Seok-Hyung Lee

PERSONAL INFORMATION

E-mail: seokhyung.lee@sydney.edu.au
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**

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

EDUCATION

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

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

Mar 2013 – Feb 2017 | **B. S. in Physics** | **Seoul National University**

> 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

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).

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, <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. *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, Department of Physics and Astronomy, 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, 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*,
   SNU Seminar, Department of Physics and Astronomy, 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. *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)

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.*