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Quantum light generation with semiconductor nanostructures

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In a semiconductor system, optical excitations can create excitons, which are bound electron-hole pairs. In semiconductor nanostructures the excitonic energy levels are quantized, leading to a strong size dependence of their optical properties and allowing engineering of classical and non-classical light generation. Two cases will be described, one involving quantum wells with 1D quantization, the other one involving quantum dots, with 3D quantization.
When a quantum well is placed in a high finesse microcavity, the strong coupling regime between 2D excitons and light is reached, forming exciton-photon mixed quasi-particles called polaritons. Polaritons combine the coherent properties of photons with the highly interacting features of electronic states. These properties have allowed us to demonstrate nonlinear and quantum optical effects in the microcavity emission, as well as quantum fluid properties in the propagation of polaritons in the system.
Quantum optical properties of quantum dots, or semiconductor nanocrystals, made of a few thousand atoms will also be described. Here, the strong confinement of electron-hole pairs leads to very interesting properties such as photon antibunching, opening the way to on-demand single photons sources at room temperature.