Spatially multimode quantum memories for light based on atomic ensembles

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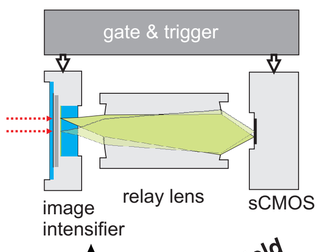
Quantum Memories Laboratory

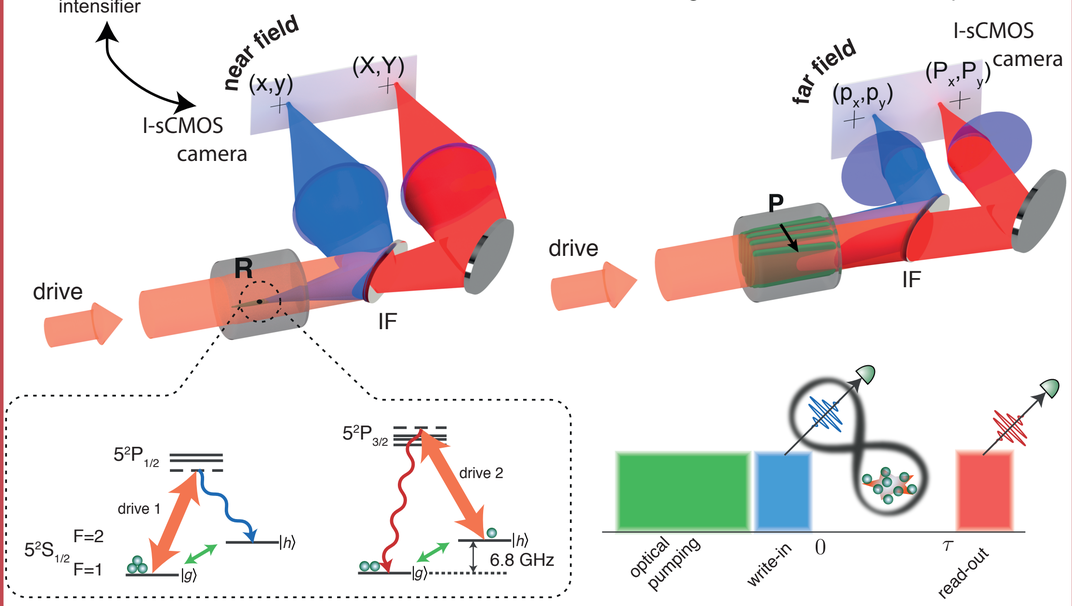
EPR entanglement

with warm vapour cells

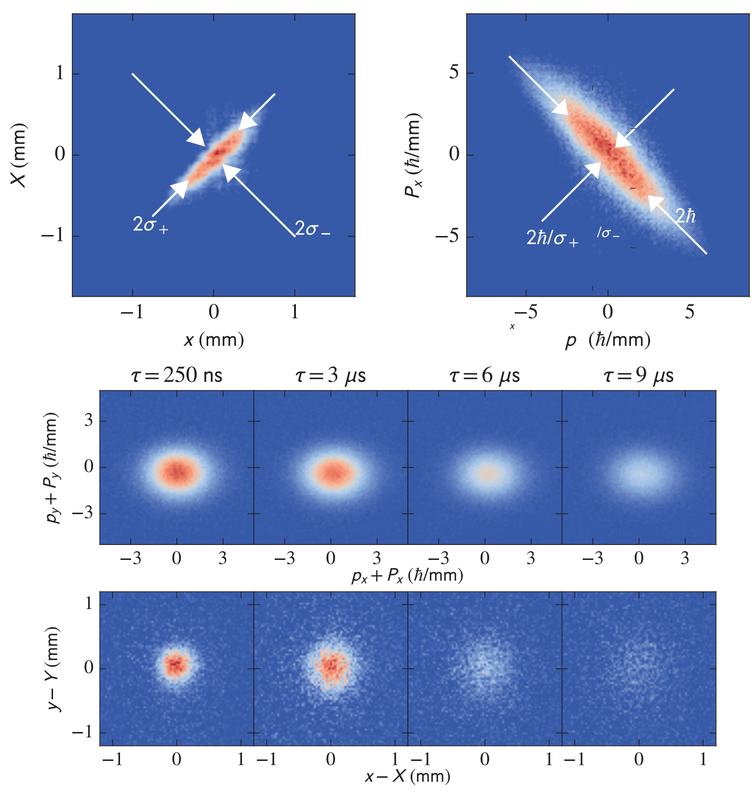
Optica 4, 272-275 (2017)

- Rubidium-87 vapor in Krypton as buffer gas
- Imaging with w I-sCMOS camera in both far and near field
- Demonstration of the EPR paradox with positions and momenta using Stokes and anti-Stokes photons

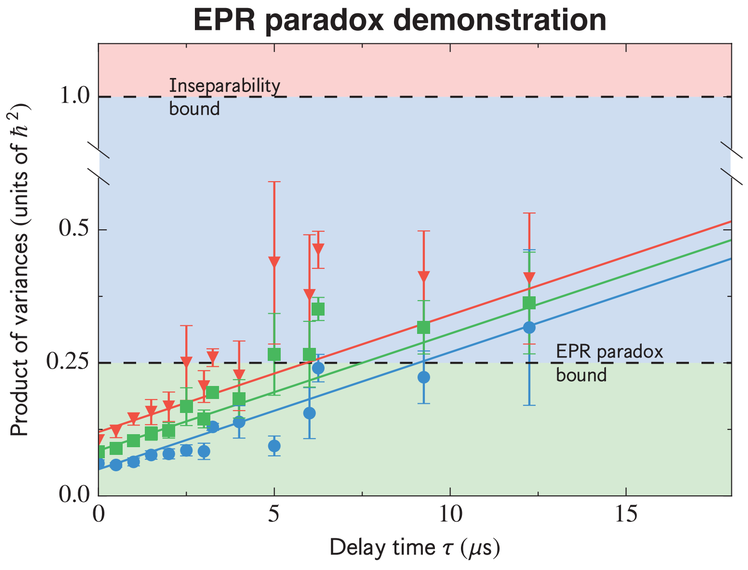




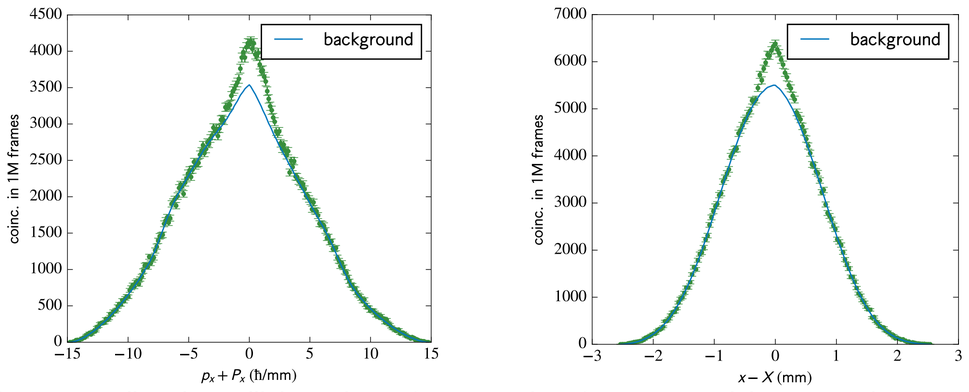
Joint position & momentum histograms and temporal evolution



EPR paradox demonstration

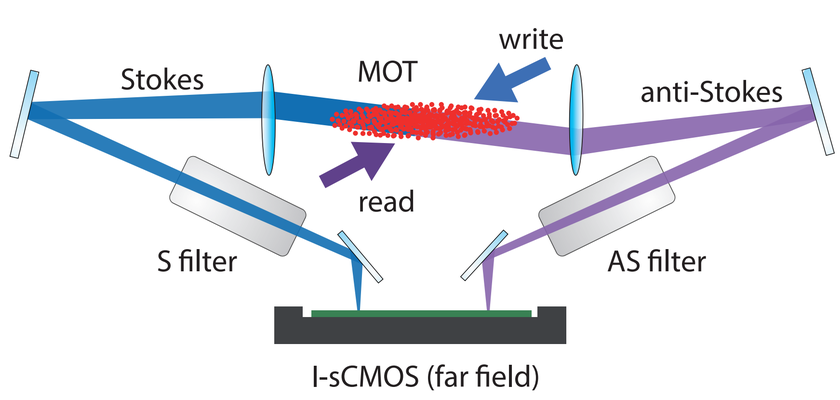


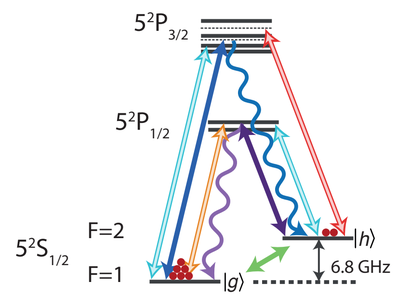
Background noise problems

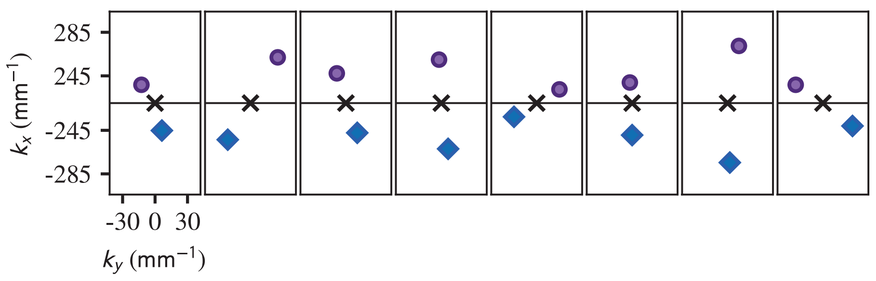


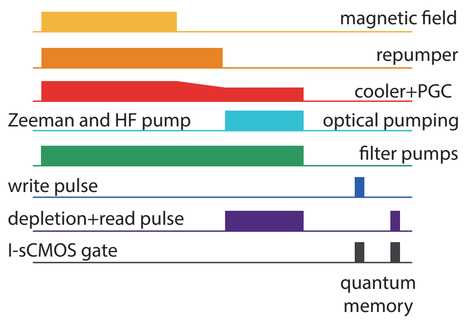
Source: mollecular collisions, imperfect pumping, four-wave mixing at readout, etc...

arXiv:1706.04426 Wavevector-multiplexed cold-atom photonic quantum state preparator



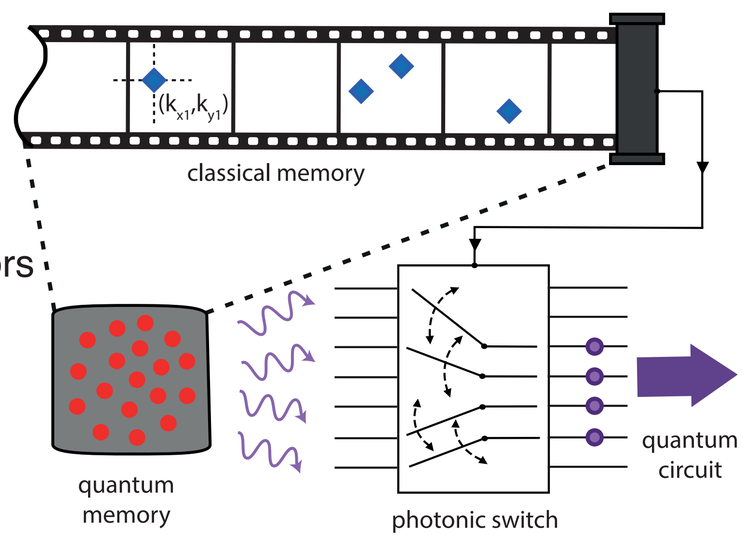




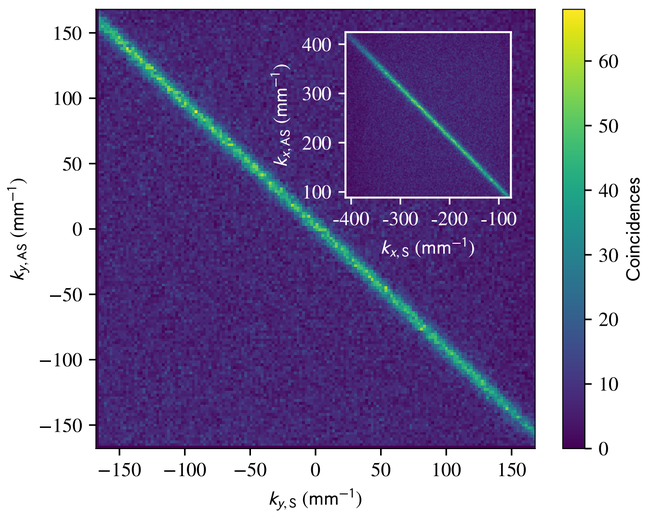


Camera-enabled wavevector multiplexing with quantum memory

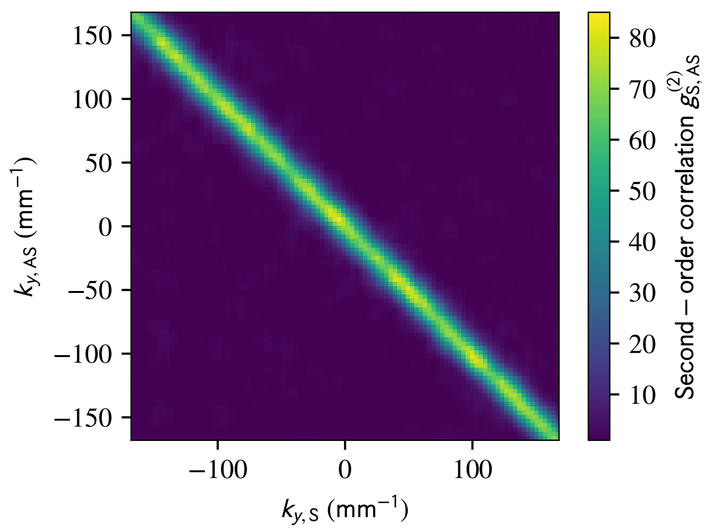
1. Generate desired number of photons in N trials
2. Register Stokes photons wavevectors and store them in a classical memory
3. Reprogram a photonic switch to channel photons to a quantum circuit
4. Retrieve all stored photons



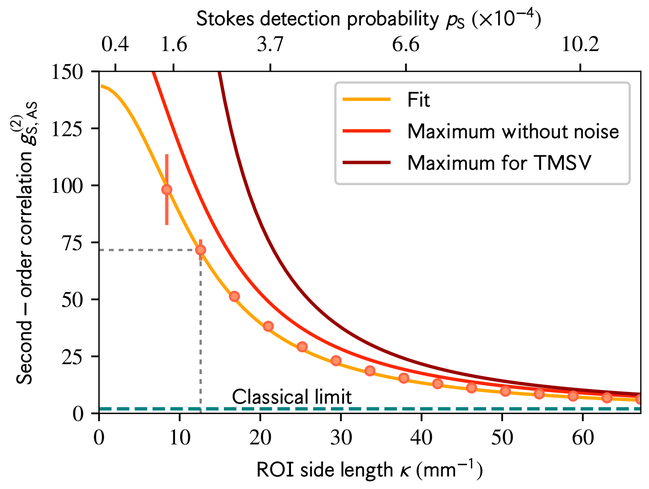
Spatial correlations and mode shape determination



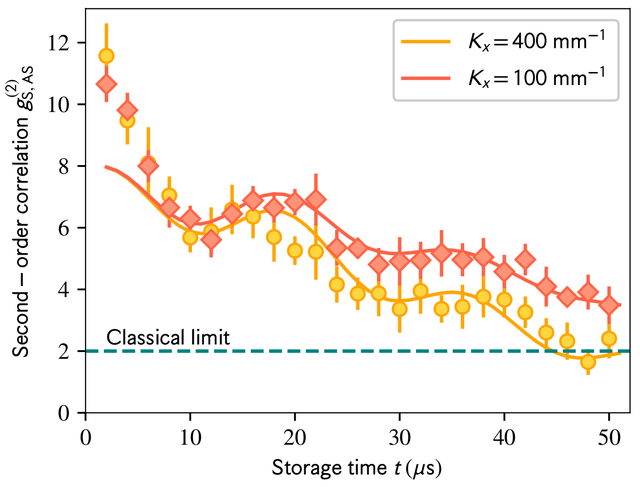
Nonclassical photon-number correlations in 665 modes



Spatially-resolved analysis of quantum correlations



Simultaneous storage in many ground-state cohrences



Key parameters

- 665 stored Schmidt modes with ~10,000 soon
- 50 μs storage time and 100 ns write/read time - perfectly matched to live-feedback applications
- camera frame rate of 500 Hz with perspectives to reach MHz-rates

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References: Quantum Memories Lab papers: Optica 4, 272 (2017); arXiv:1706.04426; PRA **91**, 023418 (2015); PRL **118**, 063603 (2017); PRA **93**, 053821 (2016); OpEx **24**, 21995 (2016); J. Mod. Opt. **63**, 2039 (2016); APL **108**, 161103 (2016); J. Mod. Opt. **63**, 2029 (2016); OpEx **25**, 284 (2017);
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