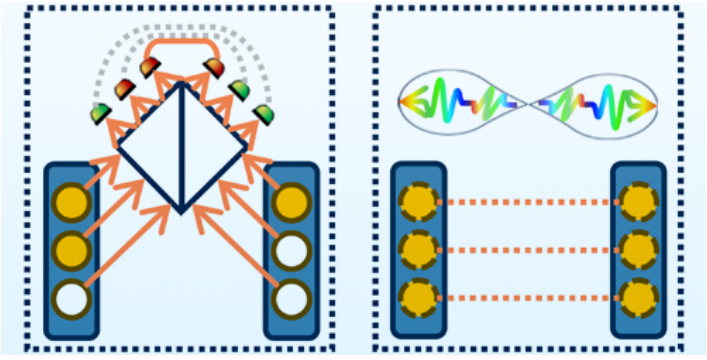
A Quantum Memory Test

Researchers propose a new way to evaluate the performance of quantum memory devices, which will be key components in a future quantum Internet.

By **Sophia Chen**

Since quantum signals can't be amplified like classical signals can, long-distance quantum networks will require quantum repeaters to relay photonic qubits over successive stages. A key component of these repeaters is a quantum memory, which stores information while adjacent links are established. Now Chang Li of South China Normal University and his colleagues have proposed a new metric to quantify the performance of a quantum memory on multiple measures [1]. Guided by this framework, they have also developed a quantum memory with an unprecedentedly well-rounded performance.

A quantum repeater transfers entanglement between photon pairs without requiring them to interact directly. A quantum memory enables this entanglement swapping by mediating between and synchronizing the photons involved. Li and colleagues identified four properties that such a memory should possess—high fidelity (accuracy), multimodal capacity (storing information encoded in multiple photon modes), long lifetime (stability), and high efficiency (the percentage of successfully recorded photons). They combine these properties into a single metric called the quantum interconnect rate (QIR).



Credit: H.-X. Luo *et al.* [1]

To maximize the QIR, the team created a quantum memory in which an incoming photon transfers its information to an ultracold cloud of rubidium atoms as a collective excitation. An identical photon is later reemitted by deexciting the gas. The researchers demonstrated the device using 11 spatial photonic modes, achieving 80% efficiency, a fidelity above 99%, and a lifetime of 28 microseconds. While other quantum memories have exceeded some of these figures, the new device has the highest overall score on the new QIR scale, which, Li says, better reflects real-world network performance.

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REFERENCES

1. H.-X. Luo *et al.*, "High-performance quantum memory for quantum interconnects," **Phys. Rev. Lett. 137, 070802 (2026).**