Search for Circular Dichroism Effects in the Auger Decay of Methyloxirane

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Synopsis: Aim of the experiments was the search for Circular Dichroism Effects in methyloxirane (C_3H_6O), after resonant excitation of the O(1s). In a first step we focus on the participator Auger decay.

When a chiral molecule is irradiated by circular polarized light the electron emission, even out of randomly oriented molecules shows a slight asymmetry in the electron flux directed parallel/antiparallel with respect to the photon propagation direction upon switching the helicity of the light. This effect is known as Photoelectron Circular Dichroism (PECD) and it has been observed for many molecules. It usually becomes stronger for lower electron energies, as electron is stronger deflected in the chiral potential. Prerequisite is that the emitted electron is somehow linked to the helicity of the light, as for linearly polarized PECD vanishes. Most experiments have investigated PECD in the valence ionization and a few for inner-shell ionization. While the inner-shell vacancy decays under emission of an Auger electron, the molecule usually undergoes Coulomb Explosion. This circumstance was utilized to postorient one axis of methyloxirane in space. As a consequence the PECD signal increased for certain (partial) orientations quite significant [1].

Here we report on the search for Circular Dichroism (CD) effects in the emitted Auger electrons. The emitted inner-shell electron (photoelectron) usually carries away all "memories" on the helicity of the light and one would expect no CD effects. Additionally due to the high kinetic energy of the Auger electron we anyhow expect just small CD effects (even if it would be a photoelectron with 500 eV). Therefore we focussed on resonant excitation in order to store the helical information of the photon in the excited state. The decay of the $O(1s^{-1})$ can take place via spectator or participator Auger decay, with the latter one likely to show an effect. In a first step we focus on the parent ion, as all fragmentation channels of methyloxirane require the removal of some inner HOMO-states (HOMO-1, HOMO-2….) [2].

The experiment has been performed using the well-established COLTRIMS (Cold Target Recoil Ion Momentum Spectroscopy) technique [3] at the synchrotron facility SOLEIL (Saint-Aubin, France). The circularly polarized photon beam is perpendicularly intersected with a molecular gas jet of enantio-pure methyloxirane. Every hour the light's helicity was switched and we measured both enantiomers as well (R/S). The electron arm of the spectrometer was optimized to measure electrons up to 550 eV (corresponding to Auger Electron from decay of a $O(1s^{-1})$). The ion arm was designed in a time- and space focussing geometry to have maximum momentum and mass resolution.

References:

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