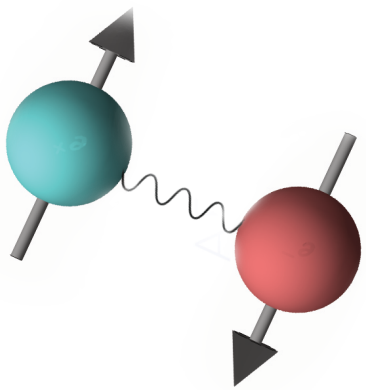
$|\Psi\rangle\langle\Psi|$

Handbook

Summer School – 2025

QUANTUM FOUNDATIONS



June 06 - 08, 2025

Biswa Bangla Convention Centre

Kolkata

Those who are not shocked when they first come across quantum theory cannot possibly have understood it.

— Niels Bohr
Nobel Laureate in Physics

Summer School – 2025

QUANTUM FOUNDATIONS

Celebrating 100 years of Quantum Mechanics

June 06 - 08, 2025

Biswa Bangla Convention Centre, Kolkata

Organized by

BHAKTIVEDANTA INSTITUTE
Kolkata
www.binstitute.org

Centre for Development of Advanced Computing (C-DAC)
Patna
www.cdac.in

Dedicated to

Dr. T. D. Singh

(His Holiness Bhaktisvarupa Damodara Swami)

(1937-2006)

Scientist and Saint

Founder Director, Bhaktivedanta Institute and

Founder President, Vedanta and Science Educational Research Foundation

सी डैक
CDAC

Dedicated to

All HUMANITY

Acknowledgements

We are thankful that by the mercy of the Supreme Lord and the blessings of our visionary, Dr. T. D. Singh, as well as the tireless efforts of dedicated team members of both C-DAC Patna and Bhaktivedanta Institute, Kolkata the 10th Summer School titled, "Quantum Foundations" have been made possible in the city of Kolkata, India. We extend our heartfelt gratitude to our Honourable Chief Guest Prof. Pankaj Joshi, Distinguished Professor & Founding Director, International Center for Space & Cosmology, Ahmedabad University; Former Senior Prof. of TIFR Mumbai and Distinguished Guests of Honour - Dr. B.D. Mundhra, Emeritus Chairman of Simplex Infrastructures Limited, Kolkata; Chairman, Bhartiya Vidya Mandir and Prof. Debi Prasad Mishra, Director, National Institute of Technical Teachers' Training and Research (NITTTR) , Kolkata and Dr. S D Sudarsan, Executive Director, CDAC Bangalore for graciously accepting our invitation and sharing their profound insights. We also acknowledge the valuable presence of esteemed special guests. We also express our deep appreciation to all the esteemed speakers for kindly accepting our invitation to share their profound wisdom.

The Summer School is a collaborative initiative jointly by the Centre for Development of Advanced Computing (C-DAC), Patna, and the Bhaktivedanta Institute, Kolkata. We extend our heartfelt gratitude to Shri Aditya Kumar Sinha, Scientist G and Director CDAC Patna, whose unwavering support and insightful guidance have been pivotal in making this collaboration possible and ensuring the success of the school. His visionary efforts to bridge science and spirituality have played a significant role in advancing Quantum Philosophy as a cutting-edge area of research. We also sincerely thank all the members of both organizations for their valuable contributions.

We extend our heartfelt thanks to Dr. Debashis Khan, Convenor of the Summer School and the entire organizing team including Dr. Roshan Tiwari, Ruthvik

Galem, Yenugu Nikhil, Jagadishwar Dasari, Sravan Velisela, Yogesh Tambe, Rajesh Pandit, Sai Vineeth, Smt. Premalatha Rajendhran, Dr. Manas Chandra Mishra, Ms Monalisa Yerrolla, Shri Avinash Kumar, Shri Jitun Dhal, Ashirbad Behera, Rahul Patel, Aniket Choudhary, Nityananda, Shri Ashini Singh, Tushar Das, Sri Sushant Sharma, Dr. Jaynarayan Tudu, Shri Ajay Sharma, Shri Sanjib Saha, Shri Dwijamani Das, Shri Nilotpal Dutta, Debjit Dey, and many more. Each of them devoted their time, effort, and enthusiasm to overseeing website design, venue logistics, registration, accommodation, hospitality, outreach, online platform management (Zoom), food service, fundraising, and other essential tasks.

We gratefully acknowledge the immense support from members and volunteers of C-DAC Patna including Dr. Kunal Abhishek, Shri Ritesh R Dhote, Cdr. Vivek Yadav (Retd), Shri Nishant Kumar Shekhar, Shri Soutik Roy, Shri Rakesh Kumar, Shri Sushil Kumar, Shri Aniket Sanjay Sinha, Ms. Sonal Priya Kamal, Shri Rejeesh A S, Shri Jai Vagwan Singh, Ms. Romi Shekhar, Shri Rohit Kumar, Shri Vishal Kumar, Shri Sumeet Kumar, Ms. Shreya Chakraborty, Shri Rahul Shaw and many more for extending their valuable time and providing immense support at various fronts especially managing the event and registration kits to distinguished guests, speakers and participants.

We thank all the participants from across the country for joining the school despite their busy schedule. We also thank the scholars for showing interest in the Young Mind Speaks competition, and sharing intriguing and novel ideas. We extend our gratitude to Presentation Review Committee members, Prof. Ramjee Repaka and Dr. Jaynarayan Tudu, for their continuous support.

Our extend heartfelt thanks to several academic institutions in Kolkata, including Jadavpur University, Calcutta University (Rajabazar Science College), S.N. Bose National Centre for Basic Sciences, Techno Main Salt Lake, Asutosh College, St. Xavier's College (Autonomous), Bethune College, Acharya Jagadish Chandra Bose

College, City College, Vidyasagar College, and Gokhale Memorial Girls' College, for their support in encouraging student participation in the Summer School.

We are equally thankful to institutions outside Kolkata such as IIT Bhubaneswar, Banaras Hindu University, Seth Anandram Jaipuria College, and others for their efforts in encouraging participants and disseminating information about the event. A special note of thanks to Dr. Amit Chatterjee (Asutosh College) and Dr. Goutam Goswami (Bethune College) for their dedicated and selfless support.

Sincere thanks to our special Sponsor Dr. B.D. Mundhra, Emeritus Chairman, Simplex Infrastructures Limited, Kolkata. We are also indebted to the kind donations for the summer school by Dr. Dheeraj Prakashchand Dube, Dr. P. R. Maiti, Dr. P. K. Singh, Dr. Ramjee Repaka and many other generous benefactors.

We also gratefully acknowledge the good wishes and prayers from friends, well-wishers, and the community of Dr. T. D. Singh's family, whose blessings have been indispensable for this school.

We extend our heartfelt gratitude to Dr. T. D. Singh (H. H. Bhaktisvarupa Damodara Swami), a visionary leader who pioneered the synthesis of science and spirituality, and the founding director of the Bhaktivedanta Institute. His invaluable guidance has been pivotal in the successful organisation of this school for the benefit of humanity.

We are also deeply indebted to Srila A. C. Bhaktivedanta Swami Prabhupada, a visionary saint and the founder acharya of the Bhaktivedanta Institute, for establishing this remarkable platform and vision.

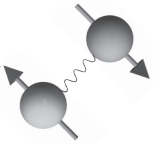
While words may fall short, our gratitude is boundless. We express our sincere thanks to everyone involved, named and unnamed, from the core of our hearts.

May positivity and goodwill flow from all directions. May happiness be with everyone.

Sarve jana sukhino bhavantu!

In the service of the Supreme Lord and your good self,

Shri K. Vasudeva Rao
President, Bhaktivedanta Institute
(Alumnus, IIT Kanpur)



Contents

Welcome Address

Respected Dignitaries on the Dais, Dear Professors, Scholars, Students, Professionals and Dear Delegates, it is a matter of great joy and privilege to welcome you all to the summer school 2025 on Quantum Foundations on behalf of the Bhaktivedanta Institute, Kolkata and Center for Development of Advanced Computing (CDAC), Patna, the joint organizers of the event. This Summer School is organized on the occasion of the 100 years of quantum physics and 50 years of the Bhaktivedanta Institute.

The journey of quantum physics is very exciting - starting from the problem of black body radiation to attempts in building quantum computers today. It is so exciting that 100 years of quantum physics appears short.

Humanity can be proud to be able to probe the reality at very micro level and be able to get information about the underlying reality using quantum physics. Scientists came up with creative experimental schemes to prove reality at quantum levels. Experimentalists developed cutting edge instruments for performing challenging experimental setups. Mathematics was applied in novel ways to model experimental results and to understand reality. Some of the experimental results were so surprising that they appeared to challenge the science itself and it took very long time to accept them. For example, entanglement of quantum particles with instantaneous effect of state of one particle on the entangled particle was too big a surprise to accept for a long time which culminated in awarding Nobel Prize to Alain Aspect and others recently for experimental demonstration of entanglement.

Werner Heisenberg's uncertainty principle states that we cannot precisely

measure position and momentum of a quantum particles. This way, quantum physics has also taught us humility in understanding the limits of our knowledge and ability to probe nature to indefinite precision. The unpredictable quantum realm with its experimental results and mathematical formalisms inspired different interpretations to make sense of the quantum phenomena.

The journey of quantum physics into the next century looks very promising and exciting with researchers around the world racing to break the quantum barriers in understanding the reality and building working quantum computers useful for real world applications by bringing together and advancing physics, mathematics and computer science. I hope the deliberations and interactions in the next three days will inspire all of us to further our engagement in this direction. Thank you for participating. We seek blessings of Dr. T. D. Singh who has shown us by his example how to be humble in our pursuits and dialogues, and blessings of many learned teachers and scholars present here and elsewhere who are our well-wishers for the success of the school.

Welcome to Summer School 2025 on Quantum Foundations.

Shri K. Vasudeva Rao
President, Bhaktivedanta Institute
(Alumnus, IIT Kanpur)

Message from Director, C-DAC, Patna

Summer School on Quantum Foundations. This is not just a program, it is opening a gateway. A gateway to a world that defies classical logic, challenges our deepest intuitions, and yet forms the very bedrock of modern science and future technologies. We live in a time where 'quantum' is no longer confined to the blackboards of theoretical physics. It is now a prefix to the future: quantum computing, quantum communication, quantum sensing. But before the excitement of application comes the reverence for foundation. Today, we return to the basics, not because we are going backward, but because the deeper we dig, the higher we build.

One may ask, why should we bother with foundations when we have practical quantum technologies to build? Here's why: Because without foundations, we have innovation without understanding. Without foundations, we risk building skyscrapers on shifting sand. Understanding the foundational questions enables us to anticipate the limits, implications, and ethical considerations of quantum technologies.

To the learners, this summer school is the launchpad. Let curiosity be your compass, and wonder your motivation. Question the equations, challenge the assumptions, and let your learning be driven not by answers, but by better questions. We must produce not only engineers of technology, but architects of understanding.

Shri Aditya Kumar Sinha
Scientist - G & Director, C-DAC, Patna

Introduction

General relativity, Quantum Mechanics, big bang cosmology, the deciphering of the genetic code, evolutionary biology, and other scientific breakthroughs are among the most significant scientific advances of the 20th century. Quantum Mechanics stands out among these due to its radically unconventional nature. Physicists were compelled by Quantum Mechanics to reassess their conceptions of reality, the fundamental essence of things, location and speed, and cause and effect. Despite being developed to explain an abstract atomic world that is very different from our everyday experiences, Quantum Mechanics has a significantly greater influence on our day-to-day existence. The Quantum Mechanics has made the amazing breakthroughs in chemistry, biology, medicine, and many other fields. Since Quantum Mechanics is the parent of the electronics revolution that gave rise to the computer age, there would be no global economy at all without it.

There was little foundation for advancement for 20 years following the introduction of quantum concepts, until a tiny group of physicists (including Max Born, Werner Heisenberg, and Erwin Schrödinger) developed Quantum Mechanics in three turbulent years. These scientists were troubled by what they were doing and, in some cases, distressed by what they had done. Not only was Quantum Mechanics extremely unsettling to its creators, but even now, some of the greatest minds in science are still puzzled with its underlying assumptions and interpretation, although acknowledging its incredible potency. Even after 100 years since the development of Quantum Mechanics, there are so many unsettled questions in its foundation. Why is the nature of measurement in Quantum Mechanics still debated? Why is there no widely accepted theory on

quantum gravity? Why are there multiple interpretations of Quantum Mechanics? While entanglement is a well-documented phenomenon, why are its implications for information transfer and the nature of reality still not fully understood? Why does the Quantum Mechanics fail to provide a satisfactory explanation for dark matter and dark energy, which together constitute about 95% of the universe? Does Quantum Mechanics indicate anything about the origin of our consciousness? These and many more foundational questions about the Quantum Mechanics and its origin are perplexing the minds of the great thinkers today. Some scientists theorize that Quantum Mechanics might hold clues to understanding consciousness. Some also say that Quantum Mechanics cannot be considered logically complete without consciousness being included as its counterpart. Some recent studies suggest that consciousness may be rooted in quantum processes within the brain.

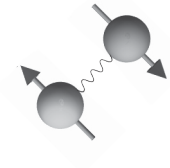
This Summer School 2025 on "Quantum Foundations" aims to delve into the above profound inquiries, offering a unique platform for interdisciplinary exploration and intellectual growth. Therefore, joining this summer school would be an exciting opportunity as it will offer to ponder over the numerous thought-provoking as well as pertinent questions as mentioned above. A number of stimulating lectures would be delivered by distinguished professors and scholars from premier institutes of the country and abroad to summarize the developments of Quantum Mechanics over these 100 years, to mention the unsettled foundational questions thereof and to show future roadmap possible for next level of developments for understanding the fundamental aspect of our nature and reality. The school would also be promising to develop priceless interactions with the researchers for an extended period of time. The school will be held in Kolkata often referred to as India's cultural and intellectual capital, has a rich history of scholarly pursuits and artistic expression. It is the

birthplace of modern Indian literary and artistic thought, and a hub for preserving Indian culture. The city's blend of Eastern and Western influences has fostered numerous organizations contributing to intellectual pursuits and cultural life, including TCG Crest, BOSE Institute, S N Bose National Centre for Basic Sciences, Indian Association for the Cultivation of Science, Indian Institute of Chemical Biology, ISI Kolkata, IISER Kolkata, C-DAC Kolkata, Bhaktivedanta Institute, and Asiatic Society of Bengal. By merging contemporary scientific knowledge with traditional Indian wisdom, the summer school seeks to offer a comprehensive and enlightening educational experience. Participants will have the opportunity to engage with leading researchers, fostering interdisciplinary collaboration and innovative thinking. This approach is especially pertinent in an era where interdisciplinary knowledge is key to breakthroughs in technology and science.

We hope the school will inspire new perspectives, stimulate intellectual curiosity, and contribute to a deeper understanding of the pivotal role of Quantum Mechanics in shaping our life. Best wishes for your journey of discovery at the Summer School 2025.

Convener
Summer School – 2025

Schedule



Day 1: June 06, 2025 (Friday)

08:00 am – 09:15 am	Registration
	Breakfast
09:15 am – 10:30 am	**Opening Ceremony & Welcome Address**
10:30 am – 11:00 am	Break
Session 1	
11:15 am - 12:00 pm	**Exploring Quantumness of Macro-objects: Motivation, The State of Play, and a Novel Proposal** Prof. Dipankar Home, *Retired Senior Scientist, Dept. of Physics, Bose Institute, Kolkata*
12:00 pm – 12:05 pm	Q & A
12:05 pm – 12:50 pm	**Physics and Consciousness** Shri Varun Agarwal, *Director, Bhaktivedanta Institute Kolkata, Alumnus, IIT Kanpur*
12:50 pm – 12:55 pm	Q & A
01:00 pm – 02:00 pm	Lunch and Break
Session 2	
02:00 pm – 02:45 pm	**AI & RI & Consciousness** Prof. Pankaj Joshi, *Distinguished Professor & Founding Director, International Center for Space & Cosmology, Ahmedabad University; Former Senior Prof. of TIFR Mumbai*

02:45 pm – 02:50 pm	Q & A
02:50 pm – 03:35 pm	Dr. S. D. Sudarsan, *Executive Director, C-DAC, Bangalore*
03:35 pm – 04:00 pm	Q & A
04:00 pm – 04:45 pm	Prof. A. K. Pati, *Director R & D, Quantum Synergy, India Former Senior Prof. TCG Crest, Kolkata & HRI, Allahabad*
04:45 pm – 04:50 pm	Q & A
04:50 pm – 05:00 pm	Break
05:00 pm – 05:30 pm	TBD
Session 3	
05:30 pm – 06:15 pm	**Prof. Anthony Leggett, *Nobel Laureate in Physics, University of Illinois, Urbana Campaign, USA (Online)***
06:15 pm – 06:30 pm	Q & A
06:30 pm – 07:15 pm	**A First-Person Approach to Quantum Paradoxes and Beyond** Dr. Markus Paul Müller, *Institute for Quantum Optics and Quantum Information, Vienna, Austria (Online)*
07:15 pm – 07:30 pm	Q & A
07:30 pm – 08:30 pm	**Cultural Program**
08:30 pm – 09:30 pm	Dinner

Day 2: June 07, 2025 (Saturday)

08:00 am – 09:00 am	Breakfast
Session 1	
09:00 am – 09:45 am	**Quantum Superposition Principle is ALL of Quantum Theory** Prof. N. D. Hari Dass, *Ex-Senior Professor, Institute of Mathematical Sciences, Chennai*
09:45 am – 09:50 am	Q & A
09:50 am – 10:35 am	**Making Sense of the Quantum and Reprogramming the Human Mind** Shri Aditya Kumar Sinha, *Scientist-G & Director, Centre for Development of Advanced Computing, Patna, India*
10:35 am – 10:40 am	Q & A
10:40 am – 10:50 am	Break
10:50 am – 11:35 am	**Do Extra Dimensions of Time Help Resolve the Puzzle of Quantum Non-Locality?** Prof. Tejinder Singh, *Professor, Tata Institute of Fundamental Research (TIFR), Mumbai*
11:35 am – 11:40 am	Q & A
11:40 am – 12:25 pm	**Why Quantum Physics calls for an Interpretation** Shri K. Vasudeva Rao, *President, Bhaktivedanta Institute, Kolkata*
12:25 pm – 12:30 pm	Q & A
12:30 pm – 12:55 pm	**Quantum Uncertainty and Information Theoretic Applications** Prof. Archan S Majumdar, *Senior Professor, SN Bose National Centre for Basic Sciences, Kolkata*

12:55 pm – 01:00 pm	Q & A
01:00 pm – 02:00 pm	Lunch and Break
Session 2	
02:00 pm – 02:45 pm	**NIST's Post-Quantum Cryptography Standardization and Quantum Readiness** Dr. Kunal Abhishek, *Scientist E and Head of the Cyber Security & Forensics Department, CDAC, Patna*
02:45 pm – 02:50 pm	Q & A
02:50 pm – 03:35 pm	**Circuit Quantum Electrodynamics Using High-Impedance Resonators and Qubits in Nanowire Quantum Dots** Dr. Deepankar Sharmah*, Basel University, Switzerland*
03:35 pm – 03:40 pm	Q & A
03:40 pm – 04:00 pm	Break
Session 3: Young Mind Speaks	
04:00 pm – 04:30 pm	**Path Integrals, Uncertainty, Entropy and Information** Arpan Dey, *Bachelor of Science (Honors) in Physics, St. Xavier's College (Autonomous), Kolkata*
	Journey of the Heisenberg Uncertainty Principle: The Known, the Knowable, and the Unknowable Yenugu Nikhil, *Ph.D. Student, Department of Chemical Sciences, IISER Kolkata*
Session 4	
04:30 pm – 05:30 pm	Panel Discussion cum Interaction Session
05:30 pm – 06:00 pm	Break

Session 5	
06:00 pm – 06:20 pm	**Niels Bohr, Life Behind the Science with a View to Connection to India** Dr. Vilhelm Bohr, *Chairman of Niels Bohr Archive, Ad. Professor University of Copenhagen, Grandson of Nobel Laureate Niels Bohr (Online)*
06:20 pm – 06:30 pm	Q & A
06:30 pm – 07:15 pm	**A Novel View on the Foundation of Quantum Mechanics** Prof. Alfred Driessen, *University of Twente, Netherlands (Online)*
07:15 pm – 07:30 pm	Q & A
07:30 pm – 08:30 pm	**Cultural Program**
08:30 pm – 09:30 pm	Dinner

Day 3: June 08, 2025 (Sunday)

08:00 am – 09:00 am	Breakfast
Session 1	
09:00 am – 09:45 am	**Toward a Modular Soliton-Polariton Quantum Supercomputer: Channel-Scaled Architecture and Invariant-Network Formalism for Quantum-Like Big-Data Analytics** Dr. Anirban Bandyopadhyay, *Principal Research Scientist, National Institute for Materials Science (NIMS), Tsukuba, Japan*
09:45 am – 09:50 am	Q & A

09:50 am – 10:35 am	**The Unthinkable Machine: On the Limits of Mechanization of Human Thought and the Quantum Possibility** Shri Nishant Kumar Shekhar, *Scientist D, Quantum Group, CDAC Patna*
10:35 am – 10:40 am	Q & A
10:40 am – 11:25 am	**Conservation of Conscious experience: A Quantum Information Approach** Dr. Roshan Tiwari, *Research Scientist, Bhaktivedanta Institute Kolkata*
11:25 am – 11:30 am	Q & A
11:30 am – 11:50 am	Break
Session 2: Young Mind Speaks	
11.50 am – 01:30 pm	**Energy Eigenvalues of Confined Hydrogen Atom within Penetrable and Impenetrable Spherical Box using Finite Element Method** Binoy Kumar Mahato, *Ph.D. student, Department of Physics, Institute of Science, BHU Varanasi*
	Quantum Mechanics and Consciousness Debansu Adhikary, *AJC Bose College, Kolkata*
	Simulating Early-Universe Baryogenesis via Quantum Circuits: A New Approach to Matter-Antimatter Asymmetry Mukul Kumar, *Indian Institute of Technology, Jodhpur*
	The Quantum Revolution: A Historical Perspective Yogesh Tambe, *B. Tech, Mechanical Engg., IIT Bhubaneswar*
	Bell's Theorem: Foundations, Derivation, and Implications for Quantum Mechanics Ruthvik Galem, *Bhaktivedanta Institute, Kolkata (Alumnus IIT Bhubaneswar)*

01:30 pm – 02:30 pm	Lunch and Break
02:30 pm – 03:30 pm	**Valedictory Session**
04:00 pm – 08:00 pm	**Summer School Tour and Quantum Games**
08:00 pm – 09:00 pm	Dinner

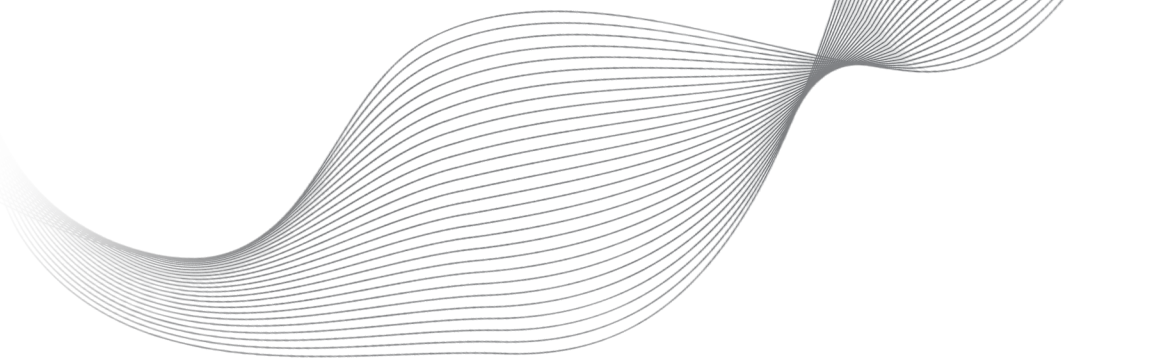
100 YEARS
OF QUANTUM MECHANICS

1925: MATRIX MECHANICS - Werner Heisenberg, Max Born and Jordan Pascual develop the first conceptually autonomous and logically consistent formulation of quantum mechanics.

1926: WAVE MECHANICS - Erwin Schrödinger's wave equation describes the behavior of particles as wave functions, giving rise to the concept of wave-particle duality.

1927: UNCERTAINTY PRINCIPLE - Werner Heisenberg states that certain pairs of physical properties, like position and momentum, cannot be precisely measured simultaneously.

1927: DIRAC EQUATION - Paul Dirac presents a relativistic theory of the electron that predicts the existence of antimatter.



1932: THE NEUTRON - James Chadwick discovers a subatomic particle with no net electrical charge.

1935: EPR PARADOX - Albert Einstein, Boris Podolsky and Nathan Rosen argue that quantum mechanics is not a complete description of physical reality.

1936: QUANTUM LOGIC - Garrett Birkhoff and John von Neumann attempt to reconcile the apparent inconsistency of classical, Boolean logic with Heisenberg's uncertainty principle.

1948: QUANTUM ELECTRODYNAMICS - Richard Feynman states the path integral formulation of quantum mechanics.

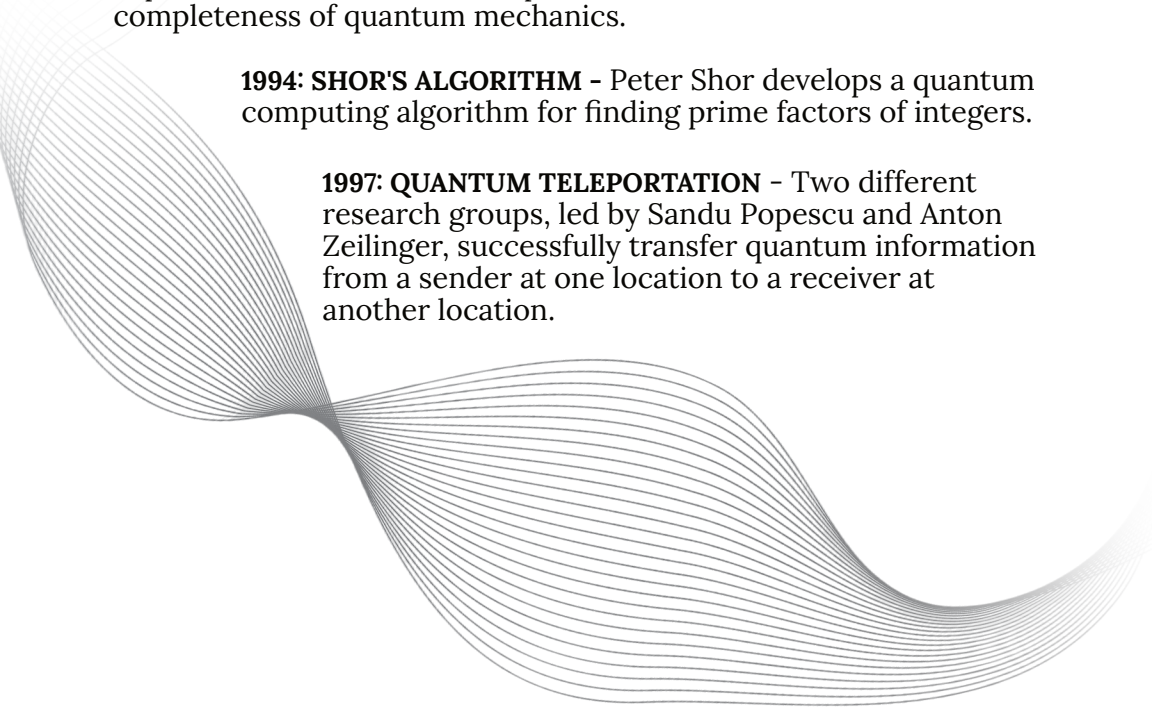
1964: BELL'S INEQUALITIES - John Bell proposes a method to test whether quantum mechanics provides the most complete description of a system.

1980: QUANTUM COMPUTING - Paul Benioff proposes using the principles of quantum mechanics to perform computations exponentially faster than classical computers.

1982: QUANTUM ENTANGLEMENT - Alain Aspect performs an experimental test of Bell's inequalities and confirms the completeness of quantum mechanics.

1994: SHOR'S ALGORITHM - Peter Shor develops a quantum computing algorithm for finding prime factors of integers.

1997: QUANTUM TELEPORTATION - Two different research groups, led by Sandu Popescu and Anton Zeilinger, successfully transfer quantum information from a sender at one location to a receiver at another location.



2001: QUBIT TEST - Researchers at IBM implement Shor's algorithm on a quantum computer with seven qubits.

2022: Quantum Entanglement Gets Awarded. Alain Aspect, John F. Clauser and Anton Zeilinger receive 2022 Nobel Prize in Physics for experiments with entangled photons, establishing the violation of Bell inequalities and pioneering quantum information science.

2025: International Year of Quantum Science and Technology.

Abstracts & Bio-datas of Speakers

Day 1

Session 1

1.1. Exploring Quantumness of Macro-Objects: Motivation, The State of Play, and a Novel Proposal

Prof. Dipankar Home, *Retired Senior Scientist, Dept. of Physics, Bose Institute, Kolkata*

The Quantum Measurement Problem and the question of precisely specifying the boundary between the quantum mechanical micro-world and the macroscopic world of everyday objects behaving classically continue to be one of the most fundamental open questions in contemporary physics. In this respect, a cutting- edge research enterprise is to empirically probe the limits of validity of the quantum mechanical superposition of states for macro-objects. In recent years, such studies have been acquiring increasing significance. This is particularly because of the ongoing efforts to provide empirical constraints on the suggested models for wave function collapse, implying dynamical modifications of QM for massive objects, proposed for addressing the quantum measurement problem, as well as owing to the recent proposals for laboratory-based tests of the quantum nature of gravity by exploiting the quantumness of massive objects. However, the state-of-the art demonstrations of quantum features have so far reached only up to macromolecules of masses ten to hundred thousand times the hydrogen atom. Hence, fresh ideas, feasible to be implemented experimentally in the near future, are called for in order to scale up the tests of macroscopic quantumness to ever more massive objects. It is precisely for addressing the above mentioned need that after reviewing the above backdrop, I shall discuss in my present talk our latest work [Physical review Letters 132, 030202 (2024)] formulating a novel procedure for demonstrating the quantum behaviour of an oscillating

object having any large mass. The key ingredients of this proposed scheme are the observable temporal correlators occurring in a suitable temporal analogue of Bell-type inequality, known as the Leggett-Garg inequality (LGI), whose empirical violation, compatible with the quantum mechanical prediction, is argued to provide a fundamental signature of irreducible quantumness of a single time-evolving particle, alongside demonstrating violation of the notion of macrorealism (viz. the everyday notion of reality entailing definite values assigned to the properties of macro-objects, even when not measured). By devising an appropriate strategy for invoking LGI using suitably designed measurements in the context of a massive harmonic oscillator, our suggested protocol would enable observing the magnitude of violation of LGI to be significant and, in particular, remarkably the same for any mass, dependent only on the choice of instants of the measurements. The flexibility herein for choosing the relevant experimental parameters would thus greatly facilitate scaling up such a test of macro- quantumness to ever more massive objects. Given the current state of technology, this type of scheme could be empirically implementable, ranging from optically levitated nano-oscillators about trillion times heavier than hydrogen atom to oscillating mirrors of 10 kg mass used in gravitational wave detection.

Finally, the far-reaching conceptual implications of the results of such envisaged experiments constraining macrorealist or dynamical theories of wave function collapse will be discussed, alongside the possibility of leveraging such demonstrated macroscopic quantumness for practical applications, say, towards developing high precision quantum sensors.

Prof. Dipankar Home is Retired Senior Scientist of Physics at the Bose Institute in Kolkata. His extensive work primarily revolves around the fundamental aspects of quantum mechanics, including quantum entanglement and quantum communication. He received his B.Sc. with Honors in Physics from Presidency College, Kolkata, followed by an M.Sc. in Physics from the University of Calcutta. He then earned his Ph.D. in Physics from the University of Calcutta.

His research interests encompass a broad range of foundational issues in quantum mechanics: Quantum Measurement Problem, Quantum

Nonlocality, Macroscopic Limits of Quantum Mechanics, Time in Quantum Mechanics, Quantum Zeno Effect, Nonstandard interpretations of quantum mechanics and their empirical discrimination, Experimental realization of quantum mechanical principles using interferometry and quantum optical methods, Quantum Information Transfer and Processing, including Quantum Cryptography and Quantum Teleportation, Applications of Quantum Entanglement in cosmology and black hole thermodynamics. He is one of the pioneering Indian researchers in the field of quantum mechanics, contributing significantly to the establishment and growth of quantum information science. His notable achievements include: Formulating ideas that utilize quantum indistinguishability for efficient entanglement production, Proposing innovative experiments to empirically verify quantum contextuality and the Quantum Zeno Effect, Contributing to foundational studies linking quantum mechanics with realizable experiments.

He has received numerous prestigious awards and honors for his significant contributions including Fellow of The National Academy of Sciences, India (2011), Jawaharlal Nehru Fellowship (2002), B. M. Birla Science Prize (1995), Associate Membership of the International Centre for Theoretical Physics, Trieste, Italy (1995), Homi Bhabha Fellowship (1993), Associateship of the Indian Academy of Sciences (1987) and Indian National Science Academy (INSA) Medal for Young Scientists (1986). He has authored and co-authored several influential books and numerous peer-reviewed articles. Some of his major publications include: Conceptual Foundations of Quantum Physics: An Overview from Modern Perspectives; Einstein's Struggles with Quantum Theory: A Reappraisal - co-authored with Andrew Whitaker; Riddles in Your Teacup: 100 Science Puzzles from Everyday Life - co-authored with Partha Ghose. He has over 100 publications in international journals.

1.2. Physics and Consciousness

Shri Varun Agarwal, *Director, Bhaktivedanta Institute Kolkata (Alumnus, IIT Kanpur)*

Consciousness is a major mystery today. In every discipline of science, from Physics and Mathematics to Biology and Artificial Intelligence, it is an

unsolved riddle. The questions raised by the founders of quantum physics about consciousness a century ago, are still perplexing us today. What is consciousness really? Can a combination of molecules generate somehow self-awareness? Or consciousness is a fundamentally different reality altogether? Can robots be ever self-aware? The present lecture will attempt to give an interesting overview of how the wonderful developments in modern science in the last century brought to limelight the mystery of consciousness, and share profound thoughts of founders of science and mathematics including Erwin Schrṭdinger, Werner Heisenberg, Max Planck, Max Born, von Neumann, Wolfgang Pauli, Eugene Wigner, Hermann Weyl, Kurt Gṭdel, and many others. The lecture will also attempt to provide hints from ancient Indian Vedantic wisdom about the root cause of these issues being faced regarding consciousness and the need and possible ways of broadening our worldview to handle the mystery of consciousness.

Varun Agarwal (also known as His Holiness Bhaktisvarupa Vrajendrakumar Swami) graduated from the prestigious Indian Institute of Technology Kanpur (IIT Kanpur), India obtaining his B.Tech in Aerospace Engineering (1999). He worked on a project of solar-powered aircraft and was ranked first in his entire department. However, his longing for something deeper about life which always bothered him finally culminated in meeting the illustrious scientist-saint Dr. T. D. Singh (His Holiness Bhaktisvarupa Damodara Swami), the Founder Director of the Bhaktivedanta Institute.

Under his guidance, he began studying ancient Vedantic wisdom, dedicating himself completely for the cause of helping humanity through the interface of scientific temper and spiritual wisdom. He is currently serving as the Director of the Bhaktivedanta Institute, Kolkata, India. Besides his various involvements, he frequently travels across India & abroad and interacts with scientists and scholars all over the world including world-renowned universities of Harvard, Princeton, ETH and Stanford to MIT. He is also the Editor of Bhaktivedanta Institute's reputed science and spirituality journal, Savijnanam.

Session 2

2.1. AI & RI & Consciousness

Prof. Pankaj Joshi, *Distinguished Professor & Founding Director, International Center for Space & Cosmology, Ahmedabad University; Former Senior Prof. of TIFR Mumbai*

Science helps us extend the limits of our five senses. If we want to look into the distant skies and see the stars and galaxies, today man has made large and magnificent telescopes, and similarly, communication has been extended over the globe thousands of miles away in a moment.

While these tools help our gross organs of action, the new development of Artificial Intelligence (AI) goes even further in that it expands the boundaries of our mind and intellect to an unprecedented extent. How does it do this? Subtle mathematics, quantum theory, and computers are involved here. In the early 20th century, Einstein, Planck and others discovered quantum science, which plays a fundamental role in today's development of modern AI. Through it, very large data or information can be analyzed in a very short time, which humans may never be able to achieve.

From such a perspective, it is worth noting that earlier, scientists did not think carefully about the question that when we consider AI, what in fact the `Intelligence' or `Real Intelligence (RI)' is? This question is now being asked in big centers of learning in the world, like Oxford, Cambridge, Harvard and others. This has led to the next question, namely, what is that we may term as `Consciousness', that lies at the base of even this intelligence or RI?

These issues such as, what is intelligence, mind, what is conscience, have been thought and explored very deeply in many of the ancient Indian traditions. Our mind, intelligence and conscience could be termed as `Real Intelligence' or RI. When the conscience works to think, understand, and shed light on new questions, it is also called 'Chitta', as the traditions would say.

An important point here is, along with research on AI, scientists have now naturally started thinking on these basic and fundamental questions. This may help draw the interest of scientists and scholars the world over to possible insights that may be gathered from ancient Indian traditions. Careful thinking on these issues may lead towards integration of spirituality and science.

Dr Pankaj Joshi, an internationally acclaimed scientist and astrophysicist, is currently Distinguished Professor of Physics and Founding Director of the International Center for Space and Cosmology at the Ahmedabad University. He was earlier Senior Professor at the Tata Institute of Fundamental Research, Mumbai, and Vice-Chancellor, Charusat University. More popularly, he is known as a Scholar, Physicist, and an expert on Cosmology. Joshi's research interests are Gravitation, Astrophysics, and Quantum Theory. He has made fundamental contributions to Blackhole Physics and Cosmology with his extensive analysis of final fate of massive collapsing stars in the universe. This work, widely recognised for providing significant insights, led to the discovery that massive stars end up in powerfully exploding fireballs, also called naked singularities. His research is reported in more than 300 research papers in International Journals of repute, and books and monographs from OUP (Oxford), CUP (Cambridge), and others.

The world-renowned Scientific American magazine published his work as their International cover story (2009), translated in more than 20 languages, also included in their Special Collector's Editions (2013, 2017, 2022). The Stanford University, USA, has placed him in their World Top 2% Scientists list for past five years (2020-24) for career achievement and contributions. The Indian Science Monitor placed him in the list of Top 10 Scientists of Indian origin, from India and Internationally. Joshi has been a Visiting Professor or Adjunct in several countries, doing research and Lectures, including Cambridge (UK), Harvard, New York University (NYU), U of Pittsburgh, U of Southampton, Osaka City U, U of Basque Country (Spain), U of Natal (SA), Queen Mary and Westfield College, London, among others. He has won several prestigious awards and coveted prizes and fellowships to scientific academies, which include Gravity Research Foundation (USA)

award, Prof A C Banerji Gold Medal and Memorial Lecture Award (National Academy of Sciences), C V Raman lecture Award by the Department of Atomic Energy, the reputed Vainu Bappu International Award (INSA), Shankar Fellowship Award (Govt of MP), among others. He is an elected Fellow of The World Academy of Sciences (TWAS, Europe), the Indian National Science Academy (INSA, New Delhi), National Academy of Sciences, India; and has been President of the Indian Association of General Relativity & Gravitation (IAGRG; 2010-12) and Gujarat Science Academy (GSA; 2020-23), with many other such distinctions. Joshi has contributed more than 350 popular articles and 25 books towards science popularisation, and has given a large number of public talks and TV shows. He has a deep interest in comparing ancient spiritual traditions and the findings of modern science.

2.2. Dr. S D Sudarsan, *Executive Director, C-DAC, Bangalore*

Dr. Sithu D Sudarsan has over 3 decades of R&D experience in India as well as the United States and a wide expertise in various technology domains. His areas of interest include Semantic mining/BIG Data, HPC, Cyber Security, IPR, Technology Management, Strategic Management and emerging technologies. Dr. Sudarsan is currently heading C-DAC Bangalore as Executive Director, where he is overseeing the development of Quantum Technologies, Chip-2-Startup program, EDA Toolgrid etc. among other technologies. Prior to his position at C-DAC Bangalore, Dr. Sudarsan was associated with ABB Corporate Research; The United States Food and Drug Administration (US FDA); Central Research Laboratory (Bharat Electronics Limited (CRL-BEL); ERDCI; CEDTI.

Dr. Sudarsan has been honoured with prestigious awards like FDA's Outstanding Service Award, FDA's Group Recognition Award. During his PhD at UALR, US he had received the Outstanding PhD Graduate Student Award, Academic Achievement Award & Professional Service Award. He has been a Featured Reviewer at "reviews.com" (2010) and he has also been mentoring Graduate and Doctoral students.

Dr. Sudarsan completed his Ph.D. from University of Arkansas at Little Rock (UALR) USA and is a Fellow IETE and Senior Member IEEE. He has

to his credit more than 100 technical papers and 8 patents (3 granted). He is actively involved in professional activities including organizing conferences.

2.3. Prof. A. K. Pati, Director, R & D, Quantum Synergy, India; Former Senior Prof. TCG Crest, Kolkata & HRI, Allahabad

Prof. Arun Kumar Pati is currently the Director (R & D) at Quantum Synergy, India and also a Former Senior Professor at Center for Quantum Engineering Research and Education (CQuERE), TCG CREST, Kolkata and an adjunct professor at IISER, Mohali. He is a Professor and Head of the Center for Quantum Science and Technology (CQST), at IIIT, Hyderabad and also Director of Quantum Ecosystem and Technology Council of India (QETCI), Hyderabad. Formerly, he was a professor of quantum information at the Harish Chandra Research Institute, Allahabad, India from January 2011 to December 2023 and scientist at BARC and Institute of Physics from 1989 to 2010. His research areas include all aspects of quantum information and quantum computation, the theory of geometric phases and its applications, and the foundations of quantum mechanics. Among his important discoveries are the No-Deletion theorem, Geometric Phases for mixed state, Remote State Preparation protocol, the No-Hiding Theorem and the Stronger Uncertainty Relations in quantum mechanics. He has more than 150 research papers in international journals and conferences on these topics. He has edited two books: (i) Quantum Information with Continuous Variables and (ii) Quantum Aspects of Life. His research papers have been highlighted in NATURE, NATURE ASIA, SCIENCE, and many national and international newspapers. He is Fellow of the Indian Academy of Science, Bangalore and National Academy of Science, Allahabad. He was Recipient of the Indian Physical Society Award for Young Physicist and awarded J C Bose National Fellowship from Department of Science and Technology, India.

Session 3

3.1. Prof. Anthony Leggett, Nobel Laureate in Physics, University of Illinois, Urbana-Campaign, USA

Prof. Anthony J. Leggett is a Nobel Laureate in Physics (2003) and an internationally acclaimed theoretical physicist widely recognized for his profound contributions to the field of condensed matter physics. He currently holds the John D. and Catherine T. MacArthur Chair at the University of Illinois Urbana-Champaign (UIUC), where he has been a central figure in advancing the theoretical framework of quantum mechanics as it applies to complex many-body systems.

Born in London in 1938, Prof. Leggett was educated at Oxford University, where he earned his D.Phil. in physics. His groundbreaking theoretical work on superfluidity in helium-3 revolutionized the understanding of quantum liquids and earned him the Nobel Prize in Physics, shared with V. L. Ginzburg and A. A. Abrikosov, for pioneering contributions to the theory of superconductors and superfluids. His research not only elucidated the behavior of helium-3 at ultra-low temperatures but also paved the way for exploring macroscopic quantum phenomena and the quantum-to-classical transition. Beyond his seminal work on superfluidity, Prof. Leggett has made influential contributions to the theory of superconductivity, the study of Bose-Einstein condensates, and the foundational questions of quantum mechanics. His efforts to bridge the gap between the philosophical and technical aspects of quantum theory have led to critical insights into decoherence, measurement, and the limits of quantum mechanics.

Prof. Leggett has authored numerous high-impact publications and delivered invited lectures across the globe. In recognition of his extraordinary scientific achievements, he has received a wide array of international honors, including his knighthood by Queen Elizabeth II in 2004 for services to physics. He is a Fellow of the American Physical Society, the American Academy of Arts and Sciences, and a foreign member of the

Russian Academy of Sciences. Known for his clear and insightful communication of complex ideas, Prof. Leggett remains a prominent voice in contemporary physics, influencing both theoretical research and philosophical discourse on quantum science. His legacy continues to shape the trajectory of quantum physics and inspire new generations of scientists.

3.2. A First-Person Approach to Quantum Paradoxes and Beyond

Dr. Markus Paul Müller, *Institute for Quantum Optics and Quantum Information, Vienna, Austria*

Quantum theory is one of our most successful physical theories, but its textbook formulation is mysterious: why do we have complex state vectors, unitary time evolution or the Born rule? In the first part of my talk, I show how quantum theory can be reconstructed, completely and rigorously, from simple information-theoretic principles, formulated without any of the usual mathematical machinery of QM. This is the result of a research program that has kept several colleagues and myself busy for many years, and which was successfully completed around 2011. It shows that the interpretation of the quantum state as a "catalog of probabilities" is powerful enough to explain the mathematical structure of quantum theory exactly.

In the second part of my talk, I argue that this is but one piece of puzzle in a larger series of arguments which point at the relevance of the first person in physics: rather than studying "what is (supposedly) the case in the world?", we should ask "what should I expect to observe next?". I argue that the difficulty of answering this question from the usual "external" third-person perspective is at the heart of several important enigmas beyond quantum theory, such as the Boltzmann brain problem, Parfit's teletransportation paradox, or our understanding of the simulation hypothesis. I argue that this motivates a particular first-person approach to physics, Algorithmic Idealism, which aims at addressing those puzzles — quantum or not — in a unified way.

Markus Mūller is a theoretical physicist and research group leader at the Austrian Academy of Science's Institute for Quantum Optics and Quantum Information in Vienna. After studies of physics and mathematics, he obtained his PhD in 2007 in Berlin and moved on to a postdoctoral position at the Perimeter Institute for Theoretical Physics in Canada. Before moving to Vienna in 2017, he has been a junior group leader at Heidelberg University, and an Assistant Professor and holder of a Canada Research Chair in the Foundations of Physics at the University of Western Ontario. Mūller dislikes speaking about himself in the third person, and prefers first-person approaches.

Day 2

Session 1

1.1. Quantum Superposition Principle is ALL of Quantum Theory

Prof. N. D. Hari Dass, *Ex-Senior Professor, Institute of Mathematical Sciences, Chennai*

It is argued that the Principle of Superposition of States, shortened to Quantum Superposition Principle (QSP), is not just an important pillar of Quantum Theory, but is ALL of Quantum Theory. It can in fact be taken as the very definition of what a quantum theory is. It is radically different from other superposition principles in physics. This dramatic difference is brought forth with a few illuminating examples. It is then demonstrated that the very essences of quantum theory like Bohr's complementarity, non-commutativity of observables, the uncertainty principle, the probability interpretation, quantum entanglement etc. are all consequences of QSP. It's central role in quantum measurements is also high- lighted. Despite its foundational nature, the genesis of this principle in the development of quantum theory is not very clearly delineated. This is in stark contrast to other deep principles in physics like special relativity, the equivalence principle of general relativity etc. To address this, a careful analysis is provided of the evolution of the nature of the quantum states right from Bohr's atomic theory to the completion of quantum theory. Brief remarks

are presented on whether this principle is forever (very unlikely), and on some implications of its breakdown.

Prof. N. D. Hari Dass is currently residing in Mysore after his Visiting Professorship at TIFR, Hyderabad. He started his career by matriculating from Mahajana High School, Mysore, and Pre-University from Yuvaraja's College in Mysore. He obtained both his BSc(Hons) and MSc in Physics from Delhi University, and his Ph.D. in Theoretical Physics from the University of California at Santa Barbara. After that he worked at University of California at Los Angeles, Max Planck Inst. for Physics at Munich, Niels Bohr Inst. at Copenhagen, Raman Research Inst. at Bangalore, and National Inst. for High Energy Physics in Amsterdam before joining the Institute of Mathematical Sciences in Chennai.

He retired from there as a Senior Professor and became the DAE Raja Ramanna Professor at IISc, Bangalore, and also the Director of the Poornaprajna Institute (PPISR) in Bangalore. After that he was the Adjunct Professor at Chennai Mathematical Inst. He is a fellow of the National Academy of Sciences, Allahabad. His current research interests are in high energy physics, astrophysics, and foundations of quantum mechanics. He has over 120 research publications. He is passionate about teaching in general and in raising awareness about science. In 2004 he built India's fastest supercomputer in academia, KABRU, which was among the top 500 supercomputers in the world. He has authored the book 'The Essentials of Thermodynamics' (SRI Publishers, Singapore). His second book 'From Strings to Strings' on strong interactions has just been released by Springer as a Lecture Notes in Physics.

1.2. Making Sense of the Quantum and Reprogramming the Human Mind

Shri Aditya Kumar Sinha, *Scientist-G & Director, Centre for Development ofAdvanced Computing, Patna, India*

With an extensive career spanning three decades, Aditya Kumar Sinha has consistently demonstrated progressive and impactful leadership in a variety of esteemed institutions, including National Research Labs, premier

National Institutes, and leading IT organizations. His multifaceted roles throughout his distinguished professional journey have significantly contributed to advancing research, technology, education, global recognition, market presence, branding, revenue growth, performance enhancement, and quality standards. Operating both at a national level and across thirty-five countries worldwide, Aditya has skillfully managed a multisite, multifunctional team overseeing the development and maintenance of eight diverse portfolios, which encompass:

- Research & Development: Spearheading advancements in areas such as High Performance Computing, AI, IoT, Cyber Security, and Quantum Computing, Digital Twin etc.
- Strategic Technology Development: Crafting technological solutions to address strategic objectives.
- International Collaborations and Development: Cultivating global partnerships to drive innovation.
- Mentoring Education & Training and advanced ICT technologies.
- Education Technology Product Development: Innovating in the realm of education technology.
- Capacity Building and Skill Development: Nurturing talent through skill-building initiatives.
- Quality Management: Ensuring high standards across endeavours.

Presently, Mr. Sinha holds the position of Scientist 'G' and Director at one of the R&D Units (Patna) within the Centre for Development of Advanced Computing (C-DAC), a prestigious scientific society operating under the Ministry of Electronics and Information Technology. His experience extends to collaborating with various ministries, including External Affairs, Defence, Education, Home Affairs, Minority, and Social Justice, along with numerous state governments. Mr. Sinha's academic credentials include a degree from Jadavpur University, Kolkata, a Masters in Computer Science from MNNIT Allahabad, and participation in certificate programs at esteemed institutions such as IIM Ahmedabad, IIT Kharagpur, and others, covering a diverse range of domains. Aditya Kumar Sinha's dedication to pushing the boundaries of knowledge and innovation is evident in his substantial contributions to multiple spheres of technology, research, and education.

1.3. Do Extra Dimensions of Time Help Resolve the Puzzle of Quantum Non-Locality?

Prof. Tejinder Singh, *Ex-Professor*, *Tata Institute of Fundamental Research (TIFR), Mumbai & Visiting Professor at the Inter-University Centre for Astronomy and Astrophysics (IUCAA)*

Consider a quantum particle emitted from a source, such that the associated wave function spreads as a spherical wave front. Assume that at a large distance from the source there is a spherical shell of a very large number of detectors. When the wave front arrives at the shell of detectors, one and only one (randomly selected) detector clicks, and the wave function is said to have collapsed to the location of that detector. At the instant of collapse, the wave function becomes zero at the location of every other detector. This vanishing of the wave function happens even before any signal (traveling at the speed of light) from the location of the clicked detector can arrive at the other detectors. How does such an influence take place, in apparent violation of the principles of special relativity? This is the puzzle of quantum non-locality. The puzzle can also be highlighted by considering a pair of correlated and entangled quantum particles emitted by a source, and traveling in opposite directions, to be received by two independent detectors (Alice, and Bob) far away from each other. The measurement on the state of one particle instantly causes the state of the other particle to collapse. This ability of one particle to influence the other particle is in violation of the relativistic principle of causality [`an event B can be influenced by event A only if B occurs after a light signal traveling from A has arrived at B']. This is known as the Einstein-Podolsky-Rosen (EPR) paradox or, equivalently, the quantum non-locality puzzle.

Independently of the EPR paradox, we ask the following question: why does the universe have only one dimension of time, whereas it has three dimensions of space? Could it be that there are in fact three dimensions of time as well, and the two additional dimensions of time are compact and too tiny (in their time-radius) and hence have escaped detection so far? Our ongoing research on unification of forces suggests this to be the case, and hence that our `quantum' universe has six space-time dimensions. It is only the classical universe which appears to have four space-time dimensions.

The four classical dimensions are curved by gravitation (according to the laws of the general theory of relativity), whereas the two additional time-like dimensions are curved by the weak force (according to the laws of the electro-weak theory). The electroweak symmetry breaking in the very early universe bifurcates the 6D space-time into two overlapping copies of 4D space-times: one is ours, with three spatial and one time-like dimension. The other 4D space-time has three time-like and one spatial dimension; and the two 4D space-times have one space and one time dimension in common.

The presence of the other 4D space-time provides a novel causal channel for influence to travel from Alice to Bob. This channel, which we may call a `quantum wormhole', offers a resolution of the EPR paradox, without having to modify the rules of quantum mechanics or of special relativity. space-time distances between Alice and Bob, through this other 4D space-time, are far, far smaller than through our space-time. A causal signal traveling from Alice, through the quantum wormhole, arrives at Bob almost instantaneously, in comparison to the corresponding signal traveling through our 4D space-time. Quantum locality is hence restored in the 6D space-time, and the apparent quantum nonlocality in our 4D space-time is only an illusion, caused by our lack of knowledge of the additional time-like dimensions. Bell's inequalities continue to be violated: the reason for their violation is indeterminism. Local hidden variable theories continue to be ruled out, but local indeterministic theories are allowed. This kind of a resolution of the EPR paradox does not work if the additional dimensions are spacelike. The quantum particle mediating the signal through the other 4D space-time is the so-called massless dark photon predicted by our unification theory; this particle couples to the square-root of mass and should be sought for in laboratory experiments.

References:

1. Time-like extra dimensions: non-locality, spin, and Tsirelson bound, Mohammad Furquan, Tejinder P. Singh and P Samuel Wesley, Universe 11, 137 (2025) https://doi.org/10.3390/universe11050137
2. Does our universe have more than one dimension of time? Tejinder P. Singh, https://www.preprints.org/manuscript/202505.1074/v1
3. Gravi-weak unification in a six-dimensional space-time with signature (3,3), T.Asselmeyer-Maluga, F. Finster, N. Gresnigt, J. Isidro, A. Marciano, C. Paganini, T.P. Singh and P Samuel Wesley, in preparation (2025).

Bio: Prof. Tejinder Pal Singh is a distinguished theoretical physicist renowned for his contributions to the fields of quantum gravity, foundational questions in quantum mechanics, and cosmology. He served as Professor at the Tata Institute of Fundamental Research (TIFR), Mumbai, until his retirement in 2022 and is currently a Visiting Professor at the Inter-University Centre for Astronomy and Astrophysics (IUCAA), Pune. Over nearly four decades of academic engagement, Prof. Singh has significantly advanced our understanding of quantum measurement, gravitational collapse, and the unification of fundamental forces. His work is particularly recognized for exploring the interface between quantum theory and general relativity through novel frameworks such as trace dynamics and spontaneous localization.

Prof. Singh's scholarly impact is evidenced by over 130 research publications, numerous invited talks at prestigious international conferences, and repeated accolades from the Gravity Research Foundation and Foundational Questions Institute. His interdisciplinary research spans octonionic unification models, quantum-classical dualities, and emergent space-time, earning him global recognition. He has also played a vital role in organizing major scientific conferences and delivering public lectures that communicate deep physics in an accessible manner. Prof. Singh's efforts have made him a leading figure in the quest for a unified theory that bridges quantum mechanics with the structure of space-time.

1.4. Why Quantum Physics calls for an Interpretation

Shri K. Vasudeva Rao, *President, Bhaktivedanta Institute, Kolkata; Alumnus, IIT Kanpur*

An interpretation of a scientific theory is necessary when there is a gap between the mathematical formalism used by the theory and the reality it aims to describe; and when there is translational gap between macrolevel experience and the constituent microlevel processes that the theory describes; and when there are multiple formalisms that give different pictures of the microscopic reality but give identical macroscopic predictions.

Determinism and predictability have been the hall mark of classical physics. Given initial conditions of position and velocity, future states of a system are

predictable with certainty. Objects in classical physics have definite properties at all times independent of the observation. Behavior of the macroscopic objects are described in terms of mass, position and velocity that can be directly measured. These concepts align with the classical view of the reality. There is no ambiguity about these properties being real or representational. These concepts correspond to our intuitive perception and experience of the reality. Therefore, classical physics, for our purpose in the above context, did not need separate interpretation.

However, with the advent of quantum physics, there is a significant gap between the quantum formalism and reality. It is not even clear what the formalism represents. Further, there were more than one formalism giving the same results. Therefore, interpretation is necessary to understand the nature of underlying reality as well as the theory. There has been great tension as it appeared that we have lost grip on the picture of reality. Some even gave up picturing the reality. Some went further and insisted others not to picture reality, with surprising statements like, "Shut up and Calculate." In certain aspects, some greatest minds were proven wrong, and some creative young minds prevailed.

A major surprise from quantum physics is that a single entity can behave either as particle or wave depending on how it is observed. It is evident in the double slit experiments involving quantum objects. How could something be localized and spread out at the same time? It is very counter-intuitive. This challenged the very foundations of how we perceive reality and the nature of matter and energy.

Uncertainty is another major surprise from quantum physics. Heisenberg showed that there is inherent limit to our knowledge about the simultaneous position and velocity of quantum particles. It implies that we cannot predict the future of quantum systems through initial conditions. Not only we cannot precisely measure the properties, the principle of superposition mandates, as demonstrated by double slit experiment and others, that quantum objects do not have a definite state at all until measured. This raises fundamental questions, what is the foundation of reality?

There are different mathematical formalisms for quantum mechanics. These formalisms do not give single picture of reality. Schrodinger's equation is one of the very successful formalisms of quantum mechanics. It gives accurate statistical prediction of the system. Schrodinger initially proposed ontology of waves to interpret the wave equation as a representation of a cloud like real physical wave. He interpreted wave equation of electron to be representing the charge density of electron spreading across the space. Later Max Born interpreted the absolute square value of wave equation to represent the probability density function to find the electron at a given point in space. This interpretation matched the experimental results.

Mathematical description of superposition involves representing a quantum state as linear combination of wavefunction of each possible state. Does this mean the system is in all those states at once or it indicates a lack of our knowledge of it? There are different interpretations to answer this fundamental question with different perspectives to make sense of the quantum phenomena.

Copenhagen interpretation, developed by the likes of Niels Bohr and Werner Heisenberg includes concepts of probabilistic nature of quantum mechanics, collapse of the wave function by measurement, role of observer, and uncertainty.

Similarly, there is many-worlds interpretation by Hugg Everette III, pilot-wave theory that is based on Louis de Broglie's work and further developed by David Bohm. Then, there is Quantum Bayesianism (QBism) developed by Christopher Fuchs and Ruediger Schack that views quantum states as subjective degrees of belief.

In the words of Ruediger Schack, "Quantum mechanics does not describe reality as it is by itself. Instead, it is a tool that helps guide agents immersed in the world when they contemplate taking actions on parts of it external to themselves. The use of the word 'agent' rather than the familiar 'observer' highlights that quantum mechanics is about actions that participate in creating reality, rather than observations of a reality that exists independently of the agent."

These attempts made tremendous contributions to interpret the quantum weirdness and understand the true nature of underlying reality. However, the work is still in progress. We bring some important perspectives to the table from Indian knowledge systems like Vedanta. According to Vedic tradition, there are five factors in the manifestation of any action namely, the place of action, the performer, the various instruments, the endeavors, and super consciousness [BG18.14]. Further, the Sankhya system indicates that there are entirely different class of fundamental particles waiting to be discovered.

Vasudeva Rao (also known as His Holiness Bhaktisvarupa Vrajapati Swami) obtained his M.Tech. (Computer Science, 1998) from IIT Kanpur, India. After a brief tenure of working as a software professional, he decided to significantly contribute himself to the science-spirituality interface under the able leadership and vision of Dr. T. D. Singh, the Founder Director of the Bhaktivedanta Institute.

Presently, His Holiness is the President of Bhaktivedanta Institute and actively promotes discussion on science and spirituality. He is also the Editor of Bhaktivedanta Institute's reputed annual journal, Savijnanam – Scientific Exploration for a Spiritual Paradigm and travels widely across India and abroad. His deep interest in the foundations of mathematics, fundamentals of computer science and logic and its relation to nature of reality as well as ancient Indian texts led him to interact and meet renowned scholars at Harvard, Princeton, ETH, Stanford, and MIT. He has delivered several talks on topics at the interface of science and spirituality.

1.5. Quantum Uncertainty and Information Theoretic Applications

Prof. Archan S Majumdar, *Senior Professor, SN Bose National Centre for Basic Sciences, Kolkata*

We present a brief review of quantum uncertainty relations in various versions. We next discuss how uncertainty leads to demonstration of the EPR paradox and quantum steering. We conclude with a discussion of quantum contextuality which causes quantum advantage in many information processing applications.

Bio: Prof. Archan S Majumdar's expertise is in the dual fields of gravitation-cosmology and quantum information science. He has published more than 150 research articles in reputed international journals. His significant contributions are in the domain of dark energy, gravitational waves, primordial black holes, quantum entanglement, nonlocality, information processing protocols and decoherence. He has delivered more than 100 invited talks on these and other topics in institutions and laboratories around the world. 20 research scholars have obtained their PhDs under his supervision. Prof. Majumdar is actively engaged in the development of quantum science and technology in India, with 3 completed projects under the QuEST programme of DST. At present he is Senior Professor at S. N. Bose National Centre for Basic Sciences, Kolkata.

Session 2

2.1. NIST's Post-Quantum Cryptography Standardization and Quantum Readiness

Dr. Kunal Abhishek, *Scientist E and Head of the Cyber Security & Forensics Department, C-DAC Patna*

In August 2024, NIST finalized three primary algorithms in the Federal Information Processing Standards (FIPS) for key encryption (FIPS 203), digital signature (FIPS 204) and hash-based alternatives for digital signature (FIPS 205). These Standards have the objective to secure electronic information against future quantum threats. In this session, we will explore how organizations can achieve quantum readiness by adopting FIPS-approved post-quantum algorithms alongside strengthened legacy cryptographic algorithms with a focus on practicality, performance, compatibility, and security.

Dr. Kunal Abhishek is a Scientist 'E' at the Centre for Development of Advanced Computing (C-DAC), where he leads the Cyber Security & Forensics Group, driving advanced cyber security solutions for government organizations. Before joining C-DAC, he served as Group Head of Network

Security Research Group at SETS Chennai and spent seven years at Weapons & Electronic Systems Engineering Establishment (WESEE), Indian Navy, developing indigenous cryptographic and information security solutions. He has spearheaded key Government of India PKI initiatives, including Lakshman (a Strategic PKI), e-Abhedya (an ECC-based PKI), and a proprietary elliptic curve-based PKI for defense applications, while designing cryptographic tools like GANGA (a formal and secure RNG for operating systems), GHOST (trusted elliptic curves generation and verification tool), and ADRISHYA (an indigenous mobile VPN).

Dr. Kunal is also the Chief Investigator of a project for recovery of ransomware keys being funded from MeitY, Govt. of India. He has also played a pivotal role in national policy development, contributing to India's Cryptography Roadmap and IT Act, 2000 amendments introducing ECC-based Digital Signature Rules, 2015. He has authored the forthcoming book titled "Deciphering Tactics, Techniques, and Procedures of Ransomware(s) 1989 to 2023". He is also co-leading a government project on HPC-based quantum accelerators for supercomputers. With 19 years of experience in R&D and deployment, Dr. Kunal's expertise spans Cryptography, Quantum Technology, Secure Kernel Development and Statistics. He holds an M.S. in Software Systems from BITS Pilani and a Ph.D. in Computer Science from Bharathidasan University, specializing in Applied Cryptography, with research published in leading journals and conferences.

2.2. Circuit Quantum Electrodynamics Using High-Impedance Resonators and Qubits in Nanowire Quantum Dots

Dr. Deepankar Sharmah, *Basel University, Switzerland*

This talk presents our work on integrating high-impedance superconducting resonators with spin qubits hosted in semiconductor nanowire quantum dots, within the framework of circuit quantum electrodynamics (cQED). We develop robust device architectures that enable strong spin-photon coupling and perform detailed characterization via charge stability diagrams, resonator response, two-tone spectroscopy, and magnetospectroscopy. These measurements reveal key aspects of

qubit-resonator interaction and shell filling. Our results demonstrate the advantages of high-impedance resonators for scalable quantum dot-based qubit systems and pave the way toward improved coherence and control in hybrid quantum devices.

Deepankar Sarmah is a specialist in nanofabrication for quantum devices, with a strong background in condensed matter physics and quantum technologies. He holds a PhD in Physics from the University of Basel, Switzerland, where his research focused on semiconducting spin qubits and circuit quantum electrodynamics (cQED). He has extensive experience in cleanroom nanofabrication and low-temperature quantum transport measurements using dilution refrigerators. Currently, he is working as a joint Postdoctoral Researcher at the University of Basel and a Research Scientist at YQuantum, a Switzerland-based quantum startup. At YQuantum, he leads the development and fabrication of next-generation quantum hardware, driving innovation toward scalable quantum technologies.

Session 3

3.1. Path Integrals, Uncertainty, Entropy and Information

Arpan Dey, *Bachelor of Science (Honors) in Physics, St. Xavier's College (Autonomous), Kolkata*

The presentation would start with an introduction to Feynman's path integral formulation of quantum mechanics, outlining the motivation behind the path integral formulation, the classical path as well as how the sum-over-paths is defined. Then we shall look at the multiplicative law of propagators, and its equivalence in the canonical formulation of quantum mechanics – the superposition principle. Next, we shall discuss Heisenberg's uncertainty principle, with the help of the double-slit experiment with electrons, as well as Feynman's alternative statement of the uncertainty principle. Then we would explore the possibility of

understanding the increase of entropy in our universe as a consequence of microscopic uncertainty, as dictated by the uncertainty principle in quantum mechanics, and finally end with some comments on the concept of information, both from a quantum mechanics perspective (unitarity) and a statistical mechanics perspective (entropy).

Keywords: Path integrals, Classical mechanics, Quantum mechanics, Lagrangian, Action, Superposition principle, Propagators, Uncertainty principle, Entropy, Statistical mechanics, Information

3.2. Journey of the Heisenberg Uncertainty Principle: The Known, the Knowable, and the Unknowable

Yenegu Nikhil, *Ph. D. student, Department of Chemical Sciences, IISER Kolkata*

The Heisenberg Uncertainty Principle, proposed in 1927, is not merely a technical feature of quantum mechanics but a profound statement about the structure of physical reality. This lecture revisits the conceptual evolution of the principle through the lenses of the known, the knowable, and the unknowable, while also tracing Werner Heisenberg's intellectual path that culminated in this landmark idea.

We begin with the known—the formal articulation of the principle within quantum theory. We discuss the non-commutativity of position and momentum operators, the emergence of uncertainty from the mathematical foundations of wave mechanics, and the experimental contexts in which these relations are manifest, such as diffraction phenomena and spectral analysis.

The knowable concerns the broader theoretical landscape shaped by the principle. Here, we consider how different interpretations of quantum mechanics—Copenhagen, decoherence theory, QBism, and others—engage with uncertainty not just as a limit on precision, but as a window into the epistemic boundaries of observation and knowledge. These perspectives continue to influence contemporary discussions in quantum information theory, foundations, and emerging technologies.

The unknowable addresses the more subtle implications of the principle—where it marks a limit not only to measurement but to ontological claims about the world. Rather than merely technical indeterminacy, uncertainty invites us to reconsider classical assumptions about determinism, causation, and objectivity. Does the principle suggest that nature itself is indeterminate, or does it hint at a deeper, concealed order not accessible to direct inquiry?

Interwoven with this exploration is Werner Heisenberg's personal scientific journey. From his early struggles with the classical theory of atomic structure to his solitary retreat on the island of Helgoland, Heisenberg's pursuit of a coherent, predictive framework led him to a radical reconceptualization of physical observables. His formulation of matrix mechanics, born of abstraction and intuition, exemplified a new paradigm where precision and ambiguity coexist at the heart of physical theory.

This lecture aims to blend rigorous exposition with philosophical reflection, offering a multidimensional view of the Uncertainty Principle—as a tool of science, a challenge to knowledge, and a continuing source of inquiry into the limits of human understanding.

Session 5

5.1. Niels Bohr, Life Behind the Science With a View to Connection to India

Dr. Vilhelm Bohr, *Chairman of Niels Bohr Archive, Ad. Professor University of Copenhagen, Grandson of Nobel Laureate Niels Bohr*

Dr. Vilhelm A. Bohr is an internationally renowned molecular biologist and neurologist, currently serving as Chief of the Section on DNA Repair at the National Institute on Aging (NIA), NIH. Trained in medicine and neurology at the University of Copenhagen, with postdoctoral research at Stanford University, Dr. Bohr has made seminal contributions to our understanding of DNA repair, particularly the discovery of transcription-coupled nucleotide excision repair (TC-NER), which unveiled a fundamental link between transcription and genome maintenance. His

pioneering work has significantly shaped the fields of molecular gerontology and neurodegeneration, with a focus on mitochondrial function, oxidative stress, and age-associated diseases, especially Alzheimer's disease.

Over his prolific career, Dr. Bohr has authored more than 600 peer-reviewed publications and has mentored over 130 young investigators. His laboratory's research has provided critical insights into the cellular mechanisms underlying aging and neurodegenerative disorders, including the development of therapeutic approaches using NAD+ supplementation. He holds professorships at Aarhus University and the University of Copenhagen and is an elected member of several prestigious academies, including the Royal Danish Academy of Sciences and the Norwegian Academy of Science and Letters. His accolades include the NIH MERIT Award and the Olav Thon International Prize in Medicine, underscoring his status as a global leader in aging research.

5.2. A Novel View on the Foundation of Quantum Mechanics

Prof. Alfred Driessen, *University of Twente, Netherlands*

Dealing with Quantum Mechanics, one encounters a paradoxical situation. The application of this modern theory has had an enormous impact and resulted in the transistor, the computer chip, solid state lighting, and has facilitated IC technology and AI. At the same time, the famous quote of Richard Feynman remains valid: If you think you understand quantum mechanics, then you don't. In this presentation, the author intends to demonstrate that the proverbial weirdness of Quantum Mechanics originates not from the theory itself but from the philosophical framework that is chosen. Classical mechanics works well for a world with deterministic physical laws and matter consisting of well-defined, tiny, billiard ball-like particles. This naïve atomistic view, originated by Democritus, is overcome by the philosophy of Aristotle. For him, movement or change must be considered a whole, a continuum. Division of movement is, in principle, possible, but it depends on its physical characteristics. There are minima of movement, which one may relate to the quantum jumps. Another subtlety in the Aristotelian framework is the

introduction of a third state of being besides an actual one and being not at all: the potential being. With this distinction, the collapse of the wavefunction can be understood as the transition from a potential to an actual state. Examples from modern physics illustrate the talk.

Prof. Dr. Alfred Driessen (b. 1949) studied Physics and Mathematics at the universities of Cologne, Bonn, and Amsterdam, completing his degree in 1972. He received his Ph.D. in 1982 with research on quantum solids, and subsequently conducted postdoctoral work on hydrogen behavior in metals. His academic tenure at the University of Twente began in 1988, where he served as associate professor and later full professor in integrated optics, focusing on photonic devices and optical waveguides.

Following his retirement in 2009, Prof. Driessen was named Professor Emeritus and turned his attention to the philosophy of science, examining foundational questions at the intersection of science, metaphysics, and religion. He has lectured and published on the philosophical implications of modern physics and the dialogue between science and theological thought, contributing to broader conversations on the nature of reality and human understanding.

Day 3

Session 1

1.1. Toward a Modular Soliton-Polariton Quantum Supercomputer: Channel-Scaled Architecture and Invariant-Network Formalism for Quantum-Like Big-Data Analytics

Dr. Anirban Bandyopadhyay, *Principal Research Scientist, National Institute for Materials Science (NIMS), Tsukuba, Japan*

We introduce a purely photonic Modular Soliton–Polariton Quantum Supercomputing (MSPQS) framework in which every computational

element is an exciton-polariton condensate gate driven by stable optical solitons at ambient conditions. The architecture grows recursively through four canonical channel tiers—16, 64, 256, and 1024—so that each 16-channel block (register + control + readout) forms a hot-swappable cell, cells weave into tiles, tiles into arrays, and arrays into racks, yielding a lattice that can be re-partitioned or physically re-ordered without disturbing global coherence. Inter-cell communication is described by a transparent invariant-network matrix T_{ij}^{(k)} whose indices simultaneously label physical modes, logical channels, and data coordinates; algebraic constraints force T to commute with all channel-transfer operators under SU(2) and SU(1,1) transformations. These symmetries endow the full stack with topological invariants that survive dynamic resource allocation, optical-path length jitter, and soliton phase drift, thereby ensuring scalability without cryogenic overhead or heterogeneous solid-state integration.

The theoretical motivation is the growing evidence that rapidly evolving big-data streams—genomic SNP clouds, Internet-traffic telemetry, climate sensor grids, wide-field astronomical surveys—exhibit four hallmark quantum-like effects: variable superposition (simultaneous multistate occupancy), entanglement-analogous cross-correlations, tunnelling-style regime shifts, and retroactive (non-Markovian) dependencies. By mapping such datasets onto virtual Hamiltonians executed in parallel across channel tiers, MSPQS extracts these latent features in real time, enabling predictive analytics and quantum-grade cryptographic primitives inaccessible to classical tensor pipelines. Analytical scaling shows that once the system reaches the 256-channel tier, invariant-network routing yields a cubic advantage in speed–accuracy product over optimised GPU clusters when evaluating quantum-inspired kernels. We thus outline both the mathematical foundations and the pragmatic engineering path toward a fully reconfigurable, cryogen-free quantum supercomputer capable of harvesting hidden quantum structure from complex, non-stationary data domains.

Anirban Bandyopadhyay is a Principal Research Scientist at the National Institute for Materials Science (NIMS), Tsukuba, Japan. He did Ph.D. in

IACS, Kolkata, 2005. During 2005-2008 ICYS research fellow at ICYS, NIMS, Japan. In 2008, joined as a scientist at NIMS, built organic jelly based artificial brain, quantum computer, molecular motor based drugs, brain inspired computing, written a book "Nanobrain: The making of an artificial brain from a time crystal", 2020. 2013-2014 visiting scientist at the Massachusetts Institute of Technology (MIT), USA. Hitachi Science and Technology award 2010, Inamori Foundation award 2011–2012, Kurata Foundation Award, and Sewa Society international member, Japan. Published more than 100 papers, 23 patents, and edited 17 books.

1.2. The Unthinkable Machine: On the Limits of Mechanization of Human Thought and the Quantum Possibility

Shri Nishant Kumar Shekhar, *Scientist D, Quantum Group, CDAC Patna*

This presentation explores the philosophical limits of mechanized cognition, questioning whether machines can truly replicate human thought or if there is always an essential aspect that evades formalization. Tracing humanity's efforts to model the mind through mathematical and computational frameworks—from the logical foundations in Principia Mathematica to the probabilistic frontiers of quantum intelligence—we examine the evolving quest to understand and simulate the human mind.

We begin by revisiting the 20th-century optimism that logic and computation could fully mechanize reasoning. However, Gödel's incompleteness theorems, Turing's halting problem, and insights from thinkers like Wittgenstein reveal inherent limitations in reducing thought to rules and algorithms. These constraints are still evident in modern artificial intelligence, where systems excel at pattern recognition but struggle with abstraction, meaning, and consciousness.

Quantum intelligence, with its non-deterministic principles, offers the potential for a new paradigm—one that goes beyond classical logic to embrace ambiguity, entanglement, and parallelism. Could this approach align more closely with human intuition, or does it merely push the boundaries of simulation without achieving true understanding?

Ultimately, this presentation argues that human thought is more than just computation. It is embodied, contextual, emotional, and self-reflective—qualities that resist formal replication. The "unthinkable machine" thus serves as both a technical and philosophical metaphor: a system that can mimic certain aspects of intelligence but may never fully grasp the entirety of the human mind. By exploring the limits of simulation, we gain a deeper understanding of what makes thought irreducibly human.

Shri Nishant Kumar Shekhar, currently serving as Scientist D and Section Head of the Quantum Technology and Application Development Group at C-DAC Patna, is a specialist in quantum and classical active photonic devices. With over a decade of experience in designing, developing, and fabricating these devices along with their embedded systems, he brings deep technical expertise and leadership to this emerging field.

Before joining C-DAC in 2023, he headed the Laser and Optics division at Shahjanand Laser Technologies Limited, Gandhinagar, Gujarat, where he worked as a Scientist in Product Development. In this role, he was instrumental in developing a commercial-grade 1 kW fiber laser system for laser cutting applications and collaborated with Indian and international organizations on the advancement of coherent beam combined laser technologies. Earlier in his six years research career at CSIR-Central Glass and Ceramic Research Institute (CGCRI), Kolkata, his work on nanosecond and Q-switched fiber lasers led to successful technology transfers to both public and private sector companies, including Bharat Electronics Limited, Bangalore, and Aeromec Pvt. Ltd, Mumbai.

Shri Nishant holds one patent and has published extensively in reputed journals and conferences. He earned his B.Tech in Electronics and Communication Engineering from the State Institute of Engineering & Technology, Haryana, and is currently pursuing his Ph.D. at Jadavpur University. At C-DAC Patna, as the Section Head of the Quantum Technology and Application Development Group, he leads initiatives in developing accelerated quantum simulators and virtual quantum computers utilizing C-DAC's high-performance computing infrastructure. His research also explores the integration of quantum and neuromorphic

computing, focusing on quantum spiking networks that emulate biological neural systems.

1.3. Conservation of Conscious experience: A Quantum Information Approach

Dr. Roshan Tiwari, *Research Scientist, Bhaktivedanta Institute Kolkata*

The observation of the natural world generates unique conscious experiences in living beings, characterized by their inherently personal, subjective, and first-person nature. These experiences, often referred to as qualia, are fundamentally inaccessible from an objective or third-person perspective, as their qualitative aspects cannot be adequately captured or transmitted through classical bits of information. Emerging research suggests that such experiences may be rooted in quantum information, which, like consciousness, remains intrinsically unobservable and incommunicable. This limitation arises from fundamental principles of quantum information theory, particularly the No-Cloning Theorem, which prohibits the perfect duplication of arbitrary quantum states, and Holevo's Theorem, which restricts the amount of classical information that can be extracted from quantum systems. In my talk, I will propose that these experiences are quantum in nature, and are never truly lost but continue to exist in some form, supported by the no-hiding theorem of quantum information theory.

Dr. Roshan Tiwari earned his MS & Ph.D. in Physics from the Indian Institute of Science Education and Research (IISER) Kolkata in 2023, following a B.Sc. in Physics from Banaras Hindu University (BHU), Varanasi, in 2014. His doctoral research spanned spectroscopy, bioinspired microwaveguides and cavities, microscopy, optical sensing, and optical trapping, with his findings published in several prestigious international journals. Driven by a deep fascination with the quantum nature of reality, Dr. Tiwari is particularly interested in exploring how quantum information theory can enhance our understanding of conscious experiences. He is currently a Research Scientist at the Bhaktivedanta Institute, Kolkata, where he focuses on developing theoretical frameworks to provide deeper insights into the fundamental nature of consciousness.

2.1. Energy Eigenvalues of Confined Hydrogen Atom within Penetrable and Impenetrable Spherical Box using Finite Element Method

Binoy Kumar Mahato, *Ph.D. student, Department of Physics, Institute of Science, BHU Varanasi*

The properties of a confined system is different from the open system due to the interaction with their environment. The confinement changes the system's energy levels and dynamics. The wave function becomes zero (i.e. impenetrable) and non-zero (i.e. penetrable) at the boundary in the hard and soft confinements, respectively. In this work, we study the energy eigenvalues of a confined system. We use the Finite Element Method (FEM) to solve the Schrodinger equation numerically. In FEM, we define the interpolation functions locally to approximate the unknown wave function rather than define the trial function globally. This study shows that FEM can be used to calculate the energy eigenvalues of confined systems very effectively.

2.2. Quantum Mechanics and Consciousness

Debansu Adhikary, *AJC Bose College, Kolkata*

To investigate foundational experiments such as the Young's Double Slit, theoretical constructs like wavefunctions and superposition, and interpretations including the Many-Worlds Hypothesis, Wigner's Friend, and Schrödinger Cat, in order to evaluate if conscious observation is responsible for the collapse of quantum possibilities into a single reality.

Classical Mechanics fails to explain the 'Young's Double Slit Experiment', at least satisfactorily, where we observe very intricate and beautiful phenomena of nature – interference. We observe that electrons passing through the slits behave in the same manner as waves do creating an interference pattern. Clearly this raises an interesting question – 'Does an

electron behave like a wave?' – a paradoxical duality of matter where particles behave like waves in the absence of an observer but appear as discrete entities when measured. This profound sensitivity to observation reveals a close link between the act of measurement and occurrence of the physical reality.

Physicists try to explain this phenomenon with the help of 'wave functions' - a mathematical construct encompassing the full superposition of a quantum system's possible states. We may ask, 'What happens to all the possible outcomes of the system?'. We found out several interpretations like Many-Worlds Hypothesis contend that all outcomes materialize in parallel branches of the universe, but our reality reflects only a single outcome, attributed to the collapse of the wavefunction.

Famous thought experiments like – Schr¨odinger's Cat and Wigner's Friend illustrate the conceptual tensions between observer and system, suggesting that consciousness may play a fundamental role in the construction of reality, where we may wonder whether consciousness is instrumental in reducing the wavefunction to a definite state or is it the reality itself that determines which state will get projected to whom and at which time as Max Planck said , "I regard consciousness as fundamental. I regard matter as derivative from consciousness." (Quoted from 1931, 'The Observer')

Conclusion: Thus, we may observe that we are not merely passive observers of reality but might actively participate in its emergence - a concept that remains deeply controversial yet profoundly important in quantum theory and the philosophy of mind.

2.3. Simulating Early-Universe Baryogenesis via Quantum Circuits: A New Approach to Matter-Antimatter Asymmetry

Mukul Kumar, *Indian Institute of Technology, Jodhpur*

The creation and annihilation of matter and antimatter lie at the heart of modern physics—and perhaps the future of human civilization.

Understanding how matter came to dominate the universe is one of the most profound unresolved questions in cosmology. According to prevailing theories, matter and antimatter were produced in equal amounts during the Big Bang. However, a slight asymmetry led to the annihilation of most antimatter, leaving behind the matter that forms the observable universe. This phenomenon, known as baryon asymmetry, raises a critical question: if matter and antimatter were created symmetrically, where did all the antimatter go?

While several mechanisms have been proposed—ranging from CP violation in the Standard Model to grand unified theory (GUT) baryogenesis and leptogenesis—there remains no definitive answer. In this work, I propose a novel approach to this cosmic mystery. Rather than relying on high-energy particle accelerators such as those at Fermilab or CERN, I explore whether quantum computers, through the simulation of quantum circuits, can capture the essential features of early-universe baryogenesis.

By leveraging quantum gates and qubits, this project aims to reproduce aspects of GUT-scale processes and potentially simulate CP-violating interactions at the quantum level. In particular, I focus on modeling GUT baryogenesis as a foundational framework, with the goal of extending this to more refined mechanisms like leptogenesis.

This work builds upon the theoretical legacy of Paul Dirac, whose equations not only predicted the existence of antimatter but also laid the groundwork for quantum field theory and modern particle physics. By merging Dirac's insights with the computational power of quantum circuits, this project offers a fresh direction in simulating early-universe dynamics—without the need for massive physical infrastructure.

Through this effort, we aim to open new pathways toward understanding fundamental symmetries, matter creation, and possibly the quantum origins of our existence.

2.4. The Quantum Revolution: A Historical Perspective

Yogesh Tambe, *B. Tech, Mechanical Engg., IIT Bhubaneswar*

The early 20th century witnessed a dramatic shift in our understanding of the physical world—a transformation known as the Quantum Revolution. This talk offers a historical perspective on the key milestones that shaped quantum theory, tracing its evolution from the classical worldview to a radically new framework that defies everyday intuition. Beginning with the revolutionary ideas of energy quantization, the narrative follows the groundbreaking contributions of scientists such as Max Planck, Albert Einstein, Niels Bohr, Werner Heisenberg, Erwin Schṛdinger, and others. Their discoveries challenged conventional physics, introduced novel concepts like uncertainty and duality, and laid the foundation for a theory that now underpins much of modern science and technology. Through a chronological exploration of these developments, the talk aims to highlight how the collective efforts of these pioneers gave rise to a new era in physics—one that continues to influence both our theoretical understanding and technological advancements today.

2.5. Bell's Theorem: Foundations, Derivation, and Implications for Quantum Mechanics

Ruthvik Galem, *Bhaktivedanta Institute, Kolkata (Alumnus, IIT Bhubaneswar)*

This lecture explores Bell's Theorem, a cornerstone in the foundations of quantum mechanics that redefined our understanding of reality, locality, and causality. We begin with an introduction to John Stewart Bell—the physicist whose deep concerns about the completeness of quantum theory led to one of the most profound results in modern physics. Tracing the historical and conceptual roots of the theorem, we delve into the Einstein-Podolsky-Rosen (EPR) paradox and the debate over hidden variables, which motivated Bell to formulate a precise test of quantum entanglement versus classical expectations.

We examine the core idea behind Bell's derivation—how he transformed philosophical questions into a mathematical inequality that any local hidden variable theory must satisfy. The violation of this inequality, as predicted by quantum mechanics, marks a decisive departure from classical notions of locality and realism. These predictions have been repeatedly confirmed through a series of increasingly refined experiments, from Alain Aspect's pioneering tests to modern loophole-free setups, all affirming the nonlocal character of quantum correlations.

In conclusion, we reflect on why Bell's Theorem stands as a revolution in quantum mechanics—not only for its technical insight but for its profound implications about the nature of reality.

— ✻ —

About Bhaktivedanta Institute

The Bhaktivedanta Institute was founded by His Divine Grace A. C. Bhaktivedānta Swami Prabhupāda in Vrindavan in August 1974. Śrīla Prabhupāda was one of the greatest exponents of Vedic culture in the 20th Century. He strongly felt that modern civilization is completely misdirected by scientific materialism and there is an urgent need to introduce the spiritual knowledge and wisdom of the *Bhagavad-gītā* and the *Śrīmad-bhāgavatam*, the essence of all the Vedic literatures, to the scientists, philosophers, scholars and students of the world. He noticed that all the prestigious academic institutions and universities of the world were teaching many different subjects but they had left out the most important branch of knowledge—the science of the soul. He envisioned that this spiritual knowledge of life would help restore an ethical culture for modern society. Thus, there would be hope for bringing lasting happiness and world peace. He felt that introducing this spiritual culture should be the contribution of India for the welfare of humanity. Śrīla Prabhupāda appointed his disciple Dr. T. D. Singh (Bhaktisvarūpa Dāmodara Swami) as the director of the Institute from its very inception and left several instructions to him to carry forward his vision.

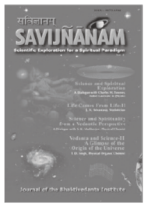
The Bhaktivedanta Institute is a center for Advanced Studies in Science and Vedānta and focuses on a consciousness-based paradigm. This spiritual paradigm has a unique potential to resolve the mind-body problem, the question of evolution and life's origin and many other

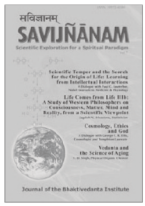
philosophical and ethical concerns. Thus, this paradigm will have profound significance for science, religion, and their synthesis. One of the primary objectives of the Bhaktivedanta Institute is to present this paradigm for the critical attention of serious scholars and thinkers throughout the world. As such, the Institute supports a closer examination of existing scientific paradigms in cosmology, evolution, physics, biology, and other sciences. The Institute also promotes scientific, philosophical and religious dialogues among scientists, scholars and theologians of the world covering various common conceptual grounds of science and religion for the purpose of creating a better and harmonious understanding among all people. In order to achieve these goals, the Institute organizes international conferences regularly and publishes books and journals. Interested persons may contact the secretary of the Institute at:

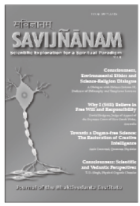
The Bhaktivedanta Institute,
RC-8, Raghunathpur,
Manasi Manjil Building, Fourth Floor
VIP Road, Kolkata 700 059, India
Tel: +91-33-2500-9018
email: bi@binstitute.org
website: www.binstitute.org, http://store.binstitute.org/

— ❋ —

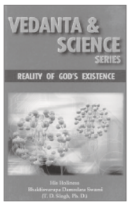
Bhaktivedanta Institute's Publications

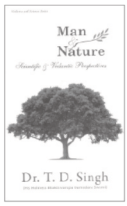


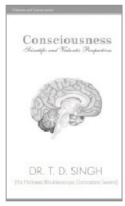


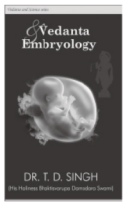


Journals

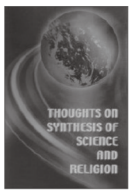


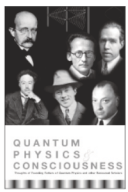


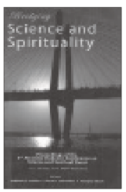




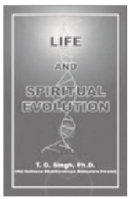
Vedanta and Science Series

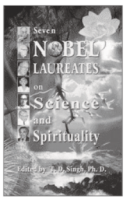




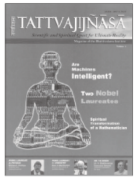


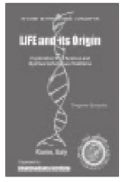

Proceedings





Books on Science - Spirituality






BHAKTIVEDANTA INSTITUTE
Manasi Apartment , RC/8, Raghunathpur, VIP Road,
Kolkata, West Bengal, 700059
Email: bi@binstitute.org
Tel: +91-33-2500-9018
http://store.binstitute.org

An Outstanding

तत्त्वजिज्ञासा

Science & Spirituality Magazine

TATTVAJIJÑĀSĀ – Scientific and Spiritual Quest for Ultimate Reality

TATTVAJIJÑĀSĀ – Scientific and Spiritual Quest for Ultimate Reality is one of the most premier magazine where articles and dialogues with renowned scholars from around the world on the interface of science and spirituality are published. Some of its highlights are:

- ✓ Articles/dialogues with 2 Nobel Laureates, and special articles on founders of science and mathematics
- ✓ Covers a wide range of disciplines from physics to cosmology, origin of life, evolutionary biology, and foundations of mathematics, among others
- ✓ Expert and renowned editorial and advisory board members
- ✓ Published 4 volumes containing 22 contributors

AVAILABLE NOW!

Available at:

store.binstitute.org
www.binstitute.org

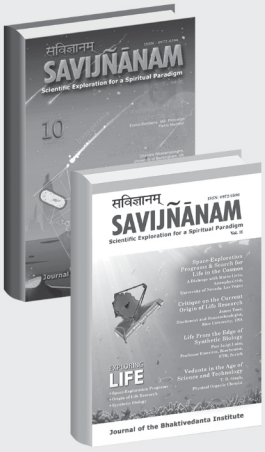
Write to us:
bi@binstitute.org | +91 9330010816

A LEADING

सविज्ञानम्

SCIENCE & SPIRITUALITY JOURNAL

SAVIJÑĀNAM – Scientific Exploration for a Spiritual Paradigm



SAVIJÑĀNAM – Scientific Exploration for a Spiritual Paradigm is one of the most premier journals where articles and dialogues with renowned scholars from around the world on the interface of science and spirituality are published. Some of its highlights are:

- ✓ Articles/dialogues with 8 Nobel Laureates, 2 Templeton Laureates and 1 Fields Medalist
- ✓ Covers a wide range of disciplines from physics to cosmology, origin of life, evolutionary biology, and foundations of mathematics, among others
- ✓ Expert and renowned editorial and advisory board members
- ✓ Published 11 volumes containing 28 contributors

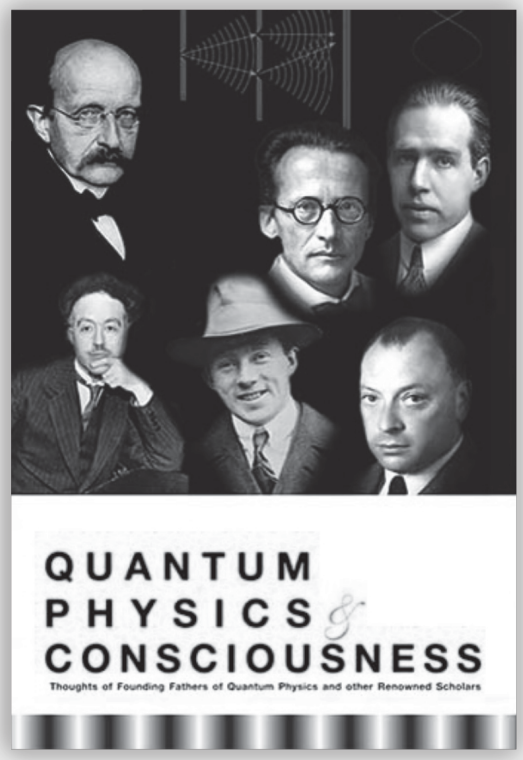
SUBSCRIBE TODAY!

Available at:

store.binstitute.org
www.binstitute.org

Write to us:
bi@binstitute.org | +91 9330010816

Read Today



QUANTUM PHYSICS & CONSCIOUSNESS

Thoughts of Founding Fathers of Quantum Physics and other Renowned Scholars

Topics Covered

- *Objectivity*
- *Subjectivity*
- *Causality and Complementarity*
- *Free Will*
- *Consciousness*
- *Quantum Physics*
- *Locality*
- *Induction*
- *EPR-Bell Experiments*
- *Michelson-Morley Experiment*
- *Neuroscience*
- *Quantum Entanglement*
- *Quantum Biology*
- *Vedanta*

Get the book at: store.binstitute.org

BHAKTIVEDANTA INSTITUTE

CONNECT TO US

Get Institute's regular Updates and News about Upcoming Events, Publications and Courses

facebook.com/binstitute.org
1.2K followers

twitter.com/Bhaktivedantal

instagram.com/bhaktivedanta_institute_

linkedin.com/in/bhaktivedanta-institute-14394920a/

in.pinterest.com/BhaktivedantaInstitute/

kooapp.com/profile/binstitute.org
1.1K followers

Bhaktivedanta Institute - Media
@BhaktivedantaInstituteMedia | 1.07K followers
200+ Videos of Science and Spirituality Lectures, Seminars and conferences

Get our Science and Spirituality publications

store.binstitute.org | binstitute.org

About
C-DAC, Patna

C-DAC Patna, the 12th R&D center of C-DAC established in March 2020, serves as a premier Research & Development organization under the Ministry of Electronics & Information Technology (MeitY), Government of India. This center is dedicated to advancing AI technologies, Information and Cyber Security, contributing significantly to building a technically advanced nation.

C-DAC Patna focuses on developing and strengthening the skills, abilities, processes, and resources necessary for organizations and communities to thrive in a rapidly changing world. In its initial planning phase, C-DAC Patna has launched R&D activities in Artificial Intelligence, Data Science, Cyber Security & Cyber Forensics, and the Internet of Things (IoT). The scope of research has further expanded to include Blockchain Development, Quantum Computing, Digital Twin, Drone Technologies and Cyber-Physical Systems. Additionally, the center is actively involved in ICT projects for agriculture, health, education, language computing, e-governance, heritage preservation, and smart city technologies.

C-DAC Patna aims to develop core competencies in these areas, leveraging knowledge from the eleven other C-DAC labs across the nation, which collectively have over three decades of experience. C-DAC Patna will continue to strengthen these competencies by executing projects, fostering collaborations, and offering high-end training and

mentoring. C-DAC Patna also offers high-end training programs and mentoring to build capacity in emerging technologies. These programs are designed to equip professionals, students, and entrepreneurs with the skills needed to excel in the digital age.

C-DAC Patna is poised to continue its trajectory of growth and impact, expanding its research horizons and deepening its engagements with various stakeholders for national benefit.

State-of-the-art Labs:

Param Buddha AI HPC Lab

A high-performance supercomputing center delivering 2 petaflops of processing power, dedicated to AI workloads.

Quantum Research Lab

Powered by high performance quantum simulators and synthesizers

Advanced Analytics and Artificial Intelligence Lab

Research facility for next generation research driven product development

IoT & Drone Technology Lab

Lab set up for unmanned aerial system and aligned internet of thing component research

Cyber Security & Forensics Lab

Implement advanced cybersecurity and digital forensics platforms and software to offer expert consultation and services.

KRISHNA Lab (Knowledge Research & Investigation for Strategic and High assuraNce softwAre Systems)

A protected environment engineered to address complex challenges in cyber defense, strategic initiatives, and research.

Formal Verification & Applied Technology Lab

A research lab dedicated to developing mathematically rigorous methods for verifying software correctness

Advanced Computing and Training School

A center of excellence for cultivating advanced ICT skills, led by researchers and industry professionals.

Digital-Twin Lab

Innovation for cognitive work automation

Ransomware Research Lab

R&D lab on ransomware key recovery mechanisms

इलेक्ट्रॉनिकी और सूचना प्रौद्योगिकी मंत्रालय
Ministry of Electronics and Information Technology
Government of India

Digital India
Power To Empower

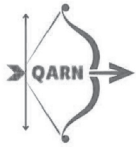
Azadi Ka Amrit Mahotsav

सी डैक
CDAC

QUANTUM RESEARCH LAB

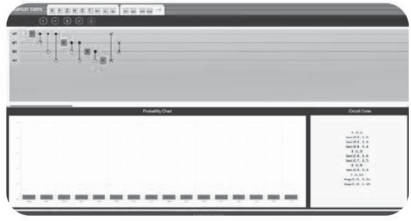
Quantum Platforms at a Glance: QARN, QUTE, ShAQTI & Qniverse

QARN (Quantum Accelerated and Reconfigurable Noisy) Simulator:



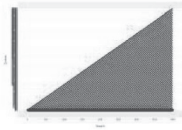
- Simulates quantum circuits up to 35 qubits.
- GPU acceleration for high-speed performance.
- Supports multi-GPU, multi-node, and distributed computing systems.

QUTE: (Quantum Unified Tools Ecosystem)



- Includes Circuit Designer and Debugger tools.
- Offers multiple simulators: State vector, Density matrix, and Tensor network.
- Supports circuit optimization and transpilation. Compatible with simulators and real quantum hardware.

ShAQTI: (Shape Augmented Quantum Topology-based Interface)



- Quantum algorithms and quantum circuits visualized as shapes or topologies.
- An innovative approach to understand and design quantum algorithms.

Qniverse (https://qniverse.in/)

- The quantum circuit frontend design tool integrating various backends like qiskit, cirq, OPENQASM, etc. It is also includes QARN as a backend.
- Supports superconducting, photonic, and neutral atom qubit hardware.
- Integrates seamlessly with HPC systems with GPUs, FPGAs, and vector processors.
- Facilitates collaborative research and education in quantum computing.

+91-612 2219021 (Ext.- 103)

प्रगत संगणन विकास केंद्र
CENTRE FOR DEVELOPMENT OF ADVANCED COMPUTING

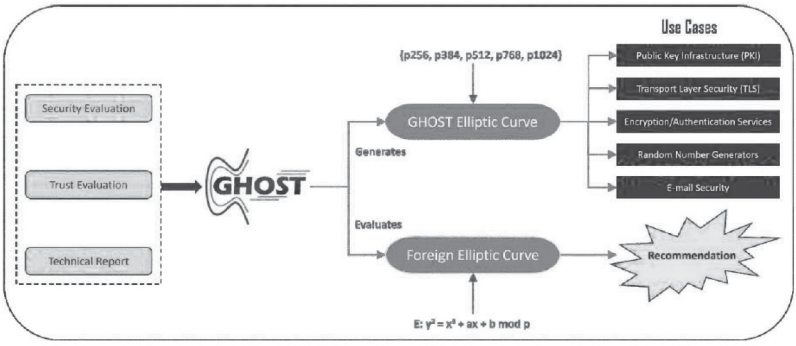
infocdacpatna@cdac.in

Generation of In-House Secure and Trusted Elliptic Curve

An Indigenously Developed Tool By C-DAC Patna

GHOST is a Cryptographically Secure and Trusted Elliptic Curve Generation tool indigenously developed by C-DAC Patna. GHOST generates elliptic curves of short weirstrass form over arbitrary prime field sizes for scalable security in a transparent and well-explained manner. It uses novel algorithms to ensure that the elliptic curve is not only cryptographically secure but also trusted for use in strategic applications. GHOST curves are supported by mathematical proofs and validations along with comprehensive technical report. These elliptic curves are useful for implementation in SSL / PKI / Authentication / Digital Signing etc. applications. GHOST as an application provides estimates for computational investment required for generating elliptic curves over certain prime field size. GHOST is designed and developed in consideration with the needs of strategic requirements.

GHOST Modules & Use Cases



Salient Features

- GHOST competitively offers elliptic curve over largest prime field size of 768 bit for highest security so far reported in literature
- Indigenously developed cryptographic tool
- Aimed for strategic applications
- Rigorous trust evaluation of elliptic curves using novel trust evaluation criteria
- Rigorous security evaluation of elliptic curves
- Provision to verify foreign elliptic curve w.r.t. its cryptographic security and trust evaluation
- Intelligent Prediction Panel for prediction of computational investment required in randomly drawing elliptic curve
- Gives idea about quantum attack resiliency on the selected field size of elliptic curve
- Comprehensive Technical Report
- Recommendation of secure and trusted elliptic curve for cryptography
- Well-explained documentation
- Transparent source code
- GHOST curves for standardization
- GHOST curves are used for cryptographic applications such as PKI, TLS, Encryption/Authentication services, RNG development as well as developing customized proprietary security protocols based on elliptic curves

Highlights

- GHOST is developed keeping ECDLP Security, ECC Security and Trusted Security of elliptic curves into consideration
- C-DAC Param Budhha HPC facility has been extensively used in generation and testing of GHOST curves
- C-DAC indigenous PKI called Lakshman is powered by the GHOST curves

Contact us

Desk: 0612- 2219021 (Ext:116)
Mob: +91 9791006182

akunal@cdac.in

Cyber Security and Forensics Group

Available for Deployment

Centre for Development of Advanced Computing
(C-DAC) Patna
14th Floor, Biscouman Tower
West Gandhi Maidan, Patna – 800 001
https:// www.cdac.in

GANGA : A Formal Cryptographically Secure PseudoRandom Number Generator

An Indigenously Developed CSPRNG By C-DAC Patna

GANGA is the only Kernel CSPRNG (Cryptographically Secure Pseudorandom Number Generator) with formal proofs. It employs novel algorithms to generate non-reproducible random bitstreams, ensuring complete unpredictability across independent executions, even when starting with the same seed and IV (initialization vector). This unique feature makes GANGA behave like a true random number generator (TRNG) for the first time in the literature. In addition to this, GANGA's design emphasizes a long period, good structure, and strong non-linearity, while maintaining both forward and backward secrecy. It integrates cryptographically secure and trusted in-house GHOST elliptic curves to provide provable security, further reinforcing its trustworthiness. Developed indigenously by C-DAC Patna, GANGA comes with thorough technical documentation, ensuring transparency and fostering trust for use in strategic and high-security applications. With exceptional benchmarks in security, performance, and reliability, GANGA is ideal for deployment across a wide range of cryptographic applications.

BENCHMARKS

S.No.	Criterion	/dev/(u)random	Yarrow	Fortuna	GANGA	Remarks on GANGA
1	Hard problem used	ChaCha20, Stream cipher	3DES	AES128 in counter Mode	ECDLP	Optimal for best trade-off between security & performance
2	RNG requirements met	R1, R2, R3	R1, R2, R3	R1, R2, R3	R1, R2, R3, R4	Best randomness provider in software
3	Unblocked supply of random bits	No	No	Yes	Yes	Entropy management for uninterrupted randomness supply
4	Correlation Test	*	*	*	Passed (auto- Correlation of -0.000144)	Best non-correlation
5	Initial entropy requirement	*	*	*	256 bits	Minimal entropy requirement
6	Per bit entropy rate	0.897697	*	*	Shannon-1 Renyi- 0.999999 Tsallis- 0.996093	Highest entropy per bit rate
7	Linear complexity	*	*	*	$8182^{31917} < LC(x) \leq 8182^{31918}$	Highest linear complexity
8	Period	*	*	2^{128} in single call	$[2^{703}, 2^{706}]$	Longest period
9	Key space	*	*	*	$[2^{704}, \infty)$	Largest Key space
10	Certification(s)	Diehard	*	Diehard	NIST, Diehard, TestU01 (Alphabit, Rabbit)	Certification for statistical randomness
11	Non-reproducibility Test	*	*	*	Passed	Practices robust non- reproducibility through novel design
12	Memory Footprint	*	*	*	22.7 KB source code, 496 kB binary	Light weight CSPRNG in kernel space
13	Formal Proofs Given	*	*	*	Yes	The only Kernel CSPRNG backed with formal proof

* No reference available in literature

R1 : Requirement of Statistical indistinguishability R2 : Requirement of Forward secrecy R3 : Requirement of backward secrecy R4 : Requirement of Non-reproducibility

Table : Comparison of GANGA with popular kernel CSPRNGs

USE CASES

- Candidate CSPRNG for operating system kernels
- Low constraint devices which demand small memory footprints with competitive security
- Trusted CSPRNG for strategic applications

GANGA has been successfully evaluated and used by the Indian Army.

CONTACT US

Desk: 0612- 2219021 (Ext:116)
Mob: +91-9791006182
akunal@cdac.in

Cyber Security & Forensics Group

Available for Deployment

Centre for Development of Advanced Computing (C-DAC) Patna
14th Floor, Biscouman Tower
West Gandhi Maidan, Patna – 800 001
https:// www.cdac.in

A Strategic PKI
लक्ष्मण
Your Trusted Saviour

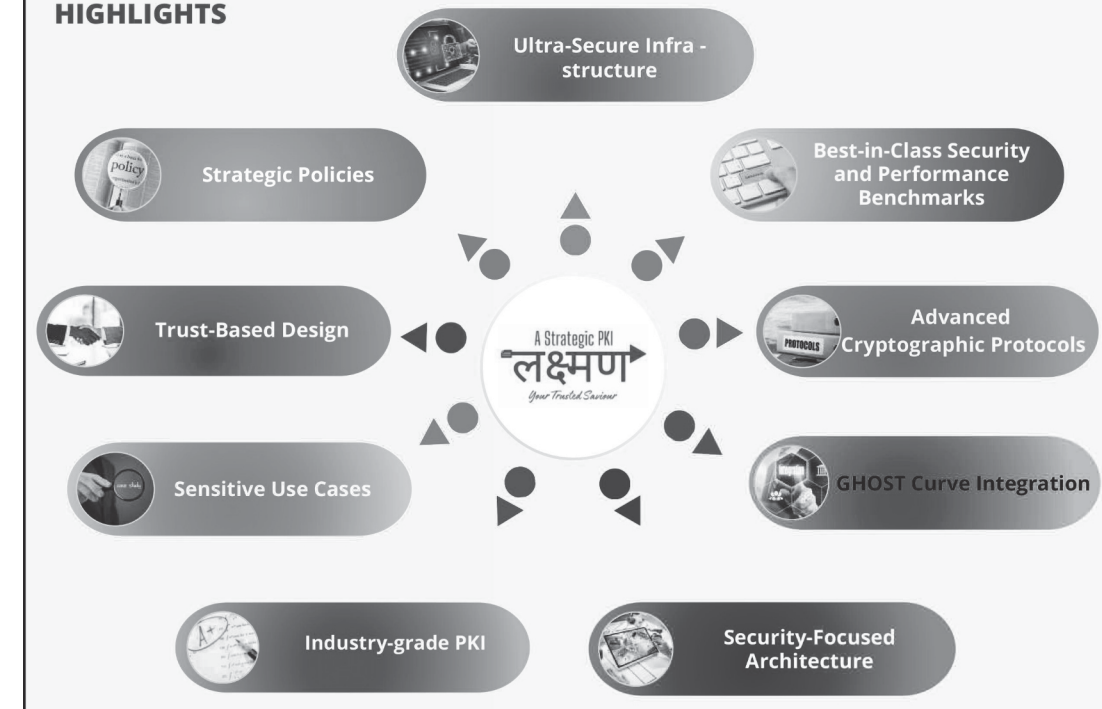
Lakshman : A Strategic Public Key Infrastructure

An Indigenously Developed PKI By C-DAC Patna

सी-डैक
CDAC

Lakshman is a strategic Public Key Infrastructure (PKI) application, developed by C-DAC Patna, that ensures secure and reliable digital certificate-based communication within an enterprise. It leverages GHOST elliptic curves to provide trusted security to the digital certificate infrastructures of the PKI. Lakshman also sets up and enforces key policies and controls to implement PKI across closed network or enterprise. Its primary goal is to ensure strong security, transparency, and accountability, while simplifying the management of digital certificates for enterprise users.

HIGHLIGHTS



POTENTIAL USERS

- Indian Army
- Indian Air Force
- Indian Navy
- Law Enforcement Agencies
- Indian Intelligence Agencies
- Ministry of Home Affairs and its Departments
- Other Interested Government Organizations

CONTACT US

Desk: 0612- 2219021 (Ext:116)
Mob: +91-9791006182

akunal@cdac.in

Cyber Security & Forensics Group

Available for field trials

Centre for Development of Advanced Computing (C-DAC) Patna
14th Floor, Biscouman Tower
West Gandhi Maidan, Patna – 800 001
https:// www.cdac.in

इलेक्ट्रॉनिकी और सूचना प्रौद्योगिकी मंत्रालय
Ministry of Electronics and Information Technology

Digital India
Power To Empower

Azadi Ka Amrit Mahotsav

सी डैक
CDAC

GLAMS

GLAMS (Gamified Learning Assessment and Management System) is a revolutionary online platform that transforms the learning experience through engaging quizzes and competitions. By integrating gamification and collaborative challenges, GLAMS motivates learners and enhances knowledge retention, making skill development fun and effective across diverse educational environments.

Winner of Indian Education Awards 2024
for
Emerging Technology Solution of the Year

Features

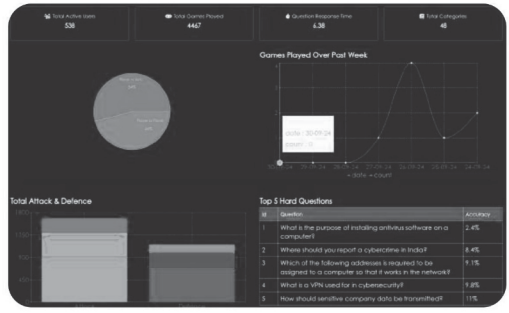
- **Gamified Quizzes & Tournaments**
- **Modular Content Management**
- **Continuous AI-Driven Engagement**
- **Real time Performance Insights**
- **Advanced Analytics**
- **Automated Certificates & Badges**

Benefits

- **Continuous & Enhanced Learning**
- **Encourage Critical Thinking**
- **Increased Competitiveness**
- **Recognition & Rewards**
- **Scalable for Large Audiences**

Clients

- **CERT-In**
- **Army Public School, Danapur Cantt, Patna**
- **Bihar Regimental Center**
- **DISA Office C-DAC**



+91-7979033285
infocdacpatna@cdac.in
प्रगत संगणन विकास केंद्र
CENTRE FOR DEVELOPMENT OF ADVANCED COMPUTING

इलेक्ट्रॉनिकी और सूचना प्रौद्योगिकी मंत्रालय
भारत सरकार
Ministry of Electronics and Information Technology
Government of India

Digital India
Power To Empower

Azadi Ka Amrit Mahotsav

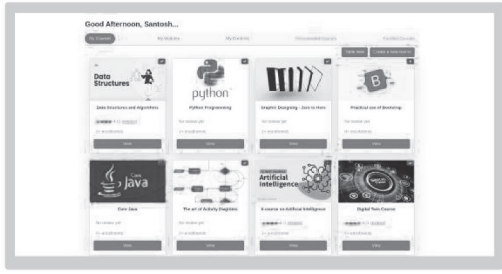
सी-डैक
CDAC

LEARNDEX

LearnDex is an interactive e-Learning platform that empowers learners through a diverse range of courses and engaging content. Designed for students and instructors, LearnDex features intuitive course management, user management, content delivery, certification and collaborative tools that enhance the learning experience and foster skill development.

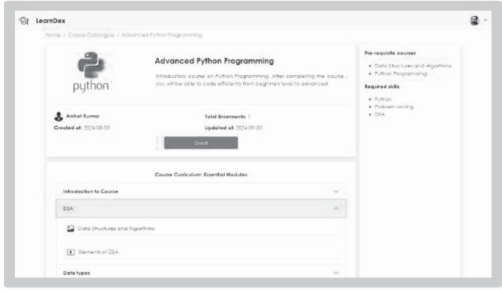
Features:

- **Dynamic Course Management**
- **Automated User Managemen**
- **Content Management and Delivery**
- **Real-time Progress Monitoring**
- **Accredited Certification**
- **Data-Driven Insights**
- **Feedback and Quality Assurance**



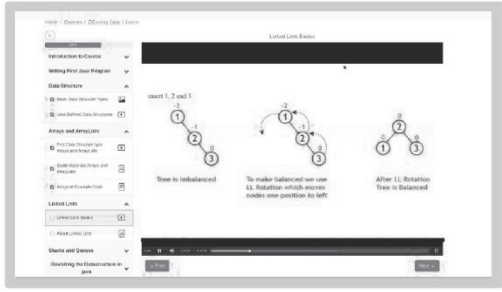
Benefits

- **Centralized Learning Hub**
- **Continuous Learning & Learner Engagement**
- **Adaptive & Personalized Learning Paths**
- **Achievement Recognition & Certification**



Use Cases

- **MOOC Platform for:**
  - **Skill Development and Competency Building**
  - **Accredited Professional Certifications**
  - **Community Learning Initiatives**



+91-7979033285
infocdacpatna@cdac.in
प्रगत संगणन विकास केंद्र
CENTRE FOR DEVELOPMENT OF ADVANCED COMPUTING

इलेक्ट्रॉनिकी एवं सूचना प्रौद्योगिकी मंत्रालय
MINISTRY OF ELECTRONICS AND INFORMATION TECHNOLOGY

Digital India Power To Empower

SwaYaan

सी डैक CDAC

Capacity Building for Human Resource Development in Unmanned Aircraft System (Drone and related Technology)

"Bootcamp on Drone and Allied Technology"

What is it?
40 hours of In-person training on Drone Technology

Who is it for?
B.E/B.Tech students (30 per batch)

Why?
Spread Drone Awareness to Future Innovators

What's unique?
Every Trainee will assemble & fly Drones

Topics covered

1. *Introduction to Drone Technology*
2. *Aerodynamics and Flight Mechanics*
3. *Payloads and applications*
4. *Drone Hardware & maintenance*
5. *Drone data analysis & interpretation*
6. *Navigation and mapping*
7. *Drone regulations and laws*
8. *Hands-on flight training*

नालंदा इंजीनियरिंग कॉलेज में ड्रोन तकनीकी के ऊपर सी-डैक पटना द्वारा बूटकैंप का आयोजन

कॉलेज के छात्रों ने सीखे ड्रोन तकनीक के कई गुर

बीटेक के छात्रों के लिए ड्रोन एंड एलाइड टेक्नोलॉजी बूट कैंप लगा

अब वीएयू में तैयार होगा कृषि के लिए उपयोगी ड्रोन

S. No	Bootcamp Venue	Location	Participants
1	Bakhtiarpur College Of Engineering(BCE)	Champapur, Bihar 803212	50
2	Patna Women's College(PWC)	Patna, Bihar 800001	57
3	Amity University	Patna, Bihar 801503	30
4	Government Engineering College(GEC)	Munger, Bihar 811201	44
5	Jharkhand University of Technology(JUT)	Ranchi, Jharkhand 834010	32
6	Bihar Agricultural University(BAU)	Sabour, Bhagalpur, Bihar 813210	42
7, 8	Darbhanga College of Engineering(DCE)	Darbhanga, Bihar 846005	69
9	Nalanda College of Engineering(NCE), Chandi	Gokhulpur, Bihar 803108	42
10, 11	Bhagalpur College of Engineering(BCE), Bhagalpur	Bhagalpur, Bihar 812001	65
12	Government Engineering College(GEC), Khagaria	Roun, Alauli, Bihar 848203	48
13, 14	Government Engineering College(GEC), Buxar	Itarhi road, Buxar 802103	65
15, 16	Government Engineering College(GEC), Sheikhpura	Bazidpur, Bihar 811105	64

600+ Drone Mavericks & counting...

Join us & Learn Hands-on!

CENTRE FOR DEVELOPMENT OF ADVANCED COMPUTING(C-DAC)
(An Autonomous Scientific Society of Ministry of Electronics & Information Technology(MeitY), Govt. of India)
14th floor, BISCOMAUN Tower, West Gandhi Maidan,
Patna, Bihar, India - 800001
Phone: +91-82485 93185, Email: cpat_cpsg@cdac.in

इलेक्ट्रॉनिकी एवं सूचना प्रौद्योगिकी मंत्रालय
MINISTRY OF ELECTRONICS AND INFORMATION TECHNOLOGY

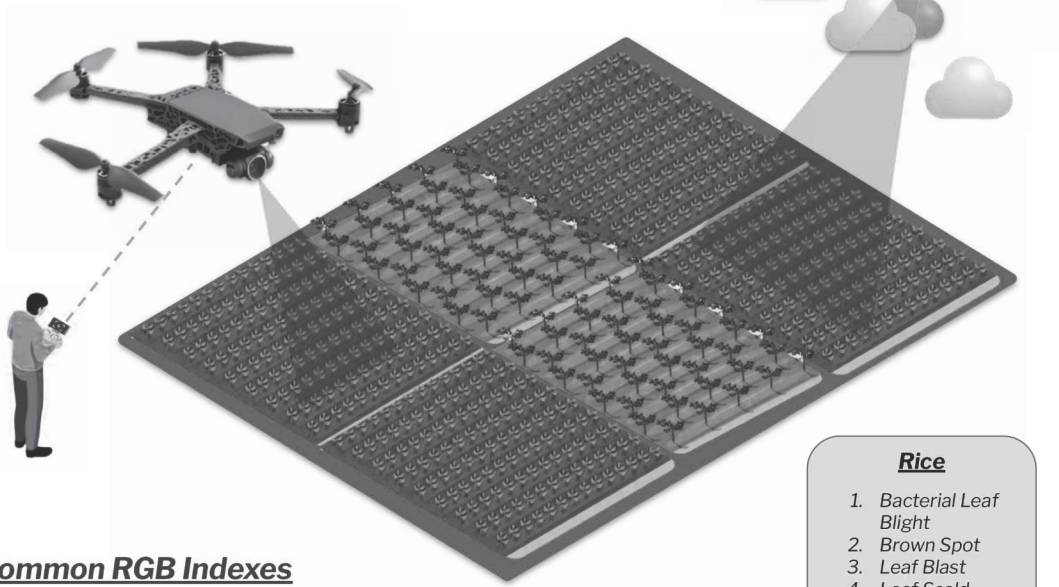
Digital India Power To Empower

SwaYaan

सी डैक CDAC

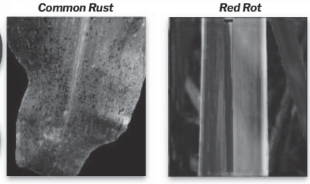
A Framework for Multi-layered Crop Health Monitoring using UAVs

Data Collection	Layer 1: Early Detection	Layer 2: Disease Identification
UAV mounted with RGB Camera	RGB-based Vegetation Analysis	AI/ML driven Classification



Common RGB Indexes

NGRDI (Normalized Green Red Difference)	• Chlorophyll indicator • Biomass measurement
GLI (Green Leaf)	• Vegetation vs. bare soil differentiation
RGBVI (RGB Vegetation)	• Growth stage analysis • Qualitative predictor
VARI (Visible Atmospherically Resistant)	• Vegetation highlighting in images



Rice

1. Bacterial Leaf Blight
2. Brown Spot
3. Leaf Blast
4. Leaf Scald
5. Brown Spot

Sugarcane

1. Red Rot
2. Red Rust

Highlights

- ❖ **In-house HPC: PARAM Buddha used for AI model training**
- ❖ **Collaborative research with Bihar Agricultural University(BAU), Bhagalpur Bihar**

Join us to Harness the Power of UAV Technology for Proactive Crop Management!

CENTRE FOR DEVELOPMENT OF ADVANCED COMPUTING(C-DAC)
(An Autonomous Scientific Society of Ministry of Electronics & Information Technology(MeitY), Govt. of India)
14th floor, BISCOMAUN Tower, West Gandhi Maidan,
Patna, Bihar, India - 800001
Phone: +91-82485 93185, Email: cpat_cpsg@cdac.in

इलेक्ट्रॉनिकी एवं सूचना प्रौद्योगिकी मंत्रालय
MINISTRY OF ELECTRONICS AND INFORMATION TECHNOLOGY

Digital India Power To Empower

SwaYaan

सी डैक CDAC

Aerial Rescue System: UAVs for Detection, Tracking and Aid Deployment

KEY FEATURES

- *AI enabled Real Time Object Detection*
- *Precise Geolocation Tracking*
- *Live Dashboard with Visual Insights*
- *Thermal Imaging for Night Operations*

सी डैक CDAC — Aerial Rescue System: UAVs for Detection, Tracking and Aid Deployment — SwaYaan

Waypoints	Timestamp	GPS Data			Detected Objects		Image
	Date	Latitude	Longitude	Altitude	Label	Confidence	
1	2025:01:02, 10:57:26	25.6159	85.1654	15	Person	73.83%	View
2	2025:01:02, 10:57:26	25.6162	85.1657	12	Person	75.00%	View
3	2025:01:02, 10:57:26	25.6165	85.166	10	Person	75.00%	View
4	2025:01:02, 10:57:26	25.6168	85.1663	11	Person	75.00%	View
5	2025:01:02, 10:57:25	25.6171	85.1666	13	Person	73.05%	View
6	2025:01:02, 10:57:25	25.6177	85.1672	12	Person	73.83%	View

CENTRE FOR DEVELOPMENT OF ADVANCED COMPUTING(C-DAC)
(An Autonomous Scientific Society of Ministry of Electronics & Information Technology(MeitY), Govt. of India)
14th floor, BISCOMAUN Tower, West Gandhi Maidan,
Patna, Bihar, India - 800001
Phone: +91-8248593185, Email: cpat_cpsg@cdac.in

EXPLORE THE WORLD OF DIGITAL TWIN TECHNOLOGY

REVOLUTIONIZE YOUR OPERATIONS WITH C-DAC PATNA'S DIGITAL TWIN TECHNOLOGY

C-DAC Patna is leading the charge in digital twin technology, transforming how organizations manage and optimize complex systems. Our cutting-edge solutions empower businesses to unlock new levels of efficiency, reliability, and innovation.

Key Features of Our Digital Twin Solutions

AUTOMATED REALTIME VISUAL MONITORING

VISION-BASED DECISION-MAKING

SCENARIO SIMULATION

UNKNOWN FEATURE DISCOVERY

MULTIDISCIPLINARY APPLICATION INTEGRATION

Partner with C-DAC Patna to Shape the Future

infocdacpatna@cdac.in

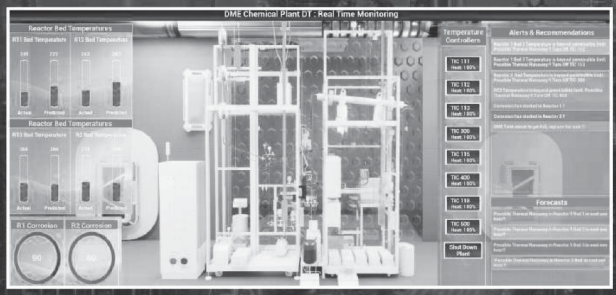
+91-612-2219021 /
+91-8757570233

www.cdac.in

DIGITAL TWIN FRAMEWORK FOR CHEMICAL PLANT AND URBAN SMART SOLUTION

Chemical Plant Digital Twins

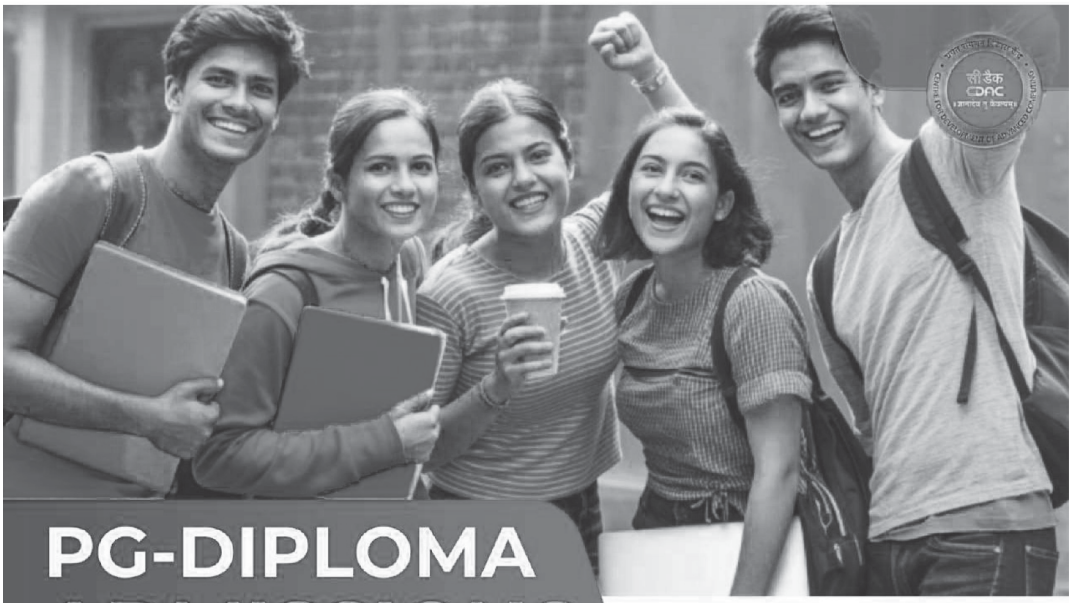
- Simulate complex chemical processes.
- Optimize production efficiency while ensuring safety standards.



Urban Smart Solutions

- Create digital replicas of cities.
- Optimize urban planning, transportation, and resource management.

Join us in leveraging digital twin technology to revolutionize industries and drive transformative change. Together, we can enhance operational performance, reduce risks, and unlock innovative opportunities.



PG-DIPLOMA ADMISSIONS

AUGUST 2025 BATCH

OPEN FOR REGISTRATIONS

27 MAY - 25 JUNE, 2025

APPLY NOW acts.cdac.in

UNLOCK YOUR FUTURE WITH C-DAC

Previous Conference on Quantum Physics

Quantum Physics & Consciousness

Visionary: Dr. T. D. Singh

4 & 5 February 2017

Venue

Rabindra Tirtha Complex
New Town, Kolkata - 700156
India
10 am to 6 pm

For Registration

www.binstitute.org/qpc
Limited registrations available

Contact

Sri Sushant Sharma
Organizing Secretary
sushant@binstitute.org
+91-9538422297

Topics

- Foundations of Quantum Mechanics: lessons learned
- Physics and Spirituality: Wisdom from Religious Traditions
- Looking Inside: Cells, Brain, Mind and Consciousness
- Science of Consciousness: Brain psychology and Health
- Quantum imprints in Life
- Copenhagen Interpretation and alternatives
- Theistic interpretation of quantum mechanics
- Quantum computing, Artificial Intelligence & Mind
- Probability, statistics and freewill
- Unsolved problems of Quantum Physics
- Philosophical implications of Quantum Mechanics
- Quantum Entanglement & Consciousness

Invited Speakers

- Prof. Amit Goswami, University of Oregon, USA
- Dr. Bernard Haisch, Astrophysicist, CA, USA
- Prof. Vittorio Marchi, Rome, Italy
- Prof. Sudipto Ghosh, IIT Kharagpur
- Dr. V. K. Saraswat, Ex-DG, DRDO & Member, Niti Ayoga
- Dr. Partha Ghose, S.N. Bose National Centre for Basic Sciences, Kolkata
- Dr. Bhaskar Kumar, IIT Guwahati
- Many more…

Organized by

Bhaktivedanta Institue, Kolkata & Bharatiya Vidya Mandir, Kolkata
www.binstitute.org www.bharatiyavidyamandir.org

For More Details:
https://binstitute.org/conference-quantum-physics-consciousness/

Appreciations by Past Participants

The way every lecture was presented, strong arguments were given to prove their points and they really widen my thinking.

– Prajwali Praveen Khirid

I liked how you connected spirituality to science and explained it very clearly and scientifically.

– Anitha Mandala

These kind of arrangement for delivering value education even at this pandemic influence where people are so much in depression and exhaustion being unable to be free to communicate properly outside. I am very much impressed with the beautiful arrangement made by BHAKTIVEDANTA INSTITUTE who worked so hard by themselves for the welfare of everyone. Thank you.

– Brajalika Devi

What was most amazing was that everyone, in their own way has to the best of their ability tried to expand, explain the existing facts and give a theory to what may be... And that's the first step to any research. This platform has been a yardstick to measure up against the best in the field, a way to glance at it through a window of safety (i.e. student's life) and prepare for what's expected in the field to come up successful if we step into research.

– Akash Dilip Tejwani

I liked the in depth knowledge and dedication of each of the teachers for their research.

– Siddharth Panwar

I really loved the explanation of Vedic perspective and why Science can't explain origin of life. Especially the session by Prof. Wickramsinghe and Prof Tour.

– Ravi Garg

Notes

Notes

भारतीय विद्या मन्दिर

योगः कर्मसु कौशलम

वसुधैव कुटुम्बकम

Our Vision & Mission

* Development of Society through Cultural, Ethical & Skilling Practices * Upliftment of humanity through talents of Indian Heritage & Culture * Education & Research * Publication of Books & Magazine * Social & Cultural Activities * Workers Training

BHARATIYA VIDYA MANDIR

12/1 NELLIE SENGUPTA SARANI, KOLKATA 700087
Email : bvm.vaichariki@gmail.com
Website : www.bharatiyavidyamandir.org
Phone : 033-7100-1614/1608
For more details please contact :
SECRETARY, SHANKAR LAL SOMANI - M : +91-9830559364

I am convinced that theoretical physics is actual philosophy. It has revolutionized fundamental concepts... and it has taught us new methods of thinking (complementarity) which are applicable far beyond physics.

— Max Born
Nobel Laureate in Physics

Jointly Organized by

Bhaktivedanta Institute
Kolkata | www.binstitute.org

C-DAC
Patna | www.cdac.in