

Curriculum Vitae - Dr. Debasis Sadhukhan

CONTACT INFORMATION	Department of Physics, Institute of Science Banaras Hindu University, Varanasi, 221005	<i>E-mail:</i> debasis@bhu.ac.in <i>Phone:</i> (+91) 8765839618
PERSONAL INFORMATION	<i>Gender:</i> Male <i>Nationality:</i> Indian	<i>Date of Birth:</i> 1st May, 1990 <i>Marital status:</i> Married with one child
RESEARCH STATEMENT	My current research primarily lies in the intersecting fields of Quantum Computation and Quantum Simulations and can be divided in the following four categories: Near-term Quantum Technologies: Efficient Techniques to Benchmark/Certify Noisy Quantum Hardwares, Quantum Error Mitigation/Characterization, Circuit Knitting Technique to Integrate Classically Parallelized Quantum Processors Quantum Algorithms: Variational Quantum Algorithms, Adiabatic Quantum Computation, Shortcut-to-adiabaticity, Tensor-Network based Algorithms for Simulating Quantum Mechanical Systems HPC Based Quantum Simulation: Efficient Programming Models for Simulating Quantum Computers using HPC, Classical Resource Estimation of Quantum Computing, Integration of Quantum Computing with HPC Quantum Foundation: Multipartite Entanglement Measures and their Computational Complexity, Quantum Communication in a Network, Quantum Correlations Beyond Entanglement, Resources behind Quantum Advantage	
CURRENT POSITION	Assistant Professor at Department of Physics, Institute of Science Banaras Hindu University (BHU) , Varanasi, India	MAY 2024 - PRESENT
PAST WORK EXPERIENCES	Senior Researcher at Quantum Software Lab University of Edinburgh , Edinburgh, United Kingdom	NOV 2021 - MAY 2024
In this role, I co-led the Innovate UK project “<i>Quantum Computing Platform for NISQ Era Commercial Application</i>” together with Prof. Elham Kashefi from University of Edinburgh. I make extensive use of the cloud-based quantum processors and its possible HPC based simulations to identify quantum advantage in real-world problems. My engagement in several academia-industry collaborations, especially with Standard Chartered Bank, Phasecraft, Rigetti and Multiverse Computing within the Innovate UK framework, has equipped me with insights into the applicability of quantum technologies across real-world challenges from generative modelling in finance to efficient solution of combinatorial optimization problems via quantum simulation. In collaboration with Rigetti, I developed several benchmarking techniques for Rigetti’s quantum processor which not only measure the overall error rate but also can identify component wise error in the hardware that in turn make the error mitigation efficient. I have designed efficient techniques to filter-out noise from the output of quantum computers exploiting symmetry of a given problem. Since current quantum computers are noisy, how can we authenticate noisy quantum data and make sure that it is indeed coming from a quantum computer and it is not a bluff by some powerful classical computer combined with machine learning algorithm? With QuEra’s Aquila platform for neural atom based analog quantum computer, I built an analog verification protocol to authenticate non-universal analog processors. This endeavour addresses a critical aspect of quantum computing namely ensuring the reliability and authenticity of cloud-based quantum processors and their trustworthiness against malicious attacks.		

Postdoctoral Researcher at the Laboratoire d'Informatique de Paris AUG 2021 - OCT 2021
Sorbonne University, Paris, France

Before moving to Edinburgh, I spend three months at Sorbonne and was involved in the project 'Photonics Quantum Sampling Machine (PHOQUSING)'. During this short endeavour, I developed a machine learning based certification technique for lossy photonic architectures.

Research Assistant at the Institute of Theoretical Physics JUN 2018 - AUG 2021
Jagiellonian University, Krakow, Poland

My research at Krakow mostly concerned long-range complex quantum systems. I proposed a scaling hypothesis that to my knowledge is the first attempt to define correlation length in long-range systems where correlation is not exponentially decaying even away from the critical point. I generalized the framework of non-equilibrium quantum dynamics for integrable long-range systems. In the realm of adiabatic quantum computing, I demonstrated a technique to suppress error by introducing inhomogeneity in the system.

EDUCATION

Ph.D. in THEORETICAL PHYSICS AUG 2012 - MAY 2018
Harish-Chandra Research Institute (HRI), Prayagraj, India
Homi Bhabha National Institute, Mumbai, India

- Thesis Title: Effects of Disorder on Nonclassicality in Many-Body Systems
- Supervisor: Prof. Aditi Sen(De)

Master of Science in PHYSICS JUL 2010 - MAY 2012
Indian Institute of Technology Bombay (IIT Bombay), Mumbai, India

- Thesis Title: Generalization of Quantum Search Algorithm
- Supervisor: Prof. T. A. Tuli

GPA: 8.01/10.00

Bachelor of Science with Honours in PHYSICS JUN 2007 - MAY 2010
Ramakrishna Mission Vidyamandira, Belur Math, Howrah
University of Calcutta, India
69.48% - First Class Honours

AWARDS

Infosys Foundation Award for Distinction in doctoral research in Quantum Information 2017

Bhabesh Gandhi Memorial Prize for being the most outstanding of all the students who completed the requirements for the degree of Master of Science in Physics at IIT Bombay 2012

Wipro Academy of Software Excellence (**WASE**) Award 2010

Gold Medal in the **National Graduate Physics Examination** (pan India) 2010

RESEARCH GRANTS

Co-Lead of Quantum Verification Node from University of Edinburgh 2021-23
Innovate UK grant for *Quantum Computing Platform for NISQ Era Commercial Applications*
UK Research and Innovation, United Kingdom

Participant 2018-21
QuantEra grant titled *Non-equilibrium dynamics in Atomic systems for QUAntum Simulation*
National Science Centre (NCN), Poland and EU Horizon 2020

TEACHING
EXPERIENCE

1. **Instructor: Mechanics and General Properties of Matter** SEP 2024 - JAN 2025
major course, UG, 1st Semester (following NEP2020) at Banaras Hindu University, India
2. **Instructor: Quantum Mechanics - II** AUG - DEC 2024
PG, 3rd Semester at Banaras Hindu University, India
3. Short lecture series on **Multipartite Entanglement** MAR - APR 2019
advanced course for PhDs at Jagiellonian University, Poland
4. Tutor: Quantum Mechanics - I AUG - DEC 2016
PG, 1st Semester at HRI, India
5. Tutor: Research Methodology and Numerical Methods AUG - DEC 2015
PG, 3rd Semester at HRI, India

SCHOLARSHIP/
FELLOWSHIP

- | | |
|--|---------|
| Junior and Senior Research Fellowship
Department of Atomic Energy, Govt. of India | 2012-17 |
| Junior Research Fellowship (not availed)
Council of Scientific & Industrial Research, Govt. of India | 2012-14 |
| <i>Innovation for Scientific Pursuit of Inspire Research</i> (INSPIRE Scholarship)
Department of Science and Technology, Govt. of India | 2007-12 |
| <i>Merit-Cum-Means (MCM) Scholarship</i>
Indian Institute of Technology Bombay, India | 2011-12 |
| West Bengal Govt. MCM Scholarship for Higher Education
Ministry of Higher Education, Govt. of West Bengal | 2007-10 |

SCHOLASTIC
ACHIEVEMENTS

- | | |
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| <i>All India Rank 50</i> in National Eligibility Test (NET) in Physics by CSIR, India | 2013 |
| <i>All India Rank 70</i> in Joint Entrance Screening Test (JEST) for PhD in India | 2012 |
| <i>All India Rank 25</i> in Joint Admission test for Masters (JAM) to the IITs | 2010 |

PUBLICATIONS

Journal papers (19), conference proceeding (1), book (2)
The total number of **citations** is **501**, **h-index** = **10** ([Google Scholar](#), Sep 2024)
Five selected publications are marked with (*).

Journal papers (in reverse chronological order)

1. M. Mehrani, K. Masoudi, R. Mezher, E. Kashefi, **D. Sadhukhan**, *Restricted Randomized Benchmarking with Universal Gates of Fixed Sequence Length*, in communication to Phys. Rev. A, [arXiv:2405.05215 \(2024\)](#)
2. L. G. C. Lakkaraju, S. Ghosh, **D. Sadhukhan**, A. Sen(De), *Framework of dynamical transitions from long-range to short-range quantum systems*, to be published in Phys. Rev. B, [arXiv:2305.02945 \(2023\)](#)
3. James Mills, **D. Sadhukhan**, Elham Kashefi, *Simplifying errors by symmetry and randomisation*, to be published in Phys. Rev. A, [arXiv:2303.02712 \(2023\)](#)
4. L. G. C. Lakkaraju, S. Ghosh, **D. Sadhukhan**, A. Sen(De), *Mimicking quantum correlation of a long-range Hamiltonian by finite-range interactions*, *Phys. Rev. A* **106**, 052425 (2022) (*)
5. **D. Sadhukhan**, J. Dziarmaga, *Is there a correlation length in a model with long-range interactions?* to be published in Phys. Rev. B, [arXiv:2107.02508 \(2021\)](#)
6. A. Sinha, **D. Sadhukhan**, M. M. Rams, J. Dziarmaga, *Inhomogeneity induced shortcut to adiabaticity in Ising chains with long-range interactions*, *Phys. Rev. B* **102**, 214203 (2020) (*)

7. **D. Sadhukhan**, A. Sinha, A. Francuz, J. Stefaniak, M. M. Rams, J. Dziarmaga, W. H. Zurek, *Sonic horizons and causality in the phase transition dynamics*, [Phys. Rev. B **101**, 144429 \(2020\)](#) (*)
8. A. Bera, **D. Sadhukhan**, D. Rakshit, A. Sen(De), U. Sen, *Response of entanglement to annealed vis-à-vis quenched disorder in quantum spin models*, [Europhys. Lett. **127** 30003 \(2019\)](#)
9. S. Roy, T. Chanda, T. Das, **D. Sadhukhan**, A. Sen(De), U. Sen, *Phase boundaries in alternating field quantum XY model with Dzyaloshinskii-Moriya interaction: Sustainable entanglement in dynamics*, [Phys. Rev. B **99**, 064422 \(2019\)](#)
10. T. Chanda, T. Das, **D. Sadhukhan**, A. K. Pal, A. Sen(De), U. Sen, *Scale-invariant freezing of entanglement*, [Phys. Rev. A **97**, 062324 \(2018\)](#)
11. T. Chanda, T. Das, **D. Sadhukhan**, A. K. Pal, A. Sen(De), U. Sen, *Emergence of entanglement with temperature and time in factorization-surface states*, [Phys. Rev. A **97** 012316 \(2018\)](#)
12. A. Bera, T. Das, **D. Sadhukhan**, S. Singha Roy, A. Sen(De), U. Sen, *Quantum discord and its allies: a review of recent progress*, [Rep. Prog. Phys. **81** 024001 \(2018\)](#)
13. **D. Sadhukhan**, S. Singha Roy, A. K. Pal, D. Rakshit, A. Sen(De), U. Sen, *Multipartite Entanglement Accumulation in Quantum States: Localizable Generalized Geometric Measure*, [Phys. Rev. A **95** 022301 \(2017\)](#) (*)
14. T. Chanda, T. Das, **D. Sadhukhan**, A. K. Pal, A. Sen(De), U. Sen, *Static and dynamical quantum correlations in phases of an alternating field XY model*, [Phys. Rev. A **94** 042310 \(2016\)](#)
15. T. Chanda, T. Das, **D. Sadhukhan**, A. K. Pal, A. Sen(De), U. Sen, *Statistics of leading digits leads to unification of quantum correlations*, [Europhys Lett. **114**, 30004 \(2016\)](#) [Editor's choice, Highlights of 2016]
16. **D. Sadhukhan**, R. Prabhu, A. Sen(De), U. Sen, *Quantum correlations in quenched disordered spin models: Enhanced order from disorder by thermal fluctuations*, [Phys. Rev. E **93**, 032115 \(2016\)](#)
17. **D. Sadhukhan**, S. Singha Roy, D. Rakshit, R. Prabhu, A. Sen(De), U. Sen, *Quantum discord length is enhanced while entanglement length is not by introducing disorder in a spin chain*, [Phys. Rev. E **93**, 012131 \(2016\)](#) (*)
18. T. Chanda, T. Das, **D. Sadhukhan**, A. K. Pal, A. Sen(De), U. Sen, *Reducing Computational Complexity of Quantum Correlations*, [Phys. Rev. A **92**, 062301 \(2015\)](#)
19. **D. Sadhukhan**, S. Singha Roy, D. Rakshit, A. Sen(De), U. Sen, *Beating no-go theorems by engineering defects in quantum spin models*, [New J. Phys. **17**, 043013 \(2015\)](#)

Conference Proceedings

20. J. Miller, B. Yang, E. Kashefi, **D. Sadhukhan**, *Inter-qubit Correlation of Readout Noise in Near-Term Quantum Devices*, In: K. Arai, (eds) *Intelligent Computing. SAI 2024. Lecture Notes in Networks and Systems*, Springer, vol. 1019, pp. 33 (2024)

Book

21. **D. Sadhukhan**, *Effects of disorder on non-classicality in many-body systems*, [Lap Lambert Academic Publishing GmbH KG](#) (2023) [ISBN 9786206779551]
22. **D. Sadhukhan**, *Generalization of quantum search algorithm: A generalized version of Grover's search operator*, [Lap Lambert Academic Publishing GmbH KG](#) (2013) [ISBN 9783659342660]

SUPERVISORS	Project students	
	1. Mushkan Sureka (Main supervisor, co-supervisor: Elham Kashefi)	MAY-AUG 2022
	Project Title: <i>Machine Learning Based Certification of Many-Particle Interference Events</i>	
	2. Mohsen Mehrani (Main supervisor, co-supervisor: Elham Kashefi)	NOV 2021 - JUN 2022
	Project Title: <i>Cross-Platform Randomized Benchmarking with Limited Resources</i>	
ACADEMIC REVIEWER	Journals:	
	Phys. Rev. A, Phys. Rev. B, Quantum, Quantum Information Processing - Springer	
	Conferencences:	
	QIP 2023, TQC 2023	
INVITED TALKS	1. <i>Hardware-friendly assessment of errors in universal quantum computers</i>	JUN 2024
	National Symposium on Quantum Information and Many-Body Physics, HRI, Prayagraj, India	
	2. <i>Efficient Simulation of Long-Range Many-Body Systems in the NISQ Era</i>	MAR 2023
	Indian Institute of Technology Kharagpur, India	
	3. <i>Efficient Simulation of Long-Range Many-Body Systems in the NISQ Era</i>	FEB 2023
	Indian Institute of Information Technology Allahabad, India	
	4. <i>Efficient simulation of long-range quantum systems in the NISQ era</i>	DEC 2022
	Quantum Software Lab Workshop, NQCC and University of Edinburgh, UK	
	5. <i>Efficient simulation of long-range many-body systems in the NISQ era</i>	Nov 2022
	QCA Forum Meeting, University of Glasglow, UK	
	6. <i>Shortcut to adiabaticity in long-range quantum systems</i>	NOV 2021
	Sorbonne University, France	
	7. <i>Sustainable entanglement in the dynamics of ATXY model</i>	FEB 2019
	Jagiellonian University, Poland	
	8. <i>Trends of quantum correlation in many-body systems under closed and open dynamics</i>	JUL 2017
	Universidad Complutense de Madrid, Spain	
	9. <i>Quantum correlations in disordered quantum systems</i>	JUL 2017
	Karlsruhe Institute of Technology, Germany	
CONTRIBUTED TALKS	1. <i>Is there a correlation length in a model with long-range interactions?</i>	FEB 2023
	Young Quantum - 2023, HRI, India	
	2. <i>Efficient Simulation of Long-Range Many-Body Systems in the NISQ Era</i>	JAN 2023
	Progress in Quantum Science and Technologies, IIT Madras, India	
	3. <i>Statics and dynamical quantum correlations in phases of an alternating transverse field XY model</i>	FEB 2017
	Young Quantum-2017, HRI, A India	
	4. <i>Statics and dynamical correlations in inhomogeneous transverse field XY model</i>	AUG 2016
	CMSP Seminar, ICTP, Trieste, Italy	
ACADEMIC VISITS	1. Theoretical Quantum Optics Group, University of Tübingen	JUL 2017
	Delivered seminar on <i>Multipartite entanglement accumulation in quantum states</i>	
	2. QIC Group, Institute for Theoretical Physics, University of Innsbruck, Austria	JUN 2017
	Delivered seminar on <i>Freezing of entanglement in inhomogeneous quantum systems</i>	
	3. Laboratory of Solid State Physics, Université Paris-Sud, France	JUN 2017
	Delivered seminar on <i>Freezing of entanglement in alternating transverse field XY model</i>	
	4. Laboratoire de Physique, Ecole Normale Supérieure de Lyon, France	JUN 2017
	Delivered seminar on <i>Freezing of entanglement in alternating transverse field XY model</i>	

	5. Centre de Physique Théorique, Ecole Polytechnique, France Delivered seminar on <i>Freezing of entanglement in inhomogeneous many-body systems</i>	JUN 2017
	6. Quantum Optics and Statistics group, University of Freiburg, Germany Delivered seminar on <i>Quantum correlation length in disordered spin systems</i>	Jul 2017; Aug 2016
	7. Experimental Quantum Optics group, University of Siegen, Germany Delivered seminar on <i>Quantum correlations in realizable quantum systems</i>	JUL 2016
CONFERENCES (POSTER CONTRIBUTION)	1. School on algorithms in lattice gauge theory and spin systems, IACS, India 2. Time Crystals and Related Phenomena, Jagiellonian University, Poland 3. Collective Behaviour in Quantum Matter, ICTP, Trieste, Italy 4. Recent Trends in Condensed Matter Physics, Bose Institute, Kolkata, India 5. Workshop on on Fundamentals on Quantum Transport, ICTP, Trieste, Italy 6. Conference on Entanglement and Non-Equilibrium Physics of Pure and Disordered Systems, ICTP, Trieste, Italy 7. Conference on Long-Range-Interacting Many Body Systems: from Atomic to Astrophysical Scales, ICTP, Trieste, Italy 8. Meeting on Quantum Information Processing and Applications, HRI, India 9. School on Topological Quantum Matter, HRI, India 10. Discussion Meeting on Frontiers in Light-Matter Interactions, IACS, India 11. International Program on Quantum Information, IOP, India 12. Meeting on Quantum Information Processing and Applications, HRI, India	JAN 2020 SEP 2019 AUG 2018 OCT 2017 AUG 2017 JUL 2016 JUL 2016 DEC 2015 FEB 2015 DEC 2014 FEB 2014 DEC 2013
NUMERICAL SKILLS	• Numerical Tools: Matrix Product States, Tensorflow/Keras, Lanczos • Quantum Interfaces: Qiskit (IBM Quantum), pyQuil (Rigetti), Aquila/BloQade (QuEra)	
POSITION OF RESPONSIBILITY	1. Member of Organizing Committee Young Quantum - 2017, HRI, Allahabad (34 speakers, 87 participants) 2. Member of Local Organizing Committee Meeting on Quantum Information Processing and Applications, HRI Allahabad (55 speakers, 111 participants) 3. Member of Organizing Committee Young Quantum - 2015, HRI, Allahabad (26 speakers, 84 participants) 4. Member of Local Organizing Committee Meeting on Quantum Information Processing and Applications, HRI, Allahabad (61 speakers, 125 participants) 5. PG Cultural Secretary Department of Physics, IIT Bombay (all postgraduate ((MSc, MTech, PhD) Physics students)	27 FEB - 01 MAR 2017 07 - 13 DEC 2015 24 - 26 FEB 2015 02 - 08 DEC 2013 JUL 2011 - MAY 2012

REFERENCES

1. Prof. Aditi Sen(De)
Professor, Harish-Chandra Research Institute, India
E mail: aditi@hri.res.in
2. Prof. Elham Kashefi
Chief Scientist, National Quantum Computing Centre (NQCC)
Personal Chair in Quantum Computing, University of Edinburgh, UK
E mail: ekashefi@exseed.ed.ac.uk
3. Prof. Jacek Dziarmaga
Professor, Jagiellonian University, Poland
E mail: dziarmaga@th.if.uj.edu.pl