A broadband Rb vapor cell quantum memory for single photons

Gianni Buser[1], Roberto Mottola[1], Björn Cotting[1], Janik Wolters[2], and Philipp Treutlein[1]

[1] University of Basel, Department of Physics, Klingelbergstrasse 82, 4056 Basel, Switzerland
[2] Deutsches Zentrum für Luft- und Raumfahrt e.V. (DLR), Institute of Optical Sensor Systems, Rutherfordstrasse 2, 12489 Berlin, Germany

Hot vapor cell based quantum memories for single photons have many advantages, including technological simplicity, high intrinsic efficiencies, and long storage times. To turn them into useful components for quantum networks, a few challenges remain, such as reducing read-out noise, increasing end-to-end efficiency, and resolving the bandwidth-mismatch to solid-state single photon sources. A few years ago we implemented a broadband optical quantum memory with on-demand storage and retrieval in hot Rb vapor [1]. Operating on the Rb D_1 line with attenuated laser pulses, this memory was shown to be in principle suited, in terms of its acceptance bandwidth, for storing single photons emitted by GaAs droplet quantum dots or by spontaneous parametric down conversion (SPDC) sources. In the meantime, we constructed and characterized a compatible SPDC single photon source with bandwidth on the order of 100s of MHz and with 50% heralding efficiency [2]. Subsequent improvements to the memory scheme and implementation improved weaknesses of [1], in particular significantly reducing noise and extending lifetime. We now report on the logical combination of these experiments, the storage of true single photons, and show non-classical $g^{(2)}$ of the photons read out of the memory.

[1] J. Wolters, G. Buser, A. Horsley, L. Béguin, A. Jöckel, J.-P. Jahn, R. J. Warburton, and P. Treutlein, Simple atomic quantum memory suitable for semiconductor quantum dot single photons, Phys. Rev. Lett., **119**, 060502 (2017).
[2] R. Mottola, G. Buser, C. Müller, T. Kroh, A. Ahlrichs, S. Ramelow, O. Benson, P. Treutlein, and J. Wolters, An efficient, tunable, and robust source of narrow-band photon pairs at the ^{87}Rb D_1 line, Opt. Express **28**, 3 3159 (2020).