International Symposium on Quantum Information and Communication, 2025

Centre for Quantum Engineering, Research, and Education, TCG CREST, Kolkata

The dawn of a new era of quantum communication

Quantum Teleportation Meets the Internet: A Sci-Fi Dream Becomes Reality!

Quantum Information | Quantum Entanglement | Quantum Teleportation

Prof. Prem Kumar

"This is incredibly exciting because nobody thought it was possible. Our work shows a path towards next-generation quantum and classical networks sharing a unified fiberoptic infrastructure. Basically, it opens the door to pushing quantum communications to the next level "

Jordan Thomas

"By performing a destructive measurement on two photons – one carrying a quantum state and one entangled with another photon – the quantum state is transferred onto the remaining photon, which can be very far away,"

Key Idea

A method to place photons in a less crowded wavelength of light to minimize light scattering and reduce noise from busy high-speed Internet traffic.

Journal Reference

The discovery is published in the journal Optica vol 11, Issue 12, pp. 1700 – 1707 (2024).

What is quantum Teleportation?

Imagine a world where information doesn't just travel through cables but appears instantaneously at its destination, as if by magic. That's not just a sci-fi fantasy—it's the incredible power of **quantum teleportation**!

If you're picturing Star Trek-style teleportation, let's set the record straight—quantum teleportation doesn't move physical objects but instead transfers **quantum information**. Using the bizarre principle of **quantum entanglement**, two particles become so intertwined that measuring one instantly affects the other, no matter how far apart they are. This allows for the secure and seamless transmission of information without physically moving it—like sending a secret message through an invisible cosmic thread!

And now, thanks to cutting-edge research, this mind-bending phenomenon has taken a giant leap forward by proving it can work alongside the very fiber-optic networks that power our internet today. This can pave the way for revolutionary advances in secure communications and quantum computing.

Quantum Entanglement

Quantum entanglement is one of the strangest and most fascinating phenomena in physics. Albert Einstein famously called this "*spooky action at a distance*" because it seemed to defy classical physics. However, experiments have confirmed that entanglement is real and plays a key role in quantum mechanics.Entanglement has exciting applications, including ultra-secure quantum encryption and quantum computing, which could revolutionize technology in the near future.

Future Possibilities

The researchers believe this is just the beginning. Future quantum networks could enable:

- **Unhackable communications** using quantum cryptography.
- **Ultra-fast cloud computing** powered by quantum processors.
- **Teleportation of complex quantum states** over even greater distances.

As scientists refine the technology, we may soon see quantum-powered services running alongside our everyday internet, bringing us closer to a future where information moves in ways we once thought impossible!

The Big Breakthrough: Quantum and Classical Internet in Harmony

Until now, quantum teleportation was mostly demonstrated in special, isolated conditions. But a recent groundbreaking experiment, led by *Prof. Prem Kumar* and his group at *Northwestern University*, have successfully demonstrated **teleportation of quantum information over 30 kilometers of fiber**—the same type that carries everyday internet traffic at blazing speeds of **400 gigabits per second**!

Why is this huge? Because classical (regular) data signals are powerful and noisy, often drowning out delicate quantum signals. The fact that quantum teleportation worked under these real-world conditions means we're a step closer to a future where quantum networks can integrate seamlessly with existing internet infrastructure.

How did they do it ?

To pull off this technological magic trick, the scientists used a three-node system:

- **Alice** prepares a quantum state that she wants to send.
- **Bob** waits at the receiving end to reconstruct the state.
- **Charlie** acts as the middleman, performing a **Bell State Measurement** that destroys Alice's original state but instantly transfers it to Bob's end.

The trick was to protect the quantum signals from the interference of classical data traffic. The team achieved this using **special wavelength engineering, advanced filtering techniques, and ultra-sensitive detectors** that ensured the fragile quantum signals survived the noisy environment.

Why Does This Matter?

This breakthrough is a major stepping stone toward the **quantum internet**, a futuristic network that could revolutionize everything from **ultra-secure communications** to **supercharged computing**. By proving that quantum information can be teleported alongside conventional data, researchers have shown that we won't need an entirely new infrastructure to build the quantum internet—we can upgrade the one we already have!

So, the next time you send a message or stream a video, remember—you might just be using the same fiber-optic highway that, in the near future, could help quantum teleportation change the world!