Press release:

New progress in quantum communication: Physicists realized a long-lived quantum memory for single excitations.

Scientists from the University of Heidelberg, the University of Science and Technology of China, and the TU-Wien have taken a new step towards scalable quantum communication. They succeed in extending the lifetime of an atomic-ensemble-based quantum memory to the order of milliseconds, which for the first time allows for the quantum memory to persist for times comparable to the propagation of light over a few hundred kilometers.

In recent years, quantum repeater with atomic ensembles has attracted much attention, since it holds the promise to realize scalable long-distance quantum communication. Although significant progress has been achieved along this direction and the quantum repeater node has been experimentally demonstrated, scalable quantum communication remains challenging, due to the short lifetime of the quantum memory, which is currently on the order of 10 microseconds. It is long believed that the short coherence time is mainly caused by the residual magnetic field.

In the coming issue of the scientific journal Nature Physics, Jian-Wei Pan and his colleagues report now the realization of a long-lived quantum memory, where a single-quanta spin-wave excitation is stored in the atomic ensemble for 1 millisecond. The lifetime of the quantum memory has been enhanced by 2 orders of magnitude compared with previous work, and is long enough for photon transmission over several hundred kilometers.

In the present work, the scientists carefully analyze the decoherence mechanism of the quantum memory. They find that the effect of the magnetic field is not the only reason for the short lifetime. There is another important decoherence mechanism, i.e. the dephasing of the spin-wave induced by atomic random motion, which plays an important role in previous works but has not attracted sufficient attention. On the basis of this finding, the scientists exploit the magnetic field insensitive state, the “clock state”, and generating a long wavelength spin-wave, and succeed in extending the lifetime of the quantum memory from 10 microseconds to 1 millisecond.

Reference:

A millisecond quantum memory for scalable quantum networks

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