Ganga Singh Manchanda

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EDUCATION

Imperial College London *Oct 2023 - Oct 2024*
MSc Quantum Fields & Fundamental Forces, 80.52%
Graduated with Distinction
Nominated for Imperial President's Scholarship
Shortlisted for Bayforest Technologies Limited Prize

Imperial College London *Oct 2020 - Jun 2023*
BSc Physics with Theoretical Physics, First Class Honours

PUBLICATIONS

[1] G. S. Manchanda, "When energy isn't enough: Understanding structural failures in VQE", *Preparing for submission to Phys. Rev. A*.

[2] G. S. Manchanda, "A classification of gauge degrees of freedom in constrained Hamiltonians", *in progress*.

[3] J. Magueijo and G. S. Manchanda, "Quantum wormholes at spatial infinity", *Phys. Lett. B* ***864*** *139434 (2025)*.

RESEARCH EXPERIENCE

Imperial College London London, England
Postgraduate Researcher - Quantum Optics and Laser Science Group *Jun 2025 - Present*

- Independently initiated research in Quantum Computing after identifying poorly understood failure modes in the Variational Quantum Eigensolver.
- Joined QOLS to receive help formalising my results and understanding their wider implications.
- Currently preparing a manuscript for submission to *Physics Review A*.

Imperial College London London, England
Postgraduate Researcher - Abdus Salam Centre for Theoretical Physics *Oct 2024 - Mar 2025*

- Co-authored a peer-reviewed paper in *Physics Letters B* in the field of Canonical Quantum Gravity.
- Collaborated at every stage of the research process, from model building and theoretical analysis to interpretation of results, addressing key challenges along the way.
- Independently began a follow-up paper addressing key questions raised about gauge degrees of freedom.

SELECTED PROJECTS

When energy isn't enough: Understanding structural failures in VQE

- Presented a novel phenomenon where VQE can fail to reproduce key observables even when energy is successfully minimised to match theoretical expectations.
- Proposed three sources of failure in the VQE sequence: deep-local minima, non-linear error amplification, and resolution ambiguity to explain the discrepancies.
- Identified a class of Hamiltonians which are more susceptible to these errors and gave solutions to how one can avoid them during.

Quantum wormholes at spatial infinity

- Co-developed a theory of quantum wormholes which exist at spatial infinity and whose existence is enforced by unitarity in quantum gravity.

- Worked with constrained Hamiltonians to derive and solve Wheeler-DeWitt partial differential equations using a variety of theoretical techniques, numerical methods, and approximation schemes.
- Predicted corrections to the far out Newtonian potential due to attraction from across the wormhole.

Distances in Discrete Space-time

- Investigated various measures of distance in causal set space-times by analysing procedurally generated directed acyclic graphs.
- Developed algorithms to identify extremal chains under the class of metrics defined by the Minkowski distance.
- Identified phase transitions in geodesic behaviour and discussed the Lorentzian continuous structure expected to emerge under coarse-graining.

Investigations on the Barabási-Albert model

- Simulated large networks (10^6 nodes), modelling stochastic and preferential growth to study critical exponents in network structure evolution.
- Employed statistical methods including log-binning, χ^2 testing, Kolmogorov-Smirnov testing, and data collapse to validate scale-free behaviour and finite-size effects.
- Built efficient analysis tools in Python to visualise behaviour across hundreds of simulations and graph sizes.

RELATED EXPERIENCE

Meditations on Second Philosophy (Physics & Philosophy Blog) — Online
Creator \ Writer — *Jun 2025 - Present*

- Explored and communicated foundational issues in Quantum Mechanics and Gravity.
- Producing an article to contribute to the 3Blue1Brown Summer of Math Exposition.

Visely (AI EdTech Company) — (Remote) London, England
Academic Writer — *Mar 2025 - Present*

- Generated graduate-level exam questions in topics ranging from Riemannian Geometry to Quantum Information.
- Designed and refined LLM prompts to improve solution accuracy and academic rigour, ensuring high-quality content.

Tutorful — Online
Private Tutor — *Mar 2025 - Present*

- Tutored students taking A-level and undergraduate examinations in Physics and Mathematics.
- Led students to improve their grades from the ranges B/C to A/A*.

Imperial College Punjabi Society — London, England
President \ Vice-President — *Oct 2022 - Jun 2024*

- Oversaw operations and co-organized the UK's largest annual student-run dance competition (∼£50,000 budget).
- Represented Imperial on stage in our national competition (The Bhangra Showdown).

TECHNICAL SKILLS

Programming: Python (Pennylane, NumPy, SciPy, Pandas, Matplotlib, NetworkX), Git, Jupyter, LaTeX

Languages: English, Punjabi, Hindi, French, Thai

REFERENCES AVAILABLE UPON REQUEST