

Attosecond insights into chiral ionization dynamics : CHABBIT and ESCARGOT

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Life is a chiral puzzle based on the stereochemistry of chiral molecules and chiral receptors. Tackling this chiral recognition at the atomic scale by taking into account the electronic cloud is one of the Grails of chemical physics. Meanwhile photoionization can produce strong chiral signals : when photoionization of chiral molecules is induced by circularly polarized light, the 3D-angular distribution of photoelectrons exhibits a forward/backward asymmetry with respect to the laser propagation axis. This circular dichroism effect has been called PhotoElectron Circular Dichroism (PECD) [1-3] and has been observed in all photoionization regimes [4]. This asymmetry results from the scattering of the electrons in the chiral molecular potential and is quantum mechanically described as interferences between partial ionization waves. Is there a temporal correspondence between the interference nature of PECD and the photoemission times of these electrons? We answer this question by using two different experimental setups : a RABBIT (Reconstruction of Attosecond Beatings By Interference of Two-photon transitions) ionization technique with chiral light (circularly polarized) to which we refer to as CHABBIT and a two-color ionization scheme leading to an Enantiosensitive Sub-Cycle Antisymmetric Response Gated by electric-field rOTation (ESCARGOT). CHABBIT is a self-referenced attosecond photoelectron interferometry to measure the temporal profile of the forward and backward electron wavepackets emitted upon photoionization of chiral molecules by circularly polarized laser pulses. We found a delay between electrons emitted in the forward hemisphere and in the backward one, which depends on their ejection angle and if resonance has a hand in the ionisation [5]. In ESCARGOT, we control the instantaneous ellipticity and chirality of the light at the sub-cycle level. Chiral photoionization is still revealed by using such composite field in spite of its zero net chirality. The sub-cycle chiroptical signal varies with the instantaneous chirality of impinging light pulse, during the temporal gate imposed by the potential vector which monitors the electron trajectory within the chiral molecular core just after ionization.

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