



CALIFORNIA INSTITUTE OF TECHNOLOG

## Uses of a Microwave Spectrometer for a small lunar impactor mission



Matt Siegler (JPL) Thanks to Sam Gulkis, Imran Mehdi, Andy Ingeroll



## **Concept for a ride along instrument in impact chaser or orbiter**

# The MIRO instrument on Rosetta(7 arcmin FWHMcan examine water isotopesfield of view)

• Main 3 water isotopes can be differentiated in vapor

It can see in the dark

### **Species visible with MIRO spectrometer**

Species	Frequency (MHz)	Transition
Water		
$H_2^{16}O$	556936.002	1(1,0)-1(0,1)
$H_2^{17}O$	552020.960	1(1,0)-1(0,1)
$H_2^{18}O$	547676.440	1(1,0)-1(0,1)
Carbon monoxide		
CO	576267.9305	J(5-4)
Ammonia		
NH <sub>3</sub>	572498.3784	J(1-0)
Methanol		
CH <sub>3</sub> OH	553146.296	8(1)-7(0) E
CH <sub>3</sub> OH	568566.054	3(-2)-2(-1) E
CH <sub>3</sub> OH	579151.005	12(-1)-11(-1) E



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• Can see 10<sup>12</sup> Molecules/cm<sup>2</sup>/sec

#### **MIRO** spectrometer specification

	Millimeter	Submillimeter
Telescope		
Diameter	30 cm	30 cm
Beam-Size (FWHM)	22 arc min	7 arc min
Foot-Print (2 km nadir distance)	15 m	5 m
Spectral Characteristics		
Frequency	188.5-191.5 GHz	547.5-580.5 GHz
IF Bandwidth 1-1.5 GHz		5.5-16.5 GHz
Spectral Resolution		44 kHz (.023 km/s)
Individual spectral bandwidth		20 MHz (11 km/s)
Spectral Bandwidth/No. Channels		180 MHz/4096
Radiometric Characteristics		
DSB Noise Temp.	1000K	5000K
RMS Spectroscopic Senstivity		2K
(300 kHz, 2 min.)		
RMS Continuum Sensitivity(1 sec)	< 1 K	< 1 K
Data Collection Rate	0.23 - 2.53 kbp	S

## Par and the

## The minimum detectable water signature is 10<sup>7</sup> times more sensitive than LCROSS visible plume requires





## Microwave spectrometers have been developed for CubeSats (MIT's MicroMAS shown here) (2.5° FOV\*)





MicroMAS has 8 channel "spectrometer" 115-119 GHz- Launches Dec 8



## This observation would not require illumination (and plume is much denser near the surface)



...which is especially important if impactor is too small to make a visible plume.

- Could be implemented as a separate CubeSat or as impact chaser.

#### The MIRO instrument on Rosetta (7 arcMin FWHM can examine water isotopes field of view)

**Species visible with MIRO spectrometer** Near surface dielectric constant (with cross polarization) Near surface thermal gradient Very low temperatures at high precision (extending Diviner's temperature range) **Development** of arrays underway at JPL

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## **Could a short wavelength Microwave radiometer find ice?**

Near surface dielectric constant (with cross polarization)
Near surface thermal gradient
Extreme sensitivity to chemical species in vapor

 Very low temperatures at high precision

**Development of arrays underway at JPL** 

MIRO: Measured Flight Performance Passband: 190 GHz, ~1.6 mm (millimeter wavelengths); 562 GHz, ~0.5 mm (submillimeter wavelengths) Spectral resolution: < 100 kHz (sub-millimeter) Spatial resolution: 75 m (millimeter); 25 m (sub-millimeter) Field of view: < 22 arc minutes (millimeter); < 8 arc minutes (sub-millimeter) Radiometric sensitivity: 1 K (continuum) Mass/power: 19.9 Kg / 43 W







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