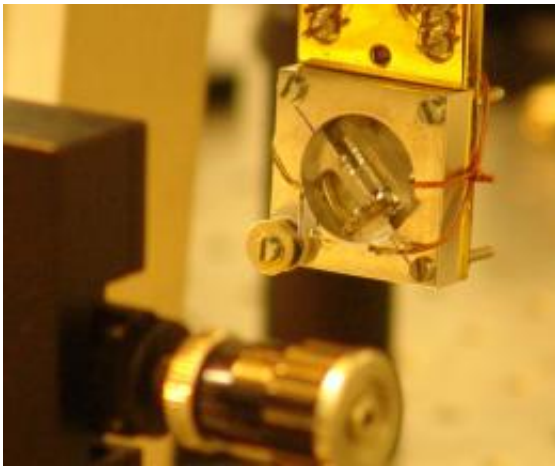


Single photon solid-state memory for telecommunications

March 8 2010, By Miranda Marquit



Cold finger of the cryostat with the erbium-doped crystal in which the light pulses were stored. The crystal is at the center of the circle at an angle of 45° . You can see two of the four electrodes attached to the crystal used to control the atomic coherences (the two parallel silver stripes also at an angle of 45°). Image source: University of Geneva

(PhysOrg.com) -- One of the issues associated with quantum information schemes revolves around the ability to develop quantum memories that allow for the retrieval of information on demand. Overcoming this issue is especially important for the advancement of long distance telecommunications. In order to use quantum means to send information over long distance, it is necessary to implement quantum repeaters so that data is not destroyed due to the absorption loss in optical fibers.

These quantum repeaters require some sort of solid-state memory at the single [photon](#) level. And, thanks to a recent experiment at the University of Geneva in Switzerland, it's possible that quantum information science is a little closer to application. "We were able to show how to store and retrieve, on demand, weak light pulses at the single photon level with a wavelengths optimized for fiber transmission. This provides a direct way to interface photons used for quantum communication with a [quantum memory](#)," Björn Lauritzen tells *PhysOrg.com*. Lauritzen and his colleagues present their work in *Physical Review Letters*: "Telecommunication-Wavelength Solid-State Memory at the Single Photon Level."

"We managed to reduce the noise involved with this technique as well," Lauritzen says. "What we have shown is a proof of principle that you can create a solid-state quantum memory for photons at telecommunication wavelengths, and this should be quite helpful in long distance [quantum communications](#)."

Lauritzen and his peers used an yttrium orthosilicate crystal doped with erbium ions to store light pulses on the single-photon level. The memory uses a photon echo technique based on controlled reversible inhomogenous broadening. "First, we prepared the crystal through optical pumping," Lauritzen explains. "We prepared a narrow absorption line, which we artificially broadened using an external electrical field. When we sent in a weak pulse of light, which then was collectively absorbed by the ensemble of ions, and a de-phasing took place. We can reverse it by flipping the polarity of the electrical field."

With this method, it was possible for the Geneva team to retrieve the information it had sent in originally when it wished. "This method is especially good for quantum repeaters, providing quantum memory at telecommunication wavelengths, making it possible to send quantum over distances not possible now."

Other applications are also possible, according to Lauritzen. “This method could also provide a single photon source,” he says. “If you can retrieve the photon on demand, you can build up a source of photons, and command the emission of one at a time. This could be useful in a number of science experiments that require a single photon source.”

The results are also interesting in terms of materials research. Exploring the properties of rare earth metals, like the erbium used to dope the crystal in the experiment, could provide some insight into new methods and techniques for future applications. “This might stimulate some materials research, especially with erbium,” Lauritzen insists.

For now, though, Lauritzen is interested in improving this technique for communication purposes. “We’re working on memory based on atomic frequency combs, as well as testing out different conditions, such as temperature and influence of the magnetic field, to see whether we can reduce losses due to an absorbing background to increase efficiency and really make long distance quantum [telecommunications](#) possible.”

More information: Björn Lauritzen, et. al., “Telecommunication-Wavelength Solid-State Memory at the Single Photon Level,” *Physical Review Letters* (2010). Available online: link.aps.org/doi/10.1103/PhysRevLett.104.080502

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