Generating multi-photon entangled states from a single deterministic single-photon source

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We present a new compact fiber optic system which together with a high brightness single-photon source facilitates the generation of many photon entangled states. This configuration could generate entangled states of any number of photons.

A key resource for quantum computation is many particle entangled states of which states known as linear clusters[1] serve as a fundamental infrastructure. Notoriously, creating entangled states with larger and larger photon numbers is difficult and complex. This is a result of the non-deterministic emission of current photon sources, different photon source distinguishability and the scalability of such current schemes. Our previous work[2] demonstrated a solution for the latter two using a probabilistic single photon source.

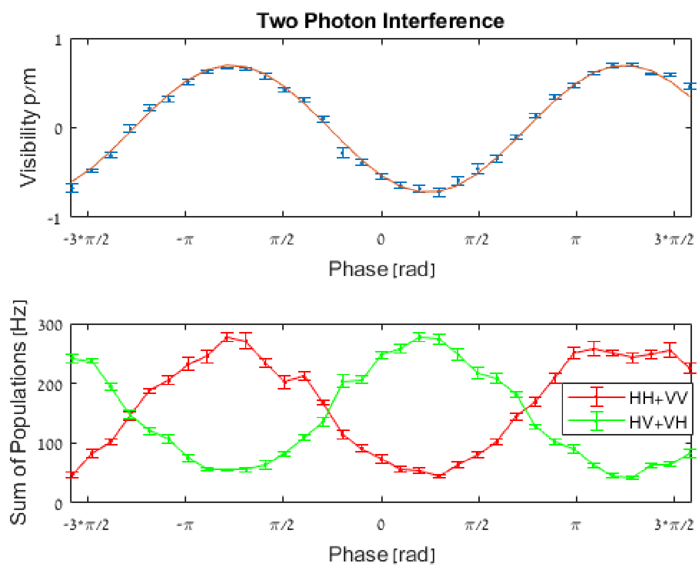

Figure 1: Preliminary results for a two-photon entagled state: The visibility (top) and the respective two-photon populations (bottom) as a function of the controlled phase.

In the work presented here, utilizing a single semi-conductor quantum dot in an electrically controlled cavity as a deterministic high brightness single-photon source[3], we use a specially fabricated fiber optic system to entangle consecutive photons in the polarization degree of freedom. Denoting horizontal (vertical) polarization as $|H\rangle\,(|V\rangle)$, Figure 1 presents the two-photon entanglement measurements for the Bell state $|\phi^+\rangle = \frac{1}{\sqrt{2}}\left(|HH\rangle + e^{i\varphi}|VV\rangle\right)$ in the $|p\rangle, |m\rangle = \frac{1}{\sqrt{2}}(|H\rangle \pm |V\rangle)$ basis with the achieved visibility of more than 70%.

References

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