Optimal chiral light and its enhancement using nanoantennas and metasurfaces

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We present some of our latest advancements on the topic of optical helicity for chirality detection at nanoscale. We first discuss the concept of helicity maximization applicable to structured light and show that there exists an universal bound for the maximum of helicity density at a given field energy density defining optimally chiral fields [1]. As a possible application, we demonstrate that using structured light with maximized helicity density eliminates the need of the specific knowledge of energy and helicity densities in determining the chirality of a nanoparticle. We also show that helicity density can be enhanced using nearfields of high-density of nanoantennas, and that such nearfield satisfies the universal bound. In order to obtain such an optimal chiral nearfield a precise relation must be attained with both the electric and magnetic dipoles to dominate the scattered field. The helicity maximization concept generalizes the use of the dissymmetry factor in chirality detection to any chiral structured light illuminating nanoparticles [1,2].
We show how achiral nanoantennas can be used as chiral probes when illuminated by chiral light [2]. As an example we study dielectric nanospheres as nanoantennas and show that their nearfield is optimally chiral when optimal chiral light is used for their illuminations. Two light sources are considered here for illumination, circularly polarized beams and azimuthally radially polarized beams (ARPBs) elaborated in [2,3].
The above concepts clarify the applicability of chiral structured light at nanoscale, however in the last part of the talk we will show how they can be extended to metasurfaces that generate high helicity with the same handedness of the incident field all over a surface [4].

References

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