India Demonstrates Quantum Entanglement

Prelims: Science and technology| Current events of National Importance

Why in news?

Recently, Defence Research and Development Organisation (DRDO) and Indian Institute of Technology (IIT) Delhi successfully demonstrated quantum secure communication in India.

- India achieved **entanglement-based free-space quantum communication** over **a distance exceeding 1 kilometre**, marking a significant milestone in secure communication.
- **Quantum Entanglement** – It is a **quantum phenomenon** where two particles (like photons) become linked such that **any change in one instantly reflects in the other**, regardless of distance.

Communication through quantum entanglement

  - A pair of **entangled photons** is generated.
  - One photon is sent to the **sender**, the other to the **receiver**.
  - Characteristics of photons are **correlated**, allowing the generation of a **shared secre**t **key** forming a state of quantum entanglement.
  - If an outsider tries to intercept one photon, then the quantum state is disturbed and **intrusion is immediately detected**.
- **Free-Space communication –** The **transmission of photons through open air**, not through optical fiber or cable.
- It enables secure links over short urban distances, remote areas, and satellite-ground communication.
- **Security –** Based on the **laws of quantum physics**, any attempt to observe or intercept, changes the whole system's state.
- This makes the system **tamper-proof** and ensures that eavesdropping cannot go undetected.
- **Strategic Importance for India** – It helps to secure military, financial, and governmental communications.
- It reduces dependence on foreign encryption technologies.
- It contributes to **Atmanirbhar Bharat** in the field of cyber and data security.
- **Global context –** India now joins a list of elite countries like the **USA, China, and members of the EU** to demonstrate quantum communication and encryption technologies.
- It enhances India’s position in the emerging quantum technology race.
- **Future applications –** Forms the basis for Quantum Key Distribution (QKD) networks.
- Opens avenues for satellite-based secure links and quantum internet.

- Potential use in banking, defence, space, and critical infrastructure.

Reference

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