



Terahertz heterodyne spectral imager of planets and comets

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Target: upper atmospheres of planets, comet comae, geyser and volcano plumes

Science:

For moons and the rocky planets:

- Isotope ratio of light molecules H/D, $^{12}/^{13}\text{C}$, $^{14}/^{15}\text{N}$, $^{16}/^{17}/^{18}\text{O}$ \Rightarrow evolution and origin of the atmosphere;
- $2_{2,0}-1_{1,1}$ para and $2_{2,1}-1_{1,0}$ ortho transitions in water near 2.96 and 2.77 THz;

For the giant planets: HD, CH₄, H₂O, NH₃ are the key tracers of the upper atmosphere \Leftarrow through detection of THz lines of fragments CH (2 THz), CH₂ (1.9, 2.3, 2.7 THz), OH (2.5 THz), NH (1 THz), NH₂ (1.44 THz), O (2.06 & 5.4 THz);

For inner planets: water dynamics (1.6-1.8 THz)

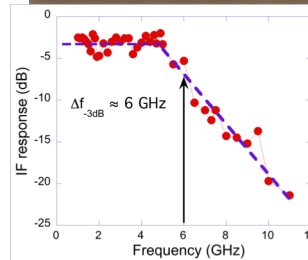
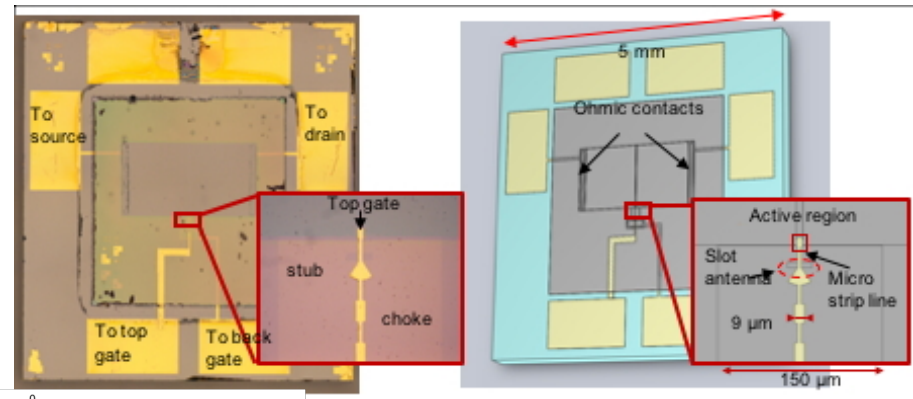
New molecular species (e.g. CH⁺ and O)

Increased wind velocity resolution \sim 1 m/s

Objectives:

- Improve the single-pixel, quasioptical TACIT and demonstrate its noise performance in a laboratory heterodyne receiver at 2.5 THz;
- Develop a waveguide-based TACIT mixer on thin Si membrane for 2.5-3.8 THz waveguide suitable for large heterodyne arrays.

CoIs: Jonathan Kawamura, Mark Hofstadter/JPL; Mark Sherwin/UCSB



Current quasioptical TACIT mixer device. Top left: optical image. Top right: schematic layout. Bottom: IF response from mixing of two 2.5 THz signals demonstrating the 6-GHz IF bandwidth in the mixer.

Key Milestones:

- Optimization of the quasioptical TACIT mixer
- Integration of the mixer with bow-tie antenna to allow for good quantum efficiency
- Validation of high-sensitivity of the mixer at 2.5 THz
- Operating temperature/noise temperature trade-off study
- Achieving a TACIT mixer on Si membrane integrated into waveguide
- Demonstration of the lab system: the starting point for the instrument development under MatISSE

TRL 3 to 4