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Light-matter coupling in imperfect lattice of coupled micro-cavities containing quantum dots

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The important features of photonic band-gap structures under discussion are connected with 'slow' light, which is one of the promising fundamental physical phenomena that can be explored in the design of various quantum optical storage devices. In particular, the effective reduction of the group velocity demonstrated in the associated optical waveguide resonators. Key role in reducing the group velocity in these systems is played by so-called light and dark polaritons, which are linear superposition of photon states of the external electromagnetic field and the macroscopic (coherent) perturbations of two-level atomic medium. Based on the representations of the ideal photonic structures, the non-ideal systems of this class - polaritonic crystal, which is a set of spatially ordered cavities containing atomic clusters, is considered. Moreover, the spatial distribution of cavities (resonators) is translation invariant, and the atomic subsystem has randomly distributed defects: Impurity atomic clusters (quantum dots) or vacancies. Numerical modeling of dependence of the dispersion of polaritons in this imperfect lattice of associated micro-resonators on impurity concentration is completed. Using the virtual crystal approximation, the analytical expressions for polaritonic frequencies, effective mass and group velocities, as a function of corresponding quantum dots and vacancies concentrations, is obtained. It turned out that even with a small number of vacancies in the lattice (one position for a thousand resonators), weight polaritons increases by three orders of magnitude. These results enable to extend the possibility of creating a new class of functional materials - polaritonic crystal systems.

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To understand atomic nucleus from a new nuclear structure model

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To explain some basic facts of atomic nucleus, a nuclear structure model of "ring plus extra nucleon" is proposed. For nuclei larger than 4He inclusive, protons (P's) and neutrons (N's) are basically bound alternatively to form an $^{2Z}_{Z}E$ ring. The ring folds with a "bond angle" of 90° for every 3 continuous nucleons to make the nucleons packed densely. Extra N('s) can bind to ring-P with the same "bond angle" and "bond distance". When 2 or more P's are geometrically available, the extra N tends to be stable. Extra P can bind with ring N in a similar way when the ratio of N/P <1 although the binding is much weaker. Even-Z rings always have superimposed gravity centers of P and N; while for odd-Z rings, both centers of P and N must be eccentric. The eccentricity results in a depression of EB and therefore specific zigzag features of E_B/A. This can be well explained by the shift of eccentricity by extra nucleons. Symmetrical center may present in even-Z rings and normal even-even nuclei. While for odd-Z ring, only antisymmetric center (every P can find an N through the center and vice versa) is possible. Based on this model, a pair of mirror nuclei, $P_{X+n}N_X$ and P_XN_{X+n}, should be equivalent in packing structure just like black-white photo and the negative film. Therefore, an identical spin and parity was confirmed for hundreds of pairs. In addition, the EB/A difference of all the mirror nuclei pair is very nearly a constant of 0.184n MeV. Many other facts can also be easily understood from this model, such as the nuclear stabilities of isotopes in elements from He to Ne; the stability sequence of ^{9}Be, ^{10}Be, ^{7}Be and ^{8}Be; the neutron halo in neutron-rich nuclides; the general rule for most stable isotopes: odd-Z elements are odd A, even-Z elements are even A; and the highest cohesive energy of Li, Be, B atoms in their own elementary group and so on.

Notes:

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