Atoms function as light-trappers and transporters

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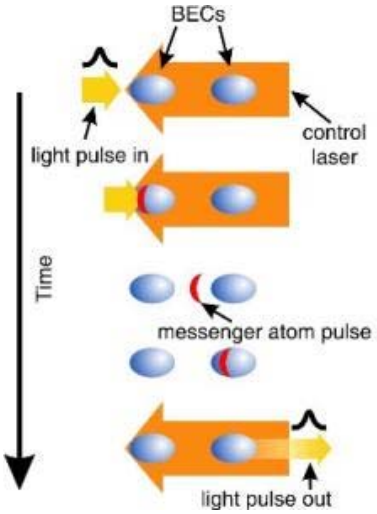
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A pulse of light can be stopped, transported, and restarted again using a cloud of super-cold atoms, US researchers have shown. The technique could ultimately be used for advanced computing devices or gravity detectors.

The experiments demonstrate physicists' increasing ability to manipulate light. Being able to control it in this way could be useful for optical or quantum computers, the team suggests.

"The first time I read this paper, I didn't believe it," says Michael Fleischhauer, a theoretical physicist at the University of Kaiserslautern in Germany. "Even though theory tells us it should be possible, actually doing it is something else."



A pulse of light can be stopped, transported, then restarted using a Bose-Einstein condensate (BEC) (Image: Nature)

Naomi Ginsberg, Sean Garner and Lene Hau of Harvard University, US, used a method first developed in 2001 to imprint a pulse of laser light onto a collection of sodium atoms cooled to just above absolute zero. (These sodium atoms were a form of matter known as a Bose-Einstein condensate - see Creation of new state of matter takes Nobel Physics Prize.)

Original pulse

When the pulse hits the atoms its features are transferred into small oscillations of positive and negative charge. These oscillations are short-lived, but a control laser can be used to turn them into longer-lasting spin states in some of the atoms.

When the control laser is switched off, the atoms drift due to recoil from its beam, carrying the information from the original pulse with them. Previous experiments have shown that turning the control laser back on, before the atoms have drifted too far, allows the light pulse to be recovered.

Ginsberg and colleagues positioned a second Bose-Einstein condensate 160 micrometres away from the first. They allowed excited atoms from the first condensate to drift over, then hit them with the control laser. The original light pulse is reconstructed - a process that depends on the presence of both excited and unexcited atoms.

No different

This is the first demonstration of one of the basic statements of quantum mechanics, called "indistinguishability", explains Fleischhauer. In the Harvard experiment, the indistinguishable nature of atoms in the two Bose-Einstein condensates allows the original light pulse to be recovered. The quantum waveform is the same whichever cloud the atoms inhabit.

The experiment "points to a number of avenues in classical and quantum information processing", write the Harvard team in the journal *Nature*. "As a messenger atom pulse that embodies the incident light travels in free space it can be independently trapped - potentially for minutes".

Fleischhauer agrees: "You can imagine a network in which photons are used to transfer information, before that information is stored in atoms."

He also told **New Scientist** that it might even be possible to transport single photons of light using single atoms. "That would be very impressive to see and might allow more powerful information processing," he says.

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