

# Jeongrak Son

Ph.D. student - School of Physical and Mathematical Sciences - Nanyang Technological University

 jeongrak.son@gmail.com    Singapore    Personal Website

## Education

Ph.D. student

Division of Physics and Applied Physics - School of Physical and Mathematical Sciences - Nanyang Technological University

 Aug. 2021 –  Singapore

Adviser: Prof. Nelly H. Y. Ng

B.Sc. Summa Cum Laude

Department of Physics and Astronomy (physics major) - Seoul National University (SNU)

 Mar. 2015 – Feb. 2021  Seoul, Korea

Military service (Rep. of Korea Air Force): Mar. 2018 – Feb. 2020

Exchange Student

Department of Physics and Astronomy - University of Manchester

 Sep. 2016 – Feb. 2017  Manchester, United Kingdom

## Languages

Korean 

English 

French 

## Hobby

 Passionate cinephile

- Selected film reviews
  - [In Search of Flowing Time: From Ink to Memories](#) (Best Piece of Oct/Nov 2023 in *Exposure*)
  - [In Perfect Days \(2023\), It's Okay to Cry](#) (Featured in Asian Film Archive's monthly newsletter)
- Check my other reviews [here](#)

## Research Interests

- Quantum algorithms: quantum state-instructed circuits, interesting algorithmic subroutines
- Catalysis in quantum information: catalysis in circuit compilation, state-oblivious catalysis
- Resource theories: resource broadcasting, composition of free state sets and free operations

## Research Experiences

PhD Study

with [Nelly H. Y. Ng](#)

 Aug. 2021 –  SPMS, Nanyang Technological University

My PhD research focuses on the non-trivial use of auxiliary systems, such as catalysts or states instructing quantum circuits. In my catalyst-related work, I established the ultimate limit of catalysis within specific and generic resource theories. In my algorithm research, I developed a novel framework for quantum recursion with a circuit depth-width trade-off.

IBS Student Trainee, Research Assistant

with [Juzar Thingna](#) and [Peter Talkner](#)

 Jul. 2020 – May. 2021  PCS, Institute for Basic Science

My goal was to persuade the quantum thermodynamics community to explicitly consider measurement strategies in the operation of quantum thermal machines. I showcased that the appropriate measurement strategy enhances the performance of quantum Otto engines and battery charging processes.

## Publications

- Y. Suzuki, B. H. Tiang, **J. Son**, N. H. Y. Ng, Z. Holmes, and M. Gluza, Double-bracket algorithm for quantum signal processing without post-selection, arXiv:2504.01077 (2024). [[arXiv](#)]
- J. Son**, R. Ganardi, S. Minagawa, F. Buscemi, S. H. Lie, and N. H. Y. Ng, Robust Catalysis and Resource Broadcasting: The Possible and the Impossible, arXiv:2412.06900 (2024). [[arXiv](#)]  
[Quantum Resources 2025 invited talk \(speaker: Nelly Ng\)](#)

3. M. Gluza, **J. Son**, B. H. Tiang, Y. Suzuki, Z. Holmes, and N. H. Y. Ng, Double-bracket quantum algorithms for quantum imaginary-time evolution, arXiv:2412.04554 (2024). [[arXiv](#)]
4. M. Robbiati, E. Pedicillo, A. Pasquale, X. Li, A. Wright, R. M. S. Farias, K. U. Giang, **J. Son**, J. Knörzer, S. T. Goh, J. Y. Khoo, N. H. Y. Ng, Z. Holmes, S. Carrazza, M. Gluza, Double-bracket quantum algorithms for high-fidelity ground state preparation, arXiv:2408.03987 (2024). [[arXiv](#)]
5. **J. Son**, M. Gluza, R. Takagi, and N. H. Y. Ng, Quantum Dynamic Programming, accepted in Phys. Rev. Lett. [[arXiv](#)]  
*honourable mentions for Top quantum algorithms papers in Spring 2024 by PennyLane (Xanadu); selected as an IPS meeting 2024 talk*
6. **J. Son** and N. H. Y. Ng, A hierarchy of thermal processes collapses under catalysis, Quantum Sci. Technol. **10**, 015011 (2024). [[Link](#)][[arXiv](#)]  
*selected as a part of AQIS2023 talk; selected as a Quantum Resources 2023 talk; selected as a Beyond IID 2024 talk*
7. A. de Oliveira Junior\*, **J. Son**\*, J. Czartowski, and N. H. Y. Ng, Entanglement generation from athermality, Phys. Rev. Research **6**, 033236 (2024). [[Link](#)] (\*: co-first authors)  
*selected as an IPS meeting 2024 talk; selected as a Quantum Resources 2025 talk*
8. **J. Son** and N. H. Y. Ng, Catalysis in action via elementary thermal operations, New J. Phys. **26**, 033029 (2024). [[Link](#)]  
*selected as a Quantum Resources 2022 talk; selected as a part of AQIS2023 talk*
9. **J. Son**, P. Talkner, and J. Thingna, Charging quantum batteries via Otto machines: Influence of monitoring, Phys. Rev. A **106**, 052202 (2022). [[Link](#)] [[arXiv](#)]  
*selected as a part of QTD2022 talk (speaker: Juzar Thingna); selected as a ICE-7 lightning talk*
10. **J. Son**, P. Talkner, and J. Thingna, Monitoring quantum Otto engines, PRX-Quantum **2**, 040328 (2021). [[Link](#)]  
*selected as a part of QTD2022 talk (speaker: Juzar Thingna)*

## Talks and Seminars

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### 5 Conference Talks and 11 Seminar Talks

- Conference Talks: **Quantum resources**: from mathematical foundations to operational characterisation (Dec. 2022), **AQIS 2023** (Aug. 2023), **Quantum resources 2023** (Dec. 2023) ([video](#)), **Beyond IID 2024** (Jul. 2024), **Quantum resources 2025** (Mar. 2025)
- Seminar Talks: **IBS PCS Seminar** (Jun. 2022) ([video](#)), **Majulab Seminar** (Dec. 2022), **Chaos and Quantum Info Seminar** [Jagiellonian U.] (Feb. 2023), **CQT Seminar** (May 2023), **QST Seminar** [Seoul Natl. U.] (Jul. 2023), **Informal Statistical Physics Seminar** [U. Maryland] (Aug. 2024) ([abstract](#)), **Q.InC Seminar** [A\*STAR] (Sep. 2024) ([abstract](#)), **KIAS Seminar** [KIAS] (Oct. 2024) ([abstract](#)), **AG Eisert group meeting** [FU Berlin] (Jan. 2025) ([video](#)), **Institut für Theoretische Physik group meeting** [Uni Ulm] (Jan. 2025), **bigQ - Center for Macroscopic Quantum States** [DTU] (Jan. 2025)

### 1 Lightning Talk and 2 Short Talks (<20 mins)

- Lightning Talk: **ICE-7 Quantum Information and Quantum Technologies Conference** (May 2022)
- Short Talks: **IPS meeting 2024** [2 contributed talks] (Oct 2024)

## Peer Review Contributions

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- Referee for **Phys. Rev. Lett.**, **Quantum**, **Phys. Rev. A**, **Phys. Rev. E**, and **J. Math. Phys.**
- Sub-reviewer for **TQC 2022**, **QIP2023**, and **TQC 2025**

## Academic Visits

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- Danmarks Tekniske Universitet (DTU), Denmark [host: **Jonatan Bohr Brask**] (Jan. 2025)
- Universität Ulm, Germany [host: **Martin Plenio**] (Jan. 2025)
- Freie Universität Berlin (FU Berlin), Germany [host: **Jens Eisert** and **Nathan Walk**] (Jan. 2025)
- Korea Institute for Advanced Study (KIAS), Korea [host: **Hyukjoon Kwon**] (Oct. 2024 and Mar. 2025)
- University of Maryland, Baltimore County, USA [host: **Sebastian Deffner**] (Aug. 2024)
- University of Maryland, College Park, USA [host: **Nicole Yunger Halpern**] (Aug. 2024)
- Nagoya Universtiy, Japan [host: **Francesco Buscemi**] (Jul. 2024)
- Jagiellonian University, Poland [host: **Kamil Korzekwa**] (Feb. 2023)
- PCS, Institute for Basic Science, Korea [host: **Dario Rosa**] (Jun. 2022)

## Teaching and Services

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Secretary (2023) and Treasurer (2024)

[Quantum Young Researchers Association \(QYRA\), Singapore](#)

📅 2023 – 2024

- Lead organiser of QYRA X Infocom Media Development Authority (IMDA) event *Careers in Quantum Communications*
- Organiser of *Quantum Energy Initiative (QEI) workshop 2023*
- Topical team member (w/ Masahito Ueda, Gentaro Watanabe, and Ariane Soret) representing one of the five workshop topics: “Fundamental thermodynamics of information” in the *Quantum Energy Initiative (QEI) workshop 2023*—moderated discussions throughout the workshop and presented the outcomes of the team’s deliberations
- Facilitator for the Townhall event *Building Singapore’s Quantum Future Together: A Multi-Stakeholder Townhall on the National Quantum Strategy and Entrepreneurship*
- Organiser (logistics) of QYRA’s End-of-Year event *What’s next for early-career Qontributors in Singapore?*

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Scientific Adviser for Korean Translation of the book series “for babies” by Chris Ferrie

[CHAEKSESANG, Korea](#)

📅 2023–2023

Advised translations for 12 books: Quantum Physics, Quantum Information, Quantum Entanglement, Quantum Computing, Optical Physics, Statistical Physics, Electromagnetism, General Relativity, Newtonian Physics, Nuclear Physics, Astrophysics, and Rocket Science

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SINGA Ambassador

[Singapore International Graduate Award \(SINGA\), Singapore](#)

📅 2023 – 2023

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Teaching Experiences

- Tutorial Classes for PH1107: Relativity and Quantum Physics, Nanyang Technological University, Singapore, AY22/23, 23/24, and 24/25
- Tutorial Class for International Students, Physics 1, Seoul National University, Korea, AY20
- Organizer/Tutor for Summer Science Camp, Korea Student Aid Foundation and Gyeongsang Girl’s High School, Korea, Jul. 2015

## Awards and Honours

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Singapore International Graduate Award (SINGA)

[The Agency for Science, Technology and Research \(A\\*STAR\)](#)

📅 2021 –

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KFAS Study Abroad Scholarship (candidate)

[Korea Foundation of Advanced Studies](#)

📅 2020 – 2021

Opted to withdraw from full award status in favour of accepting the SINGA award at NTU.

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GE Foundation Scholar-Leaders Program (GEFSLP) Scholarship

[Fulbright Korea](#)

📅 2016 – 2021

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Presidential Science Scholarship

[Korea Student Aid Foundation](#)

📅 2015 – 2021

Best Group Project Presentation

[KIAS-SNU Physics Winter Camp](#)

📅 2019

Topological Aspects of 1D SSH Model

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OIA Outgoing Exchange Student Scholarship

[Office of International Affairs \(OIA\)](#)

📅 2016

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Dean’s List

[College of Natural Sciences, Seoul National University](#)

📅 Autumn 2015, Spring 2020