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

Supervisor: 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 Letterboxd profile!

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

w/ Prof. 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

w/ Profs. 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

1. **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]**
2. 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]**
3. 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]**

4. **J. Son**, M. Gluza, R. Takagi, and N. H. Y. Ng, Quantum Dynamic Programming, arXiv:2403.09187 (2024). **[arXiv]**
   honourable mentions for Top quantum algorithms papers in Spring 2024 by PennyLane (Xanadu); selected as an IPS meeting 2024 talk
5. **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
6. 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
7. **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
8. **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
9. **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

4 Conference Talks and 8 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)
- 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)**

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

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

Academic Visits

- Korea Institute for Advanced Study (KIAS), Korea [host: **Hyukjoon Kwon**] (Oct. 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

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?***

Advisor for Korean Translation of the book series "for babies" by Chris Ferrie

CHAEKSESANG

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

SINGA Ambassador

Singapore International Graduate Award (SINGA), Singapore

2023 – 2023

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

Singapore International Graduate Award (SINGA)

The Agency for Science, Technology and Research (A*STAR)

2021 –

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.

GE Foundation Scholar-Leaders Program (GEFSLP) Scholarship

Fulbright Korea

2016 – 2021

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

OIA Outgoing Exchange Student Scholarship

Office of International Affairs (OIA)

2016

Dean's List

College of Natural Sciences, Seoul National University

Autumn 2015, Spring 2020