

## National Quantum Mission

### Why in News?

India's National Quantum Mission launched last year seeks to advance research in Quantum Technologies and promote indigenous research.

### What is Quantum Computing?

- **Quantum computing** - It is the computing technology that utilizes quantum mechanics to solve complex problems faster than on classical computers.
- It harnesses the unique behavior of quantum physics such as superposition, entanglement, and quantum interference and apply it to computing.

*Quantum mechanics - It is the science dealing with the behaviour of matter and light on the atomic and subatomic scale.*

- **Superposition** - is the ability of a quantum system to be in multiple states at the same time until it is measured.
- **Entanglement** - It is a phenomenon that explains how two subatomic particles get linked to each other irrespective of distance such that a level of change in one particle gets reflected on the other.
- **Interference** - It is a wavelike superposition of states of subatomic particles that affect the probabilities of states of these particles when measured.
- While entanglement is a phenomenon between two particles, interference is an effect of many particles surrounding each other.
- **Qubit** - It is the basic unit of information in quantum computing that plays a similar role in quantum computing as bits play in classical computing, but they behave very differently.
- Classical bits are binary and can hold only a position of 0 or 1, but qubits can hold a superposition of all possible states.
- Signals can be sent to the qubits using a variety of methods, including microwaves, laser, and voltage.
- **Quantum Computer Components** - A quantum computer has three primary parts
  - An area that houses the qubits
  - A method for transferring signals to the qubits
  - A classical computer to run a program and send instructions

To Know more about Quantum technologies , Click [Here](#).

## What is National Quantum Mission (NQM)?

- **Objectives**

- To seed, nurture and scale up scientific and industrial R&D.
- To Create a vibrant & innovative ecosystem in Quantum Technology (QT).
- To developing intermediate-scale quantum computers with 50-1000 physical qubits in 8 years.
- To create Satellite-based secure quantum communications between ground stations over a range of 2000 km within India.
- To develop long-distance secure quantum communications with other countries.
- To create inter-city quantum key distribution over 2000 km.
- To develop multi-node Quantum networks with quantum memories.

- **Launched in** - 2023

- **Mission Period** - 2023-24 to 2030-31

- **Nodal Ministry** - Ministry of Science and Technology

- **Four thematic hubs (T-hub)** - They will be established in top academic and National R&D institutes in the domains of

- Quantum Computing
- Quantum Communication
- Quantum Sensing & Metrology
- Quantum Materials & Devices

### Quantum Computer Projects in India

- The Tata Institute of Fundamental Research (TIFR), Mumbai, has developed a 3-qubit quantum computer based on superconducting qubits, and is preparing to develop a computer with 7 qubits in collaboration with DRDO and TCS.
- IISER Pune's I-HUB Quantum Technology Foundation is working on a 20+ qubit quantum computer based on ion traps and another computer based on neutral atoms along with IIT Roorkee and IIT Guwahati.
- IIT Bombay and IISER Thiruvananthapuram are working on spin qubits based on semiconductors, while IISc Bangalore is also working on superconducting qubits.
- The Chatterjee Group Centres for Research and Education in Science and Technology (TCG CREST), is building India's first quantum computer in association with TIFR and IISc Bangalore.

## How the Mission is aligned with other initiatives?

- The Mission will also provide a huge boost to National priorities like Digital India, Make in India, Skill India and Stand-up India, Start-up India, Self-reliant India and Sustainable Development Goals (SDG).
- **Digital India** - NQM supports the aims and ambitions of Digital India scheme by making effective computing and secure communication through advancements in the field of quantum technology.
- **Make in India** - The National Quantum Mission creates a niche for indigenous research and development (R&D), manufacturing, and investments for building quantum devices and related products.
- **Skill India** - The National Quantum Mission encourages skill development in the field of quantum technologies through training and education.

- **Stand-up India, Start-up India**- The National Quantum Mission stimulates innovation and entrepreneurship under its various verticals.
- **Self-reliant India** - The National Quantum Mission aims at advancing quantum technologies within the country, promoting indigenous research to minimise reliance on foreign resources.
- **Sustainable Development Goals (SDGs)** - Through NQM, global challenges related to climate (SDG 13), energy (SDG 7), and healthcare (SDG 3) can be addressed.

### What are the benefits of NQM in other sectors?

- The progress made in the field of the NQM can benefit various sectors such as communication, health, energy and finance in different ways.
- **Communication** - Quantum technologies enable secured encryption along with high speeds of data transfer in satellite communication.
- **Health** - Quantum computing would accelerate drug discovery, genomic research and precision in medical diagnostics.
- **Financial** - Quantum computing facilitates complex financial modelling and risk analysis through various optimization algorithms.
- Quantum cryptography enhances the security of financial transactions.
- **Energy** - **Improve** the optimization of energy grid and resource management through quantum computing.
- **Advanced materials** - Quantum simulations can lead to the discovery of new materials with unique properties such as superconductors, and advanced batteries.

*Quantum simulations simulate the behaviour of materials at the atomic level.*

### What are the challenges in achieving NQM Objectives?

- India is lagging behind countries like the US and China in terms of investment, publishing papers on quantum-related science, and registering patents.
- **Insufficient Investment** - India has allocated 6,000 crores (\$0.75 billion) for the National Quantum Mission whereas China and US allocate \$15.3 billion and \$3.75 billion respectively.
- **Inadequate Research** - India is 10<sup>th</sup> in terms of papers published related to Quantum Technologies.
- **Low Patent Creation** - Indian researchers had acquired only 339 such patents between 2015 and 2020 and ranks 9<sup>th</sup> by the number of patents obtained in Quantum Technologies.
- **Lack of Industry-academia linkage** - Collaborations between academic institutions, research organisations and industries are not enough to get the required momentum in research.
- **Fewer Quantum manufacturing** - In India, only about 3 per cent of deep tech start-ups are involved in the manufacturing or development of materials related to Quantum Technologies.
- **Deficient Skilled workforce** - Sufficient pool of scientists, engineers, and professionals who have specialised in quantum technology is not available.

## What lies ahead?

- Research in this area would require building state-of-the-art laboratories, the purchase of advanced equipment, and long-term support.
- Public and private sectors can come forward to fund research infrastructure and facilities through comprehensive investment models
- A collaborative research and development ecosystem would help integrate efforts across academia, industry, and government.
- Educational outreach initiatives to increase public awareness and industry-specific conferences to engage business leaders and investors would aid such efforts.

## References

[The Indian Express | National Quantum Mission](#)

