Plasmonic nanostructures for subwavelength focusing of light with orbital angular momentum

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ABSTRACT

How do the living organisms distinguish between two identical molecules of opposite chirality? Can we, somehow, efficiently induce and probe dipole-forbidden or magnetic transitions in the biomolecules? Structured light provides a bridge between optical physics and bioscience and helps us gaining insight into these questions. We study structured beams of light that carry orbital angular momentum (OAM) and have left- or right-handed screw dislocations of phase fronts. The OAM light is chiral in the same sense as the biomolecules, however, diffraction limits focusing of spatial light features to micron sizes, while the molecules are nanometers in size. With this size mismatch, dipole-forbidden transitions (magnetic and electric quadrupole) are orders of magnitude weaker than electric dipole. If we preserve the chirality of light, while confining it into nanometer-sized volume containing the atoms of interest, dipole-forbidden optical transitions become as strong as the allowed ones. This will provide a tool to study the nature of chirality and the effect of OAM light on chiral molecules. To that end, we propose a nanoantenna for focusing light into subwavelength volume while preserving its chiral properties and structure.

Fig.1 (a): Experimental setup for detecting structured electric field distribution on the nanoscale. (b): Coupling of an atom with the plasmonic nanostructure allows for modification of its internal state or, in other words, induces dipole forbidden atomic transitions.

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