Chirality Sensitive Effects in Electron Collisions against Halocamphors

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Chirality sensitive effects in electron collisions are often referred to as electron circular dichroism (ECD) and amount to the preferential scattering of spin-polarized beams from pure enantiomer samples. Kessler and co-worker performed a series of gas-phase experiments with halocamphors and other target molecules [1], expressing the ECD effects in terms of electron scattering asymmetries. Those experiments were at least partly motivated by the Vester-Ulbrich (VU) hypothesis for biological homochirality [2], which claims that parity-violating interactions might have selected optical isomers in the early stages of life in our planet. While the VU conjecture is not broadly accepted as an explanation for the chiral selection of biomolecules, Dreiling and Gay (DG) recently reported on the chirality sensitive dissociation of halocamphor molecules [3]. These experiments are fascinating in a number of ways. They are consistent with the principle underlying the VU hypothesis; they are the first account of chiral effects on dissociation electron attachment (DEA) reactions; the reported DEA asymmetries magnitudes sometimes largely exceed those of the scattering asymmetries; and the DEA asymmetries do not correlate with the atomic number of the halogen substituents, as expected from theory.

While theories of scattering asymmetries have long been proposed [4], with emphasis on the basic mechanisms and symmetry properties, little is known about the dynamics of electron-halocamphor collisions. We report fixed-nuclei scattering simulations for 3-Br-camphor, 3-I-camphor and 10-I-camphor molecules, paying special attention to the resonances lying within the energy range addressed in the DG experiments, which are expected to initiate the DEA reactions of interest. We also generalized the usual Feshbach projection operator approach to DEA processes [5] to account for the Coulomb and spin-orbit interactions. We thus obtained expressions for the DEA symmetries that might be of help to understand the DG data.

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