Nonlinear optical phenomena in planar microcavities

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A semiconductor microcavity is a photonic structure designed to enhance the light-matter interaction. The cavity photons are confined between two mirrors and resonantly interact with the excitonic transition of a 2-dimensional semiconductor quantum well. In strong coupling regime the normal modes of the system are cavity polaritons that are half-light, half-matter quasiparticles. Being composite objects, polaritons inherit the properties of both cavity photons and excitons. The presence of the photonic component results in extremely small effective mass of cavity polaritons (10-4- 10-5 of free electron mass), while excitonic component leads to the efficient polariton-polariton interactions. This makes cavity polaritons a unique laboratory for study of the nonlinear optical phenomena at low pumping powers. In the talk we plan to give an overview of the polariton physics and in this context discuss the nonlinear effects, including bistability, multistability and pattern formation.

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General session VII

Single NV Centers in Nanostructured Diamond for Quantum Informatics and Quantum Magnetometry

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Individual nitrogen-vacancy (NV) color centers coupled to proximal 13C isotopic atoms in nano-structured diamond are now considered as one of the most perspective candidates for practical implementation of hardware for quantum information (QI) processing such as room-temperature processor for quantum computer, single-photon emitter for quantum cryptography, quantum memory, quantum repeater etc. Moreover, surface-functionalized nanodiamonds hosting single NV centers can be used as nano-sized sensor for detection of weak magnetic fields providing the capability to probe biologically relevant spins in living cells with unprecedented spatial resolution. All these promising applications require a precise characterization and complete understanding of properties of single NV centers in nano-structured diamond.
In the report we are going to present a review of our results on DFT simulation of structural, electronic and spin properties of NV center in bulk and nano-structured diamond as well as on interpretation of a wide range of experimental data on single NV centers or on their complexes with nearby 13C nuclear spins. Kramers degenerated spin systems comprising electron spin of a single NV center and odd number of nearby 13C nuclear spins in nano-sized diamond are studied and their application as a probe for local magnetometry is discussed. As well, control of single NV emission in nano-structured diamond like photonic crystal is studied and perspectives to implement various diamond-based QI applications are discussed.

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