High indistinguishability of two dissimilar and independent cold-atomic quantum nodes.

Félix Hoffet, Jan Lowinski, Lukas Heller, Auxiliadora Padrón-Brito and Hugues de Riedmatten

ICFO – The Barcelona Institute of Science and Technology,
Av. Carl Friedrich Gauss, 3 - 08860 Castelldefels, Barcelona - SPAIN

Felix.hoffet@icfo.eu

In quantum communication research, the ultimate goal is to distribute entanglement between remote quantum nodes [1]. In this prospect, the indistinguishability of single photons emitted from these nodes is a crucial parameter that dictates the overall entanglement rate one can achieve in a quantum network.
Here, we demonstrate highly indistinguishable two-photon interference involving single photons emitted from two different and completely independent cold-atomic quantum nodes.
The first quantum node is a quantum repeater link based on the generation of atom-photon entanglement while the second node consist of a fully-blockaded Rydberg cold atomic ensemble as a deterministic source of photons [2].
This experiment opens up new possibilities for the interconnection of hybrid quantum nodes via entanglement.

References

[1] H. J. Kimble, "The quantum internet," Nature 453, 1023 (2008).
[2] J. Lowinski, L. Heller, F. Hoffet, A. Padrón-Brito, K. Theophilo, and H. de Riedmatten "Strongly Nonlinear Interaction between Nonclassical Light and a Blockaded Rydberg Atomic Ensemble," Phys. Rev. Lett. 132, 53001 (2024)

Figures

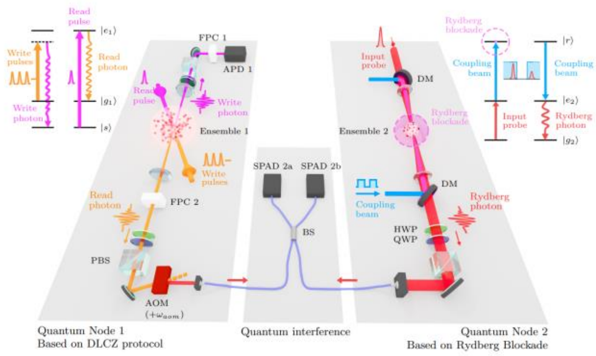

Figure 1: Experimental setup and relevant level scheme. Node 1 is a cold atomic ensemble based on probabilistic generation of atom-photon entanglement. Node 2 is based on the deterministic generation of single photons via Rydberg blockade.

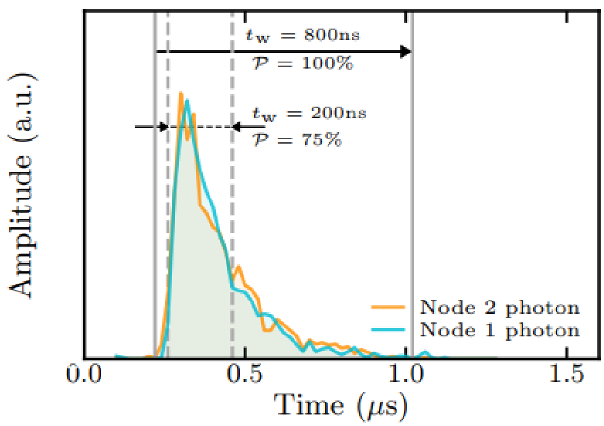

Figure 2: Temporal modes of the single photons emitted from Node 1 and Node 2. Grey lines indicate the windows used for the interference analysis. We compare the visibility we obtain when analyzing the full pulse with the case when we analyse 75% of all photon counts.