Electrically pumped mid-IR optical frequency combs for dual frequency spectroscopy

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Target: Mars Exploration Program missions, Discovery-class Program missions, and New Frontiers missions—Venus *In-Situ* Lander, Comet Surface Sample Return, etc.

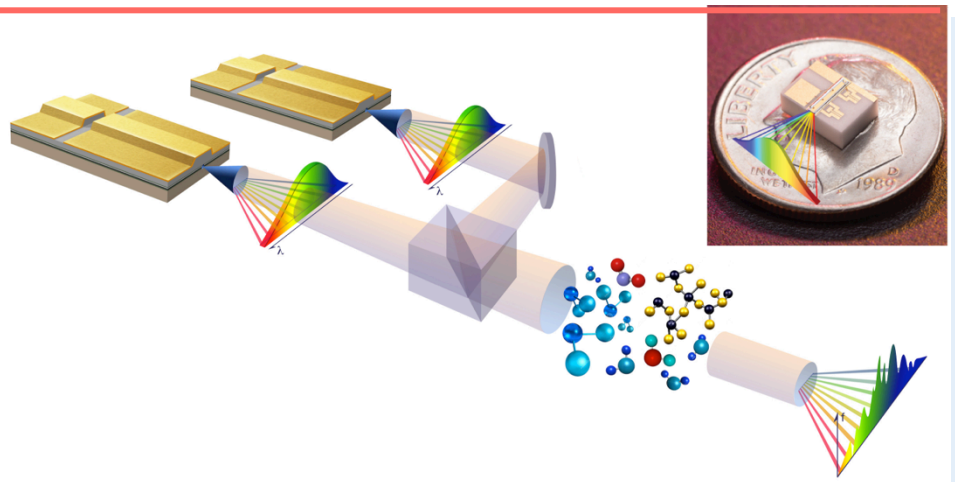
Science:

- Simultaneous high-resolution, broadband and instantaneous analysis of
  - atmosphere of Venus, Mars and Titan
  - water (robotically volatilized) on Europa
  - volatile components of samples returned from the Moon and comets

Objectives:

- Demonstrate broadband and stable mid-IR optical frequency combs by passively mode-locking interband cascade lasers (ICL)
  - 3-5 µm range
  - < 1 W power consumption
  - < 1 KHz linewidth
- Extend the stable operation condition of frequency combs by dispersion compensation of ICLs
- Demonstrate broadband, high resolution and high sensitivity spectroscopy of (NH3-CH4) and (PH3-HCN) mixtures with ICL combs in a dual frequency comb spectroscopy setup

CoIs: Dr. Clifford Frez, Mr. Mathieu Fradet and Dr. Siamak Forouhar (JPL); Professor Gerard Wysocki (Princeton University)



A Dual frequency comb spectroscopy setup; Two slightly mismatched optical frequency combs are detected on a fast detector after passing through the medium under investigation. It allows a wide optical spectrum to be mapped into an electrical spectrum. Our proposed comb devices' ease of use, their compact size and low power consumption makes an ideal candidate for such motion-less spectrometers

Key Milestones:

- Design and qualify dispersion compensated ICLs (yr 1)
- Setup a DFCS setup (yr1)
- Demonstrate stable dispersion-compensated comb operation (~50 nm bandwidth) (yr 2)
- Develop multi-species detection algorithms and methodologies (yr 2)
- Demonstrate broadband dispersion-compensated ICLs (~200 nm) (yr 3)
- Demonstrate multi-specie detection using DFCS setup.

TRL: 3 to 4