



## Prof. Aditi Sen De



**N**ational Quantum mission is a bold step through which India aims to harness the power of quantum technology to drive innovation, strengthen security and boost various industries, positioning itself as a global leader in this cutting-edge field. A quantum information theorist from Harish-Chandra Research Institute, Prof. Aditi Sen De (Born 1<sup>st</sup> October 1974) is a pioneer contributor of this mission ensuring India's quantum leap! Her work stands at the forefront of quantum science, contributing profoundly to our understanding and application of quantum principles in technology and information processing.

Aditi's deep interest in mathematics and enthusiasm to find solutions to complex problems through logical reasoning was inspired by her mother who served as a maths teacher in a nearby school. Thanks to her parents Lakshmi Dey and Ajit Kumar Dey, her outlook about society expanded when she learnt history and archaeology, which increased her thirst towards development. She did her schooling at Sree Sarada Ashrama Balika Bidyalaya and completed higher secondary education at Sakhawat Memorial Govt. Girls High School, Kolkata.

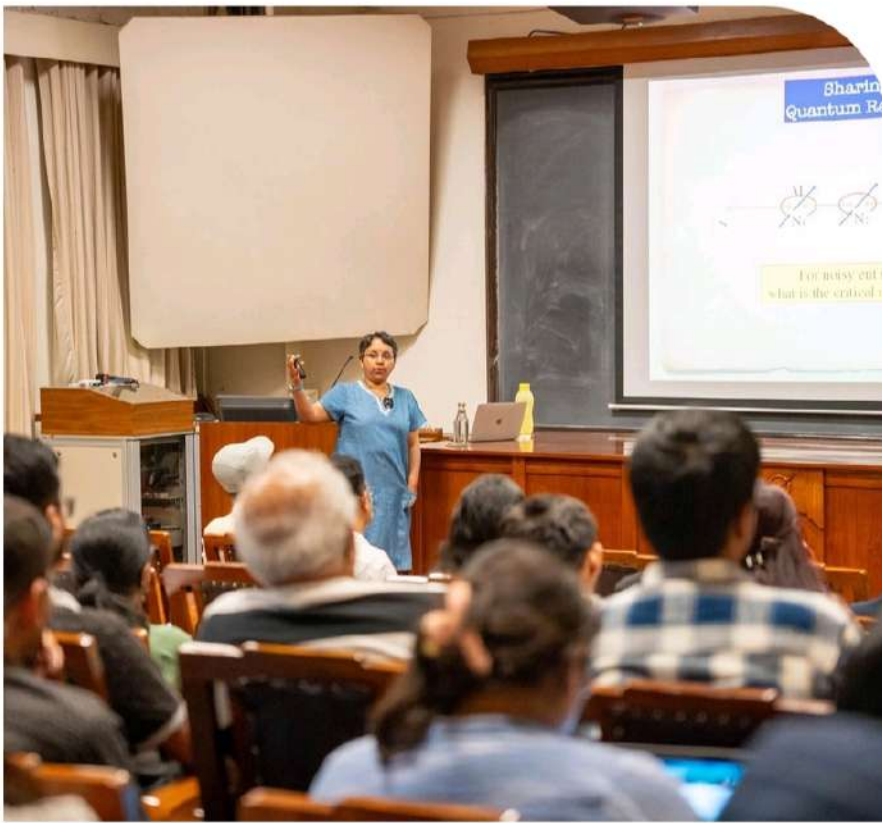
During her school days, she loved to role play teaching

mathematics using the blackboard at home, for her imaginary students. Her elder cousin who did Masters in statistics from Indian Statistical Institute (ISI), Kolkata broadened her path and passion to pursue Mathematics. She joined B.Sc. (Hons) in Mathematics from Bethune College.

Later she did her Masters at the reputable Applied Mathematics Department of the Rajabazar Science College, University of Calcutta. This department has produced a number of mathematicians as well as mathematical physicists renowned as international figures, like S.N. Bose, Meghnad Saha, Nikhil Ranjan Sen and many more. She recalls how being in this department greatly motivated her to pursue bigger ambitions. This is the place where she honed her expertise in quantum and statistical physics and started her preliminary research in the field of quantum information theory.

After obtaining her master's degree in 1997, she pursued her passion for quantum physics by joining research at the University of Gdańsk, Poland.





The field of quantum information and computation was still in its early days, and University of Gdańsk was one of the main research centres in the world, where important work on the theory of quantum entanglement was being done. In collaboration with her supervisor Marek Żukowski and other eminent physicists, she worked on some fundamental problems on quantum entanglement theory, quantum cryptography and quantum communication. Her husband Ujjwal Sen was also a researcher in the same institute. Aditi and her husband supported each other, grew together in an environment that was intellectually vibrant and rewarding.



Completing her doctoral studies, Dr. Aditi moved to Hanover, Germany as a Alexander von Humboldt research fellow to work with Maciej Lewenstein at the Leibniz University in 2004. She joined the quantum optics theory group at ICFO-The Institute of Photonic Sciences at Barcelona, Spain as postdoc fellow. Soon she became a Ramón y Cajal researcher by winning the prestigious tenure-track position from the Spanish Ministry of Science and Innovation. Here, she worked on implementation of error resistant universal quantum information processing during 2005-2008. Her group was involved in realising a neural network, in a chain of trapped ions with induced long range interactions, which permits one to store information distributed over the whole system. Her research also focused on the study of quantum phase transitions using entanglement as a key figure of merit.



Aditi decided to return to our motherland. After a brief stint as a faculty member in Jawaharlal Nehru University, she joined





Harish-Chandra Research Institute in Prayagraj in 2009. Along with other physicists, she started the Quantum Information and Computation (QIC) group here, which is involved in research on a wide spectrum of topics in quantum information and computation. This includes quantum algorithms, quantum communication, quantum cryptography and theory of entanglement. In 2012, she won the biennial Buti foundation award, given by the Indian Physics Association for her outstanding contributions in the area of theoretical physics. Other interests of this group include realisable quantum computers in

ultra-cold gases and in quantum optical systems. “It is a science at the crossroads of physics, computer science, mathematics, and information theory, and can potentially revolutionise the future of communication and computational technologies,” Prof. Aditi points out.

Dr. Aditi's research has been instrumental in advancing the field of quantum information and communication. Her notable contributions include the formulation of a computable entanglement measure, developing a novel density-matrix recursion method.

In the field of cyber security, her work involves investigations into the theory of quantum channels, the security of quantum cryptography and the quantification of quantum correlations. A giant leap in processing speeds also means faster breaking of encryption, which is the pillar of secure banking. “Currently, no country in the world has a quantum computer. But when anybody does, they will be able to break all the codes protecting our data today. People around the world are trying hard to build a quantum computer, they have built a few qubit-functional quantum computers, but there are lots of difficulties like scalability and proper physical systems. So, we need to work towards creating our own quantum computer as well as codes that cannot be broken by a future computer,” says this icon of quantum computing.

### Accolades

**2018-** Dr Shanti Swarup Bhatnagar Prize for Science and Technology given by CSIR each year. **She was the first woman to receive this prestigious award in the physical sciences category.**

**2022** - Elected to Indian Academy of Sciences and then to Indian National Science Academy.

**2023** - GD Birla Award for scientific excellence.

- **Neural network** is a computer system modelled on the human brain and nervous system.
- **Quantum entanglement** is when two particles link together in a certain way no matter how far apart they are in space.

