Research group creates longer lived and more efficient quantum memory

May 30 2012, by Bob Yirka

(Phys.org) -- One of the main sticking points to creating a true quantum computer capable of performing meaningful work, is the problem of storing quantum state information in memory. Recent efforts have resulted in highly efficient memory that lasted only a short time or low efficient memory that lasts longer. Now, a combined group of two teams, one from China and one from Germany, have come up with a way that appears to offer the best of both worlds. As they describe in their paper published in the journal *Nature Physics*, they found that they were able to store quantum information in atomic spin waves.

Spin waves are where the electronic spin of one atom is transferred to another and then to another and so on propagating through a group. In this new research, the team found that by embedding information in a spin wave, and then retrieving it later, they could take advantage of the time it takes for the propagation to occur all the way though all of the atoms, thus allowing for holding onto quantum state information for a specified period of time.

To make this come about, the team built a magneto-optical trap that first slowed atoms down using a laser beam. Once slowed, the atoms were held steady using magnets in a vertical triangular trap. When a photon was introduced, it caused a spin that was propagated through the atoms, creating a spin wave. At the other end, another laser fired at the same frequency as the first but with the opposite polarization caused the spin to be converted back into a photon, which revealed the quantum state information that had been held first in the original photon, and then

conveyed through the wave. Using this technique, the team found that they could hold on to the quantum state information for 3.2 milliseconds and that the process was between seventy one and seventy five percent efficient.

What's more, the team believes that if optical lattices were introduced into the trap, i.e. crossed laser beams with different frequencies, they could make the whole system even more efficient. They also believe that this new process could be used as a means for creating memory storage in an actual quantum computer.

More information: Efficient and long-lived quantum memory with cold atoms inside a ring cavity, *Nature Physics* (2012) doi:10.1038/nphys2324

Abstract
Quantum memories are regarded as one of the fundamental building blocks of linear-optical quantum computation and long-distance quantum communication. A long-standing goal to realize scalable quantum information processing is to build a long-lived and efficient quantum memory. There have been significant efforts distributed towards this goal. However, either efficient but short-lived or long-lived but inefficient quantum memories have been demonstrated so far. Here we report a high-performance quantum memory in which long lifetime and high retrieval efficiency meet for the first time. By placing a ring cavity around an atomic ensemble, employing a pair of clock states, creating a long-wavelength spin wave and arranging the set-up in the gravitational direction, we realize a quantum memory with an intrinsic spin wave to photon conversion efficiency of 73(2)% together with a storage lifetime of 3.2(1) ms. This realization provides an essential tool towards scalable linear-optical quantum information processing.

via Arstechnica

© 2012 Phys.Org

Citation: Research group creates longer lived and more efficient quantum memory (2012, May 30) retrieved 28 April 2024 from https://phys.org/news/2012-05-group-longer-efficient-quantum-memory.html

This document is subject to copyright. Apart from any fair dealing for the purpose of private study or research, no part may be reproduced without the written permission. The content is provided for information purposes only.