Zhisen Lai

www.linkedin.com/in/zhisenlai/ — https://scholar.google.com/citations?hl=zh-CN&user=rwdaufcAAAAJ

RESEARCH INTERESTS

My research focuses on developing **AI-enhanced scientific compression** and **ROI-aware data reduction frameworks** to optimize storage and reconstruction for large-scale HPC simulations. I am also dedicated to advancing **physics-informed machine learning** architectures to improve the denoising and detection of ultra-high-energy particles within complex astrophysical detector arrays.

EDUCATION

University of Nebraska Omaha, Omaha, NE — Jan, 2026 — Present
Doctor of Philosophy: Computing & Information Science

San Francisco State University, San Francisco, CA — Sept, 2023 — Dec, 2025
Master of Science: Astronomy and Astrophysics — Cumulative GPA: 3.81/4.00

University of California, Santa Cruz, Santa Cruz, CA — Sept, 2019 — Mar, 2023
Bachelor of Science: Physics (Astrophysics) — Cumulative GPA: 3.15/4.00

ACADEMIC EXPERIENCE

Univeristy of Nebraska Omaha — Omaha, NE
Graduate Researcher — Jan, 2026 — Present

- Developing **AI/ML-driven post-processing modules** to enhance the perceptual quality and reconstruction accuracy of state-of-the-art scientific lossy compressors (e.g., **SZ3, STZ, AMR-SZ**); integrating ML-based correction kernels into data reduction pipelines for large-scale HPC datasets like **Nyx** and **AMReX**.
- Designing an **ROI-aware multi-resolution storage pipeline (MRX)** for uniform-grid data, implementing both **fixed-block** and **KD-tree-based** adaptive partitioning backends to support feature-based data conversion and reduction.

Giant Radio Array for Neutrino Detection (GRAND) — San Francisco, CA
Graduate Researcher — Sept, 2023 — Dec, 2025

- Built a deep convolutional denoiser for GRAND antenna traces that jointly processes **time- and frequency-domain** representations, suppressing Galactic/instrumental backgrounds while preserving broadband pulse morphology.
- Trained and validated on $\mathbf{4.1\times10^5}$ simulated UHECR radio traces with realistic detector response and noise; achieved a median **output-SNR gain of ∼15–23 dB (50–200 MHz)** and **∼10× lower normalized waveform MSE** versus a Hilbert-envelope denoiser baseline; verified **no spurious pulses** in noise-only windows.
- Improved near-threshold event reconstruction by increasing antennas with reliable pulse timing by **∼2–3×** (tighter direction uncertainties) and enabling a median gain of **∼3–4** antennas usable for energy reconstruction at **SNR≈5–6**; open-sourced the implementation: `https://github.com/grand-mother/ML_denoising/tree/raytune_lib_final`.

UC Santa Cruz Transient Team — Santa Cruz, CA
Undergraduate Researcher — June, 2021 — Mar, 2023

- Implemented the **Least Squares Regression** in Python to identify anomalous supernova patterns, enhancing the astronomical database's anomaly detection capabilities. The open-source on the GitHub: **https://github.com/SamLai0509/Anomalous_supernovae_detection.git**.
- Analyzed supernova data for "The Young Supernova Experiment" Collaboration, identifying anomalous supernovae (**2020wnt, 2021gno, 2021inl, 2022ann**), advancing the understanding of rare astronomical data.
- Upgraded the BLAST astronomical web application using HTML and CSS in the Docker environment, improving the user interface and data visualization for an enhanced user experience. The open-source on GitHub: **https://github.com/astrophpeter/blast**.

PUBLICATIONS

Published

- **Zhisen Lai**, Oscar Macias, Aurélien Benoit-Lévy, et al, "Deep-Learning Denoising of Radio Observations for Ultra-High-Energy Cosmic-Ray Detection" arXiv.Org, 3 Feb. 2026, `https://arxiv.org/abs/2602.03818`
- I. A. Abreu Paniagua, W. B. Hoogendam, David O. Jones, Q. Wang, et al. **Zhisen Lai** "The New Status Qvo? SN 2021qvo Is Another 2003fg-like Type Ia Supernova with a Rising Light-curve Bump." ***The Astrophysical Journal, vol. 997, no. 2, 1 February 2026, p. 261,*** *https://doi.org/10.3847/1538-4357/ae279b*.
- D. O. Jones, P. McGill,T. A. Manning, A. Gagliano, B. Wang, D. A. Coulter, R. J. Foley, G. Narayan, V. A. Villar, L. Braff, A. W. Engel, D. Farias, **Z. Lai**, K. Loertscher, J. Kutcka, S. Thor, and J. Vazquez "Blast: a Web Application for Characterizing the Host Galaxies of Astrophysical Transients." arXiv.Org, 22 Oct. 2024, `arxiv.org/abs/2410.17322v1`.

- Oscar Macias, Aurélien Benoit-Lévy, Valentin Decoene, Arsène Ferrière, Marion Guelfand, Claire Guépin, Kumiko Kotera, **Zhisen Lai**, Olivier Martineau-Huynh, Simon Prunet, Matías Tueros. "Reconstruction of Highly Inclined Extensive Air Showers in GRAND." Presented at the 39th International Cosmic Ray Conference (ICRC 2025), PoS(ICRC2025)062, `https://doi.org/10.22323/1.470.062`.
- The GRAND Collaboration, Aurélien Benoit-Lévy, **Zhisen Lai**, Oscar Macias, Arsène Ferrière. "Denoising radio pulses from air showers using machine-learning methods." Presented at the 39th International Cosmic Ray Conference (ICRC 2023), PoS (ICRC2025)185, submitted 9 July 2025, `https://doi.org/10.48550/arXiv.2507.06688`.
- K W Davis, K Taggart, S Tinyanont, R J Foley, V A Villar, et al. **Z Lai** "SN 2022ANN: A type ICN supernova from a dwarf galaxy that reveals helium in its circumstellar environment." **Monthly Notices of the Royal Astronomical Society, vol. 523, no. 2, 15 May 2023, pp. 2530–2550,** `https://doi.org/10.1093/mnras/stad1433`.
- Samaporn Tinyanont, Stan E. Woosley, Kirsty Taggart, Ryan J. Foley, Lin Yan, et al. **Zhisen Lai**, "Supernova 2020wnt: An Atypical Superluminous Supernova with a Hidden Central Engine", ***The Astrophysical Journal, vol. 951, no. 1, 29 June 2023, p. 34.*** *https://doi.org/10.3847/1538-4357/acc6c3*.
- Wynn Jacobson-Galán, Padma Venkatraman, Raffaella Margutti, David Khatami, Giacomo Terreran, et al. **Zhisen Lai** "The circumstellar environments of double-peaked, calcium-strong transients 2021gno and 2021inl." **The Astrophysical Journal, vol. 932, no. 1, 1 June 2022, p.58,** `https://iopscience.iop.org/article/10.3847/1538-4357/ac67dc`.

Workshop/Conference

Workshop on Machine Learning for Analysis of High-Energy Cosmic Particles University of Delaware, Newark, DE, USA
Presenter for "Denoising Radio Pulses from Air Shower Using Machine Learning Method" Jan. 2025

- Presented an unsupervised autoencoder model to denoise simulated radio signals from ultra-high-energy cosmic particles for the GRAND experiment.
- Presented preliminary results demonstrating sensitivity gains from applying the denoising algorithm to noisy GRAND signals at varying signal-to-noise ratios.

GRAND Collaboration Workshop Nanjing, China
Presenter for "Using ResNet Autoencoder Model to reconstruct Voltage Signal From AirShower" June. 2024

- Introduced the ResNet Autoencoder model to reconstruct voltage signals from air showers, focusing on denoising noisy data.
- Results show effective denoising for high SNR signals, with some improvements for low SNR signals.
- Presentation slides: **here**

No Jargon talk Workshop Santa Cruz, CA, USA
Organizer for "No Jargon Talk" June. 2024

- Organized discussions within the field of physics, focused on jargon-free communication.
- Shared techniques for audience-specific scientific writing and collaborated these into social media and blogs.
- Information of the Talks: **here**

SELECTED COURSES

Master's Courses

- COMPUTATIONAL PHYSICS
- OBSERVATIONAL TECHNIQUES IN ASTRONOMY RESEARCH
- INCLUSIVE PEDAGOGY
- STELLAR ASTROPHYSICS

Bachelor's Courses

- PHYSICS AND MACHINE LEARNING
- ASTROPHYSICS ADVANCED LAB
- PLANETARY SYSTEM
- SCIENCE COMMUNICATION IN PHYSICS

AWARDS

Kazuko Walson Scholarship San Francisco, CA
A financial support to graduate students who teach Physics and Astronomy laboratory classes. Sept, 2023

Kazuko Walson Scholarship San Francisco, CA
A financial support to graduate students who teach Physics and Astronomy laboratory classes. Sept, 2024

TEACHING EXPERIENCES

PHYS 102, CONCEPTUAL PHYSICS LAB San Francisco, CA
LAB INSTRUCTOR, SAN FRANCISCO STATE UNIVERSITY Sept, 2024 — Dec, 2024

- Taught students to apply scientific methods and laboratory procedures, emphasizing hypothesis development, experimental controls, and data analysis for experiments in motion, force, and energy.
- Guided students in interpreting graphs, algebraic equations, and written descriptions of motion, while fostering critical thinking to assess the validity of experimental results.
- Instructed on measurement accuracy, sources of error, and application of key physics principles, such as conservation of energy, Newton's laws, and wave properties, through hands-on laboratory activities.

PHYS 112, GENERAL PHYSICS LAB San Francisco, CA
LAB INSTRUCTOR, SAN FRANCISCO STATE UNIVERSITY Sept, 2023 — May, 2024

- Led students in applying data analysis methods for experiments on motion, force, and energy.
- Instructed students on standard laboratory procedures for accurate measurements of physical quantities such as velocity, acceleration, and momentum.
- Guided students in the critical evaluation of results related to Newton's laws and energy principles.

SKILLS

- **Programming and Packages:** Python (Pytorch, Scikit-Learn, Matplotlib, Numpy, Scipy, Pandas), HTML, SQL, CSS, Latex
- **Software:** Linux, Git, Docker.
- **Soft Skills:** Machine Learning, Denoising Modeling, Predictive Modeling, Data Analysis, Data Visualization, Data Mining.