PROGRESS ON THE DEVELOPMENT OF A MILLIMETER-WAVE CHIRALITY SPECTROMETER (CHIRALSPEC)

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Homochirality is omnipresent in nature on Earth in which life predominately utilizes one handedness of a chiral molecule over another. It is considered a biomarker that can aid in the search for life elsewhere in the solar system on places like Mars, Titan, Europa, and Enceladus. The 2013 planetary science Decadal Survey recommends “a detailed characterization of organics to search for signatures of biological origin, such as molecules with preferred chirality or unusual patterns of molecular weights” as a key future investigation for determining the possibility of life beyond Earth. Mass spectrometers are the primary choice for chemical detection and identification of simple organics for planetary and astrobiology investigations. However, mass spectrometry alone cannot address the challenge of successfully deconvolving mixtures of structurally complex organic molecules of approximately the same molecular weight; this includes lacking the chirality detection capability required for analysis of chiral molecules.

ChiralSpec can provide synergetic measurements to mass spectrometers for planetary science and is funded by the NASA Planetary Instrument Concept for the Advancement of Solar System Observations (PICASSO) program. ChiralSpec is a millimeter-wave spectrometer operated in two modes: (1) chirality detection mode, based on a novel three-wave mixing; and (2) survey mode, with the instrument acting as a traditional millimeter-wave spectrometer to characterize chemical composition and quantify abundance of planetary samples. ChiralSpec extends the work done on microwave three-wave mixing into higher frequencies of light where size, weight, and power of many components of the instrument can be reduced.

We will report on the current state of this instrument and its future developments. G-band (180-200GHz) and W-band (70-90GHz) excitation channels have been designed, tested, and optimized to show that power requirements are met and that molecular emission can be detected for many two level systems for a test case molecule, propylene oxide. Three-wave mixing experiments are on-going, and we will report our findings.