How a broadband single-photon interacts with resonant atomic gas?

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Photons are the preferred carrier for fragile quantum states in near-term quantum information protocols. While ultra-short single-photon states can be easily and massively produced in non-linear crystals, their efficient interfacing with narrowband atomic media remains challenging. In a recent demonstration [1] a broadband single-photon has been shown to strongly yet briefly interact with an orders of magnitude narrower atomic transition of Rb, forming a zero-area temporal pulse. Here we combine the idea of single-photon zero-area pulses with the so-called single-photon holography [2] performing a spectral characterization of an ultra-fast zero-area single-photon via a fundamentally quantum effect of two-photon interference.

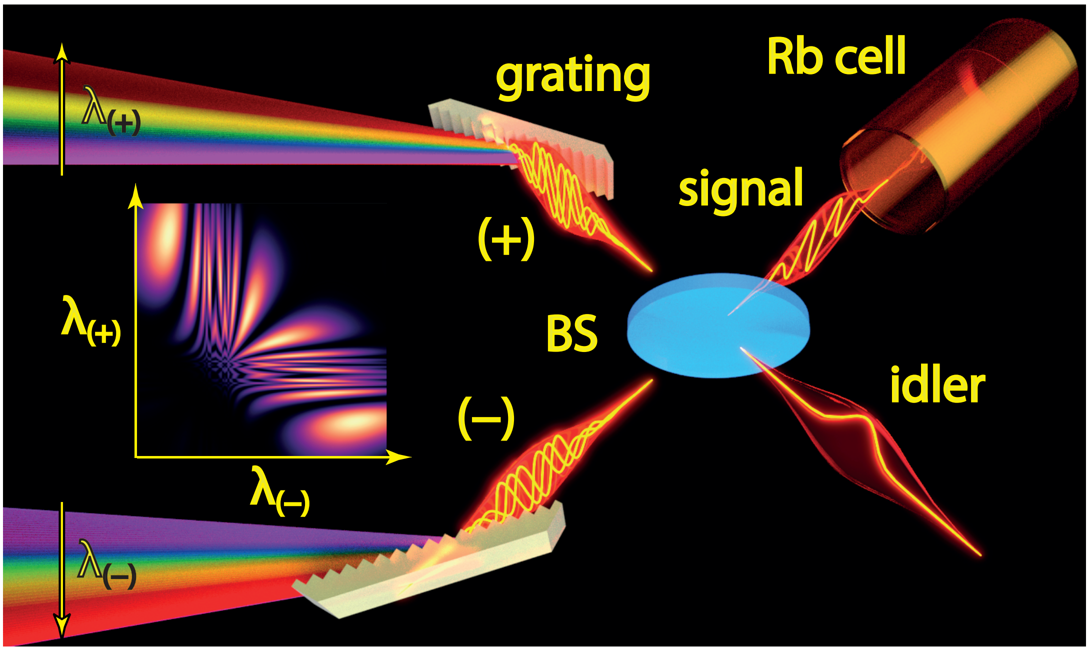

Figure 1. Spectral single-photon holography. Broadband (10 nm) ultra-short (100 fs) single-photon (signal) interacts with resonant hot Rb vapor, obtaining a zero-area temporal shape and a complex spectral phase. Two-photon interference with a reference (idler) photon reveals the phase pattern in the joint spectral intensity.

[1] L.S. Costanzo, A.S. Coelho, D. Pellegrino, M.S. Mendes, L. Acioli, K.N. Cassemiro, D. Felinto, A. Zavatta, and M. Bellini, Zero-Area Single-Photon Pulses, Phys. Rev. Lett. **116**, 023602 (2016)

[2] Radosław Chrapkiewicz, Michał Jachura, Konrad Banaszek, and Wojciech Wasilewski, Hologram of a single photon, Nat. Photonics **10**, 576–579 (2016)