James Buda

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Education

University of California, Irvine ***GPA*: 3.95** Irvine, California
Bachelor of Science majoring in Physics, Mathematics *Sep. 2022 – June 2026 (Expected)*

Relevant Coursework:

- Graduate Quantum Mechanics
- Graduate Particle Physics
- Graduate Quantum Field Theory I, II
- Graduate General Relativity
- Graduate Tensor Networks
- Graduate Machine Learning
- Graduate Special Topics in QFT
- Complex Analysis

Research Experience

Caltech SURF in Graviational Wave Physics and Cosmology *Prof: Yanbei Chen, Caltech*
June 2025 - now

- Used CCE waveforms to accurately model gravitational wave memory and study the SNR forecasts for single memory signals of Massive Black Hole Binaries (MBHBs). Extrapolated single memory events to forecasts of memory-driven stochastic backgrounds (SGWMB) in light of different MBHB population models with Monte Carlo simulation
- Evaluated both agnostic analytical models and complex, astrophysically-informed models that connect MBHB populations to dark matter halos. Demonstrated that variance in current population models is the dominant limiting factor in forecasting the background, showing that predicted SNRs can vary by over an order of magnitude between models at the 2σ range
- Simulated long-term 5-year observing runs within LISA to predict that the SGWMB will likely be a faint foreground, with a characteristic strain below LISA's primary sensitivity curve at a median SNR of $\mathcal{O}(0.1)$ and 2σ varying up to SNR of $\mathcal{O}(10)$.

Research in Theoretical Cosmology and BBN *Prof: Tim M.P. Tait, University of California Irvine*
Feb. 2025 - now

- Designed and coded the first framework to embed a stasis epoch via decaying particle towers into Big Bang Nucleosynthesis (BBN) simulations. Built routines to evolve tower states, inject decay products into radiation baths, and dynamically track the baryon-to-photon ratio (η_b), enabling precise modeling of BBN beyond the ΛCDM cosmology
- Developed a joint likelihood analysis combining Planck 2018 cosmological parameters with Subaru Survey and PDG Helium-4 abundances. Innovated a nearest-neighbor stepping strategy for MCMC chains in stasis parameter space, cutting runtime by over 500 compute hours by reducing optimization from thousands to hundreds of steps while preserving convergence
- Achieved statistically significant fits that demonstrate cosmological stasis as a viable and natural explanation for the Helium-4 abundance tension

Research in Cosmology using Machine Learning *Prof: Asantha Cooray, University of California Irvine*
Sep. 2024 - June 2025

- Generated images of galaxies in the form of large arcs created by the gravitational lensing of galaxy clusters or other similarly heavy objects using the python software PyAutoLens
- Created a dataset using sky maps and injecting simulated lensing systems to match SPHEREx and Euclid telescope real data
- Trained an machine learning algorithm to be able to recognize the large arcs in current Euclid and future SPHEREx astronomical data catalogs; computing was performed on UCI's high performace computing cluster and funded by the UCI Research Experience Fellowship

Research in Cosmological Inflation Theory *Prof: Asantha Cooray, University of California Irvine*

March. 2024 - Sep. 2024

- Generated clear predictions for the non-Gaussian parameter for slow roll inflation model without assuming any particular form of the inflationary potential.
- Performed Monte Carlo simulation techniques to reconstruct the inflationary potential and generate a large family of models.
- Used the results of the simulations and combined the non-Gaussianity with other inflation parameters in order to accurately determine the nature of inflation with data from the upcoming SPHEREx mission.

Publications

- Stochastic Memory Backgrounds in LISA (In Preparation)
- Cosmological Stasis Confronts BBN (In Preparation)
- SPHEREx Inflationary Model Predictions and the Search for Non-Gaussianity (In Preparation)

Awards

- Caltech VURP Fellowship, $8000
- UCI Summer 2025 SURP Fellowship, $1500
- UCI 2024-25 REF Fellowship, $1000
- UCI 2024-25 Travel Grant and Publication Award, $800
- UCI Summer 2024 SURP Fellowship, $1500

Presentations

- Caltech Summer 2025 Seminar, Caltech, Oral Presentation
- AAS January 2025 Meeting at Ann Harbor, Oral Presentation
- APS March 2025 Joint Meeting at Anaheim, Oral Presentation
- UCI May 2025 SPS Meeting at Irvine, Oral Presentation
- UCI June 2025 Research Symposium, Poster Presentation