

# Seok-Hyung Lee

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## 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

**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, 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).
7. SHL and H. Jeong, *Graph-theoretical optimization of fusion-based graph state generation*, Quantum 7, 1212 (2023).
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).
5. Y. S. Teo, S. Shin, H. Kwon, SHL, and H. Jeong, *Virtual distillation with noise dilution*, Phys. Rev. A 107, 022608 (2023).
4. 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).
3. SHL and H. Jeong, *Universal hardware-efficient topological measurement-based quantum computation via color-code-based cluster states*, Phys. Rev. Research 4, 013010 (2022).
2. 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).
1. S. Choi, SHL, 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. SHL, F. Thomsen, N. Fazio, B. J. Brown, S. D. Bartlett, *Low-overhead magic state distillation with color codes*, arXiv:2409.07707 (2024).
1. SHL, A. Li, and S. D. Bartlett, *Color code decoder with improved scaling for correcting circuit-level noise*, arXiv:2404.07482 (2024).

## CONFERENCE PROCEEDINGS

1. 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.

## 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

1. H. Jeong, SHL, 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)
5. *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)
1. *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)
4. *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)
2. *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)
1. *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*, EQUUS 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)
5. *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)
2. **[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)
1. *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)
- *Dean's List*  
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*.