Quantum Optical Networks based on Exciton-polaritons (Q-ONE)

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One of the main needs in Quantum Optics and Quantum Information is the ability to generate, manipulate and characterize arbitrary quantum states both in discrete and continuous variable domains. Q-ONE aims at exploring a novel approach for sensing and generating quantum states of light based on quantum neural networks (QNN) in integrated photonic devices. This proposal has the ambition to solve one of the most interesting problems of quantum mechanics: the recognition of quantum states of photons, like Fock states or entangled pairs, without the need of correlation measurements. Moreover, our platform has the ability to be reversible: by injecting a quantum state into the QNN, the output gives access to the full characterization of the input quantum state; conversely, with a classical state of light as input (a coherent state, emitted by a laser), an arbitrary quantum state can be generated on demand at the output of the QNN. This is all realised in a single device.

The project idea places itself at the frontier between quantum physics and applied artificial intelligence, building on top of state-of-the-art semiconductor material growth and processing. The consortium targets the realization of a novel device based on strongly interacting photons (exciton-polaritons) that, using principles of neuromorphic computing, is able to recognize, characterize, and generate a variety of quantum states. Importantly, we propose to exploit the properties of a quantum neural network which is able to identify and generate quantum states without the need to reach extreme single-particle interaction strengths: this innovative idea relies on the physical realization – rather than the simulations – of a massively parallel computing task.

If successful, the Q-ONE approach will enable the realization of a completely new, fully reconfigurable and reversible universal quantum platform which will significantly advance the state of the art in the field of Quantum Technologies.