An efficient and long-lived quantum memory for quantum repeater

A research team led by Prof. Pan Jianwei (潘建伟) and Prof. Bao Xiaohui (包小辉) at the University of Science and Technology of China, reported the successful realization of an efficient quantum light-matter interface with sub-second lifetime, which can be used as an elementary unit to extend the distance of quantum communication through quantum repeater. This result was recently published in *Nature Photonics* (2016, 10: 381—384).

Towards a first quantum repeater based on memory-photon entanglement, significant progress has been made in improving performances of the building blocks. Further development is hindered by the difficulty of integrating key capabilities such as long storage time and high memory efficiency into a single system. Given a threshold efficiency of 50%, the longest storage time reported previously is merely limited to 1.2 ms, which is far away from the second regime requirement of quantum repeater.

In this paper, they report an efficient quantum light-matter interface with sub-second storage lifetime by making use of a 3D optical lattice confined atomic ensemble inside a ring cavity. The 3D lattice limits all atom-motion induced decoherence, and the ring cavity enhances the retrieval process. They use the technique of magic trap to compensate the lattice induced differential light shift. In order to be compatible with second regime storage, the ring cavity is stabilized during storage with a large-detuned reference beam. By taking the above measures, they finally realize a light-matter interface with an initial efficiency of 76(5)% together with an 1/e lifetime of 0.22(1) s simultaneously. Such a result already supports sub-Hz entanglement distribution up to 1000 km through quantum repeater, assuming perfect telecom interface, single-photon detectors with 100% efficiency and moderate multiplexing. In contrast, direct transmission of single photons does not allow quantum communication longer than 500 km. This study thus may enable a first quantum repeater system that beats direct transmission in the near future.

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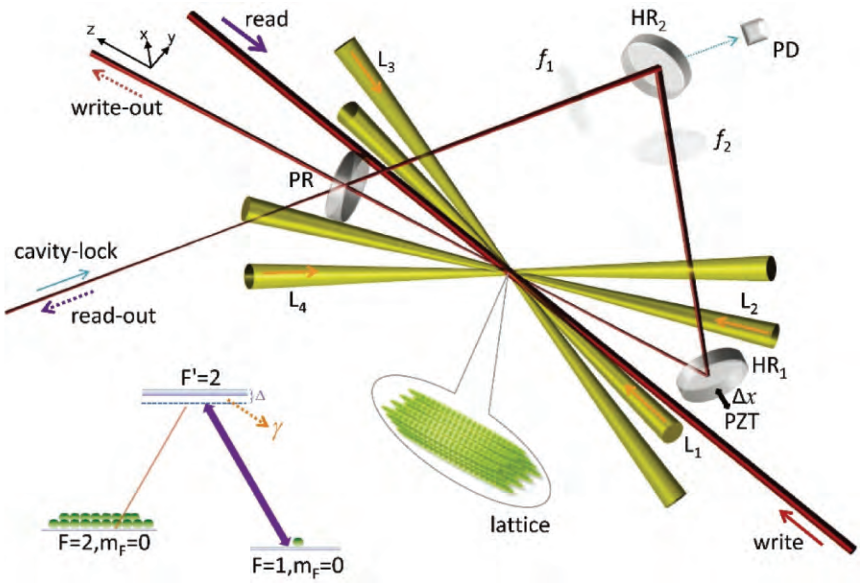

Figure Layout of the experimental setup.