Quantum memories entangled over 50-kilometer cable

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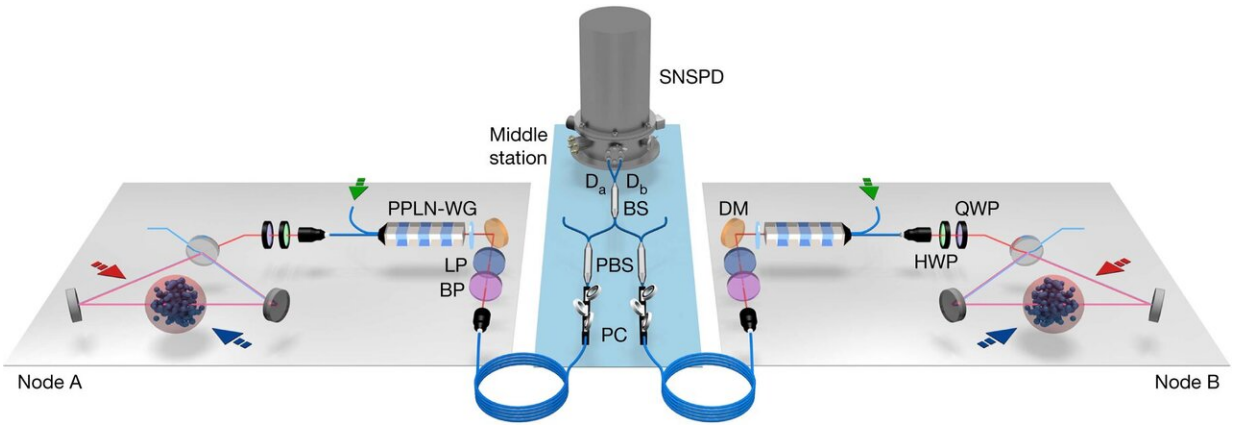

Schematic of the remote entanglement generation between atomic ensembles. Credit: *Nature* (2020). DOI: 10.1038/s41586-020-1976-7

A team of researchers affiliated with several institutions in China has succeeded in sending entangled quantum memories over a 50-kilometer coiled fiber cable. In their paper published in the journal *Nature*, the group describes several experiments they conducted involving entangling quantum memory over long distances, the challenges they overcame, and problems still to be addressed.

Over the past several years, scientists have been working toward the development of a quantum internet—one very much the same as the present-day network, but with much stronger security. One such

approach is based on the development of quantum keys that would allow parties to a private conversation to know that an interloper is eavesdropping, because doing so would change the state of the keys. But in such systems, measurements of the quantum state of the keys is required, which can be impacted by environmental conditions, making the approach nearly impractical.

Another approach involves using entangled particles to form a network—but this has proven to be difficult to implement because of the sensitivity of such particles and their short lifespan. But progress is being made. In this new effort, the researchers in China succeeded in entangling quantum memory between buildings 20 kilometers apart and across 50 kilometers of coiled cable in their lab.

The first experiment was based on the use of a small cloud of atoms placed in a desired quantum state—it represented a memory state—reading and writing operations were done using photons. To engage the memory state, the researchers forced them into an optical cavity, allowing photons to interact with the atoms in the cloud. Once the memory state was set, the cloud emitted a photon to announce its readiness.

That photon was then polarized, allowing it to carry information regarding the state of the memory collective, which meant it could be used to entangle the memory. But preventing it from being lost during transmission required shifting its wavelength to one that is commonly used in fiber cable communications. It was at this point that the memory was ready to travel across the cable. The process proved to be approximately 30 percent efficient. The second experiment involved creating just two quantum bits of memory from photons and sending them through 50 kilometers of coiled fiber.

Neither experiment is likely to lead to the creation of a quantum

internet, but both demonstrate that scientists are edging ever close to the ultimate goal.

More information: Yong Yu et al. Entanglement of two quantum memories via fibres over dozens of kilometres, *Nature* (2020). DOI: 10.1038/s41586-020-1976-7