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Quantum entanglement mediated by plasmon-polaritons

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This talk starts with a tutorial introduction to the field of plasmonics in nanostructures. Plasmon-polaritons are produced by the coupling of plasmons in metallic nanostructures to electromagnetic fields which decay out of the metallic interfaces. Molecules, quantum dots, defect centers or other semiconductor nanostructures with a discrete electronic spectrum, when are close to a metallic nanostructure, behave as qubits coupled to plasmon-polaritons. We present here a study of the quantum properties of such a system.

In a first step, we use classical electrodynamics for obtaining all the ingredients required in the quantum mechanical description of the system. By means of the adequate quantization procedure, one can analyze the physics determining the conditions under which the open system of qubits and plasmon-polaritons is in a strong- or in a weak-coupling regime.

Later, we concentrate on the generation of entanglement between two of those qubits mediated by the plasmon-polaritons of a metallic waveguide. A V-shaped channel milled in a flat metallic surface is much more efficient for this purpose than a metallic wire. We study important experimental aspects as the role of the misalignments of the dipole moments of the qubits or the influence of a coherent external pumping, needed to achieve a steady state entanglemen. A careful analysis of the quantum-dynamics of the system by means of a master equation shows that two-qubits entanglement generation is essentially due to the dissipative part of the effective qubit-qubit coupling provided by plasmon-polaritons.