2021 - Presented talk at event aimed at improving the pipeline of women and gender minorities in physics and astronomy - **Invited**
- Syracuse Diversity Symposium - Autumn 2021 - Presented talk at event hosting alumni of the Syracuse Physics Department to foster networking opportunities for current students and help to highlight the diversity of physicists and their research - **Invited**

- Gravitational Wave Open Data Workshop - Spring 2020 and Spring 2021 - Mentored students at a three-day virtual workshop on gravitational-wave data science - **Invited**
- Pasadena CC outreach night - Autumn 2020 - Participated in outreach event targeted to support undergraduate STEM students
- Physics Cafe - Winter 2019 - Co-hosted a science session through the Aspen Science Center aimed at the general public to discuss gravitational-wave science and what it means to be a physicist
- Holden Observatory - Autumn 2015 through Spring 2019 - Led personalized tours of historic Syracuse University observatory and organized physics and astronomy demonstrations for the general public
- GW150914 Announcement @ Syracuse - Winter 2016 - Participated in public outreach event to accompany the first announcement of the detection of gravitational waves
- Practicum in Physics Education - Autumn 2015 - Attended semester-long course in physics educational theory, pedagogy, content, and practice at Syracuse University
- Young Scholars Program - Summer 2015 - Supervised middle school students during a University of Chicago summer program aimed at encouraging exceptional students in mathematics
- Adler Planetarium - Autumn 2014 through Summer 2015 - Led science demonstrations for planetarium guests featuring specialized astronomy topics during special events

Academic Memberships and Service

- LIGO Scientific Collaboration Management Team - member, since Autumn 2022
- LIGO Detector Characterization Group - co-chair, since Autumn 2021
- LIGO Scientific Collaboration Council - member, since Autumn 2021
- Gravitational-Wave Transient Catalog Group - co-chair, since Autumn 2023
- GWIC-Braccini Thesis Prize - committee member, since Winter 2024
- CaJAGWR - executive committee member, since Autumn 2019
- LIGO Scientific Collaboration - member, since Autumn 2015
- Cosmic Explorer Consortium - member, since Autumn 2020
- LISA Consortium - associate member, since Winter 2019
- APS - member, since Autumn 2017
- Monthly Notices of the Royal Astronomical Society - reviewer, since Autumn 2020
- Classical and Quantum Gravity - reviewer, since Summer 2021
- Progress of Theoretical and Experimental Physics - reviewer, since Winter 2022
- Annalen der Physik - reviewer, since Spring 2022

- Physical Review D - reviewer, since Summer 2022
- Nature Astronomy - reviewer, since Spring 2023
- Institute for Cosmic Ray Research, University of Tokyo - Inter-University Research Program Researcher, since Winter 2024

Selected Conference Talks and Seminars

- Too many glitches, not enough time - Banff International Research Station Workshop, November 2024
- High precision gravitational-wave astronomy - University of Rhode Island, November 2024 - **Invited**
- Decoding LIGO detector data for high-precision gravitational-wave astronomy - Vanderbilt University, October 2024 - **Invited**
- Decoding LIGO detector data for high-precision gravitational-wave astronomy - CSU Los Angeles, September 2024 - **Invited**
- Broad astrophysical impacts of LIGO-Virgo-KAGRA observations through the fourth observing run - APS April Meeting in Sacramento, California, April 2024 - **Invited**
- Solving the challenges of working with real data from ground-based gravitational-wave detectors - Syracuse University, January 2024 - **Invited**
- LIGO Science in O4 - LIGO Program Advisory Committee Meeting, November 2023
- Combining Results of Multiple Gravitational-wave Searches - University of Massachusetts Dartmouth, October 2023 - **Invited**
- Rapid Detection of Data Quality Issues Surrounding Gravitational-wave Events - APS April meeting in Minneapolis, Minnesota, April 2023
- Hiding in Plain Sight: Identifying Exceptional Gravitational-wave Events in Noisy LIGO data - Pomona College, March 2023 - **Invited**
- Status of LVK Detector Characterization - LIGO-Virgo Conference in Chicago, Illinois, March 2023 - Plenary
- Identifying the Next Exceptional Gravitational-wave Event and Solving the Challenges of Working with Real Detector Data - University of British Columbia, October 2022 - **Invited**
- Mitigating the Effects of Glitches on Gravitational-wave Event Sky Localizations - APS April Meeting in New York, New York, April 2022
- Improving the Quality of Gravitational-wave Data - Gravitational Wave Physics and Astronomy Workshop in Hannover, Germany December 2021 - **Invited**
- GWTC-2.1: Deep Extended Catalog of Compact Binary Coalescences Observed by LIGO and Virgo During the First Half of the Third Observing Run - LIGO-Virgo Collaboration Results Webinar Panel, November 2020 - **Invited**
- The Impacts of LIGO-Virgo Data Quality on Low-latency Gravitational-wave Analyses - Virtual Amaldi 14 Meeting, July 2021

- LIGO Detector Characterization in the Second and Third Observing Runs - APS Virtual April meeting, April 2021
- Identifying Novel Gravitational Wave Signals in a Noisy Detector - University of Texas Rio Grande Valley, March 2021 - **Invited**
- Compact binary mergers observed in the first half of the third LIGO-Virgo observing run - LIGO-Virgo Collaboration Results Webinar, November 2020 - **Invited**
- LVK Transient Data Quality - LIGO-Virgo Virtual Conference, September 2020
- Introduction to Searches for Gravitational Waves with PyCBC - Gravitational Wave Open Data Virtual Workshop, May 2020 - **Invited**
- Validating Gravitational Wave Events - APS Virtual April meeting, April 2020
- The Impact of Detector Noise on Gravitational-wave Astrophysics - Astrophysics with Gravitational-Wave Populations Workshop in Aspen, Colorado, February 2019
- Detector Characterization in the Era of Gravitational-wave Astronomy - LIGO Laboratory Award Seminar at California Institute of Technology, February 2019 - **Invited**
- The Role of Detector Characterization in Gravitational-wave Astronomy - University of Wisconsin-Milwaukee, February 2019 - **Invited**
- Discovering New Gravitational Waves in Noisy LIGO Data - Marquette University, January 2019 - **Invited**
- Detector Characterization in the Era of Open Data - LIGO Detchar Meeting in Livingston, Louisiana, January 2019
- The Impact of Detector Noise on Multi-messenger Gravitational-wave Astrophysics - JSI Gravitational Wave Physics and Astronomy Workshop in College Park, MD, December 2018 - **Invited**
- Gravitational Wave Detection: Challenges in the Noise - Portsmouth University, Portsmouth, UK, September 2018 - **Invited**
- LIGO Detector Characterization Update - LIGO-Virgo Conference in Maastricht, Netherlands, September 2018 - Plenary
- Detector Characterization for the O1-O2 CBC Catalog - LIGO-Virgo Conference in Maastricht, Netherlands, September 2018
- O2 LIGO Noise Subtraction - LIGO-Virgo Conference in Sonoma, California, March 2018 - Plenary
- The Impact of Detector Characterization on Gravitational Wave Searches - California Institute of Technology, October 2017 - **Invited**
- The Most Troublesome LIGO Noise Sources for the Searches - LIGO-Virgo Conference in Geneva, Switzerland, September 2017