

A final-year graduate student at the Graduate University for Advanced Studies, SOKENDAI, with a broad interest in theoretical quantum physics. Primary research interests include quantum gravity and quantum information, in particular, quantum information theoretic aspect of holographic principle and entanglement in quantum many-body systems and quantum field theories. I particularly enjoy collaborating with various fields including particle physicists, quantum information theorists, condensed matter physicists, and quantum cosmologists. I have conducted research on entanglement in tensor networks and interacting quantum field theories, and holographic conformal field theories, aiming at realizing 'it from qubit' beyond the conventional AdS/CFT correspondence. In addition, I am conducting research on quantum cosmology using the AdS/BCFT correspondence towards a consistent quantum theory of our universe. Published 4 papers in peer-reviewed journals. 1 paper is accepted by a peer-reviewed journal. Reviewed 1 article in Journal of High Energy Physics.

EDUCATION/FELLOWSHIPS

- Ph.D. candidate in Physics**, *The Graduate University for Advanced Studies (SOKENDAI), Ibaraki, Japan* Expected Mar 2023
The Department of Particle and Nuclear Physics, School of High Energy Accelerator Science
2nd-year student research report title: "Tensor network, entanglement and holography"
Supervisor: Satoshi Iso
- Atsumi International Foundation 2022 Scholarship (3,000,000 JPY)* Apr 2022 — Present
Japan Society for the Promotion of Science (JSPS) Research Fellowship for Young Scientists (PD) (Offered) Sep 2022
SOKENDAI Student Dispatch Program (Adopted: 1,000,000 JPY) Jul 2022
Japan Society for the Promotion of Science (JSPS) Research Fellowship for Young Scientists (DC2) (Declined) Dec 2021
Japan Student Services Organization (JASSO) Category 1 Scholarship Loans with "Exemption from Repayment for Graduate School Students with Particularly Outstanding Achievements" (Offered) May 2021
SOKENDAI COVID-19 Scholarship Loans with Exemption From Repayment (50,000 JPY) Jun 2020
- B.Sc. in Physics**, *Nagoya University, Nagoya, Japan* Mar 2018
The Department of Physics, School of Science
Graduation report title: "STRING ACTIONS AND CLASSICAL SYMMETRIES"
Supervisor: Tadakatsu Sakai
- Certificate of Completion, the international study training program in the United Kingdom* Mar 2013
"Developing Scientific and Technical Experts with Both a Global Point of View and Practical Communication Ability,"
St. Paul's School, Cambridge University, and University College London, organized by Ministry of Education, Culture, Sports, Science and Technology of Japan

WORK EXPERIENCE

- Perimeter Institute for Theoretical Physics (PI)** Sep 2022 — Present
Visiting graduate student Ontario, Canada
- Investigating the holographic correspondence for quantum tasks using the AdS/BCFT correspondence
 - Collaborating and discussing with theoretical physicists at PI including Beni Yoshida, Subhayan Sahu, Meenu Kumari, Coughlin Cole, and Rene Meyer
- Institute of Particle and Nuclear Studies, High Energy Accelerator Research Organization (KEK)** Jun 2022 — Present
Research assistant Tsukuba, Japan
- Conducted research on tensor network and entanglement distillation
 - Investigating observer effects on black holes
 - Investigating the bubble nucleation and vacuum decay via the AdS/BCFT correspondence
 - Performed analytical calculations for entanglement distillation in tensor networks and detectors in field theory for a toy model of black hole
 - Collaborated with one condensed matter physicist, two quantum information theorists, and two quantum cosmologists
- Institute of Particle and Nuclear Studies, High Energy Accelerator Research Organization (KEK)** Jun 2021 — Mar 2022
Research assistant Tsukuba, Japan
- Conducted research on entanglement entropy in quantum field theories
 - Formulated a calculation method for entanglement entropy in interacting field theories and computed it using the perturbation theory
 - Collaborated with two particle physicists including the supervisor
 - Discussed entanglement entropy in continuous multi-scale entanglement renormalization ansatz (cMERA) with J. Molina-Vilaplana and J. Fernandez-Melgarejo, theoretical physicists working in holography in Spain
 - Discussed a possible lattice calculation of entanglement entropy in interacting field theories with E. Ito, a theoretical physicist working in lattice calculations in Japan

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Takato Mori Website: research.kek.jp/student/moritaka/
orcid.org/0000-0001-6442-875X
Theoretical Physicist / Ph.D. Candidate inspirehep.net/authors/1869768

Yukawa Institute for Theoretical Physics (YITP), Kyoto University

Oct 2021 — Dec 2021

Atom-type fellow

Kyoto, Japan

- Conducted research on the AdS/BCFT correspondence and established a correct prescription for holographic local quench in the presence of boundaries
- Collaborated with theoretical physicists in the entanglement group at YITP including Tadashi Takayanagi and Tomonori Ugajin
- Computed the energy-momentum tensors and entanglement entropies in boundary conformal field theories (BCFTs) and clarified the proposed correspondence from BCFTs

Institute of Particle and Nuclear Studies, High Energy Accelerator Research Organization (KEK)

Jun 2020 — Mar 2021

Research assistant

Tsukuba, Japan

- Worked on entropy in interacting quantum field theories based on a nonperturbative method called two-particle irreducible effective action
- Worked on a relation between critical ground states and information geometry with H. Matsueda, a condensed matter physicist

High Energy Accelerator Research Organization (KEK)

Jul 2020 — Aug 2020

Student assistant for Online Open House

Tsukuba, Japan

- Considered and broadcasted an easy science experiment for kids

Institute of Particle and Nuclear Studies, High Energy Accelerator Research Organization (KEK)

Jun 2019 — Mar 2020

Research assistant

Tsukuba, Japan

- Considered a generalization of tensor networks to include bulk entanglement
- Studied holography and quantum error correcting codes

High Energy Accelerator Research Organization (KEK)

May 2019 — Aug 2019

Student assistant for Tsukuba Chibikko Hakase 2019

Tsukuba, Japan

- Prepared kits of thermal imaging infrared cameras on a Raspberry Pi with an AI image upscaler and assisted kids to work with them in an open house of KEK

Institute of Particle and Nuclear Studies, High Energy Accelerator Research Organization (KEK)

Jun 2018 — Mar 2019

Research assistant

Tsukuba, Japan

- Studied tensor networks, e.g. matrix product states, projected entangled pair states, multi-scale entanglement renormalization ansatz
- Studied black holes in anti-de Sitter spacetime

PROFESSIONAL SERVICE

Reviewer, *Journal of High Energy Physics*

SKILLS

Tools and Languages	Python, LaTeX, Qiskit
Quantitative Research	Tensor networks, Quantum computation
Communication	Japanese (native), English (fluent)

AWARDS

Student Presentation Award of the Physical Society of Japan	Oct 2021
Best Oral Presentation in YONUPA Summer School 2018	Aug 2018
One of the Top 15 Papers Prize in Best Paper Prize Contest in STEM for Undergraduate and Graduate Students in Japan 2015	Mar 2015
Best Student Essay Prize in Nagoya University	Dec 2014

CONFERENCES/PRESENTATIONS

1. **T. Mori**, “Holographic local operator quenches in BCFTs,” Quantum extreme universe from quantum information, YITP, Kyoto University Sep 2022
2. **T. Mori**, “Entanglement distillation in tensor networks,” YITP workshop TQFT2022, Tsukuba Sep 2022
3. **T. Mori**, “Holographic local operator quenches in BCFTs,” Strings and Fields 2022, YITP, Kyoto University Aug 2022
4. **T. Mori**, “Holographic entanglement distillation in tensor networks,” Quantum Information Entropy in Physics, YITP, Kyoto University Mar 2022
5. **T. Mori**, “Entanglement entropy in interacting quantum field theories,” Quantum Information Entropy in Physics, YITP, Kyoto University Mar 2022
6. **T. Mori**, “Holographic entanglement distillation in tensor networks,” JPS annual meeting 2022, online Mar 2022
7. **T. Mori**, “Entanglement entropy in interacting quantum field theories,” Westlake University, online Feb 2022
8. **T. Mori**, “Entanglement entropy in interacting QFTs,” Particle physics group, YITP, Kyoto University, online Nov 2021
9. **T. Mori**, “Proposal for entanglement distillation in holography,” Quantum Information & Foundation of Quantum Mechanics Workshop, online Oct 2021
10. **T. Mori**, “Explicit renormalization group flow of entanglement entropy,” Kansai Regional Seminar, Kyoto Oct 2021
11. **T. Mori**, “Entanglement entropy in interacting QFTs,” Particle physics group, Komaba, The University of Tokyo, online Oct 2021
12. **T. Mori**, “Entanglement entropy in interacting quantum field theories,” Statistical & Quantum Physics Autumn School 2021, online Sep 2021
13. **T. Mori**, “Entanglement entropy in interacting field theories,” JPS autumn meeting 2021, online Sep 2021
14. **T. Mori**, “Entanglement entropy in interacting QFTs,” Entanglement meeting, Entanglement group, YITP, Kyoto University, online Jun 2021
15. **T. Mori**, “Entanglement entropy in interacting field theories,” The 44th Quantum Information Technology Symposium (QIT44), online May 2021
16. **T. Mori**, “Entanglement entropy with interactions,” KEK Particle, Nuclear, Cosmology, and Condensed Matter Physics Joint Colloquium, Tsukuba, online May 2021
17. **T. Mori**, “A method for calculating entanglement entropy of semi-infinite plane in interacting theories,” JPS annual meeting 2021, online May 2021
18. **T. Mori**, “Entanglement entropy in interacting QFTs,” The 15th Kavli Asian Winter School on Strings, Particles and Cosmology, Beijing, online Jan 2021
19. **T. Mori**, “A general formula for von Neumann entropy of non-Gaussian states,” KEK theory center workshop TQFT2020, Tsukuba Oct 2020
20. **T. Mori**, “An analysis of the von Neumann entropy of general non-Gaussian states,” JPS autumn meeting 2020, online Sep 2020
21. **T. Mori**, “Analysis of the bulk entanglement by tensor networks,” JPS autumn meeting 2019, Yamagata Sep 2019
22. **T. Mori**, “What’s behind language?,” International Science Conference for Students, St. Paul’s School, London Mar 2013
23. **T. Mori**, “What’s behind language? – Formant analysis on vowels,” Kagaku-Zanmai in Aichi 2012, National Institutes of Natural Sciences Okazaki Conference Center, Okazaki Dec 2012

PUBLICATIONS

- [1] **T. Mori**, H. Manabe and H. Matsueda, “Entanglement distillation towards minimal bond cut surface in tensor networks,” [arXiv:2205.06633 [hep-th]]. (Accepted by Physical Review D on Sep 23, 2022)
Revealed that changing the location of the bond-cut surface in tensor networks can be interpreted as entanglement distillation and a minimal surface is characterized as a surface defining the closest state to the maximally entangled state (MES). Established a systematic method to evaluate how these distilled states are close to MES in generic tensor networks beyond holographic ones.
- [2] T. Kawamoto, **T. Mori**, Y. K. Suzuki, T. Takayanagi and T. Ugajin, “Holographic local operator quenches in BCFTs,” JHEP **05**, 060 (2022) doi:10.1007/JHEP05(2022)060 [arXiv:2203.03851 [hep-th]].
Established a correct correspondence between conformal field theories with boundaries and their gravity dual description in the presence of a local operator quench for the first time.
- [3] S. Iso, **T. Mori** and K. Sakai, “Wilsonian Effective Action and Entanglement Entropy,” Symmetry **13**, no.7, 1221 (2021) doi:10.3390/sym13071221 [arXiv:2105.14834 [hep-th]].
Provided a unified framework to address vacuum entanglement entropy in various interacting quantum field theories including operator mixings and suggested such contributions are dominant in low energy using the Wilsonian renormalization group. Furthermore, the area law of entanglement entropy is analytically derived for any interacting quantum field theories.
- [4] S. Iso, **T. Mori** and K. Sakai, “Non-Gaussianity of entanglement entropy and correlations of composite operators,” Phys. Rev. D **103**, no.12, 125019 (2021) doi:10.1103/PhysRevD.103.125019 [arXiv:2105.02598 [hep-th]].
Showed the propagator and vertex contributions in vacuum entanglement entropy of various interacting quantum field theories can be summed to all orders as a function of renormalized propagators of fundamental fields and composite operators, respectively.
- [5] S. Iso, **T. Mori** and K. Sakai, “Entanglement entropy in scalar field theory and \mathbb{Z}_M gauge theory on Feynman diagrams,” Phys. Rev. D **103**, no.10, 105010 (2021) doi:10.1103/PhysRevD.103.105010 arXiv:2103.05303 [hep-th].
Formulated a novel approach to calculate vacuum entanglement entropy in interacting quantum field theories for a half space subregion. Contributions from propagators are shown to come from renormalized two-point function via a nonperturbative formalism. Discovered a new, truly non-Gaussian contribution from vertices after renormalization and it is perturbatively studied.
- [6] **T. Mori**, “Proposal for the Power and Data Transmission Lines Using Natural Spider Silk and Carbon Nanotube,” The Nikkan Kogyo Shimbun, Ltd., Collection of Award-winning Papers in The 15th Best Paper Prize Contest in STEM for Undergraduate and Graduate Students in Japan, 73-78 (2015), <http://www.rikokei.jp/winning/2014.html> [in Japanese].
Proposed a new transmission wire transmitting both electricity and data made of spider silk coated with carbon nanotube film.
- [7] **T. Mori**, “Comparative Analysis of Vowels in Multiple Languages by Formants in Acoustic and Articulatory Phonetics,” Center for the Studies of Higher Education (2015), <http://hdl.handle.net/2237/21109> [in Japanese].
Compared formants of vowels in various languages and analyzed the result based on acoustic and articulatory phonetics. Quantified the closeness among languages by scatter plots of the first and second formant frequencies.

(Note that authors are usually listed alphabetically in high energy physics.)

[Updated October 8, 2022]