A photon-atom interface at telecom wavelengths

Natalia Bruno[1 2]

1.Istituto Nazionale di Ottica (CNR-INO), Largo Enrico Fermi 6, 50125 Florence, Italy

2. European Laboratory for Non-linear Spectroscopy (LENS), Universita` degli Studi di Firenze, I-50019 Sesto Fiorentino, Italy

Abstract: Photonic qubits at telecom wavelengths combined with Yb atoms trapped in optical tweezers and strongly coupled to resonators can be used for efficient quantum network of quantum devices, distributed sensing or computing

Enabling communication between quantum devices, such as clocks, computers, and simulators has the potential to significantly enhance the capabilities of their applications, such as quantum sensing and computing[1], [2], [3].The key to achieving this lies in establishing efficient communication channels among these quantum devices even over a long distance, which involves the exchange of qubits encoded in light at telecom wavelengths through optical fibers [4], [5]. In this context, I will present an overview of the new experiment that we are building in Florence, which focuses on interfacing single photons at telecom wavelengths with individual neutral ytterbium atoms trapped in optical tweezers. By leveraging the unique properties of the ytterbium clock state and its telecom transitions[6], our objective is to interface a long-lived ”matter” qubit and resonant light, including atom-resonant heralded single photons or photons forming entangled pairs. I will discuss the first developments, the motivation for exploring this research line and its impact as a crucial foundation for distributing entanglement between light and matter.

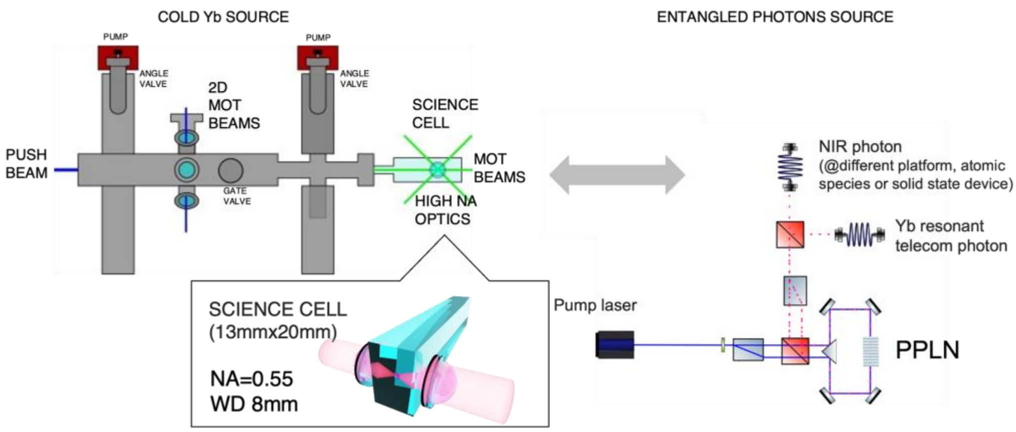

Fig. 1 Sketch of the experimental setup for an atom-photon interface.

I will report the status of the system we are building, which consists of:

1) A source of cold Yb atoms to trap single atom in high NA optical tweezers and generate atom-photon entanglement.
2) A source of non degenerate, entangled photon pairs with one photon in the telecom band, optimized for quantum information processing (entanglement swapping) over long distances, and the other in the visible band, compatible with devices based on cold atoms or solid state integrated platforms. The sources is based on spontaneous parametric down conversion in a Sagnac configuration.

This activity bridges results from spoke 3,4 and 6.

References

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