

Enhorabona a la nova graduada de doctorat de l'ICFO

La Dra. Susana Plascencia Orozco s'ha doctorat amb una tesi titulada i¿½Quantum memories based on rare-earth doped solids: from spatial multiplexing to new materialsi¿½

November 16, 2026

Felicitem la Dra. Susana Plascencia Orozco que aquest mati ha defensat la seva tesi a l'Auditori de l'ICFO.
La Dra. Plascencia Orozco va obtenir el Master en Optica pel Centro de Investigaciones en Optica A.C; i es va unir a l'equip d'investigacio Quantum Photonics with Solids and Atoms dirigit pel professor ICREA a l'ICFO, el Dr. Hugues de Riedmatten. La seva tesi titulada i¿½ Quantum memories based on rare-earth doped solids: from spatial multiplexing to new materialsi¿½ va ser dirigida pel professor Dr. Hugues de Riedmatten.

RESUM:
Quantum repeaters play a fundamental role in the development of long-distance quantum network. In most architectures, their functional core is constituted by quantum memories.

Although many systems have been investigated as potential quantum memory, no single platform yet satisfies all the requirements simultaneously. Solid-state systems, particularly cryogenically cooled rare-earth doped crystals represent one of the most promising routes toward efficient, long-lived and massively multiplexed quantum memories, with great prospects for integration. This thesis addresses two main objectives. The first is to extend the spatial multimode capacity of a rare-earth-doped quantum memory using a praseodymium-doped yttrium orthosilicate Pr^{3+}:Y_2SiO_5 to increase the entanglement generation rate required for realistic quantum repeater application. The second objective, carried out in collaboration with Corning, investigates the spectroscopic properties of? erbium-doped-chalcogenides to assess their suitability as fiber-integrated quantum memor operating at the telecom wavelength.

To achieve spatial multiplexing in the Pr^{3+}:Y$_2SiO_5 crystal, we implement a quantum memory array (QMA) using a pair of acousto-optic deflectors, creating ten individually controllable spin-wave memory cell featuring on-demand read-out. By combing the spatial multiplexing of the array with the intrinsic temporal multimodality of the atomic frequency comb (AFC) protocol, we store and retrieve on-demand up to 250 modes using weak coherent pulses at the single-photon level, both surpassing the current state-of-the-art for solid-state quantum memory. The high signal-to-noise ratio and low cross-talks enable the storage of heralded single-photons. To do so, we use a cavity enhanced spontaneous parametric down conversion source to generate a pair of photons, with the signal photon stored in the QMA and the idler at telecommunication wavelength. We demonstrate the violation of the Cauchy-Schwarz inequality by at least 4.8 standard deviations in all th memory cells, demonstrating light-matter quantum correlations between the QMA and th telecom photon.

We further demonstrate the potential use of our system as a random access quantum memory (RAQM) by storing path and time-bin qubits encoded with weak coherent states in the quantum memory array, achieving average fidelities of 95 ± 2% and 91 ± 2%, respectivel . We further load sequentially a time-bin qubit in two different memory cells, simultaneous y store both qubits, and perform a collective read-out. The high fidelities together wi h independent control pair represent a significant step toward a solid-state RAQM for quant m repeaters and photonic quantum processors.

For the fiber-compatible quantum memory, we study three Er-doped chalcogenide glasses with a different glass network rigidities quantified by the coordination mean number (MCN). We measure their optical coherence time (T_2) through two-pulse photon echo (TPE) technique and find that the sample with MCN

Tribunal de Tesi:

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