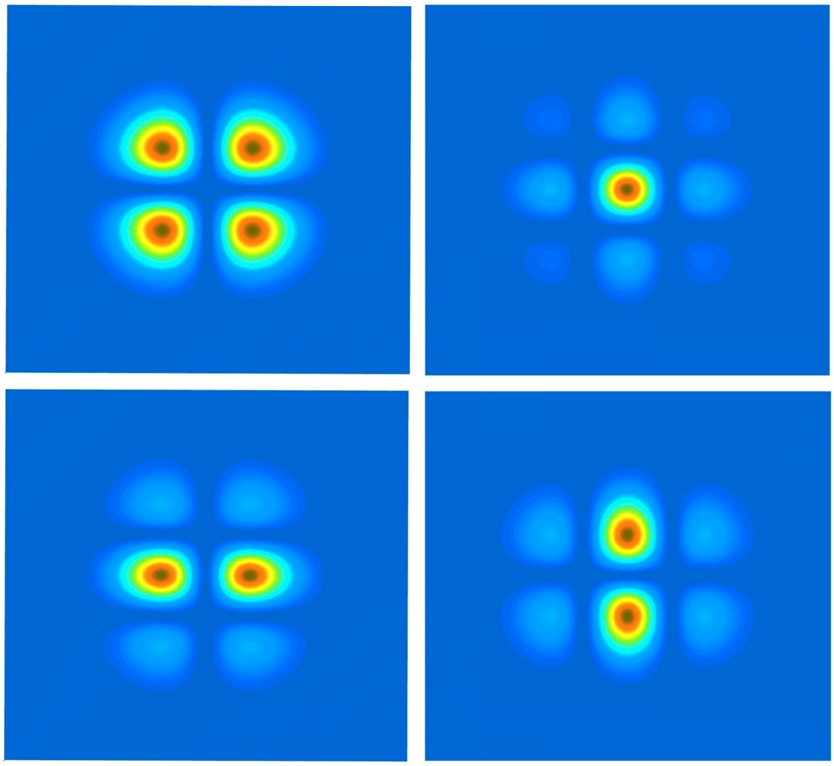
OPTICAL BEAMS AT DIELECTRIC INTERFACES
- fundamentals

Wojciech Nasalski

Institute of Fundamental Technological Research
Polish Academy of Sciences



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Selected applications

A dielectric interface, or, in general, any planar multilayered structure, can be used as a mean of control the interplay between the beam field distribution, in its magnitude and phase, and the beam field polarization. The control process is based on the cross-polarizarion coupling (XPC) effect acting at the interface and depends on the incident beam parameters like the beam polarization, shape and angle of incidence. The ability to control the beam shape and polarization may appear useful in many applications in contemporary optics.

In three-dimensional optical imaging the polarimetric passive imaging systems are used to extract three-dimensional information from an object scene. The three-dimensional imaging can be achieved by computing orientation angles of normal vectors of the light-reflecting surface. Values of these angles can be retrieved from Stokes vector parameters of the reflected optical field with the help of the well-known Fresnel equations and Snell's law. The imaging process depends considerably on shape and polarization of the illuminating beam, especially when the elements of the object scene are of a nanometric scale.

In nanoscopic space-time-resolved spectroscopy polarization pulse shaping can be used to control spatial and temporal evolution of optical near field. By appropriate control of two polarization components of an incident femtosecond laser wave-packet, pump and probe excitation occur at different positions and at different times, with nanometer spatial and femtosecond temporal resolution. Narrow or focussed beams are commonly used to trap dielectric or metallic particles in optical tweezers. The corresponding field distribution generates a trapping potential, strongly influenced by, for example, a metal nanostructure located in the vicinity of a focus of the beam. In such a trapping configuration the superposition of a non-resonant beam field with a resonant beam or plane wave illumination provides the possibility to modify the trapping potential. The processes of this sort strongly depend on distribution of the optical field intensity, phase and polarization.

It is well-known that light beams carry, besides the spin angular momentum (SAM) associated with beam polarization, the well-defined orbital angular momentum (OAM) associated with their spiral wave fronts. Both parts of the beam angular momentum can be used to cause trapped particles to rotate. Moreover, as it has been shown here for beam reflection and transmission, exact relations induced by the XPC effect exist between these two parts of the beam angular momentum at the interface. Both of them can be used in the planar configuration for beam sorting on the basis of SAM and OAM, per analogy to the known methods of encoding and processing optical information that is carried by individual photons.

It seems that coexistence of the XPC effect with the beam shifts of nonspecular reflection can be also observed for beam fields in optical resonators. Meanwhile the XPC effect determines a transverse pattern of the beam field in an optical cavity, the beam shifts should enter into the resonance condition for beam eigenmodes of this cavity. This type of interplay between polarization and shape of nonspecularly reflected beam fields in an optical resonator has been recently reported for the case of a dome cavity.

Having in mind the applications mentioned above, as well as many others reported elsewhere, interactions of optical beams with dielectric interfaces are analysed in this book.