Measurements of Mars Methane at Gale Crater by the SAM Tunable Laser Spectrometer on the Curiosity Rover

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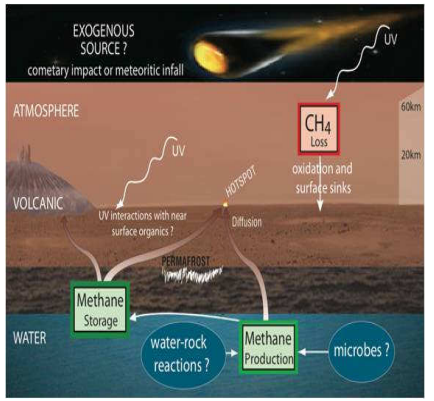
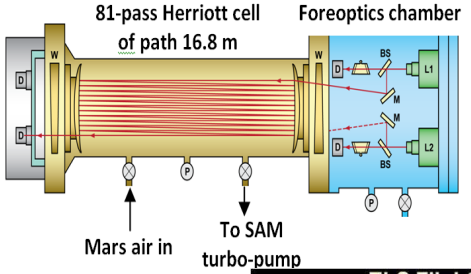
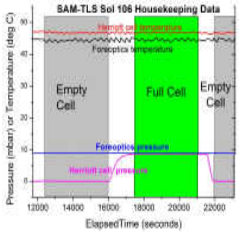
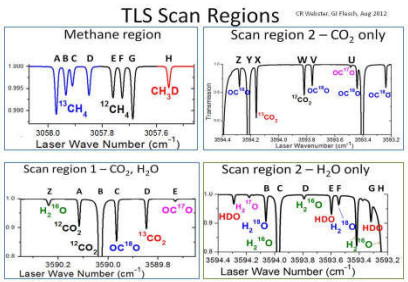


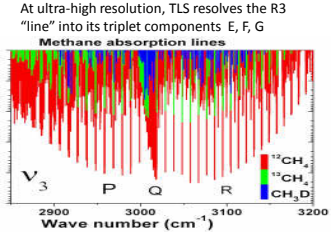
The Tunable Laser Spectrometer (TLS) is one of three instruments that make up the Sample Analysis at Mars (SAM) suite on the Curiosity Rover that landed in August 2012. TLS is a two-channel tunable laser spectrometer (3.7 kg) using an Interband Cascade (IC) laser at 3.27 µm for methane measurements, and a near-IR tunable diode laser for measurements of water and carbon dioxide isotopes. To date, TLS has measured in CO_2 the isotope ratios $^{13}C/^{12}C$, $^{18}O/^{16}O$, $^{17}O/^{16}O$ and $^{13}C^{18}O/^{12}C^{16}O$; and in water the isotope ratios D/H and $^{18}O/^{16}O$ in both the atmosphere and gases evolved from pyrolysis of soils and rock samples. Only methane search results are reported here.

Methane in the atmosphere of Mars is a potential signature of ongoing or past biological activity on the planet. During the last decade, Earth-based telescopic and Mars orbit remote sensing instruments have reported significant abundances of methane in the Martian atmosphere ranging from several to tens of parts-per-billion by volume (ppbv). Observations from Earth showed "plumes" of methane with variations on timescales much faster than expected and inconsistent with localized patches seen from orbit, prompting speculation of sources from sub-surface methanogen bacteria, geological water-rock reactions or infall from comets, micro-meteorites or interplanetary dust. From measurements on NASA's Curiosity Rover that landed near Gale Crater on 5th August 2012, we here report **no definitive detection of methane** in the near-surface Martian atmosphere. Our *in situ* measurements were made using the Tunable Laser Spectrometer (TLS) in the Sample Analysis at Mars (SAM) instrument suite that made three separate searches on Martian sols 79, 81 and 106 after landing. The measured mean value of 0.4 ppbv corresponds to an **upper limit for methane abundance of <3 ppbv** at the 95% confidence level.

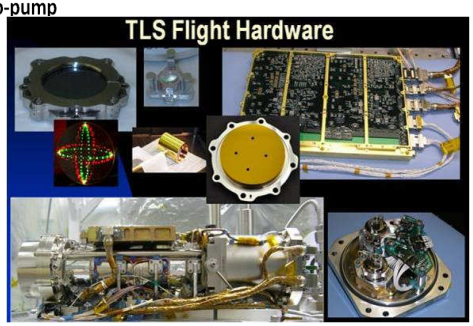


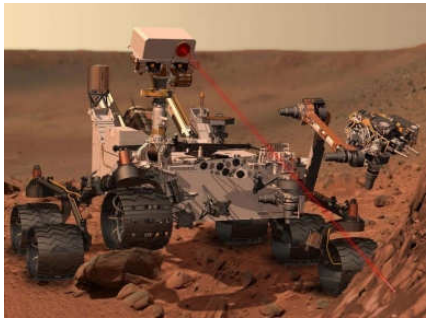






The IC laser was invented (Rui Yang et al.) and developed by researchers at JPL's Microdevices Laboratory (MDL). For TLS, it produces single-mode output of ~5 mW at 245 K. The laser is scanned over the methane region every second with spectra co-averaged for 2 mins on board before downloading to Earth. The TLS NIR laser was provided by Nanoplus.





Mars methane at Gale Crater (4.5°S, 137°E, Ls=157): Expectations

Technique	Observation	Max (ppbv)	Min (ppbv)	Prediction (ppbv)
TLS-SAM	ν_3/R3 (3057.7 cm^{-1})	3 ppbv (2σ)	-	< 3ppbv
MEX/PFS	ν_3/Q (3018 cm^{-1})	70	<3	10-15 ppbv
2003-Present	R=2000	N. summer	N. winter	
		N. polar		
MGS/TES	ν_4/Q (1306 cm^{-1})	60	<1	5-20
2001-2003	R=100-200	N. summer	N. winter	
		N. polar		
IRTF, Keck	ν_3/(R0, R1 at 3029 and 3039 cm^{-1})	40	<3	20-30
2003-2006	R=10^5	N. summer	N. winter	
		Equatorial		
CFHT/FTS	ν_3/P (2997 cm^{-1})	10 (<30)	10 (<30)	10 (<30)
2003	R=1.8X10^5	Global average	Global average	Global average

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Acknowledgement: The research described here was carried out at the Jet Propulsion Laboratory, California Institute of Technology, under a contract with the National Aeronautics and Space Administration (NASA). The TLS instrument was built at JPL and delivered to NASA GSFC for integration into the SAM suite.