EFFECT OF METAL NANOPARTICLES ON ENERGY SPECTRUM
AND OPTICAL PROPERTIES OF PERIFERAL LIGHT-HARVESTING LH2 COMPLEXES
FROM PHOTOSYNTHETIC BACTERIA

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Unique optical properties of localized surface plasmons are recently of considerable interest due to potential applications in constructing biosensors or optical data storage devices using the surface-enhanced Raman scattering, surface enhanced photoluminescence and other phenomena related to the enhancement of the probability of electronic transitions.

The purpose of this paper [1] is to consider the effect a metal particle or a nanoshell may have on the photosynthetic light-harvesting pigment-protein complexes, namely, on the B850 band of the peripheral light-harvesting complexes (LH2) from photosynthetic bacteria. The model of the B850 ring from the LH2 complex was considered as a system consisting of N dipoles, arranged in a ring on a plane.

It was shown that the mixing of exciton and surface plasmon states may significantly change properties of the system composed of a metal nanoparticle and a molecular aggregate. The free electrons of the metal may contribute to the absorption of the light by organic molecules by increasing the total dipole moment of the hybrid transitions of the system. The effect is more pronounced if the energy of the surface plasmon is close to the energy of the exciton band. In order to reach the resonance between molecular levels and surface plasmons we have considered the nanoparticle with a dielectric inclusion inside (nanoshell). The calculations were performed for spherical nanoshells with silver coating.

The calculations demonstrate that the enhancement of the absorption grows with increasing the size of the nanoparticle, approaching the nanoparticle to the molecular complex and for the nanoshells containing a material with low dielectric constant inside. We present results of our calculations as the squared value of the ratio of transition dipole moment of the hybrid state and the transition dipole moment for the ring. The enhancement of the absorption may reach an order of magnitude (Figure).

The enhancement of the absorption rate due to the hybridization of the molecular excitations with the surface plasmons competes with the enhancement of the exciton damping induced by a metal particle.

Enhancement of the absorption (a) as a function of the core radius for the nanoparticle with R = 10 nm, L = 1.5 nm (solid curve) and 2.5 nm (dashed curve) and the linewidth (b) for the same values of parameters.

The effectiveness of the light-harvesting by the ring is determined by the rate of the excitation transfer to the reaction center. Estimates of the kinetics of the exciton transfer to the molecular entities further in the photosynthetic antenna show that the process of the light harvesting may either gain or lose from the effect of a metal nanoparticle. The parameters of the nanoparticles and nanoshells required to ensure the gain have been estimated.