

CHIRALSPEC: CHIRALITY DETECTION BY MILLIMETER-WAVE THREE-WAVE MIXING

MARTIN S. HOLDREN, KEVIN J MAYER, BROOKS PATE, *Department of Chemistry, The University of Virginia, Charlottesville, VA, USA*; DEACON J NEMCHICK, SHANSHAN YU, *Jet Propulsion Laboratory, California Institute of Technology, Pasadena, CA, USA*.

In the search for life elsewhere in our solar system, the development of tools to measure key biomarkers is a critical area of research. One biomarker found in nature on Earth is homochirality, the predominant utilization of one handedness (enantiomer) of a biological chiral molecule over another. For example, the biological prevalence of left-handed amino acids and right-handed sugars. Developing compact, low-power instruments to detect important chiral biomolecules and measure their enantiomeric excess with high sensitivity is a challenge. We are developing and testing the three-wave mixing technique for rotational spectroscopy which was demonstrated in 2013 [1, 2] to meet these challenges. The instrument can perform sensitive detection when operated as a traditional rotational spectrometer and subsequently perform chiral measurements (absolute configuration and the enantiomeric excess) by three-wave mixing without the need for derivatizing agents or prior separation of mixtures. We use W-band (70-90 GHz) and centimeter-wave (2-8 GHz) excitation sources to excite a small amount (3-5 mTorr) of gas phase chiral molecules and generate a chiral free-induction decay in the W-band. Propylene oxide is used as the test-case molecule and chiral emission is detected for its R-and S-forms with 180 degrees phase shift allowing us to differentiate the two enantiomers. The use of millimeter-wave technology in the instrument design provides a path to future reductions in size, weight, and power of the ChiralSpec instrument that make it compatible with the stringent requirements of space missions.

[1] D. Patterson, M. Schnell, and J.M. Doyle, "Enantiomer-specific detection of chiral molecules via microwave spectroscopy", *Nature* 497, 475-478 (2013). [2] D. Patterson and J.M. Doyle, "Sensitive Chiral Analysis via Microwave Three-Wave Mixing", *Phys. Rev. Lett.* 111, 023008 (2013).