

On the peculiarities of light scattering by nanoparticles and nanowires near plasmon resonance frequency

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Modern nanotechnology and nanooptics deal with objects of the size that is smaller (or even greatly smaller) than the radiation wavelength. Thus the actual problem for nanotechnology, Data Storage technology and nanopatterning with laser irradiation is related to the ability to overcome the diffraction limit. Many ideas were suggested, including Near-field Scanning Optical Microscope (NSOM) technique and other techniques using laser in combination with a tip of AFM, etc. Lately much attention was given to the methods of plasmonics [1], closely related to excitation of surface electromagnetic waves within different nanostructures. These structures are now used in many modern applications, e.g. in super-RENS [2].

In this paper we report our results, related to the peculiarities of light scattering by nanoparticles and nanowires near plasmon resonance frequency. Since the times of Rayleigh and Debye there exists the paradigm of simple “dipole type scattering” of small objects with the size comparable to the irradiation wavelength. This paradigm is based on the calculation of object polarizability in a constant and uniform electric field. However when the surface plasmon is excited the field inside the small sphere (or nanowire) becomes non-uniform anymore. This kind of scattering problem cannot be analyzed by the dipole approximation. It was demonstrated for spherical particles [3], a similar effect was found with nanowires. The extinction coefficient for spherical particle can demonstrate the inverse hierarchy of optical resonances [4, 5].

It is shown that even a small number of interacting modes can produce a complicated structure of the Poynting vector field in the near-field region. Thus, with a small variation of the size parameter one can produce many transformations of the field distribution. It is the proper way for optical manipulation in the field structure in the nanoscale region, which can be used for different applications in nanooptics. The areas with radially polarized light in nanoscale region also have a potential interest for applications. In the conclusion we should emphasize that many bifurcations in the Poynting vector field are quite general for weakly dissipating materials. Only with sufficiently big dissipation one returns to simple dipole type of scattering.

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