



10th Summer School 2025 Report



On

Quantum Foundations

06-08 June 2025, BiswaBangla Convention Centre, Kolkata

The three-day Summer School, held on 06-08th June 2025, was a significant event organized jointly by the Bhaktivedanta Institute, Kolkata and Centre for the Development of Advanced Computing (C-DAC), Patna. The event is also part of Golden Jubilee celebrations of the Bhaktivedanta Institute, Kolkata. Hosted at Biswabangla Convention Centre, Kolkata, the summer school drew over 150 delegates and guests from premier institutions like IITs, IISERs, AIIMS, and other leading universities and colleges across India, filling the auditorium to capacity. There were banners and hoardings on Foundations of Quantum Physics and its incomprehensibility and possible connections with consciousness in and around the venue, featuring the views of the founding fathers of Quantum Physics and other renowned scientists as well as Scientist & Saint Dr. T. D. Singh, Founder Director of Bhaktivedanta Institute. A special banner was also displayed, offering a glimpse into the 50-year journey of the Bhaktivedanta Institute, highlighting its immense and selfless contributions to humanity, particularly in engaging the intellectual community through the integration of science and spirituality. Several thought-provoking quotes were displayed during the event, emphasizing the profound intersection between quantum physics and philosophical insight. Among them were: *“The great scientific contribution in the East has always been the realization that reality is not describable in terms of isolated material particles, but only in terms of interconnectedness and interdependence.”* – Werner Heisenberg, Nobel Laureate in Physics and *“The laws of quantum mechanics itself cannot be formulated... without recourse to the concept of consciousness.”* – Eugene P. Wigner, Nobel Laureate in Physics. In addition, individual book exhibitions by the Bhaktivedanta Institute were showcased at the venue, offering attendees a deeper exploration into the synthesis of science, consciousness, and spirituality.



Fig 1: Summer School Venue at Biswabangla Convention Centre, Kolkata

The conference commenced with a prayer to the almighty for blessings. Honourable Chief Guest **Prof. Pankaj Joshi**, *Distinguished Professor & Founding Director, International Center for Space & Cosmology, Ahmedabad University and Former Senior Prof. of TIFR Mumbai* along with other Distinguished Guests of Honour were invited onto the stage to address the gathering with their insightful words of wisdom. These include **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*. Dignitaries **Shri Aditya Kumar Sinha**, *Scientist G and Director CDAC Patna*; **Shri Vasudeva Rao**, *President, Bhaktivedanta Institute* and **Dr. Debasish Khan**, *IIT BHU, Convenor of Summer School 2025* & **Dr. Roshan Tiwari**, *Secretary of Summer School 2025* was also invited onto the stage. Shri Vasudeva Rao gave a welcome address highlighting the journey of Quantum physics and its surprising experimental results which appeared to challenge the science itself. He also said that quantum physics has taught us humility in understanding the limits of knowledge and ability to probe nature to indefinite precision. Shri Aditya Kumar Sinha emphasized on the importance of understanding quantum foundations despite having practical quantum technologies to build. He said that without foundations, we risk innovation without understanding. Prof. Pankaj Joshi and the guests of honor expressed their appreciation to the organizers and shared insightful remarks about the importance of the Quantum Foundations and its possible hints for Consciousness. The dignitaries also released the conference handbook.



Fig2: Inauguration of the Summer School: Release of Summer School Handbook

Around nineteen thought provoking lectures have been deliberated by the eminent speakers of the conference. The speakers were **Prof. Dipankar Home** (Retired Senior scientist) *Bose Institute, Kolkata*; **Prof. Pankaj Joshi**, *Distinguished Professor & Founding Director, International Center for Space & Cosmology, Ahmedabad University*; **Prof. Arun Kumar Pati**, *Director R & D, Quantum Synergy, New Delhi, Former Senior Prof. TCG Crest, Kolkata & HRI, Allahabad*; **Prof. Anthony Leggett**, *Nobel Laureate in Physics, University of Illinois, Urbana Campaign, USA*; **Dr. Markus Paul Müller**, *Institute for Quantum Optics and Quantum Information, Vienna, Austria*; **Prof. N.D. Hari Dass**, *Ex-Senior Professor, Institute of Mathematical Sciences, Chennai*; **Prof. Tejinder Singh**, *Professor, Tata Institute of Fundamental Research (TIFR), Mumbai*; **Prof. Archan S Majumdar**, *Senior Professor, S N Bose National Centre for Basic Sciences, Kolkata*; **Dr. Kunal Abhishek**, *Scientist E and Head of the Cyber Security & Forensics Department, CDAC Patna*; **Dr. Vilhelm Bohr**, *Chairman of Niels Bohr Archive, Ad. Professor University of Copenhagen, Grandson of Nobel Laureate Niels Bohr*; **Prof. Alfred Driessen**, *University of Twente, Netherlands*; **Dr. Anirban Bandyopadhyay**, *Principal Research Scientist, National Institute for Materials Science (NIMS), Tsukuba, Japan and many more.*

Day 1 hosted three technical sessions: The first technical session was chaired by Prof. Tapas Chakraborty, Vice-Chancellor, Maulana Abul Kalam Azad University of Technology (MAKAUT), Kolkata. The speaker was Prof. Dipankar Home.

Prof. Home talked about the quantum measurement problem remaining a central unresolved issue, particularly regarding the boundary between quantum and classical behavior in massive objects. He highlighted a novel experimental scheme using Leggett-Garg inequalities (LGI) which proposed to demonstrate quantum behavior in oscillating systems of any mass, challenging classical macrorealism.

The second technical session was chaired by Prof. Tejinder Pal Singh. The speakers were Prof. Pankaj Joshi, Sri Varun Agarwal (Director Bhaktivedanta Institute, IIT Kanpur alumnus) and Prof. Arun Pati. Prof.

Prof. Pankaj Joshi, in his talk, remarked that while science and technology extend the capabilities of our physical senses, artificial intelligence (AI) pushes the boundaries of the human mind and intellect, leveraging advancements in quantum theory, mathematics, and computing. This evolution prompts fundamental inquiries into the nature of intelligence, real intelligence (RI), and consciousness, which are now being actively explored by leading institutions worldwide. He further noted that ancient Indian traditions provide profound insights into these concepts, referring to such intelligence as Chitta—the conscious force that underlies thought, awareness, and understanding. The session continued with a talk by Sri Varun Agarwal. He presented how Consciousness remains a profound mystery across all scientific disciplines, including physics, mathematics, biology, and AI. He said that Founders of quantum physics and mathematics recognized its enigmatic nature, questioning whether self-awareness can arise from mere matter. He also added that insights from ancient Indian Vedantic wisdom may offer deeper understanding and suggest the need to broaden our scientific worldview to address the challenge of consciousness.

The third technical session was online sessions with Prof. Anthony Leggett and Dr. Markus Paul Müller as the speaker.



Fig 3: Talk by Prof. Anthony Leggett, Nobel laureate in Physics

Prof. Anthony Leggett, in his talk, delved into the profound question of whether the physical world possesses definite, observer-independent properties—a principle known as realism—and how recent quantum experiments challenge this foundational notion. He explained that EPR-Bell experiments test the boundaries of objective local theories, which are based on three key assumptions: realism, locality (no influence faster than light), and the absence of retrocausality (future events cannot influence the past). Notably, Prof. Leggett highlighted that it was only after November 2015 that experiments successfully closed all major loopholes—locality, freedom of choice, and detection—providing strong empirical evidence against classical realism and supporting the view that quantum mechanics is fundamentally nonlocal.

Dr. Müller said in his talk that quantum theory, though mathematically successful, can be reconstructed from simple information-theoretic principles without relying on traditional formalism. This reconstruction supports viewing the quantum state as a "catalog of probabilities", fully explaining its mathematical structure. He added that a broader shift toward a first-person perspective in physics—through *Algorithmic Idealism*—is proposed to address deeper enigmas like the Boltzmann brain problem and the simulation hypothesis.

The day concluded with a vibrant cultural segment, featuring spectacular performances of Manipuri and Odissi dance forms, offering a delightful and graceful finale to the first day of the event.



Fig 4: Cultural performances

On Day 2 five technical sessions were conducted. The first session was chaired by Prof. Dipankar Home. The speakers were Prof. ND Haridass, Shri Aditya Kumar Sinha & Shri Vasudeva Rao. During this session Prof. ND Haridass in his talk remarked that the Quantum Superposition Principle (QSP) is argued to be not just a key part, but the defining essence of quantum theory and the Fundamental features of quantum mechanics—such as complementarity, uncertainty, and entanglement—are shown to arise as direct consequences of QSP. However, he also noted that, despite its foundational role, the historical development of QSP lacks clarity, and its future validity is questioned, with potential implications if it were ever to break down. Shri Aditya Kumar Sinha said that thriving in a quantum-driven world requires reprogramming the human mind—shifting from rigid, linear thinking to adaptive, interconnected, and probabilistic reasoning. He also emphasized that the quantum-inspired practices in education, leadership, and personal growth foster exploration, empathy, and pattern recognition. He concluded that embracing quantum habits empowers individuals to tolerate paradox, adapt continuously, and see beyond surface-level patterns in an AI- and tech-transformed era. Shri Vasudeva Rao said that unlike classical physics, quantum mechanics lacks a clear picture of reality, with multiple mathematical formalisms yielding identical predictions but differing ontologies. This ambiguity necessitates interpretations—such as Copenhagen, Many-Worlds, and QBism—to bridge the gap between abstract formalism and observed phenomena. He remarked that the mysterious features of quantum theory,

like superposition, uncertainty, and wave-particle duality, challenge our classical intuition and invite deeper inquiry, including insights from Vedantic philosophy on consciousness and causality. The second session of Day 2 was chaired by Prof. Arun Pati. The speakers were Prof. Tejinder Pal Singh and Prof. Archan Majumdar.

Prof. Tejinder Singh, in his talk, addressed the puzzling nature of quantum nonlocality, as observed in wavefunction collapse and EPR experiments, which appears to challenge special relativity due to the presence of instantaneous, distance-spanning effects. He proposed a novel resolution involving the existence of two additional compact timelike dimensions, forming a 6D spacetime. This expanded framework introduces a new causal channel—described as a "quantum wormhole"—that connects distant events while preserving both quantum mechanics and relativity. Notably, it predicts the existence of a massless dark photon, offering a potential avenue for experimental validation.

Prof. Archan Majumdar focused on the central role of quantum uncertainty relations in shaping our understanding of nonclassical phenomena. He explained how these principles form the basis for key quantum effects such as the EPR paradox and quantum steering, which expose the limits of predictability and local realism. He further highlighted quantum contextuality—a consequence of uncertainty—as a foundational resource driving quantum advantage in various information processing applications.

The third session of Day 2 was chaired by Prof. (Dr.) Dhrubajyoti Chattopadhyay, VC of Sister Nivedita University, Kolkata. The speakers were Dr. Kunal Abhishek and Dr. Deepankar Sarmah.

Dr. Kunal Abhishek, in his talk, highlighted that in August 2024, NIST finalized three Federal Information Processing Standards (FIPS 203, 204, and 205) aimed at securing digital systems against emerging quantum threats. These post-quantum cryptographic algorithms strengthen encryption and digital signatures, ensuring enhanced security and future-proof compatibility. He emphasized that organizations can achieve quantum readiness by integrating these standards with fortified legacy systems, striking a balance between security, performance, and practicality.

Dr. Deepankar Sarmah presented his work on integrating high-impedance superconducting resonators with semiconductor spin qubits hosted in nanowire quantum dots, within the circuit QED framework. Using advanced spectroscopic and magneto-characterization techniques, his research reveals crucial insights into spin-photon coupling and qubit behavior. The results demonstrate the scalability and improved coherence offered by high-impedance resonators, marking a significant step toward robust, hybrid quantum computing architectures.

The fourth session of Day 2 was a Panel discussion providing the platform for a comprehensive dialogue on the topic "Past, Present & Future of Quantum Foundations". The panelists were Shri Varun Agarwal, Shri Aditya Kumar Sinha, Prof. Pankaj Joshi, Prof. Dipankar Home Dr. B.D. Mundhra, Prof. ND Haridass & Prof. Tejinder Singh who shared diverse perspectives drawn from their rich academic and professional experiences.



Fig 5: Interactive Panel on the topic (Day 2): Past, Present & Future of Quantum Foundations

The fifth session of Day 2 were online talks by Dr. Vilhelm Bohr & Prof. Alfred Driessen. Prof. Alfred Driessen explained that the commonly perceived "weirdness" of quantum mechanics stems more from the philosophical lens through which we interpret it than from the theory itself. He proposed that applying Aristotelian concepts, such as potentiality and the continuity of motion, provides a more coherent understanding of quantum phenomena like wavefunction collapse. This philosophical shift challenges the classical, atomistic worldview and offers a more intuitive and holistic framework for interpreting the foundational aspects of quantum mechanics.

On Day 3, four sessions were conducted. The first session was chaired by Shri Yogesh Udgire, CEO Quantum Trinetri. The speakers were Prof. Anirban Bandopadhyay, Shri Nishant Kumar Sekhar & Dr. Roshan Tiwari.

Prof. Anirban Bandopadhyay delivered the talk on the Modular Soliton–Polariton Quantum Supercomputing (MSPQS) framework which proposes a fully photonic, cryogen-free quantum supercomputing architecture using soliton-driven exciton-polariton condensate gates operating at ambient conditions. He added that by harnessing quantum-like behaviors in real-world data streams, MSPQS offers real-time predictive analytics and quantum-grade performance, surpassing classical methods in complex data environments.

Shri Nishant Kumar Sekhar, in his talk, emphasized that despite significant progress in logic, computation, and artificial intelligence, human thought remains resistant to complete mechanization due to its deeply rooted qualities of abstraction, emotion, and self-awareness. He highlighted the contributions of Gödel, Turing, and Wittgenstein, who revealed intrinsic limitations in algorithmic reasoning—limitations that continue to challenge both classical and quantum AI. Referring to the idea of the “unthinkable

machine,” he underscored that while machines can simulate certain cognitive functions, true human understanding is fundamentally complex, embodied, and beyond full replication.

Dr. Roshan Tiwari discussed conscious experiences (qualia) as inherently first-person phenomena, which cannot be fully captured or accessed through classical, third-person perspectives. He said that these experiences may be quantum in nature, exhibiting properties akin to quantum information—unobservable, incommunicable, and fundamentally private. Drawing on key principles such as the No-Cloning Theorem, Holevo’s Theorem, and the No-Hiding Theorem, Dr. Tiwari proposed that although qualia remain inaccessible, they are never truly lost, but may continue to persist in quantum form.

The second session was Short Oral Presentations from Young Minds. These talks represent a diverse and interdisciplinary exploration of quantum science, spanning foundational theory, historical perspectives, computational methods, and philosophical implications. Topics range from hydrogen atom modeling and baryogenesis simulations to Bell’s theorem, consciousness, and the uncertainty principle, showcasing both academic depth and emerging student insights. Collectively, the presentations highlight how quantum mechanics continues to inspire inquiry across physics, cosmology, computation, and human cognition, bridging past discoveries with future possibilities. The first three presenters were awarded cash prizes and books worth INR 10,000.



Fig 6: Young Minds Presenters with Commander Vivek Yadav (Retd), Scientist E & HoD, CDAC Patn

The third session featured an engaging mix of quizzes and interactive games. The quizzes focused on quantum phenomena, testing participants' understanding of key concepts. The

games included "Act It," "Chinese Whispers," and several others, adding a fun and collaborative element to the learning experience.



Fig 7: Quizzes and Games Session

The valedictory session marked the end of the Summer School, with the organizers extending their gratitude to all speakers, guests and all the volunteers.



Fig 8: Group Photo