Phase modulation **spreads** the single photon over multiple frequencies and **keeps** the **single photon property**

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Reconfigurable frequency coding of triggered single photons in the telecom C–band

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10.1364/OE.27.014400 (2019)

Talk to me

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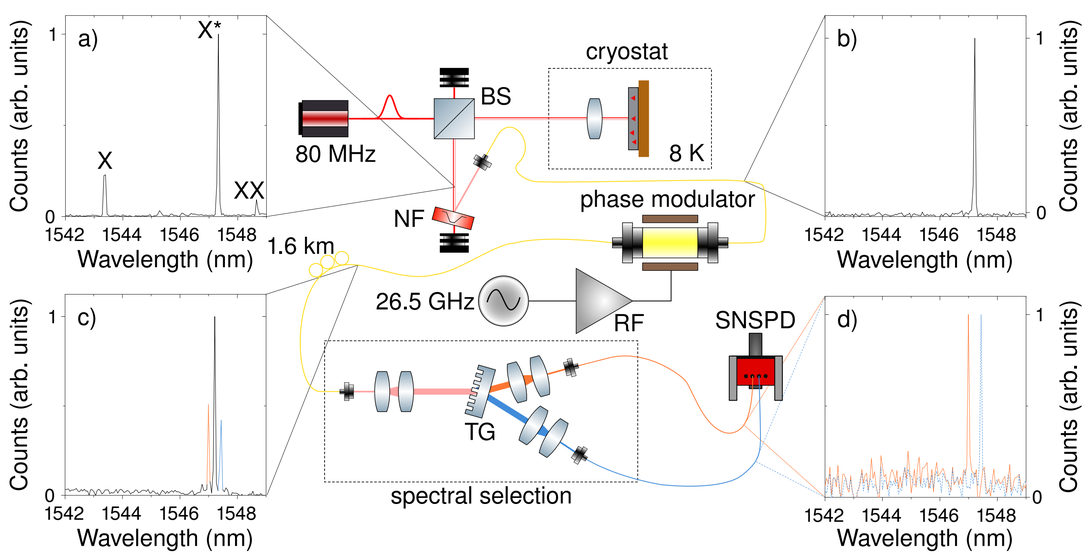
Intro

Quantum Key Distribution (QKD) can provide **key exchange** secured by **physical laws**.

Photons at Telecom wavelength (1550nm)[1] allow to **reuse deployed infrastructure** with **low propagation loss**.

Quantum Dots (QD) can create **pure single photons**[2].

Setup



a) Quantum dot spectrum under pulsed quasi-resonant excitation (1470nm) with 2ps pulses.

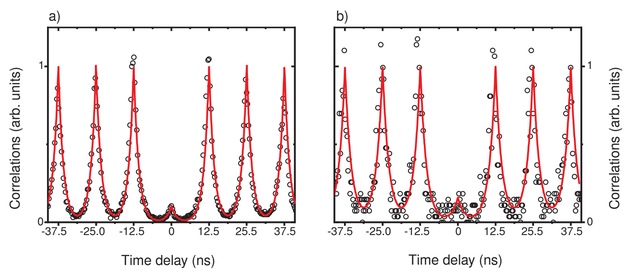
b) Filtered spectrum (only X* line) after reflection on a tunable notch-filter.

b) Modulated spectrum using a phase modulator driven with 26.5GHz.

b) Sidebands (0.42nm spectral separation) are spectrally filtered from each other by using a transmission grating and coupling the sidebands into separate optical fibers which are connected to SNSPDs.

BS: Beamsplitter, NF: Notch Filter, TG: Transmission Grating,
SNSPD: Superconducting nanowire single photon detectors

Second order correlation before and after modulation



a) Autocorrelation measurement of the filtered X* line. A fit to the data yields $g_2(0)$ = **0.11 ± 0.03**.

b) Cross-correlation between the two sidebands yields $g_2(0)$ = **0.16 ± 0.06**.

Results

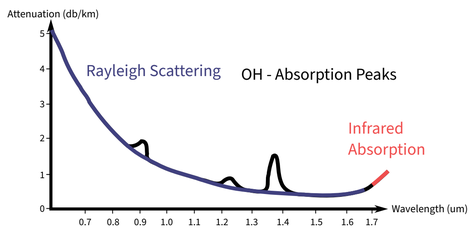
Photons at 1550nm allow the use of **off-the-shelf** telecom **equipment**.

Low insertion loss for classical communication is **not low enough** for quantum technologies

Phase modulation offers a **flexible tuning mechanism** that keeps the **single photon properties**.

Additional Resources

Loss in fiber



1310nm: 0.42 db/km
1550nm: 0.28 db/km

1310nm: 0.91 ps nm/km
1550nm: 18.2 ps nm/km

Prior and related work

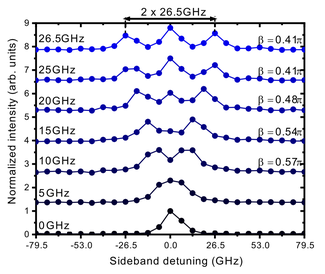
Sideband generation and HOM of the modulated signal.
Paudel, et al. (2018) 10.1103/PhysRevA.98.011802

Tuning single photon frequency using a single sideband modulator.
Lo, et al. (2017) 10.1364/OPTICA.4.000919.

Phase Modulation

$$A\exp(i\omega t + i\varphi(t)) = A\exp(i\omega t + i\beta\sin(\Omega t))$$
$$= A\exp(i\omega t)(J_0(\beta) + \sum_{k=1}^{\infty} J_k(\beta)\exp(ik\Omega t) + \sum_{k=1}^{\infty}(-1)^k J_k(\beta)\exp(-ik\Omega t)$$

Tunable Modulation



References
[1] M. Paul, et al. "Single-Photon Emission at 1.55 um from MOVPE-Grown InAs Quantum Dots on InGaAs/GaAs Metamorphic Buffers." (2017) 10.1063/1.4993935.
[2] L. Schweickert, et al. "On-Demand Generation of Background-Free Single Photons from a Solid-State Source." (2018) 10.1063/1.5020038.

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