

Donnerstag | 12. Juli | 16:15 Uhr | Hörsaal 1

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On subtle difference between left and right: inducing and probing ultrafast chiral dynamics

I will describe a new technique of chiral recognition, based on the excitation of coherent helical motion of bound electrons in valence shells of a chiral molecule [1]. Unlike the helix of light, traditionally used for chiral recognition in neutral molecules, the helical motion of the electrons has the right size to explore molecular chirality, leading to strong ultrafast chiral response.

The most established technique of probing chiral interactions, the photoabsorption circular dichroism, relies on interaction with circularly polarized light. Distinguishing right-handed from left-handed molecules relies on the molecule sensing the chiral nature of the circular light. The helix of the light-wave is given by its wavelength. Hence, for optical fields, it exceeds the size of the molecule by several orders of magnitude. As a consequence, the related chiral effect – the photoabsorption circular dichroism – is very small. Formally, to feel the pitch of the lightwave, one needs to look be-yond the dipole approximation, relying on the magnetic component of the laser field. Small value of the chiral signal makes ultrafast measurements of chiral dynamics very challenging.

One possible way of increasing chiral response is to avoid the reliance on magnetic field effects and therefore perform chiral measurements without chiral light. We describe the concept underlying such measurements. We present a unified description of several methods of chiral discrimination based on electric-dipole interactions. We show that, in spite of the fact that the physics underlying the appearance of a chiral response is very different in all these methods, the chiral observable in all cases has a unique form. It is a polar vector given by the product of (i) the molecular pseudoscalar and (ii) the field pseudovector specified by configurations of the electromagnetic fields interacting with an isotropic ensemble of chiral molecules. The molecular pseudoscalar is a rotationally invariant property, which is composed from different molecule-specific vectors and in the simplest case is a triple product of such vectors. The key property that enables the chiral response is the non-coplanarity of the vectors forming such triple product. The key property that enables chiral detection without using chiral electromagnetic fields is the vectorial nature of the enantio-sensitive observable.

Finally, we will discuss geometrical and topological origins of chiral response. Handedness is a purely geometrical degree of freedom. In analogy with solids, where geometry and topology play important role in electronic response, we show that one can introduce chiral fields and chiral charges of geometrical origin that drive one-photon chiral response .

[1] S. Beaulieu, et al. "*Photoexcitation Circular Dichroism in Chiral Molecules*", *Nature Physics*, 2018

Einlader: Prof. Thomas Fennel

