

# Tathagata Karmakar

Andrew N. Jordan  group

+1 585-967-8496

tkarmaka@ur.rochester.edu

<https://tathagata-karmakar.github.io/>

## Expertise

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Theoretical quantum optics, quantum measurement, open quantum systems, machine learning approaches in physics, analytical/numerical modeling and optimization.

**Programming languages:** Python (PyTorch, JAX, 5+ yrs), Mathematica (5+ yrs), QuTiP.

## Education

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- Ph.D., Department of Physics and Astronomy, University of Rochester *2018–present*
- BS Physics CPI: 9.9/10, Indian Institute of Technology, Kanpur *2014–2018*

## Academic Affiliations

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- Research Intern, PHI Lab, NTT Research, Inc., Sunnyvale, CA *Jul. –Sep. 2023*
- Affiliated student researcher, Chapman University *Aug. 2021–present*
- Graduate student, University of Rochester *Aug. 2018–present*
- Summer research assistant, Center for Computational Astrophysics (CCA), Simons Foundation *May – Jul., 2017*

## Publications

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- [1] Sethuraj K. R., **T. Karmakar**, A. N. Jordan and A. N. Vamivakas, and “Experimental realization of supergrowing fields”, arXiv: 2309.00016 (2023).
- [2] **T. Karmakar**, A. Chakraborty, A. N. Vamivakas and A. N. Jordan, “Supergrowth and sub-wavelength object imaging”, arXiv: 2307.03352 (2023).
- [3] **T. Karmakar** and A. N. Jordan, “Beyond Superoscillation: General Theory of Approximation with Bandlimited Functions”, arXiv: 2306.03963 (2023).
- [4] **T. Karmakar**, É. Jussiau, S. K. Manikandan, and A. N. Jordan, “Cyclic superconducting quantum refrigerators using guided fluxon propagation”, arXiv: 2212.00277 (2022).
- [5] **T. Karmakar**, P. Lewalle, and A. N. Jordan, “Stochastic path-integral analysis of the continuously monitored quantum harmonic oscillator”, PRX Quantum **3**, 010327 (2022).
- [6] **T. Karmakar**, S. Genel, and R. S. Somerville, “The relationship between galaxy and halo sizes in the Illustris and IllustrisTNG simulations”, Monthly Notices of the Royal Astronomical Society, **520**, 1630 (2023).
- [7] **T. Karmakar** and T. Sarkar, “Distinguishing Between Kerr and Rotating JNW Space-Times via Frame Dragging and Tidal Effects”, General Relativity and Gravitation **50**, 85 (2018).

## Research Experience

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- **Superoscillations and supergrowth [1–3].** *Jun. 2022 – Jul. 2023*
  - Collaborated on the first-ever experimental synthesis of supergrowing optical fields.
  - Developed a numerical algorithm for subwavelength object reconstruction using superoscillatory/supergrowing point spread functions.
  - Prescribed a Legendre polynomial-based algorithm for generating functions with arbitrary superoscillatory/supergrowing properties.
- **Fluxon refrigerator [4].** *Apr. 2021 – Dec. 2022*
  - Devised and optimized a refrigeration scheme utilizing the flow of magnetic field vortices along a magnetic field gradient in a type-II superconducting device.
- **Stochastic path integral [5].** *Jan. 2020 – Mar. 2021*
  - Formulated and optimized a stochastic action principle-based description of a monitored harmonic oscillator, and confirmed analytical findings with 100,000 simulated trajectories.

## Presentations

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- *A discussion on quantum convolutional neural networks*, original article: Cong et al., Nat. Phys. **15**, 1273–1278 (2019), PHI Lab internship journal club, NTT Research, Inc., Aug. 11, 2023.
- *Cyclic superconducting quantum refrigerators using guided fluxon propagation*, APS March Meeting 2023.
- *Stochastic path integral analysis of a harmonic oscillator undergoing simultaneous continuous position and momentum measurements*  $\square$ , Quantum Thermodynamics Conference, Jun. 30, 2022.
- *Tomography of a Continuously Monitored Qubit*, APS March Meeting 2022.
- *A discussion on 36 entangled officers of Euler*  $\square$ , original article: Rather et al., Phys. Rev. Lett. **128**, 080507 (2022), Institute for Quantum Studies, Chapman University, Mar. 08, 2022.
- *Stochastic path integral analysis of a harmonic oscillator undergoing simultaneous continuous position and momentum measurements*  $\square$ , Institute for Quantum Studies, Chapman University, Sep. 13, 2021.
- *Stochastic Path Integral Analysis of the Continuously Monitored Simple Harmonic Oscillator*, APS March Meeting 2021.
- *Simultaneous Weak-Continuous Position and Momentum measurements of a Harmonic Oscillator*, Graduate Student Research Meeting, University of Rochester, Feb. 13, 2021.
- *Optical Field Quadrature Measurements: Introduction to Homodyne and Heterodyne Detections*, with Dr. Philippe Lewalle, University of Rochester, Jan. 18, 2021.

## Awards & Achievements

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- Okubo prize (for best performance on the most recent preliminary assessment), Department of Physics and Astronomy, University of Rochester, 2020.
- Robert L. and Mary L. Sproull fellow  $\square$ , 2018–20.
- S.N. Bose scholar  $\square$  (by Winstep forward, SERB DST Govt. of India and IUSSTF), 2017.
- Academic Excellence Award for outstanding performance in academic years 2014–15 and 2015–16 (dean's office, IIT Kanpur).
- All India rank: 15, KVPY (SB) 2013 (Kishore Vaigyanik Protsahan Yojana, fellowship funded by Dept. of Science and Technology, Govt. of India), granted fellowship 2014–18.

## Peer-reviewer/Referee

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Phys. Rev. A, Annals of Physics, npj Quantum Information, Applied Physics Letters.

## Research Proposal Submission

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Department of Energy, National Science Foundation (both under evaluation).

## Teaching and Mentorship Experiences

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- **PASSAGE mentorship program, University of Rochester (2020-2021)**: Mentored a newly admitted Ph.D. student and ensured their smooth transition to graduate school.
- **Teaching assistant, 20th Century Physics (Jan.–Apr. 2019)**: Administered workshops for 50+ freshmen students, introduced them to quantum physics, designed problems.
- **Teaching assistant, Gravitation & General Relativity (Aug.–Nov. 2018)**: Graded assignments and conducted office hours for 20+ senior/junior undergraduates.

## Selected Coursework

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Quantum optics I and II (UofR), Machine learning (Andrew Ng, Coursera), Graph theory (IIT Kanpur).