Christopher Ewasiuk

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SUMMARY

PhD researcher in particle astrophysics and gravitational wave phenomenology with 7 peer-reviewed publications (5 first-author), including a submission to Physical Review Letters. Research spans primordial black hole dark matter, gravitational wave detection, dark sector effective field theory, and precision gravity constraints with active collaboration between ADMX, Fermilab, and resonant microwave cavity experiments across a multidisciplinary team environment. Experienced designing and executing large-scale simulation frameworks and particle transport models on high-performance computing systems, with a strong foundation in uncertainty quantification, signal detection, and Bayesian inference across theoretical, computational, and experimental physics. Prior operational experience at SLAC including federal security clearance for accelerator operations, with a track record of independently identifying novel research directions across multiple concurrent projects. U.S. citizen, eligible for DOE Q-level security clearance.

EDUCATION

University of California, Santa Cruz — Ph.D., Physics *(Expected June 2026)* Advisor: Prof. Stefano Profumo | Santa Cruz Institute for Particle Physics (SCIPP)

University of California, Santa Barbara — B.S., Physics, *Magna Cum Laude* (2021)

SKILLS

- **Scientific Computing:** High-performance computing, large-scale simulation pipelines, Monte Carlo methods, differential equation solvers, particle and radiation transport modeling, population synthesis, reproducible benchmark design
- **Signal Processing & Statistics:** Uncertainty quantification, matched filtering, FFT/rFFT, power spectral density analysis (Welch/robust stacking), Bayesian inference, noise modeling, time-frequency analysis, Landau-Zener transition calculations
- **Machine Learning:** PyTorch, CNNs, 3D U-Net, ResNet fine-tuning, composite loss design, class imbalance handling, model evaluation and benchmarking, experiment tracking
- **Programming & Tools:** Python (NumPy, SciPy, pandas, Matplotlib, PyTorch), C/C++, Git, Linux/Unix, LaTeX, Mathematica, FeynCalc, HDF5

PUBLICATIONS

[1] **C. Ewasiuk*** and S. Profumo, "Quantum Tunneling of Primordial Black Holes to White Holes: Rates, Constraints, and Implications for Fast Radio Bursts," *JCAP* (submitted, 2026) [arXiv:2603.22516]

[2] C. Ewasiuk* and S. Profumo, "Ghost Degrees of Freedom Without Quantum Runaway: Exact Moment Bounds from an Operator Conservation Law," **PRL (submitted April 2026)** [arXiv:2604.21348]

[3] H. Su, L. Brown, **C. Ewasiuk***, and S. Profumo, "High-Frequency Gravitational Wave Transients from Superradiance," *JCAP* (submitted, 2025)

[4] **C. Ewasiuk*** and S. Profumo, "Precision Gravity Constraints on Large Dark Sectors," *JHEP* (submitted, 2025) [arXiv:2509.02801]

[5] **C. Ewasiuk*** and S. Profumo, "Dark-Sector Modifications to Kerr and Reissner-Nordström Black Hole Evaporation," *Physical Review D* (2025) [arXiv:2505.04812]

[6] S. Profumo, L. Brown, **C. Ewasiuk***, S. Ricarte, and H. Su, "The Maximal Gravitational Wave Signal from Asteroid-Mass Primordial Black Hole Mergers at Resonant Microwave Cavities," *Physical Review D* (2025) [arXiv:2410.15400]

[7] **C. Ewasiuk*** and S. Profumo, "Gravitational Production of Dark Sector Particles and Constraints from Precision Tests of Gravity," *Physical Review D* (2024) [arXiv:2409.11359]

COLLABORATIONS

- **ADMX Collaboration** (Axion Dark Matter eXperiment, hosted at Fermilab): signal analysis pipelines and large-scale signal detection workflows for resonant cavity dark matter searches contributing to evaluation criteria adopted across a multidisciplinary experimental team
- **SCIPP** (Santa Cruz Institute for Particle Physics): home institute with direct access to KIPAC/SLAC network

RESEARCH EXPERIENCE

UC Santa Cruz | Santa Cruz, CA **Sept. 2022 – Present**
PhD Researcher — Particle Astrophysics, Gravitational Wave Phenomenology & Dark Sector Theory

- Developed an innovative operator-theoretic solution to the ghost instability problem by deriving an exact quantum conservation law. A classical conserved quantity lifts exactly to a quantum operator commuting with the Hamiltonian with no $\hbar$ corrections, establishing a state-independent upper bound on phase-space growth for all time. Findings independently coordinated for simultaneous publication with the original framework authors, submitted to Physical Review Letters.
- Developed the first high-performance computational framework for modeling particle and radiation transport from Kerr-Newman black holes coupled to large hidden sectors, discovering a reversal of the canonical charge-loss hierarchy across more than 220 dark degrees of freedom, with results published in Physical Review D.
- Accelerated gravitational wave signal detection at ADMX and resonant microwave cavity experiments by collaborating across institutions to co-lead a multi-institution effort (UCSC + UMass Amherst) to produce the first analytic waveform templates for GHz-band transients from superradiant gravitational atoms around primordial black holes, replacing a slow manual search process with matched-filter targets usable across detector configurations.
- Tightened observational and theoretical constraints on primordial black hole dark matter by computing the first volumetric tunneling rate calculation accounting for Hawking evaporation competition, extended mass functions, and memory-burden effects across thousands of parameter configurations and independently deriving model-independent bounds on dark sector particle multiplicities up to O(10^61) by connecting one-loop EFT corrections to Newton's law directly to fifth-force laboratory measurements. Results published in Physical Review D and JHEP respectively.
- Developed and executed algorithmic signal injection frameworks on high-performance computing systems, stress-testing detection models across thousands of noise realizations, quantifying failure modes, and producing evaluation criteria adopted by the ADMX experimental team.
- Mentored undergraduate students across all four years of doctoral training through laboratory sections, discussion sections, office hours, and guest lectures while regularly communicating research progress through presentations and slide-based updates to ADMX collaboration meetings and SCIPP research group seminars, translating complex theoretical and computational work for audiences ranging from introductory physics students to experimentally-focused research teams, developing strong interpersonal skills across diverse institutional and academic settings.

PROFESSIONAL EXPERIENCE

Stanford Linear Accelerator | Menlo Park, CA **Dec. 2021 – July 2022**
Accelerator Operator

- Maintained stable beam delivery for high-energy physics experiments by monitoring LCLS accelerator subsystems and diagnosing hardware/control-system anomalies using real-time instrumentation telemetry
- Developed direct operational familiarity with SLAC facility infrastructure, experimental workflows, and physicist-engineer collaboration structures across shift operations

PROJECTS

3D CNN: Brain Tumor Segmentation — Erdős Institute *(Top Project, ~200 PhD candidates)*

- Achieved Dice = 0.83 and 86% precision on 3D MRI tumor segmentation by designing a composite BCE + Dice loss function, engineering a sliding window synthetic data strategy that generated healthy patient samples from unhealthy volumes to address severe class imbalance, and building end-to-end GPU-accelerated PyTorch U-Net pipelines spanning data ingestion, training, threshold optimization, and inference evaluation
- Quantified model degradation under realistic noise conditions across thousands of synthetic test cases by tracking false positive rates and accuracy shifts through an evaluation pipeline generic enough to benchmark any new model without manual rework

REFERENCES

- Prof. Stefano Profumo — profumo@ucsc.edu — UC Santa Cruz / Stanford Institute for Theoretical Physics *(Primary Advisor)*
- Prof. Wolfgang Altmannshofer — waltmann@ucsc.edu — UC Santa Cruz, Department of Physics
- Prof. Stefania Gori — sgori@ucsc.edu — UC Santa Cruz, Department of Physics