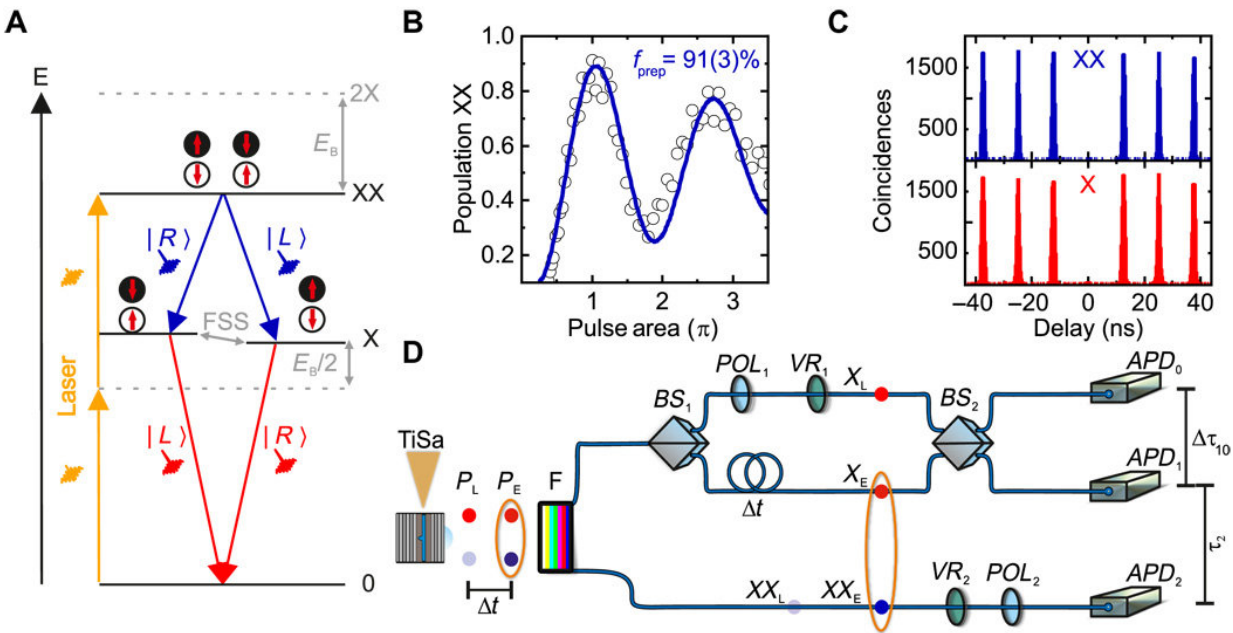


# Researchers demonstrate teleportation using on-demand photons from quantum dots

December 17 2018, by Bob Yirka



On-demand photon source and quantum teleportation setup. (A) The radiative recombination of XX-X states provides two photons entangled in polarization if the energetic splitting of the X state, the fine structure splitting (FSS), is sufficiently low. The on-demand generation occurs via a resonant laser tuned to half the energy of the XX state. EB indicates the XX binding energy. (B) Population of the XX state as a function of the pulse area. The experimental data (circles) are modeled as an exponentially damped sine-squared function (purple curve) to determine the depicted preparation fidelity. (C) The autocorrelation measurements for the XX and X transition of a representative QD. (D) The experimental setup for quantum teleportation. A pulsed laser [titanium sapphire (TiSa)] is used to excite two times the QD, which then emits an early pair (PE) and a late pair (PL) of entangled photons separated by  $\Delta t$  in time. The XX and X

photons are then spectrally separated by a filter (F). The early XE and late XL pass a HOM Mach-Zehnder consisting of two beam splitters (BSs), performing the Bell state measurement. Polarizers (POLs) and variable retarders (VRs) are used to define the XL input state and XXE detection state accordingly. The three-photon correlation measurement is then recorded as a function of arrival times  $\tau$  with avalanche photodiodes (APDs). Credit: *Science Advances* (2018). DOI: 10.1126/sciadv.aau1255

A team of researchers from Austria, Italy and Sweden has successfully demonstrated teleportation using on-demand photons from quantum dots. In their paper published in the journal *Science Advances*, the group explains how they accomplished this feat and how it applies to future quantum communications networks.

Scientists and many others are very interested in developing truly [quantum communications networks](#)—it is believed that such networks will be safe from hacking or eavesdropping due to their very nature. But, as the researchers with this new effort point out, there are still some problems standing in the way. One of these is the difficulty in amplifying [quantum](#) signals. One way to get around this problem, they note, is to generate photons on-demand as part of a quantum repeater—this helps to effectively handle the high clock rates. In this new effort, they have done just that, using semiconductor [quantum dots](#).

Prior work surrounding the possibility of using [semiconductor quantum dots](#) has shown that it is a feasible way to demonstrate teleportation, but only under certain conditions, none of which allowed for on-demand applications. Because of that, they have not been considered a push-button technology. In this new effort, the researchers overcame this problem by creating quantum dots that were highly symmetrical using an etching method to create the hole pairs in which the quantum dots develop. The process they used was called a XX (biexciton)–X (exciton)

cascade. They then employed a dual-pulsed excitation scheme to populate the desired XX state (after two pairs shed photons, they retained their entanglement). Doing so allowed for the production of on-demand single photons suitable for use in teleportation. The dual pulsed excitation scheme was critical to the process, the team notes, because it minimized re-excitation.

The researchers tested their process first on subjective inputs and then on different quantum dots, proving that it could work across a broad range of applications. They followed that up by creating a framework that other researchers could use as a guide in replicating their efforts. But they also acknowledged that there is still more work to be done (mostly in raising the clock rates) before the [process](#) could be used in real-world applications. They expect it will be just a few more years.

**More information:** Marcus Reindl et al. All-photonic quantum teleportation using on-demand solid-state quantum emitters, *Science Advances* (2018). [DOI: 10.1126/sciadv.aau1255](https://doi.org/10.1126/sciadv.aau1255)

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