



# The Search for Methane on Mars with NIRSPEC: Preliminary Results from the 2009-2010 Observing Campaign

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## Abstract

### 1. Introduction

The Martian atmosphere consists mostly of CO<sub>2</sub> (95.3%), some N<sub>2</sub> (2.7%), Ar (1.6%), O<sub>2</sub> (0.13%), CO (0.07%), H<sub>2</sub>O (0 - 300 ppm), and other trace species. Secure detections of methane on Mars were reported only recently and they suggest that methane is variable both temporally and spatially. Martian methane was detected using ground-based instruments via high-resolution infrared spectroscopy by Mumma et al. (2009, CSHELL at IRTF and NIRSPEC at Keck II), and by Krasnopolsky et al. (2004, Fourier Transform Spectrometer at the Canada-France-Hawaii telescope); and also from space using the Planetary Fourier Spectrometer (PFS) on Mars Express, reported by Formisano et al. (2004), Geminale et al. (2008/2011), and using TES on the Mars Global Surveyor by Fonti & Marzo (2010). Martian methane could have either a geochemical or biological origin, and thus, its discovery poses very interesting astrobiological questions.

### 2. Results

In this work, we present high-resolution infrared spectra of Mars, acquired in 2009 and 2010, with the Near Infrared Echelle Spectrograph (resolving power  $\sim 35,000$ ), on the Keck II telescope. The time interval of NIRSPEC observations corresponds to  $L_s = 8 - 83^\circ$ , early through late spring in the Martian Northern hemisphere. We searched for methane by creating maps of Mars with the slit fixed in the North-South position as the planet rotates, and also by stepping the slit along the East-West direction, thereby acquiring diurnal information. We detect

multiple lines of H<sub>2</sub>O and CO<sub>2</sub> in the 3.3  $\mu\text{m}$  region, and discuss possible indication of CH<sub>4</sub> in the positions of the R0 and R1 lines, on Dec. 1, 2009 ( $L_s = 17.5^\circ$ ; Doppler shift =  $-13.4 \text{ km s}^{-1}$ ; Angular diameter of Mars =  $9.9''$ ; 44 minutes on source), as well as residual features in the positions of the P2, P3 and P4 lines on Dec. 2, 2009 ( $L_s = 17.9^\circ$ ; Doppler shift =  $-13.5 \text{ km s}^{-1}$ ; Angular diameter of Mars =  $10.0''$ ; 76 minutes of maps along the planet). We present spatially resolved spectra of Mars and discuss the implications of methane variability.

### Acknowledgements

This work was funded by NASA's R&A Programs in Astrobiology (344-53-51), Planetary Astronomy (344-32-51-96), and Planetary Atmospheres (NNX09AB65G). We gratefully acknowledge the Keck observatory for supporting these observations.

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