Noise-free quantum memory at room temperature

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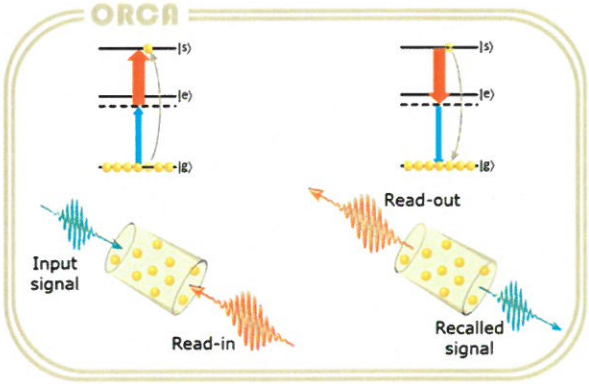
Optical memories are critical for scalable quantum networking [1]. Memory efficiencies and storage times have been improving, but protocols that are noise-free are needed to preserve quantum properties [2]. A technically simple design is also desirable because thousands of memories will be needed in a real-world quantum network.



Here we introduce light storage by off-resonant cascaded absorption (ORCA), which combines a broad acceptance bandwidth with noiseless operation at room temperature [3]. In the ORCA memory, a control pulse mediates the conversion of an incident signal pulse into a collective orbital excitation in a warm atomic vapour. Unlike Λ-type memories, the storage bandwidth is not limited by an atomic hyperfine splitting. Furthermore collisional fluorescence, thermal Raman and four-wave mixing noise [2] are all absent because the storage state lies energetically above the virtual level induced by the control field.

To test these predictions we demonstrated the ORCA memory on the $6S_{1/2}$-$6P_{3/2}$-$6D_{5/2}$ line in Cs vapour with GHz-bandwidth heralded single photons at 852 nm and confirmed that their measured autocorrelation of $g^{(2)}$ = 0.02 was unchanged after storage and retrieval. Extended storage times have recently been shown in Rb [4].

References

[1] Nunn *et al.* PRL 110 **13** (2013)
[2] Michelberger *et al.* New Jour. Phys.17 **4** (2015)
[3] Kaczmarek *et al. arXiv:1704.00013* (2017).
[4] Finkelstein *et al. arXiv:1708.01919* (2017) (to appear in Science Advances)