QED in 5 nm diamond ball with floating electron

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Cavity quantum electrodynamics (QED) has novel effective application with nitrogen-vacancy (NV) centers in diamond nanocrystals. A few theoretical models of QED diamond balls have been analyzed. Taking into account good defined properties of diamond quantum dot and Purcell effect we estimated the Purcell factor of 5 nm diamond ball for several external fields and special boundary conditions. Using the exact analytic solution in the semiclassical Jaynes-Cummings model without the rotating-wave approximation we describe QED cavity with diamond lattice in different states, i.e. before and after quantum chaos. The comparisons these solutions with chaotic Rabi vacuum oscillations in cavity QED allow to estimate quantitative characteristics of interaction into realistic model of nanodiamond. We discuss a few approaches to problem of self-consistency of volume 3D and surface 2D wave functions of 5 nm diamond ball, e.g. introduction of collective excitations or quasiparticles, strongly modified plasmon-matter interaction, floating electrons as anti-quasiparticle, possibility of semi-periodic spherical Bloch function etc. The theoretical models were applied to explain of (1) recent experimental realization of a cavity QED system in which NV centers in diamond nanocrystals are coupled to a whispering gallery mode in a nanosphere, (2) the Josephson junctions of superconductive diamond after boron doping and (3) the superlattice of 5 nm diamond balls (with & without NV centers) with floating electron.

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Multiphoton Resonant Excitation of Fermi-Dirac Sea in Graphene at the Interaction with Strong Laser Fields

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In the present work the microscopic theory of a graphene interaction with strong mid-infrared laser fields of arbitrary polarization is developed. We consider multiphoton interaction regime* to find out the nonlinear behavior of Fermi-Dirac sea in graphene and corresponding nonlinear optical response of the system. The evolutionary equation for a graphene single-particle density matrix in the field of moderately intense laser fields on the base of the second quantized formalism is formulated. The analytical solution for time-dependent density matrix in the given field of a laser radiation with arbitrary polarization is obtained. Rabi oscillations of the particle-hole states in graphene at multiphoton laser-excitation depending on the time, momentum, field polarization, and photons number are considered and analyzed on the base of numerical simulations as well. The obtained results demonstrate well expressed Rabi oscillations corresponding to multiphoton excitation of the system that can be observed by laser fields of moderate intensities and for the picosecond time scales, which is of special interest for a picosecond time-resolved photoemission spectroscopy. We also consider the particle-hole annihilation from the field induced coherent superposition states that will cause intense coherent radiation of harmonics of the applied wave-field. We consider the possibility of generation of odd as well as even harmonics of fundamental frequency strictly depending on the laser field polarization and initial state of graphene quasiparticles. This work was supported by State Committee of Science (SCS) of Republic of Armenia, Project No. 11RB-006. * H.K. Avetissian, A.K. Avetissian, G.F. Mkrtchian, and Kh.V. Sedrakian, arXiv:1112.2905v1, submitted to Phys. Rev. B.

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