# Miniature Spectrometer for Detection of Organics and Identification of their Mineral Context

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# Project Background & Motivation

- Surface reconnaissance and sample selection will be “built into” future astrobiology investigations (e.g. on Mars, Europa, small bodies)
- A “quick-look” near-IR / mid-IR spectral survey tool can be incorporated into an instrument suite. Identify (or eliminate):
  - → *Aqueous minerals*
  - → *Volatiles (ices)*
  - → *Functional group absorption features of organic materials*
- Objective: Develop a simple NIR/MIR “point” reflectance spectrometer (PS) at NMSU. Integrate with a laser desorption time-of-flight (LDTOF) mass spectrometer at GSFC/699. Shared focal plane.
- Received NASA ASTID & EPSCoR funding in FY09
- Institutional roles:

  ***NMSU***: Develop & package the NIR spectrometer
  ***GSFC***: Concurrently miniaturize the LDTOF. Accommodate the NMSU PS
  ***NM Tech***: Sample control and curation for both instruments.

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This talk

Next talk

# IR Point Spectrometer - Features

- Tuning technology: Acousto-optic tunable filter (AOTF)
  RF-tuned
- Spectral coverage: 1.6 - 3.6 μm
- Spectral resolution: 10 -15 $cm^{-1}$ ($\lambda/\Delta\lambda$ ~ 180-400)
- Sample field-of-view: ~ 1 mm
- Etendue ($A\Omega$): ~ 0.01 $cm^2$ sterad
- SNR > 100
- Co-aligns with GSFC LDTOF, or operates stand-alone
- Mass: ≤ 1 kg
- Power: ~ 10 W

# Optical Design

**5**

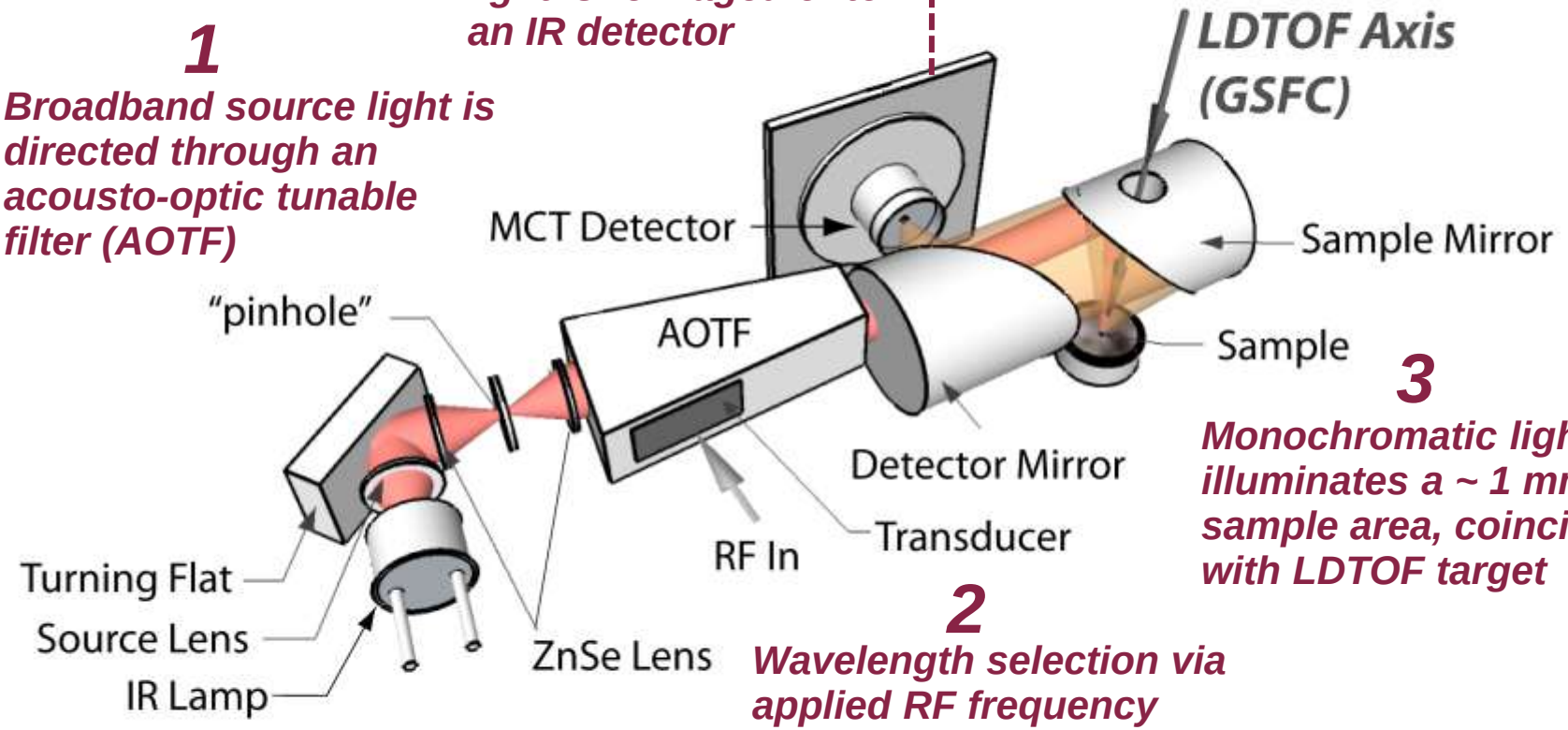
***Data acquisition: Multiple RF-sweep coaddition ("sweep averaging")***

**4**

***Reflected (scattered) light is reimaged onto an IR detector***

**1**

***Broadband source light is directed through an acousto-optic tunable filter (AOTF)***



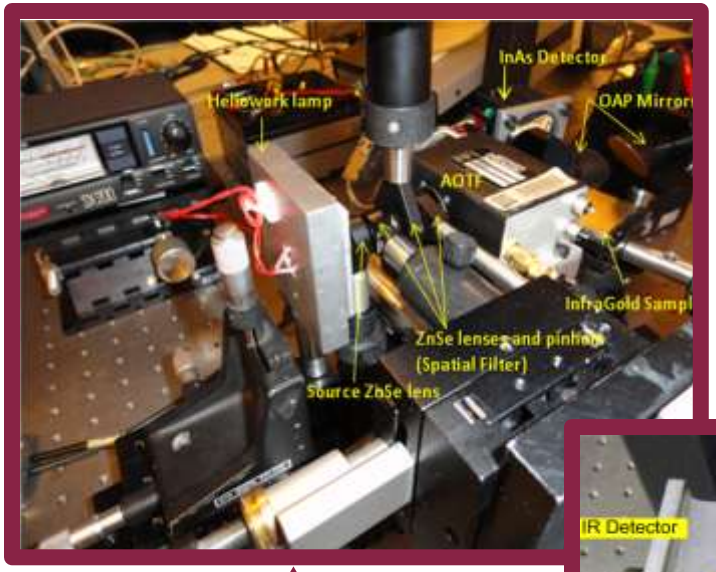

**3**

***Monochromatic light illuminates a ~ 1 mm sample area, coincident with LDTOF target***

**2**

***Wavelength selection via applied RF frequency (30-70 MHz @ 2-3 W)***

# Spectrometer Evolution at NMSU and GSFC

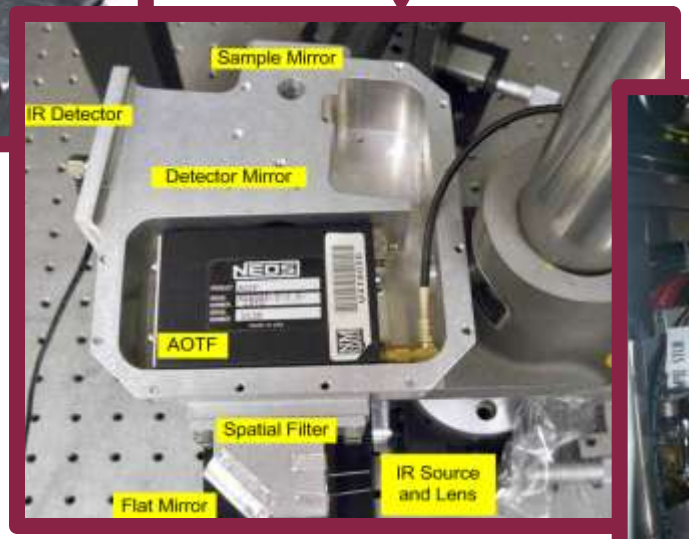



## I. NMSU breadboard

- Radiometric modeling
- Optical design
- Component testing
- Breadboard assembly
- Survey measurements

## II. Packaging (NMSU)

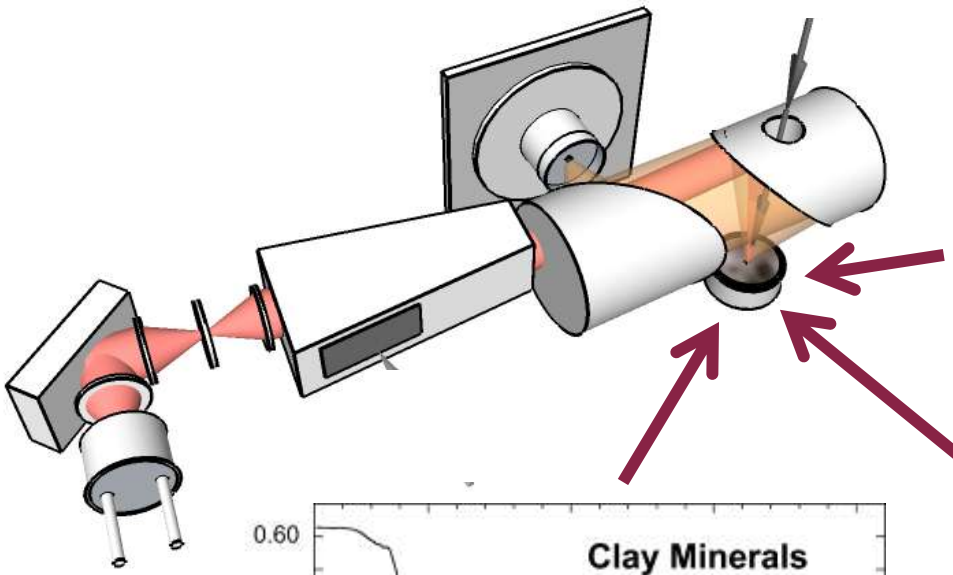
- Optomechanical design
- Fixture fabrication
- Alignment & calibration
- "Field-case" electronics
- Performance assessment

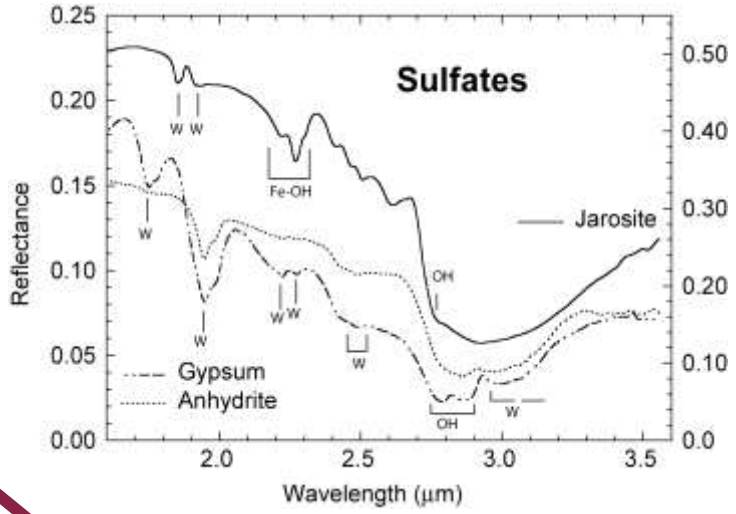


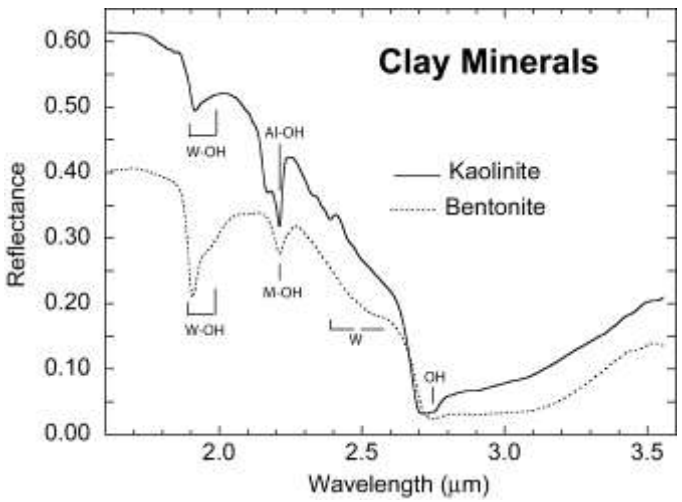

## III. GSFC Integration

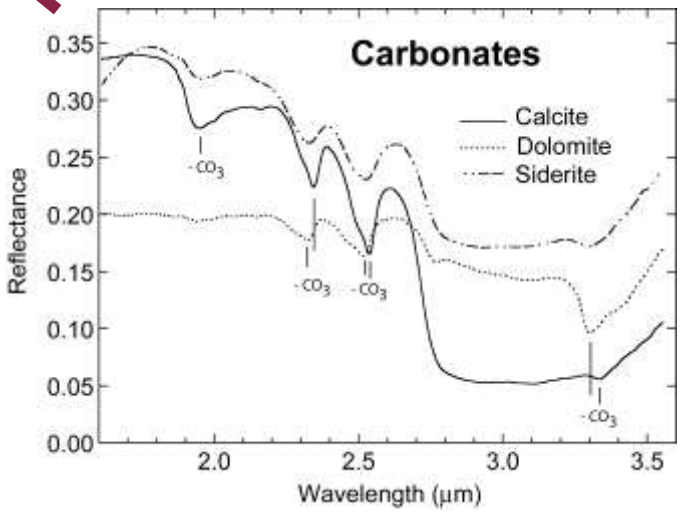
- Vacuum harnessing
- LDTOF coalignment
- Pump down
- IR checkout

# Survey Spectra of Aqueous Minerals





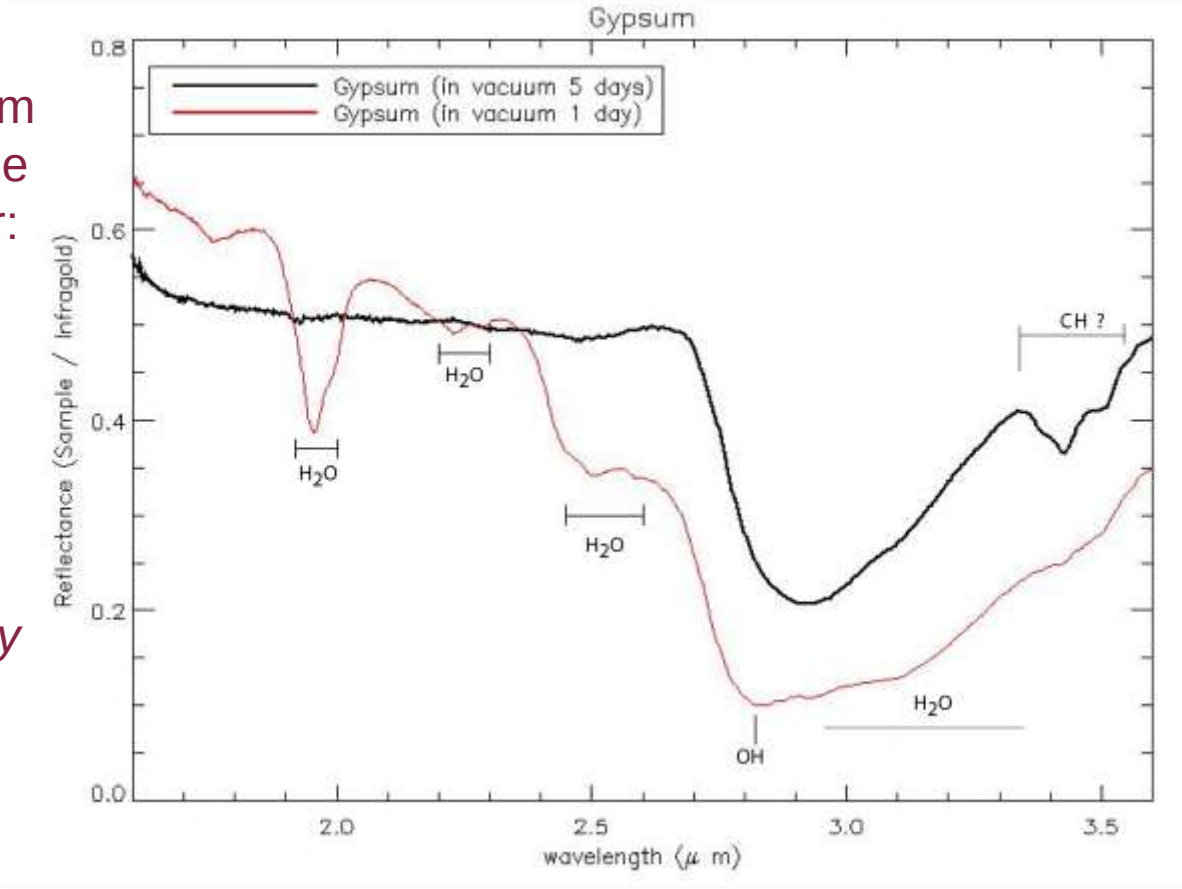
# Vacuum Desorption of $H_2O$ from Gypsum

Initial measurement of gypsum made with the AOTF PS in the LDTOF MS vacuum chamber:

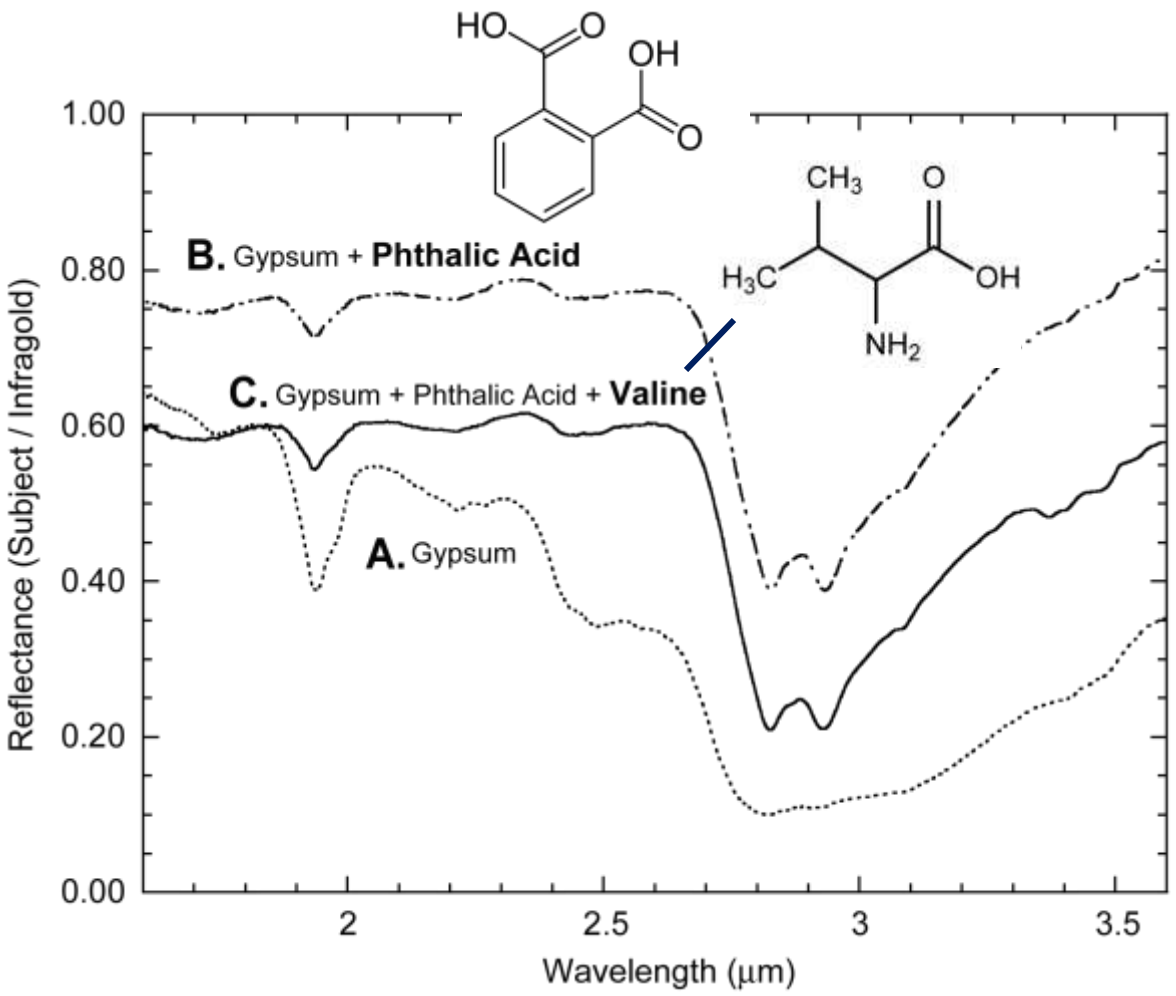
- *In vacuum, gypsum loses adsorbed as well as structurally bound $H_2O$ in the top monolayer(s).*

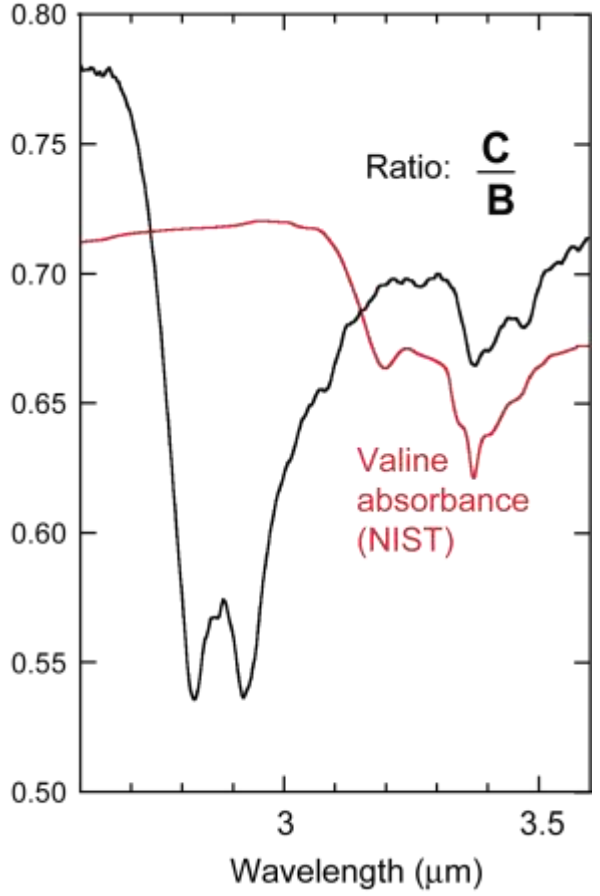
- *Similar results observed by Cloutis et al., GRL, '07*

- *Analysis of these data is ongoing*



# Carboxylic and Amino Acids



# Status and Near-Term Plans

- The AOTF point spectrometer has been mated with the GSFC LDTOF (discussed in more detail in the next talk)
- Initial diagnostic measurements using gypsum
- In progress: Measurements of reference samples, e.g. PAH's and amino acids on basalts
- Have begun looking at "unknowns", i.e. irradiated ice residues supplied by the Cosmic Ice Laboratory (Code 691), with several starting materials.

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- A steep learning curve !!