

Researchers subtract a single quantum of light from a laser beam

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In a collaboration between Aarhus University and the University of Southern Denmark, researchers have discovered a way to subtract a single quantum of light from a laser beam. This work has recently been published in *Physical Review Letters*. The method paves the way toward future quantum communication and computation using quantum mechanics for technological applications.

Light is made up of little indivisible packets of energy, or particles, known as photons. A defining property of photons is that they are non-interacting, simply passing through each other totally unaffected. In the context of quantum communication, this is a very useful feature, as it ultimately enables low-loss transmission of optically encoded data over very large distances. However, many emerging ideas for [quantum information processing](#) would greatly benefit from the ability to make two photons interact in such a way that one affects the propagation or state of another.

In recent years, ultracold atomic gases have proven to be an ideal medium in which to manipulate light. For example, using a technique known as electromagnetically induced transparency, researchers can drastically modify the velocity of light propagation and slow light down to astonishingly slow speeds of just a few meters per second.

Perhaps even more remarkably, light can be halted by converting the photons into atomic excitations within the medium. By reversing this process and mapping the excitations back onto photons, this procedure

realises a photonic [quantum memory](#) in which photons can be temporarily stored and retrieved on demand.

Together with the team from Aarhus University and collaborators from the Joint Quantum Institute at the University of Maryland, the experimental team in Odense has implemented such a photonic memory, but with a special form of atomic gas in which the constituent atoms feature strong interactions.

This effectively makes the photons detect one another in the quantum memory, allowing researchers to manipulate light on a nonlinear level. Using this idea, the groups have devised and demonstrated a novel way to subtract a single [photon](#) from an optical beam by using another beam of light.

The general idea is first to store an optical field, and then send another one through the medium. Photons in the second beam detect the stored photons and interact with them in such a way that a single photon is tagged and later discarded on retrieval. Being robbed of a single photon, the original [light](#) beam is left in a peculiar quantum state that in itself has numerous scientific and technological applications.

Indeed, the underlying idea of manipulating photons using such a nonlinear quantum memory holds promise for many applications in quantum information science. While more study is required before such capabilities become fully practical, the demonstrated prototype photon subtractor is an important milestone toward [quantum](#) technologies based on interacting photons.

More information: C. R. Murray et al, Photon Subtraction by Many-Body Decoherence, *Physical Review Letters* (2018). [DOI: 10.1103/PhysRevLett.120.113601](#)

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