Pratik Nandy

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Homepage, INSPIRE-HEP
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Current affiliation

2022-present Extreme Universe (ExU) Postdoctoral fellow, *JSPS Grant-in-Aid for Transformative Research Areas (A) "Extreme Universe"*.

Center for Gravitational Physics and Quantum Information, Yukawa Institute for Theoretical Physics (YITP) and RIKEN iTHEMS, Kyoto University, Japan.

Research experiences

2024 Visitor (RIKEN-Berkeley ASPIRE program), *Berkeley Center for Theoretical Physics (BCTP)*, University of California, Berkeley, CA, USA.

2023 Visitor (ExU overseas program), *Princeton Center for Theoretical Science (PCTS)*, Princeton University, Princeton, New Jersey, USA.

Education

2017-2022 PhD in Physics, *Centre for High Energy Physics, Indian Institute of Science*, Bangalore, India.

Thesis title: Complexity and Entanglement: From quantum gravity to many-body systems.

Supervisor: Prof. Aninda Sinha.

2015-2017 Master of Science (M.Sc) in Physics, *Indian Institute of Technology Kanpur*, India.
(received academic excellence award).

2012-2015 Bachelor of Science (B.Sc) in Physics, *Presidency University*, Kolkata, India.

Research interests

1. Quantum information in quantum gravity, 2. Holography and many-body quantum chaos, 3. Non-Hermitian and open quantum systems, 4. Random Matrix Theory, wormholes, and gravity.

Publications/Preprints

[All papers (except marked with *) are arranged in alphabetical order of the authors' names, which is conventional in the high-energy theory (hep-th) community. Papers marked with * are arranged according to the contributions of each author].

2025 ***21.** Free Probability approach to spectral and operator statistics in Rosenzweig-Porter random matrix ensembles, V. Jahnke†, **P. Nandy**†, K. Pal, H. A. Camargo, K-Y. Kim, [arXiv:2506.04520 [hep-th]] († equal contribution).

2024 ***20.** A Krylov space approach to Singular Value Decomposition in non-Hermitian systems, **P. Nandy**, T. Pathak, Z-Y. Xian, J. Erdmenger, Phys. Rev. B **111**, 064203 (2025), [arXiv:2411.09309 [quant-ph]].

19. Tridiagonal Hamiltonians modeling the density of states of the Double-Scaled SYK model, **P. Nandy**, JHEP 01 (2024) 094, [arXiv:2410.07847 [hep-th]].

18. Krylov fractality and complexity in generic random matrix ensembles, B. Bhattacharjee, **P. Nandy**, Phys. Rev. B **111**, L060202 (2025) (Letter), [arXiv:2407.07399 [quant-ph]].

17. Probing quantum chaos through singular-value correlations in sparse non-Hermitian SYK model, **P. Nandy**, T. Pathak, M. Tezuka, Phys. Rev. B **111**, L060201 (2025) (Letter), [arXiv:2406.11969 [quant-ph]].

*__16.__ Quantum Dynamics in Krylov Space: Methods and Applications, **P. Nandy**, A. S. Matsoukas-Roubeas, P. Martínez-Azcona, A. Dymarsky, A. del Campo, Phys.Rept. 1125-1128 (2025) (Invited review), [arXiv:2405.09628 [quant-ph]].

2023 **15.** Operator dynamics in Lindbladian SYK: a Krylov complexity perspective, B. Bhattacharjee, **P. Nandy**, T. Pathak, JHEP 01 (2024) 094, [arXiv:2311.00753 [quant-ph]].

14. On Krylov complexity in open systems: an approach via bi-Lanczos algorithm, A. Bhattacharya, **P. Nandy**, P. P. Nath, H. Sahu, JHEP 12 (2023) 066, [arXiv:2303.04175 [quant-ph]].

2022 **13.** Operator growth in open quantum systems: lessons from the dissipative SYK, B. Bhattacharjee, X. Cao, **P. Nandy**, T. Pathak, JHEP 03 (2023) 054, [arXiv:2212.06180 [quant-ph]].

12. Krylov complexity in large-q and double-scaled SYK model, B. Bhattacharjee, **P. Nandy**, T. Pathak, JHEP 08 (2023) 099, [arXiv:2210.02474 [hep-th]].

*__11.__ Probing quantum scars and weak ergodicity-breaking through quantum complexity, B. Bhattacharjee, S.Sur, **P. Nandy**, Phys. Rev. B **106**, 205150 (2022), [arXiv:2208.05503 [quant-ph]].

10. Operator growth and Krylov construction in dissipative open quantum systems, A. Bhattacharya, **P. Nandy**, P. P. Nath, H. Sahu, JHEP 12 (2022) 081, [arXiv:2207.05347 [quant-ph]].

9. Krylov complexity in saddle-dominated scrambling, B. Bhattacharjee, X. Cao, **P. Nandy**, T. Pathak, JHEP 05 (2022) 174, [arXiv:2203.03534 [quant-ph]].

8. Balanced Partial Entanglement and Mixed State Correlations, H. A. Camargo, **P. Nandy**, Q. Wen, H. Zhong, SciPost Phys. 12 (2022) 137, [arXiv:2201.13362 [hep-th]].

7. Q-curvature and Path Integral Complexity, H. A. Camargo, P. Caputa, **P. Nandy**, JHEP 04 (2022) 081, [arXiv:2201.00562 [hep-th]].

2021 **6.** Bath deformations, islands and holographic complexity, A. Bhattacharya, A.Bhattacharyya, **P. Nandy**, A. K Patra, Phys. Rev. D **105**, 066019, [arXiv:2112.06967 [hep-th]].

5. Partial islands and subregion complexity in geometric secret-sharing model, A. Bhattacharya, A.Bhattacharyya, **P. Nandy**, A. K Patra, JHEP 12 (2021) 091, [arXiv:2109.07842 [hep-th]].

4. Eigenstate capacity and Page curve in fermionic Gaussian states, B. Bhattacharjee, **P. Nandy**, T. Pathak, Phys. Rev. B **104**, 214306 (2021), [arXiv:2109.00557 [quant-ph]].

3. Capacity of entanglement in local operators, **P. Nandy**, JHEP 07 (2021) 019, [arXiv:2106.00228 [hep-th]].

2. Islands and complexity of eternal black hole and radiation subsystems for a doubly holographic model, A. Bhattacharya, A. Bhattacharyya, **P. Nandy**, A. K Patra, JHEP 05 (2021) 135, [arXiv:2103.15852 [hep-th]].

2019 **1.** Renormalized Circuit Complexity, A. Bhattacharyya, **P. Nandy**, A. Sinha, Phys. Rev. Lett. **124**, 101602 (2020), [arXiv:1907.08223 [hep-th]].

Presentations, Talks, and Lectures

June 2025 Invited talk at the CERN Heavy ion theory group, CERN, Switzerland.

June 2025 Invited talk at the workshop "Quantum Connections: Linking Information, Gravity, and Many-Body Physics", Jeju, Korea.

June 2025 Invited talk at the workshop "Hydrodynamics of low-dimensional interacting systems: Advances, challenges, and future directions", YITP, Kyoto University, Japan.

May 2025 Invited talk at ISSP, University of Tokyo, Japan.

May 2025 Invited talk at Gakushuin University, Tokyo, Japan.

Mar 2025 Invited talk at "Workshop on Low-dimensional Gravity and SYK Model", Matsumoto, Japan.

Mar 2025 Contributed talk at "Kyushu IAS-iTHEMS workshop: Non-perturbative methods in QFT", Fukuoka, Japan.

Mar 2025 Invited talk at the Department of Physics, Gwangju Institute of Science and Technology (GIST), South Korea

Nov 2024 Invited talk at NCTS, National Tsing Hua University, Hsinchu, Taiwan.

Nov 2024 Contributed talk at the workshop "East Asia Joint Workshop on Fields and Strings" at National Sun-Yat Sen University, Kaohsiung, Taiwan.

Oct 2024 Contributed talk at workshop "Quantum Extreme Universe: Matter, Information, and Gravity" at OIST, Okinawa, Japan.

Sept 2024 Invited talk at workshop "Focus Week on Non-equilibrium Quantum Dynamics" at Kavli IPMU, University of Tokyo, Japan.

Aug 2024 Contributed talk at workshop "Quantum Information, Quantum Field Theory and Gravity" at International Centre for Theoretical Sciences (ICTS), Bangalore, India.

July 2024 Invited talk at workshop "Holography in Beijing 2024" at Kavli Institute of Theoretical Sciences (KITS), UCAS, Beijing, China.

Jun 2024 Invited talk at Department of Physics, University of Kentucky, USA.

Feb 2024 Invited talk at the 2nd Young researchers workshop, Shirahama-so, Shiga, Japan.

Feb 2024 Invited talk at the Osaka University, Osaka, Japan.

Jan 2024 Invited talk at the Department of Physics and Material Science, University of Luxembourg, Luxembourg.

Jan 2024 Invited seminar and Invited talk at Kobayashi-Masakawa Institute, Nagoya University, Nagoya, Japan.

Dec 2023 Invited seminar at Saitama University, Saitama, Japan.

Nov 2023 Contributed talk at KEK Theory Workshop, Tsukuba, Ibaraki, Japan.

Nov 2023 Contributed talk at Quantum Gravity Gatherings, RIKEN, Wako, Japan.

Nov 2023 Invited talk at the Department of Physics, The University of Tokyo, Tokyo, Japan.

Oct 2023 Invited talk at Saha Institute of Nuclear Physics, Kolkata, India

Sept 2023 Contributed talk at the conference "Quantum Information, Quantum Matter and Quantum Gravity", YITP, Kyoto, Japan.

July 2023 Invited talk at the conference "Integrability, Deformations, and Chaos", Okinawa Institute of Science and Technology, Okinawa, Japan.

May 2023 Invited talk at the workshop "Entanglement, Large N and Black Hole", APCTP, Pohang, South Korea.

Jan 2023 Gong show and poster presentation at the 17th Kavli Asian Winter School on Strings, Particles and Cosmology, IBS, Daejeon, South Korea.

Dec 2022 Gong show and poster presentation at the ExU annual conference, Kobe, Japan.

Sept 2022 Invited talk in ExU circular meeting, YITP, Kyoto University, Japan.

June 2022 NITHeCS webinar (invited): Two lectures on "Recent progress on Krylov complexity" in the Department of Mathematics and Applied Mathematics, University of Cape Town, South Africa.

Dec 2021 Invited (online) talk at the Department of Computer Science, Texas Tech. University, Lubbock, Texas, USA.

Aug 2021 Invited (online) talk in Quantum Information in QFT and AdS/CFT-II.

Aug 2020 Invited (online) talk in Quantum Information in QFT and AdS/CFT-I.

Jul 2020 Invited (online) lectures (3 pedagogical lectures) on tensor networks and complexity in ST4-2020.

Jan 2020 Gong show and poster presentation at the 14th Kavli Asian Winter School on Strings, Particles and Cosmology, Tohoku University, Sendai, Japan.

Refereed journals

Journal of High Energy Physics (JHEP), SciPost Physics, Physical Review B (PRB), Physical Review D (PRD), Physical Review E (PRE), Physical Review Research (PRR), Progress of Theoretical and Experimental Physics (PETP).

Teaching experiences

2022 Two lectures on Krylov complexity, University of Cape Town, South Africa.

2000 3 pedagogical lectures on "Tensor networks and complexity" in ST4-2020, India.

2019-2020 Teaching assistant: Graduate course on General relativity, Indian Institute of Science, Bangalore.

Organizing experiences

2022 Workshop on Students talk on trending topics (ST4) - 2022, Indian Institute of Technology, Indore, India.

2021-2022 Math-Physics seminar series, CHEP, Indian Institute of Science, Bangalore, India.

Research visits (long and short)

May 2025 Gakushuin University, Tokyo, Japan. Host: Prof. Hal Tasaki.

Feb-Mar. 2025 Gwangju Institute of Science and Technology (GIST), Gwangju, South Korea. Host: Prof. Keun-Young Kim.

Nov. 2024 NCTS, National Tsing Hua University, Taiwan. Host: Prof. Norihiro Iizuka.

Jun. 2024 Department of Physics, University of Kentucky, Lexington, USA. Host: Prof. Anatoly Dymarsky.

May 2024 Stanford Institute for Theoretical Physics, Stanford University, USA. Host: Prof. Douglas Stanford.

May/Jun. 2024 Berkeley Center for Theoretical Physics (BCTP), University of California, Berkeley, CA, USA. Host: Prof. Yasunori Nomura.

Feb 2024 Department of Physics, University of Basque Country, Bilbao, Spain Host: Prof. Adolfo del Campo and Prof. Inigo L. Egusquiza.

Jan. 2024 Department of Physics, University of Luxembourg, Luxembourg. Host: Prof. Adolfo del Campo.

Jan. 2024 Department of Physics, Kobayashi-Masakawa Institute, Nagoya University, Japan. Host: Prof. Masamichi Miyaji.

Dec. 2023 Department of Physics, Saitama University, Japan. Host: Prof. Kentaroh Yoshida.

Nov. 2023 Department of Physics, The University of Tokyo, Japan. Host: Prof. Hosho Katsura.

Feb/Mar. 2023 Princeton Center for Theoretical Science (PCTS), Princeton University, New Jersey, USA. Host: Prof. Shinsei Ryu.

Aug. 2022 Department of Physics, Indian Institute of Technology, Gandhinagar, India. Host: Prof. Arpan Bhattacharyya.

Jun. 2022 Department of Mathematics and Applied Mathematics, University of Cape Town, South Africa. Host: Prof. Shajid Haque and Prof. Jeff Murugan.

Academic achievements, grants, awards, and scholarships

2024 Adopting Sustainable Partnerships for Innovative Research Ecosystem (ASPIRE) fellowship, iTHEMS, RIKEN, Japan, and University of California, Berkeley, USA, Japan Science and Technology Agency (JST), Grant Number JPMJAP2318..

2023 Extreme Universe Overseas visiting researchers grant, KAKENHI No. 21H05182.

2022-2025 Extreme Universe (ExU) Postdoctoral fellowship, JSPS Grant-in-Aid for Transformative Research Areas (A) "Extreme Universe" No. 21H05190, Japan.

2019-2022 SRF-Senior Research Fellowship (PhD), University Grants Commission (UGC), India.

2017-2019 JRF-Junior Research Fellowship (PhD), University Grants Commission (UGC), India.

2017 Academic Excellence Award (M.Sc), IIT Kanpur.

2012–2015 INSPIRE Scholarship (B.Sc), Department of Science and Technology, India.

Newsletters, Press releases and media coverage

2025 Understanding dynamics & quantum chaos through Krylov space (RIKEN newsletter), [link here].

2020 Optimizing efficiency of quantum circuits at Phys.org, [link here].

2020 IISc team proposes efficient design for quantum circuits (IISc press release), [link here]. (NDTV), [link here].

Personal

DOB, Gender 30 June 1994 (Age: 30), Male, Nationality: Indian, Residence: Japan

References (no particular order)

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   Yukawa Institute for Theoretical Physics (YITP), Kyoto University, Japan.
   Email: takayana@yukawa.kyoto-u.ac.jp

3. Prof. Anatoly Dymarsky,
   Department of Physics and Astronomy, University of Kentucky, USA.
   Email: a.dymarsky@uky.edu

4. Prof. Tatsuma Nishioka,
   Department of Physics, Osaka University, Japan.
   Email: nishioka@het.phys.sci.osaka-u.ac.jp

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   Department of Physics and Materials Science, University of Luxembourg, Luxembourg.
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