

Seok-Hyung Lee

PERSONAL INFORMATION

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Personal Website: <https://seokhyung-lee.github.io>

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)
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)
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)
8. *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,*
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)
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)

ACADEMIC VISITS

- Apr 2024: Korea Institute For Advanced Study, Republic of Korea
(Host: Prof. Myungshik Kim & Prof. Hyukjoon Kwon)

AWARDS

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

CONTRIBUTIONS

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