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=NURGJAwAAAJ

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

Dissertation: 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

PEER-REVIEWED PUBLICATIONS

- 8. J. Lee, N. Kang, <u>SHL</u>, 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).
- 7. <u>SHL</u> and H. Jeong, Graph-theoretical optimization of fusion-based graph state generation, Quantum 7, 1212 (2023).
- 6. <u>SHL</u>, S. Omkar, Y. S. Teo, and H. Jeong, *Parity-encoding-based quantum computing with Bayesian error tracking*, npj Quantum Inf. 9, 39 (2023).
- 5. Y. S. Teo, S. Shin, H. Kwon, <u>SHL</u>, and H. Jeong, *Virtual distillation with noise dilution*, Phys. Rev. A 107, 022608 (2023).
- 4. S. Omkar, <u>SHL</u>, 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).
- 3. <u>SHL</u> and H. Jeong, Universal hardware-efficient topological measurement-based quantum computation via color-code-based cluster states, Phys. Rev. Research 4, 013010 (2022).
- 2. <u>SHL</u>, 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).
- 1. 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).

PREPRINTS

- 2. <u>SHL</u>, F. Thomsen, N. Fazio, B. J. Brown, S. D. Bartlett, Low-overhead magic state distillation with color codes, arXiv:2409.07707 (2024).
- 1. <u>SHL</u>, A. Li, and S. D. Bartlett, Color code decoder with improved scaling for correcting circuit-level noise, arXiv:2404.07482 (2024).

CONFERENCE PAPERS

 H. Jeong, <u>SHL</u>, 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.

DEVELOPMENTS

2. *color-code-stim*: Python module for simulating and decoding color code circuits (2024),

https://github.com/seokhyung-lee/color-code-stim

1. *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

- 4. **[Long talk]** Color code decoder with improved scaling for correcting circuit-level noise, 24th Asian Quantum Information Science Conference, Sapporo, Japan (26.08.2024)
- 3. 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)
- 2. 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

- 12. Graph-theoretical optimization of fusion-based graph state generation, Foxconn Quantum Computing Center Weekly Seminar, Taipei, Taiwan (17.05.2024)
- 11. [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)
- 10. 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)
- 9. 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)
- 8. 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)
- 7. Color code decoder with improved scaling for correcting circuit-level noise, Coogee'24 Sydney Quantum Information Theory Workshop, Sydney, Australia (03.04.2024)

- 6. 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)
- 5. 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)
- 3. 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

- 10. Low-overhead Lattice-surgery-based Quantum Computing with the Color Code, Quantum Information Processing 2024, Taipei, Taiwan (16.01.2024)
- 9. Low-overhead Lattice-surgery-based Quantum Computing with the Color Code, EQUS 2023 Annual Workshop, Perth, Australia (21.11.2023)
- 8. Graph-theoretical optimization of fusion-based graph state generation, 6th International Conference on Quantum Error Correction (QEC23), Sydney, Australia (31.10.2023)
- 7. Graph-theoretical optimization of fusion-based graph state generation, Asian Quantum Information Science Conference 2023, Seoul, Republic of Korea (31.08.2023)
- 6. 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)

- 4. Loss-tolerant multiphoton-qubit-based linear optical quantum computation with nonideal fusions,
 - Single Photon Workshop 2022, Seoul, Republic of Korea (03.11.2022)
- 3. 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,
 21th 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

AWARDS

- BK Excellent Thesis Award
 by Department of Physics and Astronomy, Seoul National University (24.02.2023)
- Best Student Poster Award
 in 21th Asian Quantum Information Science Conference (04.09.2021)
- Graduated with Honors
 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.