

Minsu Park

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EDUCATION

University of Pennsylvania, Philadelphia, Pennsylvania

- PhD Candidate, Physics and Astronomy Sep 2020 – Aug 2025
 - Thesis Advisers: Prof. Bhuvnesh Jain, Justin Khoury
 - Thesis Title: “Statistical and Probabilistic Arguments About a Non de Sitter Universe”
 - GPA: 3.96/4.00

Princeton University, Princeton, New Jersey

- Bachelor of Arts in Physics, Cum Laude; Minor: Computer Science Sep 2016 – Jun 2020
 - Thesis Adviser: Prof. Paul Steinhardt
 - Thesis Title: “Constructing a Classically Stable Non-singular Cyclic Cosmology”
 - GPA: 3.77/4.00, Departmental GPA: 3.85/4.00

RESEARCH EXPERIENCE

Department of Physics and Astronomy, University of Pennsylvania

- Graduate Researcher in Weak Lensing and Data Science Group Jun 2020 – Present
 - Adviser: Prof. Bhuvnesh Jain (Co-Director of the Penn Data Driven Discovery Initiative)
 - Leveraging higher-order statistics, neural networks, and Gaussian processes to optimize parameter inference
 - Developing methodologies motivated from information theory for next generation statistical analyses
 - Generating large simulated datasets to build and test simulation based (likelihood free) inference pipelines
- Graduate Researcher in Particle Cosmology Group Jun 2020 – Present
 - Adviser: Prof. Justin Khoury
 - Applying insights from neural network loss surfaces to study high dimensional energy landscapes in string theory
 - Devising novel probes of mean first passage time in cosmic inflation using graph theory
 - Unlocking interdisciplinary insights with network scientists and biophysicists

Army Air Defense School, Republic of Korea Army (ROKA)

- Scientific Researcher in Weapons Development Group (Sergeant, E4) Jun 2022 – Dec 2023
 - Approximated solutions to non-convex optimization problems with neural networks and random forests
 - Developed software to speed up real time decision making while not sacrificing performance
 - Advised the Korean military’s policy and strategy regarding machine learning and military data

Department of Physics, Princeton University

- Undergraduate Research Assistant Sep 2018 – May 2020
 - Advisers: Prof. Paul Steinhardt, Duncan Haldane (2016 Nobel Laureate), Simone Giombi
 - Produced algorithms for analyzing numerical simulations of condensed matter systems and expanding universes
 - Diagnosed numerical stability of Runge-Kutta and Lanczos algorithms
 - Utilized high performance computing resources for intensive simulations and large datasets

Department of Astrophysical Sciences, Princeton University

- Undergraduate Research Assistant Jun 2018 – May 2020
 - Advisers: Prof. David Spergel (President of the Simons Foundation), Jo Dunkley
 - Constructed physical models of dark matter interaction and neutrino scattering
 - Performed Bayesian inference of cosmological parameters with respect to various astrophysical datasets
 - Identified statistical anomalies in data using Markov Chain Monte-Carlo and other Bayesian model comparison tools

HONORS

- Best Research Award from the ROKA TRADOC Commanding General Dec 2023
- Allen G. Shenstone Prize in Physics May 2020
- Cosmic Controversies Best Poster Oct 2019
- International Theoretical Physics Olympiad for Undergraduates Second Place Winner May 2019
- Allen G. Shenstone Prize in Physics Jun 2018

SKILLS

- Proficient in Python, Fortran, \LaTeX , Mathematica, TensorFlow, Unix, and Java
- Experience working with C, C++, parallel computing, and PyTorch

PUBLICATIONS

- **Park, M.**, Khoury, J., Wong, S. “Distance Conjecture and Random Field Inflation.” *In Prep.*
 - Random matrix theory and Bayes’ rule inform where we are in the string theory landscape.
- **Park, M.**, Gatti, M., Jain, B. “Dimensionality Reduction Techniques for Statistical Inference in Cosmology.” *Submitted to Physical Review D.*
 - CCA is the best performing dimensionality reduction scheme for simulation based inference.
- Kreisch, C. D., **Park, M.**, Calabrese, E., Cyr-Racine, F., Dunkley, J., et al. “Atacama Cosmology Telescope: The persistence of neutrino self-interaction in cosmological measurements.” *Physical Review D* 109.4 (2024).
 - Self-interacting neutrinos point to an anomalous signal from the Atacama Cosmology Telescope.
- Goldstein, S., **Park, M.**, Raveri, M., Jain, B., and Samushia, L. “Beyond dark energy Fisher forecasts: How the Dark Energy Spectroscopic Instrument will constrain Λ CDM and quintessence models.” *Physical Review D* 107.6 (2023).
 - Forecasting for both expected and outlier cases, DESI will likely not find evidence of quintessence.
- Dacunha, T., Raveri, M., **Park, M.**, Doux, C., and Jain, B. “What does a cosmological experiment really measure? Covariant posterior decomposition with normalizing flows.” *Physical Review D* 105.6 (2022).
 - Information geometry with normalizing flows finds the right parameters to infer from data.
- **Park, M.**, Raveri, M., and Jain, B. “Reconstructing quintessence.” *Physical Review D* 103.10 (2021).
 - Non-parametric approaches are useful probes of weak quintessence signals for further investigation.
- **Park, M.**, Kreisch, C. D., Dunkley, J., Hadzhiyska, B., and Cyr-Racine, F. “ Λ CDM or self-interacting neutrinos: How CMB data can tell the two models apart.” *Physical Review D* 100.6 (2019).
 - Bayesian model comparison suggests Planck CMB data favors neutrino interactions and why.

CONFERENCES

Selected Oral Presentations

- Park, M., Kreisch, C. D., Dunkley, J., “ Λ CDM or self-interacting neutrinos? - how CMB data can tell the two models apart”, Best of Posters Presentations, Cosmic Controversies, Chicago, Illinois, October 8, 2019.
- Park, M., Spergel, D., “Constraining Dark Matter Dark Energy Interaction”, Undergraduate Summer Research Program 2019 Final Presentations, Department of Astrophysical Sciences, Princeton University, August 8, 2019.
- Park, M., Kreisch, C. D., Dunkley, J., “Cosmological Bounds on Neutrino Self-Interaction”, Undergraduate Summer Research Program 2018 Final Presentations, Department of Astrophysical Sciences, Princeton University, August 9, 2018.

Selected Poster Presentations

- Park, M., et al., “Degeneracy of Dark Matter-Dark Energy Interactions: How Many Interactions Are There?”, AAS 235th Meeting, Honolulu, Hawaii, January 6, 2020.
- Park, M., et al., “ Λ CDM or self-interacting neutrinos? - how CMB data can tell the two models apart”, Cosmic Controversies, Chicago, Illinois, October 5, 2019.
- Park, M., et al., “ Λ CDM or self-interacting neutrinos? - how CMB data can tell the two models apart”, AAS 234th Meeting, Saint Louis, Missouri, June 11, 2019.

ADDITIONAL EXPERIENCES

Department of Physics and Astronomy, University of Pennsylvania

- Teaching Assistant Sep 2020 – Present
 - Instructed undergraduate intro physics and astrophysics, and graduate general relativity and quantum mechanics
 - Designed and led research methodology workshops for undergraduate researchers

Rockefeller College, Princeton University

- Peer Academic Adviser Sep 2018 – May 2020
 - Mentored undergraduate students regarding academics, campus life, and career planning
 - Provided one-on-one academic consulting for students in need of specific and personal advice