Fiber optic communication of quantum memories is

Overview

[2504.05660] Entangling quantum memories over 420 km in fiberLong-distance entanglement is pivotal for quantum communication, distributed quantum computing.

Key Takeaways

Quantum memories can be entangled and linked over long distances using fiber optic networks, enabling secure and scalable quantum communication.Overview

Fiber optic communication of quantum memories involves transmitting quantum information stored in matter-based systems, such as atomic ensembles, through optical fibers. Unlike classical bits, qubits can exist in superpositions, and entanglement allows two distant quantum memories to share correlated states instantaneously, forming the backbone of quantum networks and quantum key distribution (QKD) .

Key Techniques
• Photon-Memory Interface: Quantum memories emit photons that carry the quantum state. To minimize loss in fiber, these photons are often converted to telecom wavelengths (S-band or C-band), which experience low attenuation (~0.17 dB/km) in standard optical fibers .

• Entanglement Generation: The Duan-Lukin-Cirac-Zoller (DLCZ) scheme is commonly used, where a single photon detection event can entangle two remote atomic ensembles. This approach increases the success probability compared to two-photon or atom-photon gate schemes .

© 2026 ALFA PRO COMMUNICATION SYSTEMS (Pty) Ltd - All rights reserved

• Phase Stabilization: Long fiber links introduce phase fluctuations due to environmental factors. Advanced stabilization techniques, combining full-time far-off-resonant locking and dual-band intermittent locking, maintain coherence between distant memories over hundreds of kilometers .

• Quantum Frequency Conversion: To match the low-loss transmission window of optical fibers, photons emitted from quantum memories are converted from their native wavelength to telecom wavelengths, enabling long-distance entanglement .

Achievements and Distances

• Experiments have successfully entangled quantum memories over 33 km and 420 km of fiber, demonstrating the feasibility of intercity-scale quantum networks .

• Quantum information has also been transmitted over 158 miles (~255 km) using standard telecom fiber infrastructure without cryogenic cooling, showing compatibility with existing networks .

Applications

• Quantum Key Distribution (QKD): Secure communication using entangled quantum memories ensures that eavesdropping can be detected.

• Distributed Quantum Computing: Linking quantum memories allows computation across multiple nodes.

• Quantum Internet: Fiber-based quantum memory networks are essential for building scalable, secure quantum networks across metropolitan and intercity distances .

Challenges

• Photon Loss: Even with telecom conversion, fiber attenuation limits distance without repeaters.

• Environmental Noise: Temperature fluctuations and vibrations affect phase stability.

• Integration with Classical Networks: Coexistence with conventional telecom traffic requires careful wavelength management and synchronization .

Conclusion

Fiber optic communication of quantum memories is a critical step toward practical quantum networks, combining long-distance entanglement, telecom-compatible photon transmission, and advanced phase stabilization. Recent experiments demonstrate that quantum memories can be reliably entangled over hundreds of kilometers, paving the way for secure quantum communication and distributed quantum computing applications .

© 2026 ALFA PRO COMMUNICATION SYSTEMS (Pty) Ltd - All rights reserved

Article Content

[2504.05660] Entangling quantum memories over 420 km in fiber

Long-distance entanglement is pivotal for quantum communication, distributed quantum computing and sensing.

Physicists Shatter Quantum Entanglement Distance Record With 420 ...

Across an optical fiber measuring 420 kilometers (261 miles), the researchers successfully entangled quantum

Physicists entangle quantum memories across a record-breaking 420 ...

Optical fibers are already the backbone of global communication systems. Recently, however, physicists have started

arXiv:2504.05660v1 [quant-ph] 8 Apr 2025

c ensemble quantum memories over 420 km. We convert photons emitted from the memories to telecom S-band, which enable us to

Entangling Quantum Memories through a 420 km Long Fiber

Long-distance matter-matter entanglement is pivotal for scalable quantum communication, distributed quantum

Researchers entangle quantum memories through 260 miles of fiber

A team led by researchers at the University of Science and Technology of China (USTC) entangled two quantum

Entanglement of two quantum memories via fibres over dozens of ...

Here we demonstrate entanglement of two atomic ensembles in one laboratory via photon transmission through city

China pushes quantum entanglement 4x to 260 miles across fiber

Quantum signals weaken rapidly inside optical fiber, making long connections difficult to maintain. Researchers in China

Optical fibres ''memory'' can improve quantum communication

A study shows a new technique to better transmit quantum signals over long distances.

Quantum internet leaves the lab

© 2026 ALFA PRO COMMUNICATION SYSTEMS (Pty) Ltd - All rights reserved

By allowing fragile quantum signals and powerful classical data streams to share the same optical fiber, the work

A boost in performance in fiber-integrated quantum memories

Researchers report the demonstration of entanglement between a fiber-integrated quantum memory and a telecommunications

A boost in performance in fiber-integrated quantum memories

One other requirement that has become a matter of considerable research is designing quantum memories that can be

Scientists achieve quantum communication across 155

The same research group previously demonstrated quantum data transmission over more

Optical fibres ''memory'' can improve quantum communication

Leggi in italiano An optical fiber cable. Credit: Ivan Bajic/ E+/ Getty Images. Transmitting quantum signals over long

Quantum and Classical Data Coexist in Fiber Optics

Quantum teleportation has been achieved by Northwestern University engineers, who transmitted entangled photons

Using quantum technologies to improve fiber optic communication systems ...

We discuss the near future impact that recent developments of quantum technologies can have in the field of fiber

Fiber-integrated quantum memory for telecom light

We demonstrate the storage and on-demand retrieval of single-photon-level telecom pulses in a fiber cavity. The cavity

[2504.05660v1] Entangling quantum memories over 420 km in fiber

Long-distance entanglement is pivotal for quantum communication, distributed quantum computing and sensing.

Quantum Entanglement in Optical Fiber

An all-optical, all-fiber network for quantum communication is necessary to accommodate

Quantum cryptography integrating an optical quantum memory

© 2026 ALFA PRO COMMUNICATION SYSTEMS (Pty) Ltd - All rights reserved

Developments in scalable quantum networks rely critically on optical quantum memories, which are key components

Quantum internet leaves the lab with first real-world entanglement

Quantum information is notoriously fragile. Internet traffic is anything but. Yet Northwestern University scientists have

Optical quantum memory and its applications in quantum communication ...

Abstract Optical quantum memory is a device that can store the quantum state of photons and retrieve it with high

Quantum Communication Experiments Over Optical Fiber

Quantum key distribution (QKD) is expected to be the first application of quantum information to be realized as a practical system. In

Quantum internet leaves the lab

Quantum information is notoriously fragile. Internet traffic is anything but. Yet Northwestern University scientists have

Entanglement of nanophotonic quantum memory nodes in a telecom

A key challenge in realizing practical quantum networks for long-distance quantum communication involves robust

Quantum communication advances on fiber networks

A key challenge remains the maturity of quantum hardware. Many essential components - like quantum memories -

Capturing Quantum Optical Information with Atomic Memories

In classical communications, a pulse of light carries information encoded as zeroes and ones, enabling the

A New Era in Quantum Communication: Fiber Optics

Explore how fiber optics are ushering in a new era of quantum communication, enabling ultra-secure data transmission and

Quantum teleportation coexisting with classical communications in ...

The optical fiber infrastructure and telecommunications technology that underlie the Internet have been widely

Record-breaking quantum memory brings quantum internet one step closer

© 2026 ALFA PRO COMMUNICATION SYSTEMS (Pty) Ltd - All rights reserved

Xiao-Hui Bao at the University of Science and Technology of China and his colleagues have now smashed that

A boost in performance in fiber-integrated quantum memories

Researchers report the demonstration of entanglement between a fiber-integrated quantum memory and a telecommunications

A boost in performance in fiber-integrated quantum memories

One other requirement that has become a matter of considerable research is designing quantum memories that can be

Scientists achieve quantum communication across 155

The same research group previously demonstrated quantum data transmission over more

Optical fibres ''memory'' can improve quantum communication

Leggi in italiano An optical fiber cable. Credit: Ivan Bajic/ E+/ Getty Images. Transmitting quantum signals over long

Quantum and Classical Data Coexist in Fiber Optics

Quantum teleportation has been achieved by Northwestern University engineers, who transmitted entangled photons

Using quantum technologies to improve fiber optic communication systems ...

We discuss the near future impact that recent developments of quantum technologies can have in the field of fiber

Quantum physics: Record entanglement of quantum memories

Researchers have entangled two quantum memories over a 33-kilometer-long fiber optic connection -- a record and an

Fiber-optic communication

An optical fiber patching cabinet. The yellow cables are single-mode fibers; the orange and blue cables are multi-mode fibers:

Optical Quantum Memory and its Applications in Quantum Communication ...

Abstract Optical quantum memory is a device that can store the quantum state of photons and retrieve it on demand and with high

Chinese Scientists Just Entangled Quantum Memories Over 50 km

© 2026 ALFA PRO COMMUNICATION SYSTEMS (Pty) Ltd - All rights reserved

Scientists have managed to get two quantum memories entangled over 50 kilometres (31 miles) of fibre optic cables,

Fiber-integrated quantum memory for telecom light

We demonstrate the storage and on-demand retrieval of single-photon-level telecom pulses in a fiber cavity. The cavity

[2504.05660v1] Entangling quantum memories over 420 km in fiber

Long-distance entanglement is pivotal for quantum communication, distributed quantum computing and sensing.

Quantum Entanglement in Optical Fiber

An all-optical, all-fiber network for quantum communication is necessary to accommodate high speed, high capacity

Quantum cryptography integrating an optical quantum memory

Developments in scalable quantum networks rely critically on optical quantum memories, which are key components

[2504.05660] Entangling quantum memories over 420 km in fiber

Long-distance entanglement is pivotal for quantum communication, distributed quantum computing and sensing.

Physicists Shatter Quantum Entanglement Distance Record With 420 ...

Across an optical fiber measuring 420 kilometers (261 miles), the researchers successfully entangled quantum

Physicists entangle quantum memories across a record-breaking 420 ...

Optical fibers are already the backbone of global communication systems. Recently, however, physicists have started

arXiv:2504.05660v1 [quant-ph] 8 Apr 2025

c ensemble quantum memories over 420 km. We convert photons emitted from the memories to telecom S-band, which enable us to

Entangling Quantum Memories through a 420 km Long Fiber

Long-distance matter-matter entanglement is pivotal for scalable quantum communication, distributed quantum

Researchers entangle quantum memories through 260 miles of fiber

© 2026 ALFA PRO COMMUNICATION SYSTEMS (Pty) Ltd - All rights reserved

A team led by researchers at the University of Science and Technology of China (USTC) entangled two quantum

Entanglement of two quantum memories via fibres over dozens of ...

Here we demonstrate entanglement of two atomic ensembles in one laboratory via photon transmission through city

China pushes quantum entanglement 4x to 260 miles across fiber

Quantum signals weaken rapidly inside optical fiber, making long connections difficult to maintain. Researchers in China

Optical fibres ''memory'' can improve quantum communication

A study shows a new technique to better transmit quantum signals over long distances.

Quantum internet leaves the lab

By allowing fragile quantum signals and powerful classical data streams to share the same optical fiber, the work

[2504.05660] Entangling quantum memories over 420 km in fiber

Long-distance entanglement is pivotal for quantum communication, distributed quantum computing and sensing.

Physicists Shatter Quantum Entanglement Distance Record With 420 ...

Across an optical fiber measuring 420 kilometers (261 miles), the researchers successfully entangled quantum

Physicists entangle quantum memories across a record-breaking 420 ...

Optical fibers are already the backbone of global communication systems. Recently, however, physicists have started

arXiv:2504.05660v1 [quant-ph] 8 Apr 2025

c ensemble quantum memories over 420 km. We convert photons emitted from the memories to telecom S-band, which enable us to

Entangling Quantum Memories through a 420 km Long Fiber

Long-distance matter-matter entanglement is pivotal for scalable quantum communication, distributed quantum

Researchers entangle quantum memories through 260 miles of fiber

© 2026 ALFA PRO COMMUNICATION SYSTEMS (Pty) Ltd - All rights reserved

A team led by researchers at the University of Science and Technology of China (USTC) entangled two quantum

Entanglement of two quantum memories via fibres over dozens of ...

Here we demonstrate entanglement of two atomic ensembles in one laboratory via photon transmission through city

China pushes quantum entanglement 4x to 260 miles across fiber

Quantum signals weaken rapidly inside optical fiber, making long connections difficult to maintain. Researchers in China

Optical fibres ''memory'' can improve quantum communication

A study shows a new technique to better transmit quantum signals over long distances.

Quantum internet leaves the lab

By allowing fragile quantum signals and powerful classical data streams to share the same optical fiber, the work

Related Video Reference

This video was associated with the source search result. Verify technical details against current product documentation and project requirements.

Contact Us

Continue your research online:

Website: https://alfa-pro.co.za
Technical inquiry: https://alfa-pro.co.za/contact.html

This document is for preliminary research. Verify specifications against current standards, product documentation and project requirements.

© 2026 ALFA PRO COMMUNICATION SYSTEMS (Pty) Ltd - All rights reserved