Tae-Geun Kim

Ph.D. candidate

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Education

Physics, *Yonsei University, Seoul, Republic of Korea* — Mar. 2017 – Aug. 2025
Ph.D.

Astronomy, *Yonsei University, Seoul, Republic of Korea* — Mar. 2012 – Feb. 2017
B.S.

Military Service

Technical Research Personnel, *Yonsei University, Seoul, Republic of Korea* — Sep. 2022 - Aug. 2025

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

2024 *"Neural Hamilton"*, T.-G. Kim, S. C. Park, [2410.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

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

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

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

Selected Open Source Projects

Peroxide Sep. 2018 – Present
- Comprehensive Rust numeric library for linear algebra, numerical analysis, and statistics ★: 509
- Customizable features for pure Rust, BLAS/LAPACK integration, and plotting capabilities ⭳: 445,676
- Includes automatic differentiation, special functions, DataFrame functionality, and various numerical algorithms

Puruspe Feb. 2020 – Present
- Pure Rust library for special functions with no external dependencies ★: 14
- Implements gamma, beta, and error functions, including their regularized and inverse versions ⭳: 444,079
- Lightweight and efficient implementation ideal for mathematical and scientific computing

PyTorch Template Aug. 2024 – Present
- Flexible PyTorch template for ML experiments with modular structure ★: 7
- Supports YAML-based configuration for easy experiment setup and reproducibility
- Supports multiple random seeds, device selection, and learning rate scheduling for robust experimentation

Quantum Algorithms Dec. 2023 – Jun. 2024
- Implement quantum algorithms in Pennylane, RustQIP, Qiskit and Cirq ★: 5
- Provide jupyter notebooks for quantum algorithms with detailed descriptions and interactive visualizations

Radient Nov. 2023 – Dec. 2023
- Rust library for automatic differentiation using computational graphs ★: 2
- Implements forward and backward propagation for gradient computation ⭳: 1,366
- Supports various mathematical operations and provides flexible gradient calculation options

Forger Nov. 2023 – Nov. 2023
- Reinforcement Learning (RL) library implemented in Rust ★: 3
- Modular design with components for agents, environments, policies, and utilities ⭳: 2,850
- Framework for creating diverse RL environments, including implementations of Epsilon Greedy Policy and Q-Learning

RGE Aug. 2017 – Oct. 2017
- Go package for solving Renormalization Group Equations with Julia integration for plotting ★: 4
- Modular structure with customizable constants, variables, and beta functions for flexible RGE implementation
- Supports numerical integration methods and parallel processing for efficient computation