Amit Anand

a63anand@uwaterloo.ca
+1 226 899 2818
Waterloo, Canada
Citizenship - India

Interests

My research is centered on the fundamental physics of quantum many-body systems, investigating key phenomena such as thermalization, ergodicity, chaos, and information scrambling. I am particularly interested in exploring how quantum information theory intersects with these phenomena, with applications in quantum metrology, sensing, and the development of large-scale quantum computers. Additionally, I aim to study quantum correlations, such as entanglement, in many-body systems, utilizing current quantum computing platforms to advance both theoretical understanding and practical capabilities in quantum technology.

Technical skills

Technical: Python, Matlab, Mathematica and BlueJ

Education

PhD in Physics(with specialization in Quantum Information)	Sep 2023–Aug 2027
Institute for Quantum Computation, University of Waterloo	ON, Canada
MSc in Physics (with specialization in Quantum Information)	Sep 2021–Aug 2023
Institute for Quantum Computation, University of Waterloo	ON, Canada
B-Tech Mechanical Engineering	Sep 2017–Aug 2021
Indian Institute for Engineering Science an Technology, Shibpur	West Bengal, India

Publications/Preprints

[1] **A. Anand,** D. Valluri, J. Davis, and S. Ghose, *Quantum recurrences and the arithmetic of floquet dynamics*, arXiv.org, 2025.

[2] **A. Anand**, J. Davis, and S. Ghose, "Quantum recurrences in the kicked top", *Phys. Rev. Res.*, vol. 6, p. 023 120, 2 May 2024.

[3] **A. Anand**, R. B. Mann, and S. Ghose, "Non-linearity and chaos in the kicked top", *Physica D: Nonlinear Phenomena*, vol. 471, p. 134 455, Nov. 2024.

[4] **A. Anand**, S. Srivastava, S. Gangopadhyay, and S. Ghose, "Simulating quantum chaos on a quantum computer", *Scientific Reports*, vol. 14, Nov. 2024.

[5] **A. Anand**, *Chaos and dynamical instability in a closed kicked system*, Uwaterloo.ca, Aug. 2023.

[6] S. Chowdhury, **A. Anand**, A. Singh, and B. Pal, "Evaluation of mechanical properties of ti-25nb bcc porous cell structure and their association with structure porosity: A combined finite element analysis and analytical approach for orthopedic application", *Proceedings of the Institution of Mechanical Engineers, Part H: Journal of Engineering in Medicine*, vol. 235, pp. 827–837, Apr. 2021.

[7] N. Mishra, M. Kapil, H. Rakesh, **A. Anand**, and et.al., *Quantum machine learning: A review and current status*, Springer Link, 2021.

[8] **A. Anand**, B. K. Behera, and P. K. Panigrahi, "Solving diner's dilemma game, circuit implementation and verification on the ibm quantum simulator", *Quantum Information Processing*, vol. 19, May 2020.

Work experience

PhD's Research Experience (Sep 2023 - Present)

- **Developing novel techniques** for applying thermal states in quantum metrology and sensing, providing new benchmarks to evaluate the performance of current quantum computers.
- **Theoretical and experimental analysis** of Double-well potential as experimental test-bed of quantum kicked top model for studying quantum chaos and thermalization. Further, we look at the possibility of using the quantum recurrences in the kicked top for quantum metrology and sensing.
- **Exploring the effects of the superposition of multiple reference frames on the evolution of quantum chaos**.
- **Investigating thermalization and localization** phenomena in quantum many-body systems, revealing key dependencies on the graph structure of the Hamiltonian and enhancing understanding of the behaviors of the quantum state.
- **Analyzed the dynamical behavior** of conservative Hamiltonian systems, demonstrating the relationship between **chaos and nonlinearity**, and providing critical insights into their fractal dimensions. Paper link
- **Proposed and implemented an algorithm** to efficiently detect temporal periodicity in non-equilibrium spin systems, optimizing computational resources and advancing theoretical models in quantum mechanics. Paper link .
- **Supervised** a final year undergraduate student working on efficient circuit decomposition of chaotic Hamiltonian and its implementation on currently available NISQ quantum computer.

Master's Research Experience (Sep 2021 - Aug 2023)

- **Developed and demonstrated** a method using a Noisy Intermediate Scale Quantum (NISQ) computer to perform a programmable quantum simulation of a quantum chaotic system, highlighting quantum entanglement as a potential signature of classical chaos. Paper link
- **Discovered an infinite family of purely quantum recurrences** not present in the classical limit of chaotic systems, and analytically proved these temporal periodicities for all finite spin values, providing new insights into quantum dynamics.Paper link

Undergraduate's Research Experience (May 2019 - Aug 2021)

- **Developed a quantum strategy** to solve the Diner's Dilemma for $n = 4$, demonstrating how quantum entanglement can be leveraged as a resource to maximize individual payoffs while maintaining equilibrium in strategies, contributing to advancements in quantum game theory. Paper link
- **Established a correlation** between mechanical performance and structural parameters of a BCC Ti-25Nb porous structure and **determined an optimal porosity range**, providing insights crucial for designing advanced implants for orthopedic applications with improved integration and durability. Paper link

Research Mentoring and Supervision

- **Summer research internship**   2024
  Student: Ravneet kaur, Computer science, Final year undergraduate student
  Project: Effects of noise in implementation of chaotic system on universal quantum computer

- **Mitacas Global summer research internship**   2025
  Student: Diego Guerrero, Physics, 3rd year undergraduate student
  Project: Effects of disorder on quantum recurrences in many-body system

Service and Outreach

- Chaperone for high school students, Quantum School for high school students (QSYS)   Spring 2022 & 2023
  IQC, University of Waterloo
- Virtual presentation for Grade 11 or Grade 12 physics students on exploring wave-particle duality
  and quantum computing,Virtual Class Visits program (multiple sessions)   2022-2024
  IQC scientific outreach program, University of Waterloo.
- Volunteer for running the demos on Ion-trap experiment and talk about science with
  kids on Family Day .   Winter 2022 & 2024
  IQC scientific outreach program with LAUNCH Waterloo., University of Waterloo.
- Volunteer for leading a short discussion on quantum information and helping the students as they build
  their lab activity. Physics Lab Days.   Winter 2023
  IQC scientific outreach program, University of Waterloo.
- Volunteer for Quantum Connections Conference 2023. Institute for Quantum Computing   Spring 2023
  University of Waterloo.
- Organizing committee member for student seminar. Institute for Quantum Computing   Fall 2023 - present
  University of Waterloo.

CONFERENCE TALKS AND POSTER PRESENTATION

- Poster Presentation on 'Quantum recurrences and arithmetic of Floquet dynamics'   August, 2025
  School on Quantum Dynamics of Matter, Light and Information, 2025, ICTP, Italy.
- Poster Presentation on 'Quantum recurrences in the kicked top'   July, 2023
  Quantum Thermodynamics 2023, TU Vienna, Austria.
- Poster Presentation on 'Arithmetic of the kicked top'   June, 2024
  Geometry and non-adiabatic responses in non-equilibrium systems,
  Max-Planck institute for physics of complex systems, Dresden, Germany.
- A talk on 'Quantum Chaos' (invited)   June, 2022
  Summer School on Quantum Information and Quantum Technology at IISER Kolkata
- Poster Presentation on 'Quantum simulation of quantum chaos'   February, 2022
  Quantum days 2022, Canada.
- A talk on 'Quantum Physics and Game Theory'   June, 2019
  Summer School on Quantum Information and Quantum Technology at IISER Kolkata
- Poster Presentation on 'Solving diner's dilemma game, circuit implementation and verification
  on IBM quantum simulator'   September, 2019
  Conference on Quantum Foundation, Technology and Applications at IISER Mohali.

Awards

- David Johnston Award for Scientific Outreach 2024   2024
  IQC, University of Waterloo
- Awarded Marie Curie Award and Science Graduate Award for pursuing graduate studies   2021-2023
  IQC, University of Waterloo
- Graduate Research Award For conducting Master Thesis   2021-2023
  IQC, University of Waterloo
- Research Fellowship for excellence in research from Global Alumni Association of Bengal Engineering and Science
  University, Shibpur (GAABESU)   2021
  IIEST, Shibpur

- Scholarships by The Erwin-Schrodinger International Institute for Mathematics And Physics (ESI) to attain Winter school on Machine Learning in Physics. 2020
  University of Vienna

Teaching Assistant

- **Statistical Mechanics** at University of Waterloo   Winter 2022 & Winter 2023

- **Classical Mechanics and Special Relativity** at University of Waterloo   Spring 2022 & Spring 2023

- **Intermediate Classical Mechanics** at University of Waterloo   Fall 2023 & Fall 2024

- **Quantum Physics 2** at University of Waterloo   Winter 2024

- **Quantum Physics 1** at University of Waterloo   Winter 2025

Research Mentoring and Supervision

- **Summer research internship** 2024
  Student: Ravneet kaur, Computer science, Final year undergraduate student
  Project: Effects of noise in implementation of chaotic system on universal quantum computer
- **Mitacas Global summer research internship** 2025
  Student: Diego Guerrero, Physics, 3rd year undergraduate student
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