# Rishik Perugu

**PhD in Physics**
**University of California, Irvine**
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## Education

**University of California, Irvine** — Irvine, CA
PhD in Physics, GPA: 4.0/4.0, Advisor: Prof. Thomas Scaffidi — Sept 2024–

**Indian Institute of Science** — Bangalore
Master of Science in Physics, CGPA: 9.1/10 — Aug 2023–May 2024

**Indian Institute of Science** — Bangalore
Bachelor of Science (Research) in Physics, CGPA: 9/10 — Aug 2019–May 2023

## Research Experience

**Non-equilibrium dynamics of large N fermionic models** — Sept 2023 - Current
Mentor: *Prof. Sumilan Banerjee, Indian Institute of Science (IISc), Bangalore* — (Master's thesis)

- Studied thermal field theory for the complex Sachdev-Ye-Kitaev (SYK) model using the coherent state path integral formalism
- Studied the Keldysh-Schwinger path integral formalism for non-equlibrium many body dynamics
- Studying the non-equilibrium dynamical phases of the SYK model and investigating if there are any entanglement transitions in the presence of measurements using large N methods

**Variational wavefunctions for strongly correlated fermionic systems** — May 2023 - Current
Mentor: *Prof. Thomas Scaffidi, University of California, Irvine*

- Developed a code using the NETKET package to optimize the overlap of the variational wavefunction with the target (ground) state, complementing the existing energy optimization code in it
- Investigating if the approximation ratio, the ratio of the lowest energy of the variational ansatz to the exact ground state energy, is finite for various ansatzes inspired by neural networks that have an efficient representation on a classical computer in the large N limit
- Studying different ansatzes such as hardware efficient ansatz which are efficiently realizable on a quantum computer that yield finite approximation ratio for large N

**Measures of quantum non-markovianity** — Nov 2022 - Mar 2023
Mentor: *Prof. Kanupriya Sinha, Arizona State University*

- Studied the basics of open quantum systems such as Completely Positive and Trace preserving (CPT) maps, Redfield and Lindblad master equations and measures of non-markovianity
- Calculated the amount of non-markovianity in spin-boson model using two standard measures based on the distinguishability of states and on the divisibility of the dynamical map
- Investigated the problem of optimal system-bath partition to maximize the amount of non-markovianity in the dynamics of an artificial atom in a leaky cavity

**DMRG study of the one dimensional extended Bose-Hubbard model** — May 2022 - Apr 2023
Mentors: *Dr. Andreas Haller and Prof. Thomas Schmidt, DPhyMS, University of Luxembourg* — (Bachelor's thesis)

- Built a code to implement zero-site density matrix renormalisation group (DMRG) using ITensor library on top of the existing traditional two-site DMRG algorithm
- Simulated the phase diagram of the one-dimensional Bose-Hubbard model with on-site and nearest-neighbor density interactions using zero-site DMRG

– Characterised the supersolid, superfluid and charge density wave phases using correlation functions and quantum state tomography

**Molecular Aggregate Photophysics** June 2021 - May 2022

Mentor: *Prof. Jayashree Nagesh, Institute of Bioinformatics and Applied Biotechnology, Bangalore*

– Investigated the effects of inter-molecular charge transfer, vibrations, temperature and disorder in molecular aggregates using the Frenkel-Holstein framework

– Developed a MATLAB code to simulate absorption and emission spectra of the aggregates, incorporating the above effects

**Plasma Physics** Feb 2021 - Sept 2021

Mentor: *Prof. Animesh Kuley, IISc Bangalore*

– Analytically solved for the trajectories of charged particles in various electromagnetic field configurations

– Simulated the trajectories of charged particle in electromagnetic field using Euler, RK2, RK4 and Boris Push methods

## Course Projects

**p-spin Spherical model (PSM)** Fall 2023

*Prof. Sumilan Banerjee | Advanced Statistical Physics*

– Studied basic concepts of disordered systems such as **self-averaging**, **replica trick** and **saddle-point** solutions and reproduced the calculations to study static transition between **spin-glass phase** and **paramagnetic phase** in PSM

– Studied the **Parisi Replica Symmetry Breaking scheme** required to understand the spin-glass phase

**Topological Crystalline Insulators** Spring 2023

*Prof. Tanmoy Das | Topological Phases of Matter*

– Studied about Topological Crystalline Insulators and calculated the corresponding $\mathbb{Z}_2$ **topological invariant**

– Reproduced $\mathbb{Z}_2$ invariant calculation for a **tight-binding model** on a **tetragonal lattice**

**Dynamics in Viscoelastic Materials** Spring 2023

*Prof. Janaki Balakrishnan | Dynamical Systems Theory*

– Modelled the dynamics of a mass attached to rubber band as a damped harmonic oscillator and a **four parameter viscoelastic** model

– Obtained the phase portrait of the system numerically and investigated the effects of periodic driving

## Positions of Responsibility

**Decoherence event coordinator** Pravega '21

Part of the Science and Tech team of Pravega, the undergraduate fest of IISc, Bangalore July 2020 - August 2021

– I served as one of the two coordinators for the physics events of Pravega, where we successfully managed and led a team of 15 members.

– As part of **Coherence Lecture Series**, we organized ten online advanced undergraduate-level talks by eminent physicists from various fields on their research areas. Notable speakers include **Prof. Steve Simon, Prof. Julia Yeomans, Prof. Shiraz Minwalla** (link)

– We organized an undergraduate-level online physics competition called **Spooky Quizzes** twice spanned over 6 weeks which had a pan-India participation of **over 200 students**

– We organized another undergraduate-level online physics competition called **Decoherence** involving solving and presenting long problems to physics professors at IISc Bangalore, with a participation of over **500 students** for the preliminary round. I was involved with designing the structure and question-making of the competition

## Scholastic Achievements

- Awarded the prestigious **Regents fellowship** 2024-2026
- Recipient of the prestigious **KVPY Fellowship and Scholarship** by the Department of Science and Technology, Government of India 2019–2024
- Secured **All India Rank of 135** in **JEE Advanced** examination among 0.16 million candidates 2019
- Secured **All India Rank of 147** in **JEE Mains** examination among 1.2 million candidates 2019

## Techanical Skills

- **Programming languages:** Python, Julia, MATLAB/Octave, Mathematica, C
- **Packages and Tools:** LaTeX, Numpy, Scipy, Matplotlib, Qiskit, ITensors, NetKet, QuTip
- **Techniques:** Self-consistent mean field solver, Variational Quantum Eigensolver, Neural Quantum States, DMRG/Tensor Networks

## Selected Coursework

- **Maths:** Real analysis, Linear Algebra, Multivariable Calculus, Probability and Statistics, Introduction to Dynamical Systems Theory
- **Physics:** Intermediate Mechanics, Oscillations and Waves, Intermediate Electromagnetism and the Quantum Physics of Radiation, Intermediate Thermal Physics and the Physics of Materials, Introduction to Quantum Measurement and Control, Classical Mechanics, Quantum Mechanics 1, 2, Mathematical Methods of Physics, Nuclear and Particle Physics, Electromagnetic Theory, Fundamentals of Astrophysics*, General Relativity, Statistical Mechanics, Advanced Statistical Physics*, Condensed Matter Physics 1, Introduction to Materials for Quantum Technologies, Topological Phases of Matter, Quantum Field Theory 1*, Introduction to Quantum Computation*,
- **Miscellaneous:** Computers in Chemistry, Introduction to Algorithms, Introduction to Electrical and Electronics Engineering, Elements of Solid Mechanics, Introduction to Semiconductor Devices and Technology

  * To be completed by December 2023

## Extra Curriculars

- **Mentored two high school students** under CovEd initiative for college preparation, help improve their problem solving skills in mathematics and physics
- Demonstrated **anti-bubbles** and **chemical clock reactions** to broad audience as part of Exhibition, Pravega 2020
- Demonstrated standing wave patterns on **Chladni plate** to over 1000 people during Open Day 2020 at IISc Bangalore