Charles Gannon

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Education

2021 – Present
- **University of California, Merced** – PhD Candidate in Physics (5th Year)
- **Idaho State University** – B.S. in Physics, Magna Cum Laude

Research Experience

2021 – Present
- **Statistical Characterization of Dark Matter Substructure** – UC Merced
  Led development of statistical analysis frameworks to constrain dark matter models using strong gravitational lensing observables:
  - Designed and executed large-scale state-of-the-art simulation suites of dark matter halos.
  - Built automated pipelines for processing, analyzing, and visualizing high-dimensional simulation outputs.
  - Developed and tuned state-of-the-art analytic and semi-analytic models of dark matter substructure using simulation results and statistical/ML methods.
  - Published first-author results: "Dark matter substructure: A lensing perspective," *Physical Review D* (2025).

2025 – Present
- **T1DES: Ultra-Fast 1D Dark Matter Subhalo Simulations** – UC Merced
  Leading development of a novel simulation framework (Tidal 1D Evolution of Subhalos) for rapid parameter-space exploration of alternative dark matter models:
  - Designing computationally efficient 1D evolution models achieving orders-of-magnitude speedup over traditional 3D N-body approaches.
  - Enabling large-scale statistical studies previously intractable with conventional simulation methods.

2020 – 2021
- **Materials Under Fast Neutron Flux** – Idaho State University
  Investigated radiation effects on material properties for applications in fast neutron reactors.

Publications

1. **C. Gannon**, A. Nierenberg, A. Benson, R. Keeley, X. Du, and D. Gilman, "Dark matter substructure: A lensing perspective," *Physical Review D*, vol. 112, no. 2, 023532, p. 023 532, Jul. 2025. DOI: 10.1103/kk2n-q4ps. arXiv: 2501.17362 [astro-ph.GA].
2. X. Du, D. Gilman, T. Treu, A. Benson, and **C. Gannon**, "Empirical model for the tidal evolution of dark matter substructure around strong gravitational lenses," *Physical Review D*, vol. 112, no. 2, 023009, p. 023 009, Jul. 2025. DOI: 10.1103/6tbt-w3nv. arXiv: 2503.07728 [astro-ph.CO].
3. D. Gilman et al., "JWST lensed quasar dark matter survey IV: Stringent warm dark matter constraints from the joint reconstruction of extended lensed arcs and quasar flux ratios," *arXiv e-prints*, arXiv:2511.07513, arXiv:2511.07513, Nov. 2025. DOI: 10.48550/arXiv.2511.07513. arXiv: 2511.07513 [astro-ph.CO].
4. X. Du et al., "Tidal evolution of cored and cuspy dark matter halos," *Physical Review D*, vol. 110, no. 2, 023019, p. 023 019, Jul. 2024. DOI: 10.1103/PhysRevD.110.023019. arXiv: 2403.09597 [astro-ph.GA].

5 R. E. Keeley et al., "JWST lensed quasar dark matter survey - II. Strongest gravitational lensing limit on the dark matter free streaming length to date," *Monthly Notices of the Royal Astronomical Society*, vol. 535, no. 2, pp. 1652–1671, Dec. 2024. DOI: 10.1093/mnras/stae2458. arXiv: 2405.01620 [astro-ph.CO].

Presentations & Workshops

2026 — **AAS Winter 2026** – "Accelerated Core Collapse of Highly Tidally Truncated SIDM Halos"

2025 — **APS March Meeting 2025** – Poster – "Dark Matter: A Lensing Perspective"

— **CEVAL ARC Symposium** – Symposium on high performance computing in the California Central Valley.

2024 — **Cosmic Signals of Dark Matter Physics: New Synergies** (KITP, UCSB) – Contributed talk and poster – "Dark Matter: A Lensing Perspective"

— **KITP Workshop** – Dark Matter Theory, Simulation, and Analysis in the Era of Large Surveys

2023, 2024 — **N3AS Summer School** – Multi-Messenger Astrophysics

Software & Machine Learning

Open-Source Software

- **SubScript** (Author/Maintainer) – Statistical analysis library for dark matter halo simulations (Python)
- **Galacticus** (Contributor) – Semi-analytic galaxy formation framework (Fortran/C++)
- **pyHalo** (Contributor) – Dark matter halo rendering for lensing simulations (Python)

Machine Learning Projects

- **Exoplanet Habitability Classification** – Decision trees, k-NN (including from-scratch k-d tree implementation), cross-validation strategies for severe class imbalance.
- **Model Diagnostics & Feature Engineering** – Learning curve analysis, physics-informed feature engineering to improve classifier recall.
- **LHC Collision Event Classification** – SVMs with kernel hyperparameter tuning via grid search, feature scaling pipelines, one-hot encoding of categorical variables.
- **Classifying Radial Star Migrators in a Simulated Milky Way** – Developed and compared Random Forest, KNN, Linear Regression, and CNN approaches to identify stars that have radially migrated in the M12i cosmological simulation based on astrophysical observables.
- **Rock Paper Scissors** – Markov Chain-based opponent that learns player patterns in a rock paper scissors game.

Graduate Coursework

ML/Statistics — **Machine Learning and Statistics for Physics and Astronomy** (ASTRO 227)

Physics — Statistical Mechanics, Quantum Mechanics I, Electrodynamics I, Classical Mechanics

Astrophysics — Radiative Processes, Astrophysics I

Outreach & Teaching

2021 – 2022 — **Teaching Assistant** – UC Merced
Led Physics 18 Lab (Introductory Physics I for Biological Sciences Lab) and Physics 9 Discussion (Introductory Physics II for Physical Sciences).

Outreach & Teaching (continued)

2025 **Bobcat Summer STEM Academy: "Programming the Universe"** – Developed and taught sections of a week-long intensive for high school students covering simulation, modeling, and visualization of dark matter and gravitational lensing using Python.

2024 **Merced County Steam Fair – Judge** – Evaluated science fair submissions for the Merced County Steam Fair.