

Cooper Niu

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SUMMARY

PhD researcher with a strong background in theoretical physics and machine learning, specializing in large language models, symbolic AI, and high-performance computing. Experienced in training LLMs with reinforcement learning, developing scalable algorithms for complex datasets, and optimizing simulations on nonlinear systems. Proven ability to tackle abstract, frontier problems with rigor and creativity, now seeking to apply these skills to real-world AI challenges.

EDUCATION

Brown University, Providence, Rhode Island 2022-2027 (expected)
Ph.D. in Theoretical and Computational Physics

William & Mary, Williamsburg, Virginia 2018-2022
B.S. with honor in Physics and Philosophy, *Summa Cum Laude*, Phi Beta Kappa

RESEARCH AND PROJECTS

Large Language Model for Theoretical Physics 2024 - now

- Developed a cutting-edge Large Language Model (LLM) capable of trustworthy proposing novel particle physics models using reinforcement learning with verifiable rewards (RLVR).
- Designed a rule-based grammar and token embedding to represent the mathematical structure of fundamental particle physics.
- Built a reinforcement learning environment that integrates symbolic computation software `Mathematica` and `Sympy` and statistical analysis against state-of-the-art collider data.
- Explored 100+ candidate particle physics models, achieving autonomous construction of Nobel-winning physics models.
- Accelerated theoretical model discovery, compressing decades of research into hours of LLM training.

Anomaly Detection via Topological Data Analysis 2023 - now

- Developed a topological data analysis framework leveraging chirality-sensitive persistent homology to extract complex patterns from large-scale galaxy distributions.
- Applied the framework to the BOSS galaxy catalog (6M galaxies), uncovering higher-order correlations beyond traditional methods with improved sensitivity and robustness to noise.
- Designed a simulation-free parametric test using a stochastic simplicial complex to extract higher-order statistical information from a single dataset, eliminating reliance on costly and biased N-body simulations.

Lattice Simulation for Galaxy Formation

- Built and executed lattice simulations of axion–dark photon systems, modeling parity-violating gauge interactions that seed galaxy formation, offering a potential explanation for James Webb Space Telescope’s discovery of unexpectedly massive ancient galaxies.
- Built scalable HPC workflows and optimized the algorithm to speed up simulations from weeks to hours, extracting key statistics on halo mass, energy transfer, and parity-violating signatures.

LEADERSHIP & ACTIVITIES

- Organizer** of weekly student-led seminars and journal clubs at Brown Center for Theoretical Physics (BCTP)
- Teaching assistant** for 6 physics courses (5 undergraduate, 1 graduate), supporting instruction and mentoring students.
- Research Mentor** for 3 junior graduate students and 1 undergraduate student (incl. computer science senior thesis)
- Student Mentor** for the Post-Baccalaureate Research Education Program (PREP), providing guidance and career support to underrepresented students.

PUBLICATIONS

- Perturbations in pseudo-Nambu-Goldstone Higgs Inflation**
Stephon Alexander, Humberto Gilmer, and **Cooper Niu*** (2025), *Journal of Cosmology and Astroparticle*
- Vacuum Amplification of Chiral Gravitational Waves and the Stochastic Gravitational Wave Background**
Stephon Alexander, Heliudson Bernardo, Yiya Selina Li, and **Cooper Niu*** (2024), *Physics Review D*
- Rediscover the Standard Model using AI**, Loukas Gouskos, Benjamin Bradley, **Cooper Niu*** (2025), *under preparation*
- Parity-violation in Large Scale Structure and Chiral Persistent Homology**,
Cooper Niu*, Rongbiao Wang (2025), *under preparation*

SKILLS & LANGUAGE

Programming and Software: Python, Pytorch, CUDA, Julia, Fortran, C/C++, Mathematica, \LaTeX ,
Language: English (Near-native Proficiency), Mandarin Chinese (Native)