

# Tae-Geun Kim

Ph.D. candidate

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## Education

<b>Physics</b> , Yonsei University, Seoul, Republic of Korea	Mar. 2017 – Aug. 2025 <b>Ph.D.</b>
<b>Astronomy</b> , Yonsei University, Seoul, Republic of Korea	Mar. 2012 – Feb. 2017 <b>B.S.</b>

## Military Service

<b>Technical Research Personnel</b> , Yonsei University, Seoul, Republic of Korea	Sep. 2022 - Aug. 2025
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## Research Areas & Expertise

- **Dark matter physics**
  - Phenomenology of Axion-like particles & Primordial Black Holes
  - Detectability studies of dark matter candidates using various astrophysical and cosmological probes
  - Theoretical modeling and simulation of dark matter interactions
- **Machine Learning for Physics**
  - Development of deep learning models for missing information search and anomaly detection in high-energy physics data
  - Neural network approaches to learn and emulate complex physical systems and dynamics
  - Functional and operator learning for solving differential equations and modeling physical phenomena
- **Scientific & High Performance Computing**
  - Design and implementation of efficient numerical algorithms for physics simulations
  - Optimization of computational methods for large-scale data analysis in astrophysics and particle physics
  - Development of high-performance software tools for scientific computing, with a focus on Rust-based solutions
  - Application of parallel computing techniques to accelerate physics computations

## Programming Skills & Tools

- **Primary Languages:** Rust, Python, C++, Julia, Haskell
- **Frameworks & Libraries**
  - **Numerical Computing:** peroxide, numpy, scipy, pandas/polars, BLAS/LAPACK, eigen, matlab, mathematica
  - **Machine Learning:** pytorch, jax/equinox/optax, wandb, optuna, candle, tensorflow, scikit-learn
  - **Visualization:** matplotlib, vegas, ggplot2, plotly
  - **High Energy Physics:** BlackHawk, galprop, madgraph, root
  - **Quantum Computing:** pennylane, qiskit, cirq, rustqip
  - **Web:** django, vue, firebase, hugo, zola, elm

## Honors & Fellowships

- Academy Research Fellowship, Yonsei University (2022-2023)
- Best Oral Presentation Award, KPS 70th Anniversary and 2022 Fall Meeting (2022)
- Student Fellowship, IBS-CTPU (2017-2018)

## Publications

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- 2024    *“Neural Hamilton”*, T.-G. Kim, S. C. Park, [2409.xxxxx]
- 2024    *“HyperbolicLR: Epoch insensitive learning rate scheduler”*, T.-G. Kim, [2407.15200]
- 2023    *“Unsupervised sequence-to-sequence learning for automatic signal quality assessment in multi-channel electrical impedance-based hemodynamic monitoring”*, C. M. Hyun, T.-G. Kim, K. Lee, *Comput. Meth. Prog. Bio.* **108079**, [2305.09368]
- 2022    *“DeeLeMa: Missing information search with Deep Learning for Mass estimation”*, K. Ban, D. W. Kang, T.-G. Kim, S. C. Park, Y. Park, *Phys. Rev. Res.* **5**, 043186, [2212.12836]
- 2022    *“Axions from Primordial Black Holes”*, Y. Jho, T.-G. Kim, J.-C. Park, S. C. Park, Y. Park, [2212.11977]

## Talks

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- 2023    *“Exploration of PBHs and ALPs through a novel decay model on cosmological scale”* at 27th International Summer Institute on Phenomenology of Elementary Particle Physics and Cosmology, Nantou, Taiwan
- 2022    *“Exploration of PBHs and ALPs through a novel decay model on cosmological scale”* at 16th International Conference on Interconnections between Particle Physics and Cosmology, Daejeon, Korea
- 2022    *“Constraining ALPs via PBH with time-varying decay process”* at Workshop on Physics of Dark Cosmos: dark matter, dark energy, and all, Busan, Korea
- 2022    *“Constraining ALPs via PBH with time-varying decay process Part.2”* at KPS 70th Anniversary and 2022 Fall Meeting, Busan, Korea
- 2019    *“Bird’s eye view of Neutron star cooling”* at 16th Saga-Yonsei Joint Workshop, Saga, Japan

## Recent Conference Attendance & Schools

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- 2024    Jul. 28 - Aug. 2    **The 3rd workshop on Symmetry and Structure of the Universe**, JBNU, Korea
- 2024    Jul. 9 - 12        **Cosmology workshop on the crossroads of astrophysics and particle physics**, Hongcheon, Korea
- 2024    Mar. 18 - 22       **Workshop on Black Holes and Gravitational Waves**, IBS, Korea
- 2024    Jan. 16 - 19       **Workshop on Dark Universe**, Yeosu, Korea
- 2023    Nov. 14 - 17       **AI and Quantum Information for Particle Physics**, KAIST, Korea
- 2023    Aug. 21 - 25       **27th International Summer Institute on Phenomenology of Elementary Particle Physics and Cosmology**, Nantou, Taiwan
- 2023    Jul. 3 - 21         **Machine Learning in Particle Theory 2023**, Oppenheim, Germany
- 2023    Feb. 12 - 18       **AI and Quantum Information Applications in Fundamental Physics**, Gwangju(-si), Korea

## Teaching Experience

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2021	Spring	TA	<b>Introduction to General Relativity</b> , PHY4208, Yonsei University, Seoul, Republic of Korea
2020	Fall	TA	<b>Quantum Mechanics (2)</b> , PHY3102, Yonsei University, Seoul, Republic of Korea
	Spring	TA	<b>Quantum Mechanics (1)</b> , PHY3101, Yonsei University, Seoul, Republic of Korea
2019	Fall	TA	<b>Quantum Mechanics (2)</b> , PHY3102, Yonsei University, Seoul, Republic of Korea
	Spring	TA	<b>Elementary Particle Physics I</b> , PHY8050, Yonsei University, Seoul, Republic of Korea
2017	Fall	TA	<b>Gravity I: General Relativity</b> , PHY8030, Yonsei University, Seoul, Republic of Korea
	Spring	TA	<b>Mathematical Physics (1)</b> , PHY4205, Yonsei University, Seoul, Republic of Korea

## Selected Open Source Projects

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<b>Peroxide</b>	Sep. 2018 – Present
<ul style="list-style-type: none"><li>Comprehensive Rust numeric library for linear algebra, numerical analysis, and statistics</li><li>Customizable features for pure Rust, BLAS/LAPACK integration, and plotting capabilities</li><li>Includes automatic differentiation, special functions, DataFrame functionality, and various numerical algorithms</li></ul>	★ : 509 📄 : 445,676
<b>Puruspe</b>	Feb. 2020 – Present
<ul style="list-style-type: none"><li>Pure Rust library for special functions with no external dependencies</li><li>Implements gamma, beta, and error functions, including their regularized and inverse versions</li><li>Lightweight and efficient implementation ideal for mathematical and scientific computing</li></ul>	★ : 14 📄 : 444,079
<b>PyTorch Template</b>	Aug. 2024 – Present
<ul style="list-style-type: none"><li>Flexible PyTorch template for ML experiments with modular structure</li><li>Supports YAML-based configuration for easy experiment setup and reproducibility</li><li>Supports multiple random seeds, device selection, and learning rate scheduling for robust experimentation</li></ul>	★ : 7
<b>Quantum Algorithms</b>	Dec. 2023 – Jun. 2024
<ul style="list-style-type: none"><li>Implement quantum algorithms in PennyLane, RustQIP, Qiskit and Cirq</li><li>Provide jupyter notebooks for quantum algorithms with detailed descriptions and interactive visualizations</li></ul>	★ : 5
<b>Radient</b>	Nov. 2023 – Dec. 2023
<ul style="list-style-type: none"><li>Rust library for automatic differentiation using computational graphs</li><li>Implements forward and backward propagation for gradient computation</li><li>Supports various mathematical operations and provides flexible gradient calculation options</li></ul>	★ : 2 📄 : 1,366
<b>Forger</b>	Nov. 2023 – Nov. 2023
<ul style="list-style-type: none"><li>Reinforcement Learning (RL) library implemented in Rust</li><li>Modular design with components for agents, environments, policies, and utilities</li><li>Framework for creating diverse RL environments, including implementations of Epsilon Greedy Policy and Q-Learning</li></ul>	★ : 3 📄 : 2,850
<b>RGE</b>	Aug. 2017 – Oct. 2017
<ul style="list-style-type: none"><li>Go package for solving Renormalization Group Equations with Julia integration for plotting</li><li>Modular structure with customizable constants, variables, and beta functions for flexible RGE implementation</li><li>Supports numerical integration methods and parallel processing for efficient computation</li></ul>	★ : 4