Sasha Levina

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Research Interests

Gravitational-wave astrophysics, binary black hole populations, binary and stellar evolution, galaxy evolution and chemical enrichment; I am interested in how gravitational waves can be used to study the progenitors of double compact objects and the environments in which they form in order to better understand the intersection of galactic and stellar evolution over cosmic history.

Education

University of California San Diego, La Jolla, CA — September 2025 - present
Ph.D., Astrophysics
Advisor: Floor Broekgaarden

Johns Hopkins University, Baltimore, MD — August 2023 - September 2025
M.A., Astrophysics
Advisors: Floor Broekgaarden, Emanuele Berti

Haverford College, Haverford, PA — August 2019 - May 2023
B.S., Astronomy & Physics
Concentration: Scientific Computing
Senior thesis: "Applying Wind Roche-Lobe Overflow in Binary Evolution using MESA and POSYDON"

Research

Impact of the Star Formation History on the Binary Black Hole Merger Population
August 2023 - present
UC San Diego, La Jolla, CA; Johns Hopkins University, Baltimore, MD
Advisors: Floor Broekgaarden, Emanuele Berti, Lieke van Son

- Model the star formation rate density (SFRD) and cosmic chemical enrichment of the cosmological magnetohydrodynamic simulations IllustrisTNG using an analytical fit for the metallicity-dependent SFRD, which increases computational efficiency when modeling binary populations
- Optimize and evaluate the performance of the analytical model for the metallicity-dependent SFRD
- Test the effect of resolution and assumptions in six runs of the IllustrisTNG simulations on the metallicity-dependent SFRD and the binary black hole (BBH) merger population
- Investigate the impact of metallicity evolution over cosmic time on the merger rates and properties of the BBH merger population using the rapid population synthesis code COMPAS
- This work resulted in a paper submitted to The Astrophysical Journal, currently in review, which evaluated the impact of using the analytical model on the resulting BBH population. A second, follow-up manuscript is currently in preparation, which investigates the effect of simulation resolution and volume on the metallicity-dependent SFRD

Modeling Wind Roche-Lobe Overflow in Binary Evolution — June 2022 - May 2023
Northwestern University, Evanston, IL
CIERA REU
Advisors: Meng Sun, Vicky Kalogera, Zoheyr Doctor

- Implemented a new physical mechanism for wind mass-transfer into the stellar evolution simulation code MESA (Modules for Experiments in Stellar Astrophysics) and the detailed binary population synthesis code POSYDON (POpulation SYnthesis with Detailed binary-evolution simulatiONs)
- Simulated and analyzed a grid of binary evolution models with wind Roche-lobe overflow using MESA
- Used the Quest High-Performance Computing Cluster to run population synthesis simulations using POSYDON
- The work culminated in my undergraduate senior thesis (May 2023) and a paper published in ApJ in June 2024

Analyzing Crab Pulsar X-ray Emission June 2020 - May 2023
Haverford College, Haverford, PA
Advisor: Andrea Lommen

- Developed a script that increased the efficiency of pulse phases calculations for pulsar timing data, implemented in the NANOGrav pulsar timing analysis software PINT
- Processed and analyzed large quantities of pulsar timing data from NICER (Neutron star Interior Composition ExploreR) using NICERSoft, HEASoft, and PINT
- Fit models to observational data using Bayesian statistics to study the pulse-to-pulse phase modulation of the Crab Pulsar X-ray emission

Publications

Levina, S., Broekgaarden, F., van Son, L., Berti, E., Romagnolo, A., Pakmor, R., Lam, A., "The impact of cosmological simulation resolution and box volume on binary black hole mergers." In prep.

Levina, S., Broekgaarden, F., van Son, L., Berti, E., Romagnolo, A., Pakmor, R., Lam, A., "From cosmological simulations to binary black hole mergers: The impact of using analytical star formation history models on gravitational-wave source populations." Submitted to ApJ, in review. https://arxiv.org/abs/2601.20202

Smith, T. B., Broekgaarden, F., **Levina, S.**, Romagnolo, A., Komandur, M., Santiago, M., Rocha, K. A., "Massquerade: Impacts of Mass Ratio Reversals on Binary Black Hole Merger Rates and Mass Distributions" Submitted to ApJ. https://arxiv.org/abs/2605.21580

Sun, M., **Levina, S.**, Gossage, S., Kalogera, V., Leiner, E. M., Geller, A. M., Doctor, Z., "Wind Roche-lobe Overflow in Low-mass Binaries: Exploring the Origin of Rapidly Rotating Blue Lurkers." ApJ 969 8. DOI: 10.3847/1538-4357/ad47c1

Worchel, M., Ferris, M. M., **Levina, S.**, Horn, I., Tygh, M., Lommen, A., et al..., "Photon-Count Statistics of Crab X-ray Pulses: Skellam Behavior and Excess Variance in the Main Pulse" Submitted to ApJ. https://arxiv.org/abs/2604.05050

Susobhanan, A., et al... **Levina, S.**..., "PINT: Maximum-likelihood Estimation of Pulsar Timing Noise Parameters." ApJ 971 150. DOI: 10.3847/1538-4357/ad59f7

Awards and Grants

ACME TNA Program travel grant 2026
Travel grant for 2-week visit to UNIGE

NSF ACCESS Explore allocation, 400,000 credits 2025
"Exploring the host galaxies of merging binary black holes using cosmological simulations" (PHY260087)

William H. Miller III Graduate Fellowship 2023
Johns Hopkins University
Awarded to 10 PhD students per year

NSF Research Experiences for Undergraduates 2022
Northwestern CIERA REU

Marian E. Koshland Integrated Natural Sciences Center Summer Scholars 2020
Haverford College

Talks and Presentations

"Cosmic Fossils: Tracing Star Formation with Gravitational Waves"

- Candidacy Exam. May 2026

"To peak or not to peak: Impacts of using analytical star formation histories on binary black hole masses"

- A&A Journal Club. April 2026.
- COMPAS Meeting. March 2026
- APS Global Physics Summit, Denver, CO. March 2026

"Representing cosmological simulation star formation histories using analytical models: Impacts on binary black hole merger populations"

- GWPAW 2025, Georgia Tech, Atlanta, Georgia. December 2025
- KITP Lifecycle of Stellar Black Holes, UCSB, Santa Barbara, CA. November 2025
- GalFresca 2025, UCSD, La Jolla, CA. September 2025

"Connecting cosmological simulations to gravitational waves: The impact of the star formation history on the binary black hole merger population"

- GW Paleontology Group Meeting, UCSD, La Jolla, CA. April 2025
- 245th Meeting of the American Astronomical Society, National Harbor, MD. January 2025
- Research Exam, Johns Hopkins University, Baltimore, MD. September 2024

"The effect from uncertainties in cosmological simulations on the binary black hole merger population"

- Lorentz Center workshop: Gravitational waves: a new ear on the chemistry of galaxies, Leiden, the Netherlands. April 2024
- Nordic Winter School on Multimessenger Astrophysics, Skeikampen, Norway. January 2024

"Applying wind Roche-lobe overflow in binary evolution using MESA and POSYDON"

- Senior thesis, Haverford College, May 2023
- 241st Meeting of the American Astronomical Society. January 2023
- Summer research symposium, Haverford College, September 2022
- CIERA REU poster session, Northwestern University, August 2022

"Pulse-to-pulse intensity modulation of the Crab Pulsar using NICER"

- NANOGrav 2022 Fall Meeting poster session, University of Wisconsin-Milwaukee, October 2022
- NANOGrav 2021 Fall Meeting poster session, Vanderbilt University, October 2021

- Summer research symposium, Haverford College, September 2021
- 237th Meeting of the American Astronomical Society, January 2021
- NANOGrav 2020 Fall Meeting, October 2020
- Summer research symposium, Haverford College, September 2020

Teaching

General Physics Laboratory I & II, Teaching Assistant, Fall 2024-Spring 2025
General Physics Laboratory I, Teaching Assistant, Fall 2024

- Lead weekly, 3 hour lab; prelab discussion, lab overview presentation, and assist students during labwork
- Prepare materials and presentations for lab
- Provide feedback on prelab, lab participation, and lab reports

General Physics II for Physical Science Majors, Teaching Assistant, Spring 2025

- Lead weekly active learning section with 24 students; give short lecture, work example problem, and assist students in group work
- Grade and provide feedback on student homework and exams
- Host weekly office hours

General Physics I for Biological Science Majors, Teaching Assistant, Fall 2024

- Lead weekly active learning section with 24 students; work example problem and assist students in group work
- Grade and provide feedback on student homework
- Host weekly office hours and homework help sessions
- Manage 24 students; track student progress, communicate directly with students to provide support

Mentorship and Outreach

- Joseph Rodriguez, undergraduate student at UCSD, April 2025 - present
- Prajakta Saraf, M.S. student at UCSD, April 2025 - September 2025
- Peer-2-Peer Mentorship program: Aynsley Mauldin, 1st year undergraduate student at UCSD, October 2025 - present
- Cosmic Tours at UCSD, April 2026
- "Physics and astronomy research talks" and "Careers in STEM" Q&A panel at City Neighbors High School, December 2023

Skills

- Programming Languages: Python, Fortran, MatLab, HTML, CSS
- Operating systems: Mac OS, Windows OS, Linux
- Software: LaTeX, Git, Mathematica
- High-Performance Computing Clusters: JHU Rockfish, Northwestern Quest, SDSC Expanse