DAMOP19-2019-020084

Abstract for an Invited Paper
for the DAMOP19 Meeting of
the American Physical Society

Synthetic chiral light for extremely efficient laser-controlled chiral discrimination.

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Distinguishing left- and right-handed molecular enantiomers is challenging, especially on ultrafast time scale. Traditionally one uses a chiral reagent, an object of known handedness, to determine the unknown handedness of a chiral molecule. In optics, one uses the spatial helix formed by circularly polarized light as a "chiral photonic reagent". However, in optical domain the pitch of this helix – the light wavelength – does not match the size of the molecule, leading to very small chiral signals. In dipole approximation, which neglects the size of the molecule with respect to light wavelength, circularly polarized light is not chiral. Indeed, the Lissajous figure drawn by the tip of the electric field vector is confined to a plane: the dipole approximation turns chiral helix of light into a circle. Since the dominant optical response arises in the dipole approximation, it is destined to be the same in opposite molecular enantiomers. I will introduce a new concept of synthetic chiral light [1], which is chiral already in the dipole approximation. Compared to the inefficient chiral reagent – the light helix in space, here the helix is in time. In synthetic chiral light the electric field vector draws a three dimensional chiral Lissajous figure, at every point in space. The key point is that this chiral structure will appear already in the dipole approximation. I will show how this chiral photonic reagent can be tuned to "react" with the desired enantiomer of a chiral molecule and not with its mirror twin, achieving the ultimate limit in efficiency of chiral discrimination. The simplicity of generating synthetic chiral light in a laboratory opens a broad field of shaping and controlling chiral matter with light. [1] David Ayuso et al, Locally and globally chiral fields for ultimate control of chiral light matter interaction, https://arxiv.org/abs/1809.01632