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Ultrafast Meets Chirality

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Chirality is a symmetry property of matter, which can emerge at any length scale, from galaxies to snail shells and even to subatomic particles. Chiral light-matter interactions have been investigated for two centuries, leading to the discovery of many chiroptical processes used for discrimination of enantiomers. Whereas most chiroptical effects result from a response of bound electrons, photoionization can produce much stronger chiral signals that manifest as asymmetries in the angular distribution of the photoelectrons along the light-propagation axis (Photoelectron Circular Dichroism, PECD). Before 2012, PECD was mainly studied in synchrotron facilities, in the single-photon ionization regime [1]. In this talk, I will show you the recent advances that we made, during my Ph.D. thesis, by applying the toolbox developed in ultrafast and strong-field physics to chiral molecules. We have demonstrated that PECD is a universal effect that emerges in all photoionization regime [2]. We have also demonstrated the first pump-probe PECD experiments, allowing for monitoring photoinduced ultrafast dynamics in chiral molecules on femtosecond timescale [3,4]. Using similar experimental approaches, but by using pulse sequences with counter-intuitive polarization states, we have demonstrated a novel electric dipolar chiroptical effect, called Photoexcitation Circular Dichroism (PXCD), which emerges as a directional and chirosensitive electron current when multiple excited bound states of chiral molecules are coherently populated with chiral light [5]. Last, we introduced a time-domain perspective on chiral photoionization by measuring the forward-backward asymmetry of photoionization delays in chiral molecules photoionized by chiral light pulses. Our work thus carried chiral-sensitive studies down to the femtosecond and attosecond ranges [6].

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