Researchers demonstrate electo-optic modulation of single photons from a quantum dot

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(PhysOrg.com) -- In a recent article in *Applied Physics Letters,* CNST researchers demonstrated how commercially available electro-optic modulators can be used to tailor the single photon output of quantum dots (QDs) for use in broadband quantum memories and other systems.

Nanoscale light-emitters such as semiconductor QDs are leading candidates for the stable generation of single photons "on demand" for use in communications, information processing, and metrology.

To create such photons, a train of laser pulses can be used to optically excite a single, epitaxially-grown semiconductor QD, which then emits a train of single photon pulses. However, the temporal profile of these single photon pulses, described as a photon wave packet, is typically not ideal for use in quantum information processing.

Using commercial, high-performance telecommunications electro-optic modulators, the researchers were able to temporally manipulate these wave packets to produce a variety of shapes, including optimally-shaped Gaussian pulses. Compared to previous work, this approach reduced the modulation timescale more than two orders of magnitude, reaching the sub-nanosecond regime needed for semiconductor QDs.

Finally, the researchers proposed that such electro-optic modulation may be a method for improving the quality of single photons from existing QD sources. Because of decoherence, single photons generated by a QD are not identical, and instead have different wave packets. Electro-optic modulation could be a flexible and spectrally broadband way to select for the decoherence-free portion of the QD emission, and thereby improve the photon indistinguishability needed for quantum information processing applications.

More information: Subnanosecond electro-optic modulation of triggered single photons from a quantum dot, M. T. Rakher and K. Srinivasan, *Applied Physics Letters* 98, 211103 (2011). doi:10.1063/1.3593007

Abstract
Control of single photon wave-packets is an important resource for developing hybrid quantum systems which are composed of different physical systems interacting via photons. Here, we extend this control to triggered photons emitted by a quantum dot, temporally shaping single photon wave-packets on timescales fast compared to their radiative decay by electro-optic modulation. In particular, telecommunications-band single photons resulting from the recombination of an exciton in a quantum dot with exponentially decaying wave-packets are synchronously modulated to create Gaussian-shaped single photon wave-packets. We explore other pulse shapes and investigate the feasibility of this technique for increasing the indistinguishability of quantum dot generated single photons.

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