

# Prem Kumar

Ph.D. Student

The Institute of Mathematical Sciences (IMSc), Chennai, India

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## Education and Training

<b>Ph.D. in Theoretical Physics</b>	2021-Present
Institute of Mathematical Sciences (IMSc), Chennai, India	
Supervisor: <a href="#">Prof. Sibasish Ghosh</a>	
<b>M.Sc. in Physics</b>	2019-2021
Institute of Mathematical Sciences (IMSc), Chennai, India	
Supervisor: <a href="#">Prof. Sibasish Ghosh</a>	
<b>B.Sc. in Physics, Maths, Electronics</b>	2016 - 2019
Christ (Deemed to be University), Bangalore, India	

## Research Highlights

- Developed an analytical 4th-order Time-Convolutionless (TCL4) generator for Spin-Boson models, benchmarking it against exact numerical methods.
- Generalized the ultra-strong coupling limit quantum mean force Gibbs state to a large class of anharmonic environments.

## Publications

### Refereed Journal Publications

1. Prem Kumar, K. P. Athulya, and Sibasish Ghosh. “**Asymptotic TCL4 Generator for the Spin-Boson Model: Analytical Derivation and Benchmarking.**” *Physical Review B* (2025).
2. Prem Kumar, K. P. Athulya, and Sibasish Ghosh. “**Equivalence between the second order steady state for the spin-boson model and its quantum mean force Gibbs state.**” *Physical Review B* 111, 115423 (2025).
3. Prem Kumar, and Sibasish Ghosh. “**Ultrastrong coupling limit to quantum mean force Gibbs state for anharmonic environment.**” *The Journal of Chemical Physics* 161, 17 (2024).

### Pedagogical Reviews

- Prem Kumar. “**Local harmonic approximation to quantum mean force Gibbs state**” [arXiv:2401.11595](https://arxiv.org/abs/2401.11595) (2024).

*Note: A unified derivation and review of the harmonic approximation method for mean force Gibbs state.*

## Technical Skills

### • Computational Physics & ML:

- **Tensor Networks:** Implementation of algorithms for simulating open quantum system dynamics.

- **Machine Learning:** PyTorch for machine learning and designing transformer models.
- **Languages:** Python (QuTiP, NumPy, SciPy).

- **Symbolic Computing (Mathematica):**

- Developed [\*\*spin-boson-tcl4\*\*](#): An open-source package for the symbolic derivation and implementation of 4th-order Time-Convolutionless (TCL) master equations.

### **List of presentations and participations at conferences**

1. Poster presentation on “*Ultrastrong coupling limit to quantum mean force Gibbs state for anharmonic environment*”, [\*\*Second DPG Fall Meeting: 100 Years of Quantum Physics\*\*](#), Georg-August-Universität Göttingen, Germany, 8–12 September 2025.
2. Poster presentation on “*Equivalence between the second order steady state for the spin-boson model and its quantum mean force Gibbs state*”, [\*\*“100 Years of Quantum Mechanics”\*\*](#), IISER Kolkata, India, 18–21 December 2024.
3. Poster presentation on “*Ultrastrong coupling limit to quantum mean force Gibbs state for anharmonic environment*”, [\*\*QCMC-24: International Conference on Quantum Communication, Measurement and Computing\*\*](#), IIT Madras, Chennai, India, 26–30 August 2024.

### **Research visits and seminars**

1. “*Quantum mean force Gibbs state in weak and ultra-strong coupling limits*”, Academic visit, “Department of Mathematical Physics, Nicolaus Copernicus University, Torun, Poland”, Sept 15-19,
2. Seminar on “*Equilibrium state and dynamics of an open quantum system in weak and strong coupling limits*”, Academic visit, IIT-H, May 7-9 2025.

### **Achievements**

- JEST 2019: All India Rank 75, Percentile: 98.89
- JAM 2019: All India Rank 146, Percentile: 99.06
- During BSc, won 1st prize in State level Inter-Collegiate Fest, Jyoti Nivas College, Bangalore, February 2018 for building a 20-bit programmable computer on breadboard.