



Millimeter-wave spectrometer for chirality and relative abundance determination of amino acid biomarkers (ChiralSpec)

PI: Shanshan Yu/JPL

Target:

Atmosphere, surface, and subsurface of Enceladus, Europa, Titan, and Mars; any bodies where amino acids, fatty acids, and other organic compounds are in the gas phase or can be brought into the gas phase.

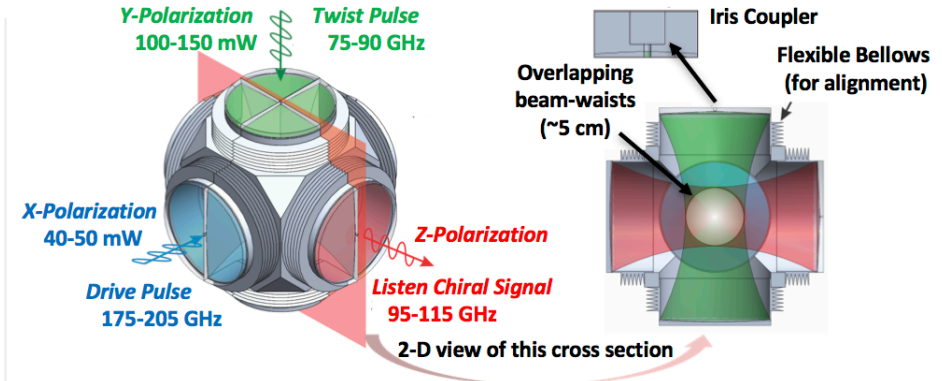
Science:

- ChiralSpec is designed for the detection of chirality, a potential sign of life, such as those found on Titan or the Gas or Ice Giants. This science is directly aligned with the goal to detect extant life in the ocean worlds of the outer solar system, a high-priority science objective from the 2013 Decadal Survey paper "*Vision and Voyages for Planetary Science in the Decade 2013-2022.*"

Objectives:

- Advance millimeter-wave three-wave mixing chirality detection technology (TRL in/out: 2/3)
- Advance millimeter-wave cavity resonance technology to increase ChiralSpec's sensitivity (TRL in/out: 2/3)
- Experimentally demonstrate ChiralSpec's ultimate sensitivity at room temperature, as well as at 77 K (TRL in/out: 3/3)

CoIs: Theodore Reck, Michael Malaska, Robert Hodyss/JPL; Brooks Pate/University of Virginia



ChiralSpec: chirality detection achieved through three-wave mixing of three transitions of a chiral molecule inside a three-axis resonator chamber (shown above), with two pulsed transmitters (drive and twist) and one receiver (listen). Vacuum and alignment components are not shown for clarity.

Key Milestones:

- Power of ~50mW achieved for the 175-205 GHz transmitter (month 6)
- Precision of 1 radian achieved for phase measurements (month 12)
- Chirality detection achieved at 300 K with ~1 mTorr of volatile propylene oxide (month 21)
- System $Q > 1000$ achieved for resonators (month 21)
- Chirality detection achieved at 300 K with 10^{-5} mTorr of propylene oxide (month 29)
- Chirality detection achieved at 77 K with alanine-impregnated water ice (month 36)

$TRL_{in} = 2; TRL_{in} = 3$