Enantiomer Identification of Mixtures of Chiral Molecules with Molecular Jets and Broadband Microwave Spectroscopy

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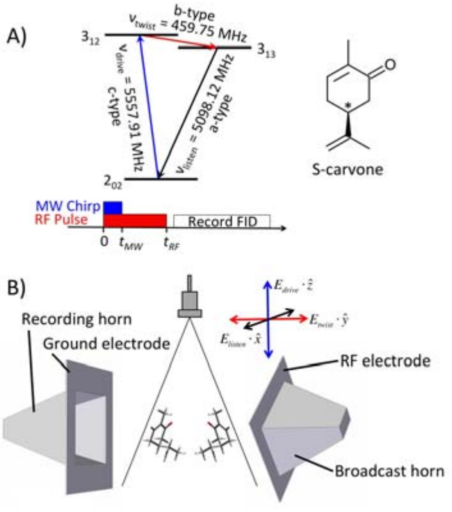
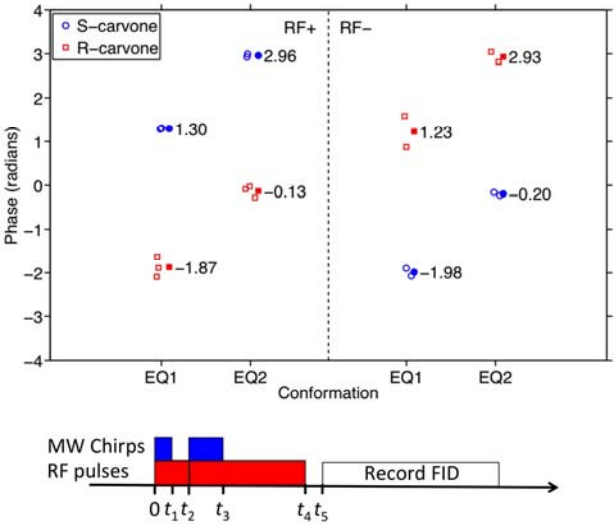
The chemistry of life is built almost exclusively on left-handed amino acid and right-handed sugars, a phenomenon known as the "homochirality of life." In fact, one enantiomer of some chiral molecules may have healthful benefits while the opposite may be toxic. As such, enantiomer identification and measurements of the enantiomeric excess (ee) in mixtures of chiral molecules are of utmost importance. Here we present a new method of differentiating enantiomeric pairs of chiral molecules in the gas phase.[1] It is based on broadband rotational spectroscopy and is a sum or difference frequency generation three-wave mixing process that involves a closed cycle of three rotational transitions, one a-type, one b-type, and one c-type. For example, c- and a-type transitions are excited and the radiation emitted via the b-type transition that closes the cycle is detected. The phase of this signal bares the signature of the enantiomer, as it depends upon the combined quantity, $\mu_a\mu_b\mu_c$, which is of opposite sign between enantiomeric pairs. Furthermore, the signal amplitude is proportional to the ee, and therefore this technique allows for both the determination of which enantiomer is in excess and by how much. A great advantage is that it can also be applied to mixtures of chiral molecules, even when the molecules are very similar. We present results on the analysis of the isomeric conformational mixture of carvone, demonstrating this technique in supersonic expansions and employing broadband rotational spectroscopy as the excitation and detection method.





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[1] D. Patterson, M. Schnell, J. M. Doyle, *Nature.* **2013**, *497*, 475-477.