Krystal Ruiz-Rocha

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PROFESSIONAL SUMMARY

PhD candidate in Astrophysics with expertise in stellar-mass and intermediate-mass black holes, gravitational waves, and black hole merger dynamics, with a focus on LISA and LIGO. Recognized for academic excellence at UC Santa Cruz and Vanderbilt, with a strong record of publications, conference presentations, and collaborative research. Dedicated to advancing scientific discovery while mentoring the next generation of physicists and broadening representation in STEM through outreach. As the first in my family to pursue a PhD, I bring resilience, determination, and a collaborative spirit to both research and teaching.

EDUCATION

PhD - Astrophysics, Vanderbilt University, Nashville, TN *August 2020 – July 2026*
Qualifying exam passed May 2022

Master of Science - Physics, Fisk University, Nashville, TN *August 2018 – August 2020*
Thesis: A Sea of Black Hole Binaries: Characterizing the Expected Signature of Stellar Origin Binaries in the LISA Band
Advisor: Dr. Kelly Holley-Bockelmann

Bachelor of Science - Physics, University of California, Santa Cruz, Santa Cruz, CA *Sept 2011 – June 2016*
Thesis: Events in the Life of a Globular Cluster
Advisor: Dr. Enrico Ramirez-Ruiz

HONORS AND AWARDS

- Dean's Undergraduate Research Reward, University of California, Santa Cruz 2016
- Chambliss Astronomy Achievement Student Award, 245th American Astronomical Meeting 2025

GRANTS

- Graduate School Conference Travel Grant *2023* *$1000*
- Graduate School Conference Travel Grant *2024* *$1000*
- McMinn Fellowship Award *2025* *$1000*

ACADEMIC EXCELLENCE AND RESEARCH EXPERIENCE

Vanderbilt University, Nashville, TN *August 2020 – Present*
Research Assistant

- Developed predictive models based on cosmological simulations to estimate detection rates of stellar-origin black hole binaries for LISA and LIGO missions (Accepted in *Astrophysical Journal*).
- Conducted parameter estimation for intermediate-mass black hole (IMBH) merger events from LIGO's third observing run(b) data using RIFT (Accepted in *Astrophysical Journal Letters*).
- Created a population of quasistatic binaries, improving the accuracy of multiband gravitational wave detection rate predictions.
- Executed N-body simulations of dwarf galaxies hosting IMBH binaries to study dynamical interactions, including recoil effects.
- Performed signal-to-noise and likelihood-based data analyses on high-redshift massive black hole binaries

(MBHBs) to evaluate LISA detection prospects.

University of California, Santa Cruz, Santa Cruz, CA *December 2012 - March 2013, December 2013 - March 2014*
Undergraduate Researcher

- Monitored and analyzed real-time data from scientific balloon missions over Antarctica.
- Identified trends in atmospheric and particle data, compiling findings into detailed technical reports.
- Maintained system status logs and supported mission operations.

LAMAT Summer Intern *Summer 2016*

- Analyzed data from high-resolution cosmological simulations of the Milky Way.
- Investigated the distribution and enrichment of r-process elements produced by supernovae and neutron star mergers.

Junior Specialist *Fall 2016- Summer 2018*

- Studied r-process enrichment in cosmological simulations to trace the origins of heavy elements.
- Provided evidence supporting neutron star mergers as significant contributors to r-process element production.
- Explored implications of galactic chemical enrichment models to explain excess plutonium measurements on Earth.

LEADERSHIP AND SERVICE

Astronomy Journal Research Club *August 2021 – May 2024*
Journal Club Coordinator

- Led weekly journal club providing students with practice in professional presentations.
- Scheduled speakers, coordinated availability, and managed cancellations or rescheduling.
- Reserved meeting rooms and facilitated hybrid logistics (Zoom setup, camera operation).
- Sent reminders and encouraged participation from students and faculty.
- Organized catering, food pickup, and event setup/cleanup.

Astronomy Department Website *August 2021 – May 2024*
Website Manager

- Maintained and updated departmental personnel website on a weekly basis.
- Posted speaker schedules, research papers, and presentation slides to support students and faculty.
- Developed online resources to assist future Astronomy Journal Research Club leaders.

Arnulfo & Jovita Scholar Award *August 2021 – May 2024*
Founding Board Executive Member

- Maintained meeting records and tracked action items to ensure accountability.
- Facilitated board meetings to improve organizational effectiveness.
- Participated in candidate review and selection, contributing to awardee decisions.
- Established organizational processes as part of the founding board.

TEACHING AND MENTORING EXPERIENCE

Vanderbilt University *Nashville, TN*
REU Mentor *August 2024 – Present*

- Co-advise an undergraduate research project focused on predicting and mapping binary black hole mergers detectable by current and future gravitational wave observatories (In preparation).
- Provide guidance on research methodology, data analysis, and presentation of findings.

Instructor – EMIT Summer School Workshop *July 2025*

- Designed and led an interactive session using Jupyter Notebooks to demonstrate the functionality of the Python module LEGWORK.

- Facilitated group activities to engage graduate students and encourage collaborative learning during the workshop.

Co-Instructor – ASTR1010 - Order of Magnitude *Sept 2022*

- Led problem-solving sessions on estimation techniques for physical systems, enhancing students' analytical skills.
- Engaged graduate students through collaborative group work and provided real-time feedback and support.

Teaching Assistant – ASTR1010 - Introduction to Astronomy *Fall 2020 – Spring 2021*

- Led weekly lab sessions, guiding students through hands-on experiments and data analysis techniques in astronomy.
- Graded lab reports with detailed feedback, and held office hours to support student learning and engagement.

OUTREACH

Vanderbilt University *Nashville, TN*

QuarkNet, Presenter *June 2023, June 2024*

- Delivered presentations to approximately 5 high school teachers on gravitational waves and their significance in astrophysics using the Laser Interferometer Space Antenna.
- Engaged with 3 high school teachers to discuss gravitational waves and their detection within the LIGO, Virgo, and KAGRA gravitational wave detectors.

Adventure Science Center *Nashville, TN*

Exhibit Astronomy Outreach Presenter *August 2022, May 2025*

- Managed a booth during the "Way Late Play Date: Boldly Go Beyond" event, educating adults about spectroscopy from stars and its relevance to astrophysical research.
- Set up multiple booths for Vanderbilt University during the "Way Late Play Date: Science Strikes Back" event and managed a booth showcasing demonstrations and actively engaging with the public by answering questions about space-time concepts.

TALKS, POSTERS AND WORKSHOPS

Ten Years to LISA *April 2025*

Oral Presentation: A Sea of Black Holes: Characterizing the LISA Signature for Stellar-Origin Black Hole Binaries

LISA Data Analysis Workshop *January 2025*

245th American Astronomical Society *January 2025*

Poster: A Sea of Black Holes: Characterizing the LISA Signature for Stellar-Origin Black Hole Binaries

University of Alabama in Huntsville Seminar *November 2024*

Invited Talk: A Sea of Black Holes: Characterizing the LISA Signature for Stellar-Origin Black Hole Binaries

15th International LISA Symposium *July 2024*

Oral Presentation: A Sea of Black Holes: Characterizing the LISA Signature for Stellar-Origin Black Hole Binaries

243rd American Astronomical Society *January 2024*

Poster: The Dynamics of Intermediate Mass Black Hole Binaries in Dwarf Galaxies

Intermediate-Mass Black Holes: The Dawn of a Revolutionary Era *December 2023*

Poster: The Dynamics of Intermediate Mass Black Hole Binaries in Dwarf Galaxies

Windows on the Universe Workshop *October 2023*

Invited Talk: EMIT: Fostering Multidisciplinary Excellence in Multi-Messenger Astronomy

MODEST-23: Star Clusters in the Post-Pandemic Era *August 2023*

Poster: The Dynamics of Intermediate Mass Black Hole Binaries in Dwarf Galaxies

EMIT Summer School *July 2023*

241st American Astronomical Society *January 2023*
Poster: A Sea of Black Hole Binaries: Characterizing the Expected Signature of Stellar Origin and LIGO Intermediate-Mass Binaries in the LISA Band

Python and Astropy for Astronomical Data Analysis Workshop *January 2023*

237th American Astronomical Society *January 2021*
Poster: Inferring Multiband IMBH Populations from Cosmological Simulations

233rd American Astronomical Society *January 2019*
Poster: A Sea of Black Hole Binaries: Characterizing the Expected Signature of Stellar-Origin Binaries in the LISA Band

229th American Astronomical Society *January 2017*
Poster: On the Radial Abundance Gradients of Europium and Oxygen of Stars Inside the Disk of a Simulated Milky Way

MEDIA

1. Smith, W.J., **Ruiz-Rocha, K.**, Jani, K. (2025) Meet 'lite intermediate black holes,' the supermassive black hole's smaller, much more mysterious cousin *The Conversation*

PROFESSIONAL AFFILIATIONS

- Laser Interferometer Gravitational-Wave Observatory Collaboration *2020 - Present*
- Laser Interferometer Space Antenna Collaboration *2023 - Present*
- American Astronomical Society

PUBLICATIONS

First Author

1. **Ruiz-Rocha, K.**, Yelikar, A. B., et al. (2025). Properties of "Lite" Intermediate-mass Black Hole Candidates in LIGO-Virgo's Third Observing Run. *Astrophysical Journal Letters*
2. **Ruiz-Rocha, K.**, Holley-Bockelmann, K., et al. (2025). A Sea of Black Holes: Characterizing the LISA Signature for Stellar-origin Black Hole Binaries. *Astrophysical Journal*
3. **Ruiz-Rocha, K.**, Jani, K., et al. (2025). Characterizing the LISA Signature for Quasistatic Black Hole Binaries. – *in preparation*
4. **Ruiz-Rocha, K.**, Kolborg,A.N., et al. (2025). Mapping r-Process Enrichment by Neutron Star Mergers in the Milky Way – *in preparation*

Short Author

1. Smith, W. J., Jani K.,**Ruiz-Rocha, K.**, Holley-Bockelmann, K. Large-scale structure of the universe as the astrophysical probe for stellar-mass binary black hole mergers – *in preparation*
2. Motuz*, M., Jani K., Smith, W J., **Ruiz-Rocha, K.** Mapping the Binary Black Hole Mergers for the Current and Next-Gen Gravitational Wave Detectors - *in prep*
3. Yelikar, A. B., Jani K.,**Ruiz-Rocha, K.**, Smith, W. J., Large-scale structure of the universe as the astrophysical probe for stellar-mass binary black hole mergers - *in prep*

* undergraduate REU mentee

Collaboration

1. The LIGO Scientific Collaboration and the Virgo Collaboration and the KAGRA Collaboration, et al. (2025) Upper Limits on the Isotropic Gravitational-Wave Background from the first part of LIGO, Virgo, and KAGRA's fourth Observing Run *arxiv*
2. The LIGO Scientific Collaboration and the Virgo Collaboration and the KAGRA Collaboration, et al. (2025) GWTC-4.0: Methods for Identifying and Characterizing Gravitational-wave Transients *arxiv*
3. The LIGO Scientific Collaboration and the Virgo Collaboration and the KAGRA Collaboration, et al. (2025) GWTC-4.0: An Introduction to Version 4.0 of the Gravitational-Wave Transient Catalog *arxiv*
4. The LIGO Scientific Collaboration and the Virgo Collaboration and the KAGRA Collaboration, et al. (2025) All-sky search for long-duration gravitational-wave transients in the first part of the fourth LIGO-Virgo-KAGRA Observing run *arxiv*
5. The LIGO Scientific Collaboration and the Virgo Collaboration and the KAGRA Collaboration, et al. (2025) GW231123: a Binary Black Hole Merger with Total Mass 190-265 $M_\odot$ *arxiv*
6. The LIGO Scientific Collaboration and the Virgo Collaboration and the KAGRA Collaboration, et al. (2025) Search for Gravitational Waves Emitted from SN 2023ixf, *The Astrophysical Journal*
7. Abac, A. G., Abott, R., et al. (2025) Search for Continuous Gravitational Waves from Known Pulsars in the First Part of the Fourth LIGO-Virgo-KAGRA Observing Run, *The Astrophysical Journal*
8. Raman, G. Ronchini, S. et al (2025) Swift-BAT GUANO Follow-up of Gravitational-wave Triggers in the Third LIGO–Virgo–KAGRA Observing Run *The Astrophysical Journal*
9. The LIGO Scientific Collaboration and the Virgo Collaboration and the KAGRA Collaboration, et al. (2024) A Search Using GEO600 for Gravitational Waves Coincident with Fast Radio Bursts from SGR 1935+2154 *The Astrophysical Journal*
10. The LIGO Scientific Collaboration and the Virgo Collaboration and the KAGRA Collaboration, et al. (2024) Search for Eccentric Black Hole Coalescences during the Third Observing Run of LIGO and Virgo *The Astrophysical Journal*
11. The LIGO Scientific Collaboration and the Virgo Collaboration and the KAGRA Collaboration, et al. (2024) Ultralight vector dark matter search using data from the KAGRA O3GK run *Physical Review D*
12. The LIGO Scientific Collaboration and the Virgo Collaboration and the KAGRA Collaboration, et al. (2024) Observation of Gravitational Waves from the Coalescence of a 2.5–4.5 $M_\odot$ Compact Object and a Neutron Star *The Astrophysical Journal Letters*
13. The LIGO Scientific Collaboration and the Virgo Collaboration and the KAGRA Collaboration, et al. (2024) Search for Gravitational-lensing Signatures in the Full Third Observing Run of the LIGO–Virgo Network *The Astrophysical Journal*
14. The LIGO Scientific Collaboration and the Virgo Collaboration and the KAGRA Collaboration, et al. (2024) Search for Gravitational-wave Transients Associated with Magnetar Bursts in Advanced LIGO and Advanced Virgo Data from the Third Observing Run *The Astrophysical Journal*
15. The LIGO Scientific Collaboration and the Virgo Collaboration and the KAGRA Collaboration, et al. (2024) A Joint Fermi-GBM and Swift-BAT Analysis of Gravitational-wave Candidates from the Third Gravitational-wave Observing Run *The Astrophysical Journal*
16. The 2023 Windows on the Universe Workshop White Paper Working Group, et al. (2024) Windows on the Universe: Establishing the Infrastructure for a Collaborative Multi-messenger Ecosystem *arxiv*
17. The LIGO Scientific Collaboration and the Virgo Collaboration, et al. (2024) GWTC-2.1: Deep extended catalog of compact binary coalescences observed by LIGO and Virgo during the first half of the third observing run *Physical Review D*

18. The LIGO Scientific Collaboration and the Virgo Collaboration and KAGRA Collaboration, et al. (2023) GWTC-3: Compact Binary Coalescences Observed by LIGO and Virgo during the Second Part of the Third Observing Run *Physical Review X*

19. The LIGO Scientific Collaboration and the Virgo Collaboration and KAGRA Collaboration, et al. (2023) Search for subsolar-mass black hole binaries in the second part of Advanced LIGO's and Advanced Virgo's third observing run *Monthly Notices of the Royal Astronomical Society*

20. The LIGO Scientific Collaboration and the Virgo Collaboration and KAGRA Collaboration, et al. (2023) Open Data from the Third Observing Run of LIGO, Virgo, KAGRA, and GEO *The Astrophysical Journal Supplement Series*

21. The LIGO Scientific Collaboration and the Virgo Collaboration and KAGRA Collaboration, et al. (2023) Constraints on the Cosmic Expansion History from GWTC–3 *The Astrophysical Journal*

22. The LIGO Scientific Collaboration and the Virgo Collaboration and KAGRA Collaboration, et al. (2022) Model-based Cross-correlation Search for Gravitational Waves from the Low-mass X-Ray Binary Scorpius X-1 in LIGO O3 Data *The Astrophysical Journal Letters*

23. The LIGO Scientific Collaboration and the Virgo Collaboration and KAGRA Collaboration, et al. (2022) All-sky search for continuous gravitational waves from isolated neutron stars using Advanced LIGO and Advanced Virgo O3 data *Physical Review D*

24. The LIGO Scientific Collaboration and the Virgo Collaboration and KAGRA Collaboration, et al. (2022) Search for gravitational waves from Scorpius X-1 with a hidden Markov model in O3 LIGO data *Physical Review D*

25. The LIGO Scientific Collaboration and the Virgo Collaboration and KAGRA Collaboration, et al. (2022) Search for continuous gravitational wave emission from the Milky Way center in O3 LIGO-Virgo data *Physical Review D*

26. The LIGO Scientific Collaboration and the Virgo Collaboration and KAGRA Collaboration, et al. (2022) Searches for Gravitational Waves from Known Pulsars at Two Harmonics in the Second and Third LIGO-Virgo Observing Runs *Physical Review D*

27. The LIGO Scientific Collaboration and the Virgo Collaboration and KAGRA Collaboration, et al. (2022) First joint observation by the underground gravitational-wave detector KAGRA with GEO 600 *Progress of Theoretical and Experimental Physics*

28. The LIGO Scientific Collaboration and the Virgo Collaboration and KAGRA Collaboration, et al. (2022) All-sky search for gravitational wave emission from scalar boson clouds around spinning black holes in LIGO O3 data *Physical Review D*

29. The LIGO Scientific Collaboration and the Virgo Collaboration and KAGRA Collaboration, et al. (2021) Tests of General Relativity with GWTC-3 *arxiv*