ICFO



INSIGHT SEMINAR: Towards non-local quantum many-body systems

JUAN JOSE GARCIA-RIPOLL

June 18, 2025
12:00 to 13:00
Elements Room

ABSTRACT:
This talk consists of two parts. In the first part I will review our work on quantum links [1,2], in which we model recent demonstrations of quantum links with superconducting quantum processors, analyzing the fidelity, transfer speed and multiplexing opportunities for these quantum channels.
In the second part I will present a more general theory for modeling quantum systems that interact with retarded photons [3]. I will discuss how this paradigm offers opportunities to explore new physics, laying in between the regimes explored by condensed matter physics and relativistic quantum information, with light cones and photon propagation times as driver for new many-body physics.
As a concrete example, I close the talk presenting results on the collective emission

properties of quantum systems (saturable or linear) that deposit energy into an infinite waveguide. These results confirm the existence of superradiant behavior even when the separation among emitters is considerable, providing evidence of new scaling laws and a phenomenon that we call "cascaded superradiance". In this process, the superradiant burst is built progressively by the connection of quantum emitters by propagating photons, with a rate of increase that depends on the propagation time of the photons among quantum nodes.

[1] Penas, Guillermo F., Ricardo Puebla, and Juan Jose Garcia-Ripoll. "Improving quantum state transfer: correcting non-Markovian and distortion effects." Quantum Science and Technology 8.4 (2023): 045026.

[2] Penas, Guillermo F., Ricardo Puebla, and Juan Jose Garcia-Ripoll. "Multiplexed quantum state transfer in waveguides." Physical Review Research 6.3 (2024): 033294.

[3] Barahona-Pascual, Carlos, et al. "Time-delayed collective dynamics in waveguide QED and bosonic quantum networks." arXiv preprint arXiv:2505.02642 (2025).

BIO:

Juanjo Garcia Ripoll is a research professor at the Institute of Fundamental Physics, where he conducts research on the physical implementation of quantum technologies. His interest currently center around the design of superconducting circuit based quantum technologie for quantum computing and quantum networks, and on the development o quantum-inspired mathematical algorithms for basic science and also for solving large-scal numerical analysis problems. Apart from this, he coordinates both the Spanish Network o Quantum Information and Quantum Technologies (www.ritce2020.hbar.es) and CSIC's Quantum Technologies Platform (qtep.csic.es).

Hosted by: Prof. Dr. Oriol Romero-Isart