

Minwoo James Kim

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Research Interests

Quantum machine learning; quantum information theory; expressivity theory of quantum algorithms; quantum reservoir computing; quantum many-body dynamics; quantum computer architecture.

Education

Seoul National University, Department of Computer Science & Engineering

Seoul, Korea

M.S. in Computer Science & Engineering

2025–Present

- Quantum Information and Quantum Computing Lab; advisor: Prof. Taehyun Kim.
- Research focus: quantum information, quantum machine learning, variational quantum algorithms, and quantum computing architectures.
- Expected completion: Feb. 2027.

Seoul National University, Department of Physics & Astronomy

Seoul, Korea

B.S. in Physics

2019–2025

- Bachelor's thesis: *Practical Limitations on Training of Variational Quantum-Neural Hybrid Eigensolver*.
- GPA / honors: 3.53/4.00.

Publications, Preprints, and Proceedings

- **M. J. Kim**, K. K. Park, K. Lee, J. Bang, and T. Kim. *A Rigorous Hybridization of Variational Quantum Eigensolver with Classical Neural Network*. arXiv:2602.17295, 2026.
- **M. J. Kim**, J. Bang, and T. Kim. *Measurement-Limited Expressivity in Quantum Reservoir Computing*. Manuscript in preparation.
- **M. J. Kim**, K. K. Park, B. Cho, and T. Kim. *Architecture of a Modular Operating System for High-Level Quantum Computation*. Poster, IEEE QCE 2025, Art. no. 11249975, 2025.
- K. K. Park, **M. J. Kim**, B. Cho, and T. Kim. *Quantum Circuit Compilation for Small Scale Trapped Ion Quantum Computer*. Poster, IEEE QCE 2025, Art. no. 11250081, 2025.
- K. K. Park, K. Choi, **M. J. Kim**, G. Song, and T. Kim. *Quantum Linear Multistep Method for Using a Quantum Oracle with Differential Equations*. arXiv:2501.03781, 2025.

Selected Research Experience

Theory of quantum-neural hybrid variational algorithms

2024–2026

- Developed and analyzed diagonal neural post-processing methods for variational quantum eigensolvers, focusing on expressivity, stability, and finite-shot limitations.
- Studied structural limitations of non-unitary neural post-processing and developed a unitary variant designed to remain stable under shot-based estimation.
- Implemented numerical experiments using Qiskit and PyTorch; software available at github.com/miinukim/vqphelib.

Quantum reservoir computing

2026–Present

- Analyzed how fixed measurement and readout constraints limit the accessible latent space of quantum reservoir computing models.
- Developed theoretical criteria relating reservoir dynamics, visible operator subspaces and expressivity.
- Implemented simulation tools for quantum reservoir models and expressivity diagnostics; software available at github.com/miinukim/pyqres.

Architecture and software stack for trapped-ion quantum computers

2025–Present

- Designed a modular architecture for user-level execution of quantum programs on trapped-ion hardware, including compilation, scheduling, hardware dispatch, and result processing.

- Developed a Qiskit-compatible Python client for submitting quantum circuits and retrieving experimental results from laboratory hardware; software available at github.com/snu-quiqcl/pyqcsnu
- Contributed to experimental software currently used in the QuIQCL laboratory for trapped-ion experiment control; software available upon request.

Selected Presentations

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- Poster presentation, AQIS 2026: *A Rigorous Hybridization of Variational Quantum Eigensolver and Classical Neural Network*
 - Oral presentation (expected), KPS 2026 Fall meeting: *Quantum reservoir computing using prethermal Floquet dynamics*
 - Poster presentation, IEEE Quantum Week 2025: *Architecture of a Modular Operating System for High-level Quantum Computation.*
 - Oral presentation, QISK 2025 Annual Meeting: *Practical Limitations on Training of Variational Quantum-Neural Hybrid Eigensolver.*

Patent

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- T. Kim and **M. Kim**. *Methods and Apparatus for Resource-Efficient Calculation of Ground State of Quantum Systems, and Recording Medium Thereof*. Korean Patent Application No. SNU202505234, filed by Seoul National University R&DB Foundation, 2025.

Awards, Honors, and Scholarships

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| • Presidential Science Scholarship, Korea Student Aid Foundation | 2019–2024 |
| • Qiskit Advocate | 2025–Present |
| • IBM Quantum Special Award, QHackathon 2024 | 2024 |
| • Quantum Excellence, Qiskit Global Summer School | 2023 |
| • Center Director Award, QHackathon 2023 | 2023 |

Technical Skills

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- **Programming:** Python, C/C++, Java, OCaml
 - **Quantum software:** Qiskit, PennyLane
 - **Scientific computing:** NumPy, PyTorch, numerical simulation
 - **Systems and tools:** Linux, Git, LaTeX, Conda, Django, FastAPI
 - **Languages:** Korean native; English, TOEFL iBT 110/120

Selected Activities

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- Teaching Asistant, *Topics in New Computer Technology*, Seoul National University, Fall 2026.
 - Teaching Assistant, *Physics Experiment*, Seoul National University, Spring 2024.
 - Undergraduate mentorship program, Seoul National University, Spring 2024. Mentored junior students on the physics course.
 - Member, *Quantum Information Science Club Association*, 2023–2026. Participated in seminars and collaborative study sessions on quantum computation.

References

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- Prof. **Taehyun Kim**, Seoul National University. Email: taehyun@snu.ac.kr. Relationship: Master’s advisor.
 - Prof. **Jeongho Bang**, Yonsei University. Email: jbang@yonsei.ac.kr. Relationship: Research collaborator.