

Manikandan Kondappan - Curriculum Vitae

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Areas of research:

Experimental Quantum Optics, Quantum Computing, Quantum Networking, Light-Matter Interactions, Atomic-Molecular-Optical Physics, Quantum Hardware Design, Semiconductor and Superconductor Coupled Optical Systems, & Quantum Key Distribution setups.

Kondappan's research experience:

Kondappan is a self-motivated scientist with strong attention to detail and excellent interpersonal skills. He has hands-on experience in building magneto-optical traps for cooling atomic ensembles and preparing single atoms in optical tweezers, dipole traps, and quantum key distribution setups. He has also designed and developed atom chips for quantum computation. His work includes equipment prototyping and studying light-matter interactions to develop quantum computing solutions, as well as experimental and product realizations. He is experienced in working in experimental quantum optical laboratories, designing and prototyping optical components, electronic controller units, microwave circuits, and lab automation in the pursuit of better qubit architecture and quantum hardware design. He has developed professional-level software solutions and has working knowledge of cutting-edge machine learning models, applying them to laboratory applications. He possesses in-depth knowledge of algorithmic architectures.

Education:

- ❖ *Doctorate in Physics (2018-2024):* - Experimental Quantum Physics, [New York University \(NYU\) of Shanghai and East China Normal University](#), Shanghai, China .
Dissertation Title: “*Quantum non-demolition-based entanglement of cold atoms on atom chip*”.
[Advisor: Prof. Tim Byrnes](#) | NYU Quantum Technology Lab, LPS – ECNU.
- ❖ *Master of Philosophy in Physics (2013-2014):-* Theoretical Physics
[University of Madras\(UNOM\), Quantum Studies Division-Theoretical Physics](#), Chennai, Tamil Nadu, India | Dissertation title: “*Qubit-Oscillator System: Analytical studies in ultra-strong coupling regime and Tavis-Cummings model for quasi-degenerate qubit using adiabatic approximation*”.
[Advisor: Prof. Ranabir Chakrabarti](#) | IMSc, UNOM.
- ❖ *Master of Science in Physics (2010-2012):* - Center for Non-Linear Dynamics (CNLD), [Quantum Division, Bharathidasan University \(BDU\), Tiruchirappalli](#), Tamil Nadu, India | Project Title: “*A thought experiment based on Swartz-Hora nonlinear optical experiment for wireless-quantum information processing*”. [Advisor: Prof. M Daniel](#) | CNLD, BDU.

Awards, Affiliations and Employment:

- Senior Research Assistant at RRI, India. Visiting Researcher, Max Plank Institute of Nuclear Physics, Germany. OIST, Okinawa, Japan. (July 2016– Nov 2018)
- Indo-French Research Fellow awardee at RRI, India. (Feb 2016 – June 2016)
- Researcher at Raman Research Institute (RRI), India. (Dec 2014 – Nov 2015)

Research Experience Summary:

Researcher, PhD
NYU- ECNU, Shanghai, China
Nov 2018 – June 2024

- Designed and developed 7-qubits (^{87}Rb -BEC) atom chips for quantum computation, and quantum non-demolition (QND) based entanglement measurement experiments.
- Developed magneto-optical traps for cooling atomic ensembles.
- Planned and procured and tested equipment and components, and designed experimental setups.
- Built optical components, vacuum & cryogenics, electronic controller units, microwave circuits, and magnetic coils.
- Developed cutting-edge optical circuits for generating multiple branches of detuned laser frequencies from two source beams, utilizing complex beam admixing matrices and original innovative methods. (<https://doi.org/10.1063/5.0180938>)
- Modeling and theoretical development on spin squeezing, QND & imaginary time evolution and quantum information with atomic ensembles control. (<https://doi.org/10.1103/PhysRevA.107.042616>)
- Working on basic quantum gates, circuits & quantum algorithms.

Senior Research Assistant (Indo-French Research Fellow Awardee: Feb 2016 – June 2016)
Raman Research Institute (RRI), Bangalore, India
Feb 2016 – Mar 2018

- Prepared single atoms qubits in optical tweezers and dipole traps.
- Research on quantum optics and atomic physics and light-matter interactions.
- Collaborated with international research institutes including the Max Planck Institute of Nuclear Physics, Germany, and OIST, Okinawa, Japan.
- Worked on AI-driven optical lab automation and component prototyping.
- Implemented AI-based lab automation for optical experiments.
- Post quantum encryption, Quantum Key Distribution & Networking setups. QKD's and QKDN's security issues over classical channels & air gapping.
- System administrator Unix/Linux, Professional software development & packaging.

Researcher (Visiting Student Research Program-VSP)
Raman Research Institute (RRI), Bangalore, India
Dec 2014 – Feb 2016

- Developed and tested advanced optical mounting hardware and automated processes.
- Created custom-designed systems for beam profile measurement and developed Arduino and Raspberry Pi controller units.
- Developed control software and system administration scripts using Python and shell scripting for lab automation.

Skills:

- *Languages:* Strong reading, writing and speaking competencies for English and Tamil.
- *Coding & miscellaneous:* Python, C++, Bash scripting, PyTorch, Anaconda, L^AT_EX, Mathematica, Sandboxie, Wireshark, etc.

- *Design and execution:* Autodesk Inventor Pro, SketchUp, L-Edit, LTSpice, Zemax & Lumerical
- *ML Models:* Deep Reinforcement Learning (DQN), Retrieval Autoregressive, LSTM, Transformers, Open source LLMs (Meta's LLaMA, Code Llama-Python 34B, etc.), Stable Diffusion and Google's Robotics Transformer (RT-1 & RT-2).
- *Neuroscience and cognitive science based algorithmic design for experimental labs:* Given lectures on quantum physics, Human brain functions, psychological reasoning, machine learning and deep learning & Human cognition based architectural designs for software applications and lab automation.

Select publications:

1. M. Kondappan, V. Ivannikov, and T. Byrnes. Optical circuit compactification for ultracold atoms, *Review of Scientific Instruments*, 2024, AIP Publishing, 95(1). DOI: 10.1063/5.0063586.
2. M. Kondappan, M. Chaudhary, E. O. Ilo-Okeke, V. Ivannikov, and T. Byrnes. Imaginary-time evolution with quantum nondemolition measurements: Multiqubit interactions via measurement nonlinearities, *Physical Review A*, 2023, American Physical Society, 107(4), 042616. DOI: 10.1103/PhysRevA.107.042616.
3. E. O. Ilo-Okeke, M. Kondappan, P. Chen, Y. Mao, V. Ivannikov, and T. Byrnes. Hybrid approximation approach to the generation of atomic squeezing with quantum nondemolition measurements, *Physical Review A*, 2023, American Physical Society, 107(5), 052604. DOI: 10.1103/PhysRevA.107.052604.
4. J. Kitzinger, M. Chaudhary, M. Kondappan, V. Ivannikov, and T. Byrnes. Two-axis two-spin squeezed states, *Physical Review Research*, 2020, APS, 2(3), 033504. DOI: 10.1103/PhysRevResearch.2.033504.
5. Y. Mao, M. Chaudhary, M. Kondappan, J. Shi, E. O. Ilo-Okeke, V. Ivannikov, and T. Byrnes. Measurement-based deterministic imaginary time evolution, *Physical Review Letters*, 2023, American Physical Society, 131(11), 110602. DOI: 10.1103/PhysRevLett.131.110602.
6. M. Chaudhary, Y. Mao, M. Kondappan, A. S. P. Paz, V. Ivannikov, and T. Byrnes. Stroboscopic quantum nondemolition measurements for enhanced entanglement generation between atomic ensembles, *Physical Review A*, 2022, American Physical Society, 105(2), 022443. DOI: 10.1103/PhysRevA.105.022443.
7. J. E. Aristizabal-Zuluaga, I. Skobleva, L. Richter, Y. Ji, Y. Mao, M. Kondappan, V. Ivannikov, and T. Byrnes. Quantum nondemolition measurement-based generation of entangled states in two Bose–Einstein condensates, *Journal of Physics B: Atomic, Molecular and Optical Physics*, 2021, IOP Publishing, 54(10), 105502. DOI: 10.1088/1361-6455/ac1a84.
8. S. Mandal, M. Narozniak, C. Radhakrishnan, M. Kondappan, Z. Jiao, X. Jin, and T. Byrnes. An observable based approach to evaluating quantum coherence, *AIP Conference Proceedings*, 2020, AIP Publishing, 2241(1). DOI: 10.1063/5.0063586.
9. J. E. Aristizabal Zuluaga, I. Skobleva, L. Richter, Y. Ji, Y. Mao, M. Kondappan, and V. Ivannikov. Generating two-spin squeezed states of separated Bose-Einstein condensates, 2020, Grupo de Física Atómica y Molecular.

Select posters, paper presentations & miscellaneous:

1. *Poster Presentation* - at ICQT 2019, World Trade Center-12, Krasnopresnenskaya Naberezhnaya, Moscow, 123610, Russia.
2. *Training Program in Optical Microscopy and Spectroscopy* held on July 17-20, 2016, at the Solid State and Structural Chemistry Unit, IISc, Bangalore, India.
3. *Seminar Talk Presentation* in One-dimensional Potential Well in Quantum Mechanics, Partial Wave Analysis in Nuclear and Particle Physics, Semiconductor Diodes in Physics, and Technology of Thin Films, University of Madras, 2014.
4. *Training Program in Nuclear Physics* - STPIP-2011 held from May 30, 2011, to June 19, 2011, at the University of Madras.
5. *National Symposium* - Best mechatronics design award of "N-SAP '10" held at NIT, Tiruchirappalli, on February 23, 2010.
6. *Paper Presentation* – Best paper presentation award, "Probabilities of quantum computation enabled space robotics" presented at National Symposium "ELECTROFEST'10" at M.I.E.T Arts and Science College on August 5, 2010.
7. *Paper Presentation* - "Theoretical Analysis on Quantum-Bio-Entanglement" presented at National Symposium "IETERSC2010" on September 18, 2010, at Muthayammal Engineering College, Rasipuram.
8. *Paper Presentation* - "Materials for Sensors and Actuators and Their Application" presented at "Sensors and Actuators Conference" on October 7-10, 2010, at Thiagarajar College, Madurai.

Projects:

1. Designing Quantum ML agents with DQN at NYU Shanghai.
2. Project consultant for QKD, QKDN lab setups constructions and procurements, and design of autonomous optimization and light coupling in a Single Mode Fiber's mode field diameter (MFD) with robot transformer model RT-2) at the IITM PRAVATA startup incubation, Indian Institute of Technology, Madras (IIT-M), Chennai.

Professional Affiliations:

Member, American Physical Society (APS)

References:

Available on request.