Ryuna Nagayama

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Second-year Ph.D. student at Department of Physics, Graduate School of Science, the University of Tokyo. I study optimal transport and nonequilibrium thermodynamics.

Contact & Links

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Keywords

Nonequilibrium thermodynamics, Stochastic thermodynamics, Optimal transport, Chemical reaction network, Reaction-diffusion system

Education

The University of Tokyo (Tokyo, Japan), Apr. 2024–present
Doctoral Program, Physics, Graduate School of Science

The University of Tokyo (Tokyo, Japan), Apr. 2022–Mar. 2024
Master's Program, Physics, Graduate School of Science
Degree Title: **Master of Science**
The School of Science Encouragement Award (Master Program)

The University of Tokyo (Tokyo, Japan), Apr. 2018–Mar. 2022
Bachelor's Program, Physics, Faculty of Science
Degree Title: **Bachelor of Science**
The School of Science Encouragement Award (Undergraduate Program)

Research Articles

Publications

"Infinite variety of thermodynamic speed limits with general activities"
Ryuna Nagayama, Kohei Yoshimura, Sosuke Ito
Phys. Rev. Research 7, 013307(2025). arXiv:2412.20690

"Force-current structure in Markovian open quantum systems and its applications: Geometric housekeeping-excess decomposition and thermodynamic trade-off relations"
Kohei Yoshimura, Yoh Maekawa, Ryuna Nagayama, Sosuke Ito
Phys. Rev. Research 7, 013244(2025). arXiv:2410.22628

"Geometric speed limit for acceleration by natural selection in evolutionary processes"
Masahiro Hoshino, Ryuna Nagayama, Kohei Yoshimura, Jumpei F Yamagishi, Sosuke Ito
Phys. Rev. Research 5, 023127(2023). arXiv:2207.04640

Preprints

"Geometric thermodynamics of reaction-diffusion systems: Thermodynamic trade-off relations and optimal transport for pattern formation"
Ryuna Nagayama, Kohei Yoshimura, Artemy Kolchinsky, Sosuke Ito
arXiv:2311.16569 (2023).

Presentations

International (oral)

"Extension of optimal transport to chemical reaction network"
2nd FoPM International Symposium, Feb. 17-19, 2025, Ito Hall, The University of Tokyo, Tokyo, Japan.

"Geometric thermodynamics of reaction-diffusion systems: Thermodynamic trade-off relations and optimal transport for pattern formation"
Workshop on Stochastic Thermodynamics V, May. 12-16, 2024, Online.

"A geometric speed limit for separable processes and its application to natural selection in evolutionary processes"
STATPHYS28, Aug. 7-11, 2023, Hongo campus, The University of Tokyo, Tokyo, Japan.

International (poster)

"Infinite variety of thermodynamic speed limits"
1st India-Japan Workshop on Physical Aspects of Living Systems, Feb. 19-21, 2025, Mishima Hall, ELSI, Institute of Science Tokyo, Tokyo, Japan.

"Geometric thermodynamics of reaction-diffusion systems Thermodynamic trade-off relations & optimal transport"
CSH Workshop: Trade-offs between thermodynamic cost, intelligence, and fitness in living organisms, Mar. 11-12, 2024, Complexity Science Hub Vienna, Austria.

"Towards the application of thermodynamic trade-off relations to reaction-diffusion systems"
FoPM International Symposium, Feb. 6-8, 2023, Ito Hall, The University of Tokyo, Tokyo, Japan.

Domestic (oral)

"Infinite variety of thermodynamic speed limits with activities based on general means"
ERATO and Academic Transformation B Joint Camp Meeting, Mar. 26-28, 2025, Hotel Hananoyu, Fukushima, Japan.

"Infinite variety of thermodynamic speed limits by generalization of activity"
2025 Spring Meeting, The Physical Society of Japan, Mar. 18-21, 2025, Online.

"Generalization of the 1-Wasserstein distance to chemical reaction networks and its application to nonequilibrium thermodynamics"

79th Annual Meeting, The Physical Society of Japan, Sep. 16–19, 2024, Sapporo Campus, Hokkaido University, Hokkaido, Japan.

"Geometric wavenumber decomposition of entropy production rate for reaction-diffusion systems"
2024 Spring Meeting, The Physical Society of Japan, Mar. 18-21, 2024, Online.

"Thermodynamic trade-off relations for reaction-diffusion systems"
The 68th Condensed Matter Physics Summer School, Aug. 12–15, 2023, Makino Parkhotel & Seminarhouse, Shiga, Japan.

"Geometric thermodynamics for reaction diffusion system"
2023 Spring Meeting, The Physical Society of Japan, Mar. 22-25, 2023, Online.

"Geometric speed limit for systems accelerated by natural selection"
UBI lunch-meeting, Nov. 16, 2022, Online & Hongo campus, The University of Tokyo, Tokyo, Japan.

"Information thermodynamic decomposition of entropy production rate on deterministic CRN"
2022 Autumn Meeting, The Physical Society of Japan, Sep. 12-15, 2022, Ookayama campus, Tokyo Institute of Technology, Tokyo, Japan.

Domestic (poster)

"Infinite variety of thermodynamic speed limits"
ERATO and Academic Transformation B Joint Camp Meeting, Mar. 26-28, 2025, Hotel Hananoyu, Hukushima, Japan.

"Optimal transport and thermodynamic speed limits for reaction-diffusion systems"
Kyushu caravan 2025, Japanese Society for Quantitative Biology, Jan. 11-12, 2025, Hospital Campus, Kyushu University, Fukuoka, Japan.

"Optimal transport and thermodynamic speed limits for reaction-diffusion systems"
7th Conference, Grant-in-Aid for Scientific Research on Innovative Areas: "Information physics of living matters," Sep. 21–22, 2023, Toki Messe Niigata Convention Center, Niigata, Japan.

"Thermodynamic trade-off relations for reaction-diffusion systems"
6th Conference, Grant-in-Aid for Scientific Research on Innovative Areas: "Information physics of living matters," Mar. 6–7, 2023, ACROS Fukuoka International Conference Hall, Fukuoka, Japan.

Awards & Fellowships

Apr. 2025-Mar. 2027 — Research Fellowship for Young Scientists (DC2), Japan Society for the Promotion of Science (JSPS)

Apr. 2024-Mar. 2027 — JSR Fellowship, The University of Tokyo & JSR Corporation

Mar. 12, 2024 — The School of Science Encouragement Award (Master Program), School of Science, The University of Tokyo

Mar. 5, 2024 — Research encouragement award, Grant-in-Aid for Scientific Research on Innovative Areas: "Information physics of living matters"

Mar. 7, 2023 — Presentation award, 6th Conference, Grant-in-Aid for Scientific Research on Innovative Areas: "Information physics of living matters"

Apr. 2022-Mar. 2027 — Forefront Physics and Mathematics Program to Drive Transformation (FoPM), a Worldleading Innovative Graduate Study (WINGS) Program, The University of Tokyo

Mar. 7, 2022 — The School of Science Encouragement Award (Undergraduate Program), School of Science, The University of Tokyo

Outreach & Popular science

May 2021 — Active matter Group in Physics Lab 2021, Students' presentation at the school festival of the University of Tokyo

May 2020 — Biophysics Group in Physics Lab 2020, Students' presentation at the school festival of the University of Tokyo

Certificates

Database Specialist Examination, Information-technology Promotion Agency, Japan (Oct 2022)

Applied Information Technology Engineer Examination, Information-technology Promotion Agency, Japan (Apr 2022)

Skills

Programming: Python, C++ (modern), Julia

Software & Service: LATEX, Adobe Illustrator

Languages: Japanese, English