Seok-Hyung Lee

PERSONAL INFORMATION

- **E-mail**: seokhyung.lee@sydney.edu.au
- **Personal Website**: seokhyung-lee.github.io
- **Google Scholar**: scholar.google.com/citations?user=NURGJAwAAAAJ
- **ORCID**: 0000-0002-1207-2752
- **Nationality**: Republic of Korea
- **Date of Birth**: 17 January 1996

RESEARCH INTERESTS

- Quantum error correction
- Quantum computing with photonic qubits
- Measurement-based/fusion-based quantum computing
- Two-dimensional color codes

EMPLOYMENT

Mar 2023 – Present | **Postdoctoral Associate** | **University of Sydney**

> **Research group:** Quantum Theory Group, School of Physics
> **Location:** Sydney, New South Wales, Australia
> **Mentor:** Prof. Stephen D. Bartlett

EDUCATION

Mar 2017 – Feb 2023 | **Ph. D. in Physics** | **Seoul National University**

> **Research group:** Center for Macroscopic Quantum Control, Department of Physics and Astronomy
> **Location:** Seoul, Republic of Korea
> **Advisor:** Prof. Hyunseok Jeong
> **Thesis:** *Universal Resource-efficient Topological Measurement-based Quantum Computing*

Mar 2013 – Feb 2017 | **Bachelor in Physics** | **Seoul National University**

> **Location:** Seoul, Republic of Korea

SKILLS

- Experienced in Python programming
  - Data analysis with NumPy, SciPy, and pandas
  - Graph analysis with NetworkX and igraph
  - Multiprocessing

PUBLICATIONS

2024

- **[Magazine]** SHL,
색 부호를 활용한 결함허용 양자컴퓨팅 *(Fault-Tolerant Quantum Computing with the Color Code)*, 물리학과 첨단기술 (Physics and High Technology) 33, 17 (2024).

- **[Preprint]** SHL, F. Thomsen, N. Fazio, B. J. Brown, S. D. Bartlett,
Low-overhead magic state distillation with color codes, arXiv:2409.07707 (2024).

- **[Preprint]** SHL, A. Li, and S. D. Bartlett,
Color code decoder with improved scaling for correcting circuit-level noise,
arXiv:2404.07482 (2024).

- J. Lee, N. Kang, SHL, H. Jeong, L. Jiang, and S.-W. Lee,
Fault-Tolerant Quantum Computation by Hybrid Qubits with Bosonic Cat Code and Single Photons, PRX Quantum 5, 030322 (2024).

2023

- SHL and H. Jeong,
Graph-theoretical optimization of fusion-based graph state generation, Quantum 7, 1212 (2023).

- **[Conference]** H. Jeong, SHL, S. Omkar, Y. S. Teo,
Highly fault-tolerant quantum computing using both discrete and continuous variables of light, in Optica Quantum 2.0 Conference and Exhibition (Optica Publishing Group, 2023) p. QTu4A.6.

- SHL, S. Omkar, Y. S. Teo, and H. Jeong,
Parity-encoding-based quantum computing with Bayesian error tracking, npj Quantum Inf. 9, 39 (2023).

- Y. S. Teo, S. Shin, H. Kwon, SHL, and H. Jeong,
Virtual distillation with noise dilution, Phys. Rev. A 107, 022608 (2023).

2022

- S. Omkar, SHL, Y. S. Teo, S.-W. Lee, and H. Jeong,
All-photonic architecture for scalable quantum computing with Greenberger-Horne-Zeilinger States, PRX Quantum 3, 030309 (2022).

- SHL and H. Jeong,
Universal hardware-efficient topological measurement-based quantum computation via color-code-based cluster states, Phys. Rev. Research 4, 013010 (2022).

2021

- SHL, S.-W. Lee, and H. Jeong,
Loss-tolerant concatenated Bell-state measurement with encoded coherent-state qubits for long-range quantum communication, Phys. Rev. Research 3, 043205 (2021).

2020

- S. Choi, <u>SHL</u>, and H. Jeong,
  Teleportation of a multiphoton qubit using hybrid entanglement with a loss-tolerant carrier qubit, Phys. Rev. A 102, 012424 (2020).

DEVELOPMENTS

- *ConcatMatching*: Python package implementing the generalised concatenated matching decoder for decoding arbitrary stabiliser codes (2024),
  https://github.com/seokhyung-lee/ConcatMatching

- *color-code-stim*: Python module for simulating and decoding color code circuits (2024),
  https://github.com/seokhyung-lee/color-code-stim

- *OptGraphState*: Python package for graph-theoretical optimization of fusion-based graph state generation (2023),
  https://github.com/seokhyung-lee/OptGraphState

PATENTS

- H. Jeong, <u>SHL</u>, Y. S. Teo, S. Omkar,
  METHOD AND APPARATUS FOR LINEAR OPTICAL QUANTUM COMPUTING,
  US Patent, App. 18/075327 (2024) & KR Patent, App. 1020220120561 (2024)

PRESENTATIONS

Contributed conference talks

- **[Long talk]** *Color code decoder with improved scaling for correcting circuit-level noise*,
  24th Asian Quantum Information Science Conference, Sapporo, Japan (26.08.2024)

- *Linear optical quantum computing tolerant to non-ideal fusions and photon losses*,
  15th Asia Pacific Physics Conference, Gyeongju, Republic of Korea, online (24.08.2022)

- *Loss-tolerant optical measurement-based quantum computing with incomplete fusion operations*,
  Optics and Photonics Congress 2022, Jeju, Republic of Korea (03.07.2022)

- *Universal hardware-efficient topological measurement-based quantum computation via color-code-based cluster states*,
  33rd Optical Society of Korea Winter Conference, Daejeon, Republic of Korea (17.02.2022)

Invited talks

- *Low-overhead magic state distillation with color codes,*
  KAIST Seminar, Korea Advanced Institute of Science and Technology (KAIST), Daejeon, Republic of Korea (23.12.2024)

- *Low-overhead magic state distillation with color codes*,
  Joint PsiQuantum-USYD Workshop, Sydney, Australia (25.09.2024)

- *Graph-theoretical optimization of fusion-based graph state generation*,
  Foxconn Quantum Computing Center Weekly Seminar, Taipei, Taiwan (17.05.2024)

- **[Series]** *Toward Fault-tolerant Photonic Quantum Computing*,
  SAIT Seminar, Samsung Advanced Institute of Technology, Suwon, Republic of Korea (Part 1: 18.04.2024, Part 2: 05.06.2024, Part 3: 12.07.2024)

- *Color code decoder with improved scaling for correcting circuit-level noise*,
  CMQC Seminar, Center for Macroscopic Quantum Control, Seoul National University, Seoul, Republic of Korea (15.04.2024)

- *Color code decoder with improved scaling for correcting circuit-level noise*,
  KIST Seminar, Center for Quantum Information, Korea Institute of Science and Technology, Seoul, Republic of Korea (11.04.2024)

- *Color code decoder with improved scaling for correcting circuit-level noise*,
  KIAS Seminar, School of Computational Sciences, Korea Institute for Advanced Study, Seoul, Republic of Korea (09.04.2024)

- *Color code decoder with improved scaling for correcting circuit-level noise*,
  Coogee'24 Sydney Quantum Information Theory Workshop, Sydney, Australia (03.04.2024)

- *Low-overhead Lattice-surgery-based Quantum Computing with the Color Code*,
  QST Seminar, Research Institute of Mathematics, Seoul National University, Seoul, Republic of Korea (15.03.2024)

- *Pauli-product-measurement-based Quantum Computing with Two-dimensional Color Codes*,
  CMQC Seminar, Center for Macroscopic Quantum Control, Seoul National University, Seoul, Republic of Korea (04.09.2023)

- *Parity-encoding-based linear-optical quantum computing with graph-theoretical optimization of cluster state generation*,
  KIST Workshop on Quantum Information Theory 2022, Center for Quantum Information, Korea Institute of Science and Technology, Seoul, Republic of Korea (19.12.2022)

- *Parity-encoding-based linear-optical quantum computing with Bayesian error tracking*,
  Quantum Information Science Strategy, KOFST 2022 BrainLink X-Lab Day, Yeosu, Republic of Korea (15.12.2022)

- *Universal hardware-efficient topological measurement-based quantum computing via color-code-based cluster states*,
  KIST Seminar, Center for Quantum Information, Korea Institute of Science and Technology, Seoul, Republic of Korea (30.05.2022)

- *Universal resource-efficient topological measurement-based quantum computation via color-code-based cluster states*,
  QST Seminar, Research Institute of Mathematics, Seoul National University, Seoul, Republic of Korea (12.11.2021)

Posters

- *Low-Overhead Magic State Distillation with Color Codes,*
  EQUS 2024 Annual Workshop, Noosa Heads, QLD, Australia (11.12.2024)

- *Low-Overhead Lattice-Surgery-Based Quantum Computing with the Color Code,*
  Quantum Information Processing 2024, Taipei, Taiwan (16.01.2024)

- *Low-Overhead Lattice-Surgery-Based Quantum Computing with the Color Code*,
  EQUS 2023 Annual Workshop, Perth, WA, Australia (21.11.2023)

- *Graph-theoretical optimization of fusion-based graph state generation*,
  6th International Conference on Quantum Error Correction (QEC23), Sydney, NSW, Australia (31.10.2023)

- *Graph-theoretical optimization of fusion-based graph state generation*,
  Asian Quantum Information Science Conference 2023, Seoul, Republic of Korea (31.08.2023)

- *Parity-encoding-based linear optical quantum computing with graph-theoretical optimization*,
  Bolder Boulder Quantum Workshop 2023, Boulder, Colorado, USA (20.06.2023)

- *Loss-tolerant all-optical quantum computing architecture using parity-state-encoded multiphoton qubits*,
  Quantum Information Processing 2023, Ghent, Belgium (06.02.2023)

- *Loss-tolerant multiphoton-qubit-based linear optical quantum computation with nonideal fusions*,
  Single Photon Workshop 2022, Seoul, Republic of Korea (03.11.2022)

- *Loss-tolerant linear optical quantum computation with non-ideal fusion operations*,
  5th Quantum Information Conference, Seoul, Republic of Korea (28.06.2022)

- **[Awarded]** *Universal resource-efficient topological measurement-based quantum computation via color-code-based cluster states,*
  21st Asian Quantum Information Science Conference, Tokyo, Japan, online (02.09.2021)

- *Loss-tolerant concatenated Bell-state measurement with coherent-state qubits,*
  20th Asian Quantum Information Science Conference, Sydney, Australia, online (08.12.2020)

MENTORSHIP

- **(2024)** *Andrew Li,* Honours Student at The University of Sydney
  Thesis: *Decoding twist defects on the color code*

AWARDS

- *BK Excellent Thesis Award*
  by Department of Physics and Astronomy, Seoul National University (24.02.2023)

- *Best Student Poster Award*
  in 21st Asian Quantum Information Science Conference (04.09.2021)

- *Graduated with Honours*
  by Department of Physics and Astronomy, Seoul National University (24.02.2017)

CONTRIBUTIONS

I am an active reviewer of the following journals: *Quantum*, *PRX Quantum*, *Physical Review Letters*, *Physical Review A, Quantum Information Processing,* and *IEEE Transactions on Network Science and Engineering.*