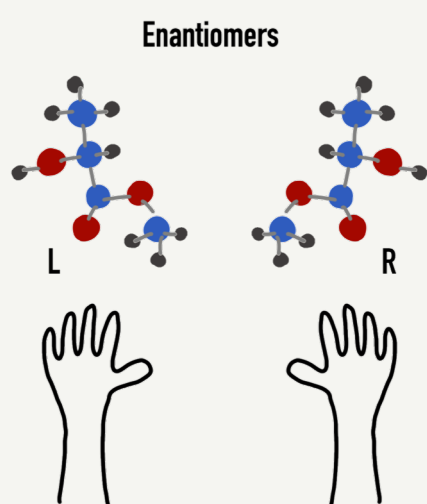


Capturing electron-driven chiral dynamics in UV-excited molecules



What is a chiral molecule?

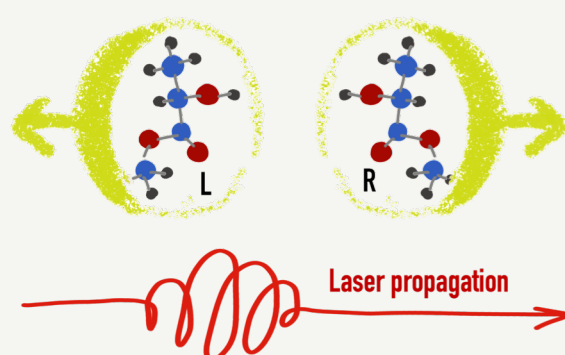
Two molecules that are mirror images of each other and cannot be superimposed form a pair of enantiomers, each of which is said to be chiral. Like choosing between our (chiral) left and right hand for a handshake, choosing one of the enantiomers to interact with another chiral entity will result in a different outcome. Life is homochiral (preferential occurrence of one enantiomer) and chirality is a key property for drug design, among several other applications.

Probing chirality: The “handshake”

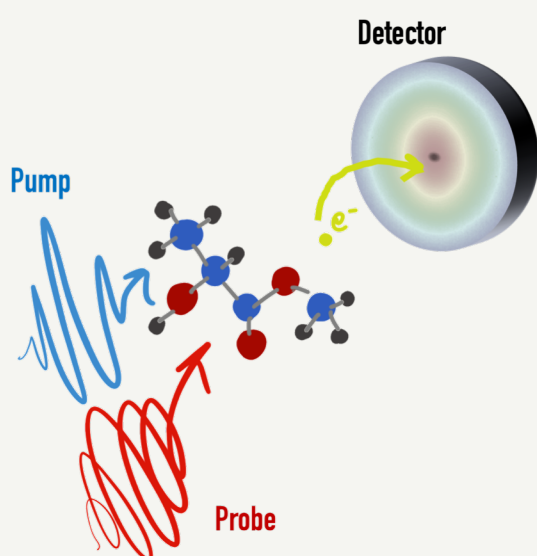
Chiral discrimination (left enantiomer, L, versus right enantiomer, R) can be achieved via the interaction of a chiral molecule with circularly polarized light, which is also chiral, in a virtual “handshake”.

Ionizing chiral molecules with circularly polarized light leads to a forwards-backwards asymmetry in the direction of the photoelectron emission (Photoelectron Circular Dichroism).

Photoelectron circular dichroism (PECD)



In PECD, if the left enantiomer (L) primarily emits backwards, the right enantiomer (R) primarily emits forward compared to the laser propagation axis



The experiment

Electron dynamics in the chiral molecule methyl lactate was initiated with ultrashort ultraviolet (UV) laser pulses. The UV pulses, lasting only 2 fs (1 fs = 10^{-15} s), were combined with time-delayed and circularly polarised infrared pulses in a conventional pump-probe scheme.

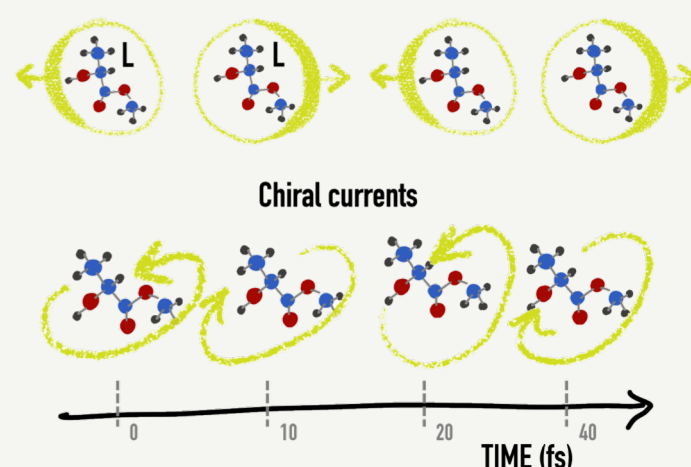
The angular distribution of the photoemitted electrons was measured with a Velocity Map Imaging spectrometer (VMIs) as a function of the delay between the two pulses.

Transient chiral response and chiral currents

The UV-activated coherent electronic motion can modulate the molecular chiral response and even induce a sign reversal, on a timescale below 10 fs.

By engineering the light-induced excitation of the chiral system, one can make the right enantiomer act periodically like the left one and vice versa, but without changing its structure.

Time-Dependent PECD



Additionally, transient chiral electronic currents are generated, which also periodically reverse their direction.

The generated chiral currents open up important perspectives for photochemical control, e.g. to dictate the fragmentation direction during photolysis, thus enabling a new protocol for charge-directed chemistry.