A High-resolution spectral survey of Mars at infrared wavelengths: Searching for signatures of life

Presentation by Nadezhda Radeva (Connecticut College)

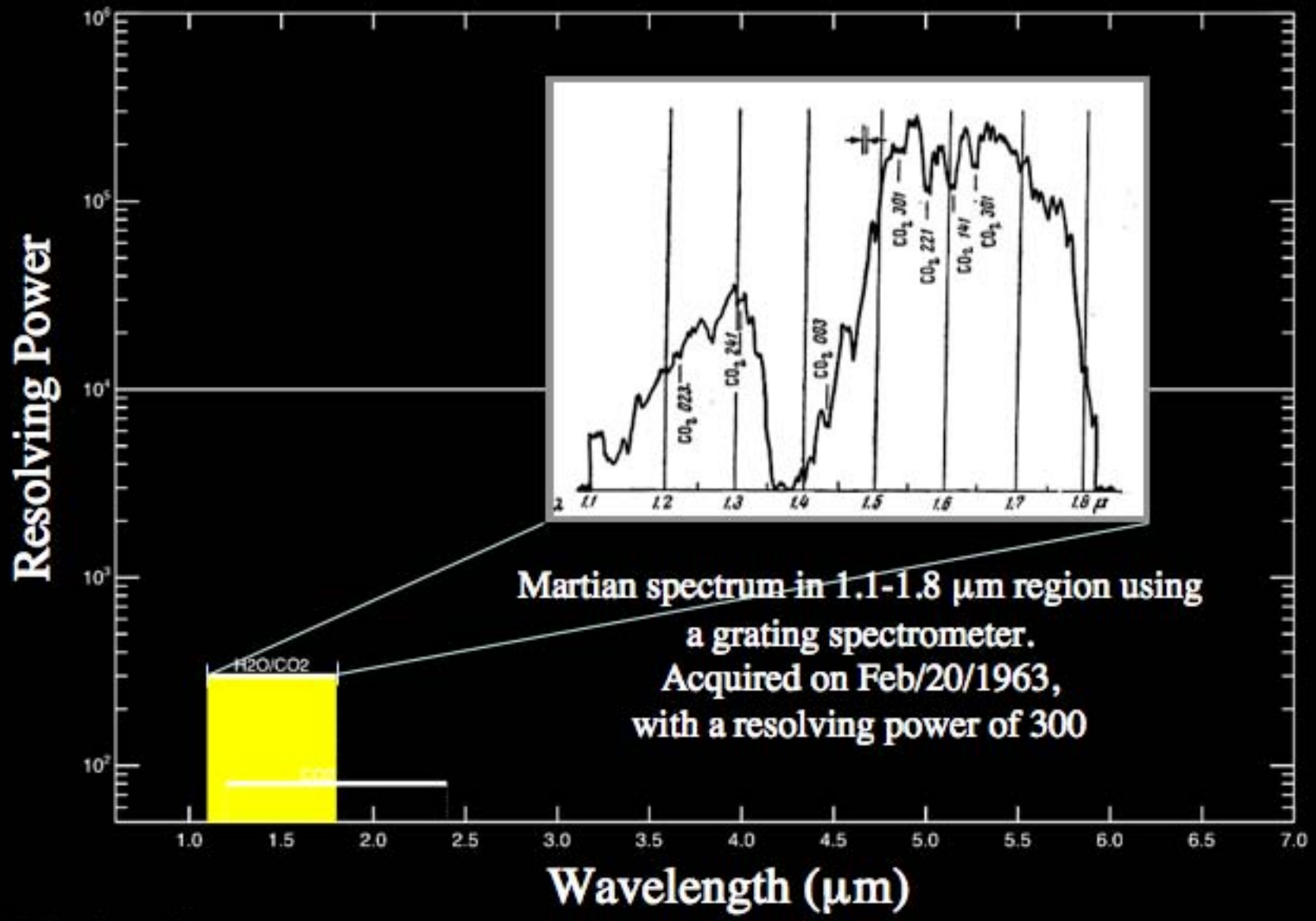
Mentor: Dr. Geronimo Villanueva (NASA-GSFC)

August 2008

1. Introduction

Before 1970:

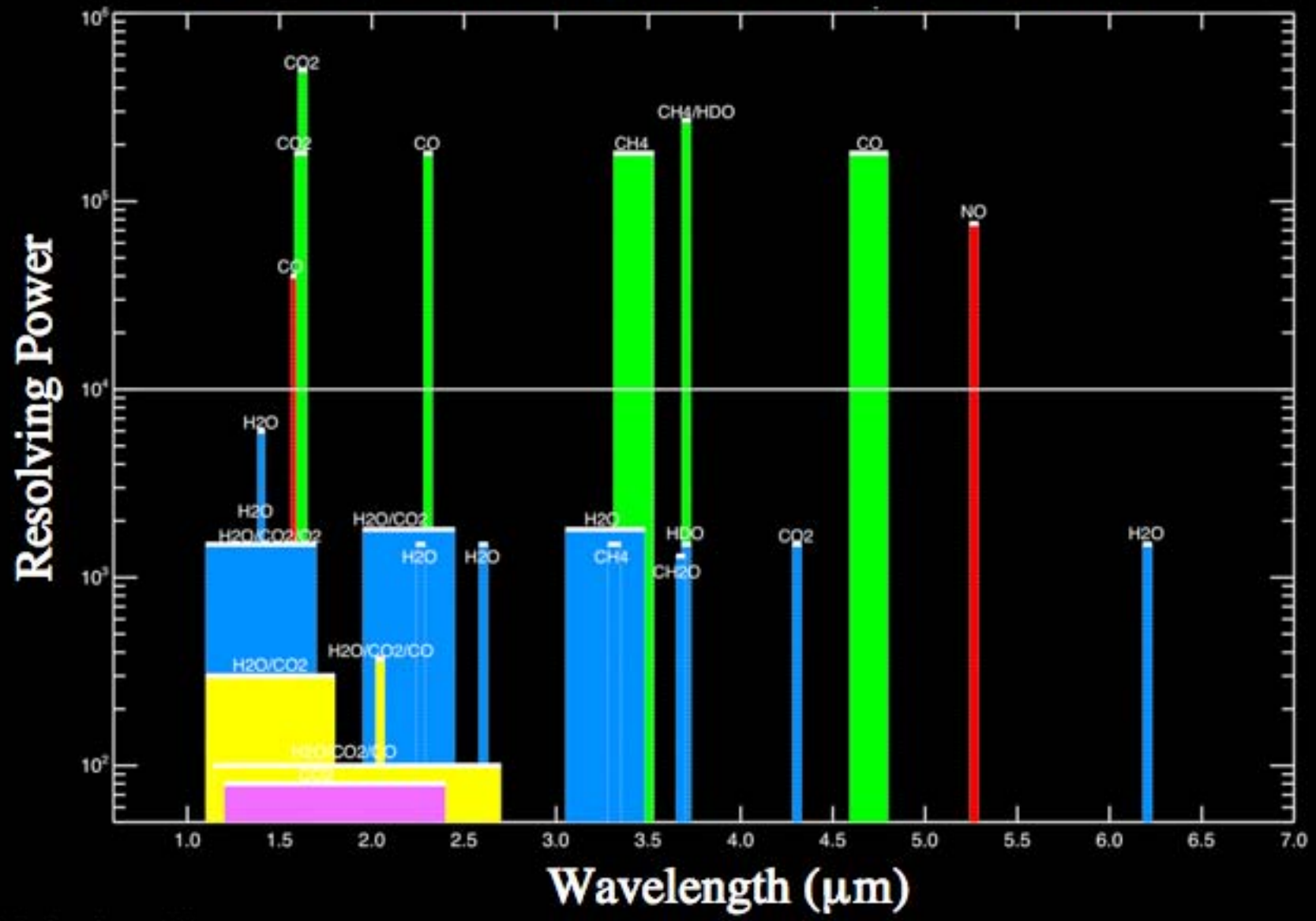
Mars is mainly composed of CO_2 and contains trace amounts of H_2O



Martian spectrum in 1.1-1.8 μm region using a grating spectrometer. Acquired on Feb/20/1963, with a resolving power of 300

In the new millennium:

Many molecules have been measured (H_2O_2, O_3, CH_4?, …) and we are re-discovering the planet: Life on Mars?



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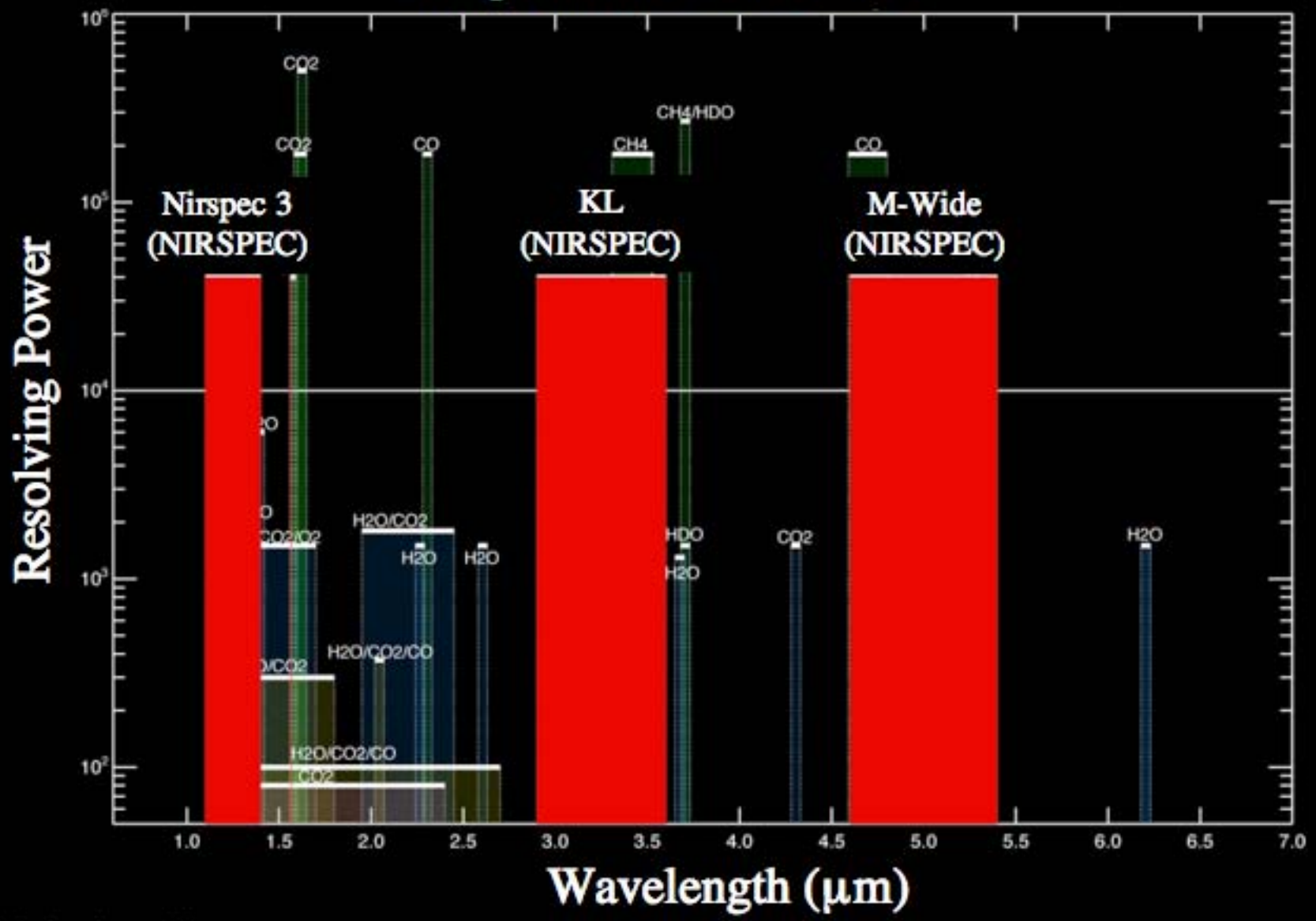
This Work:

A sensitive and extensive spectral survey of the infrared region of Mars using NIRSPEC at Keck-2



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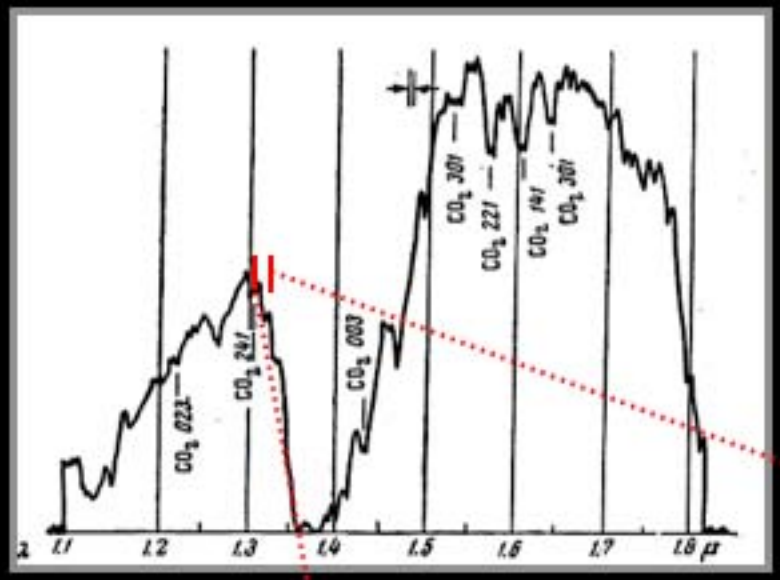
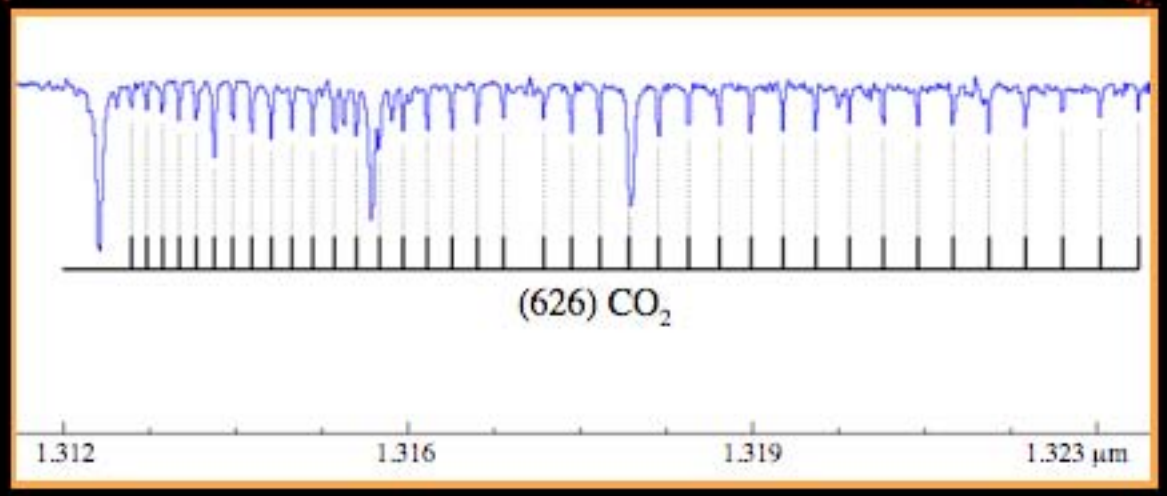


Martian spectrum in 1.1-1.8 μm region using a grating spectrometer. Acquired on Feb/20/1963, with a resolving power (RP) of 300

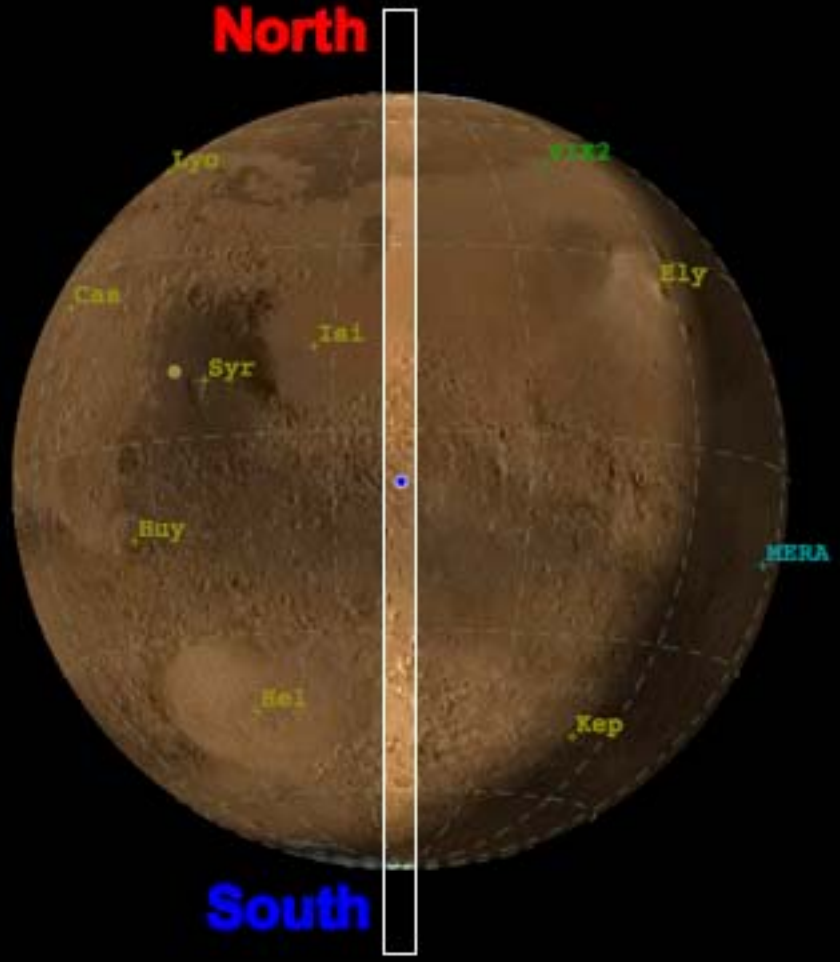
[Moroz, The Infrared Spectrum of Mars, Astronomicheskii Zhurnal, Vol 41, No.2, March-April 1964]

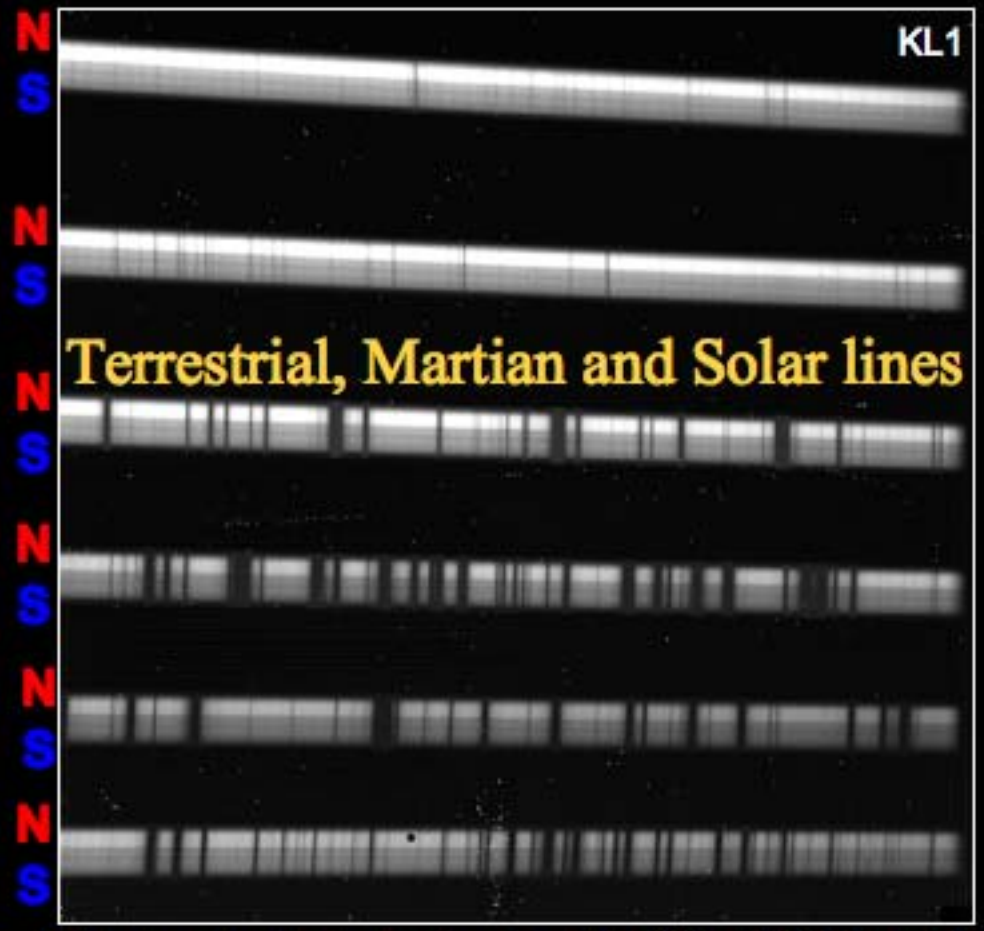


Martian spectrum in 1.31-1.32 μm region. NIRSPEC 3 setting, March/22/2003, RP=40,000

2. Data Processing

NIRSPEC spectrometer, Keck II, Hawaii, USA



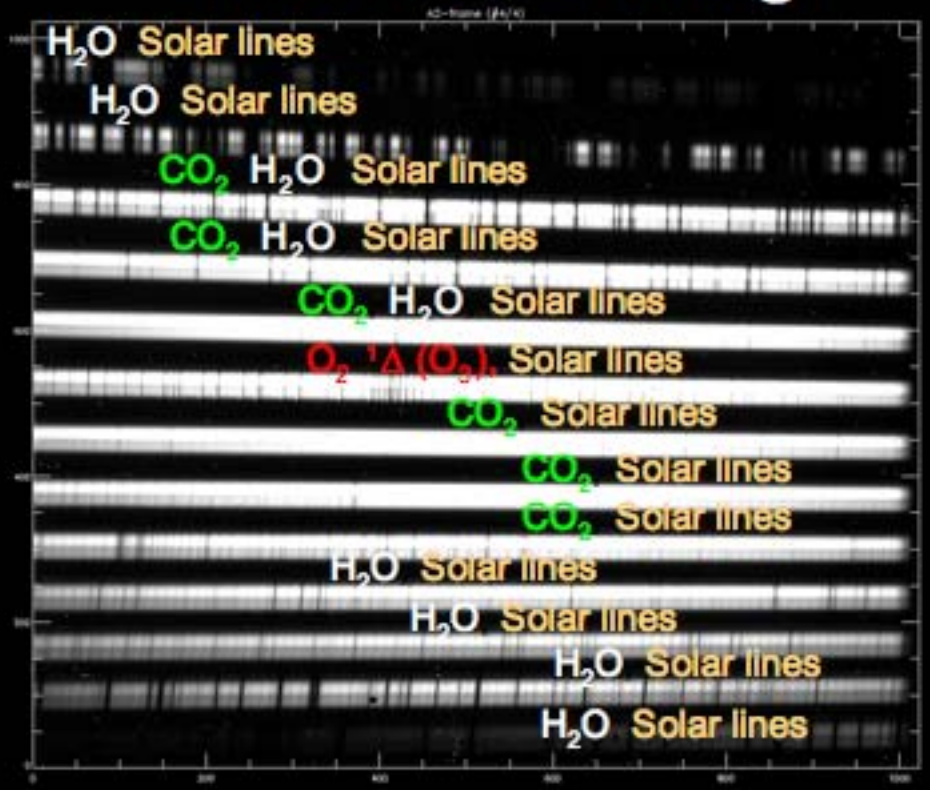


Frequencies between 2700-3400 cm^{-1} (3.7-2.9μm)

Mars Image credit: Mars24, NASA

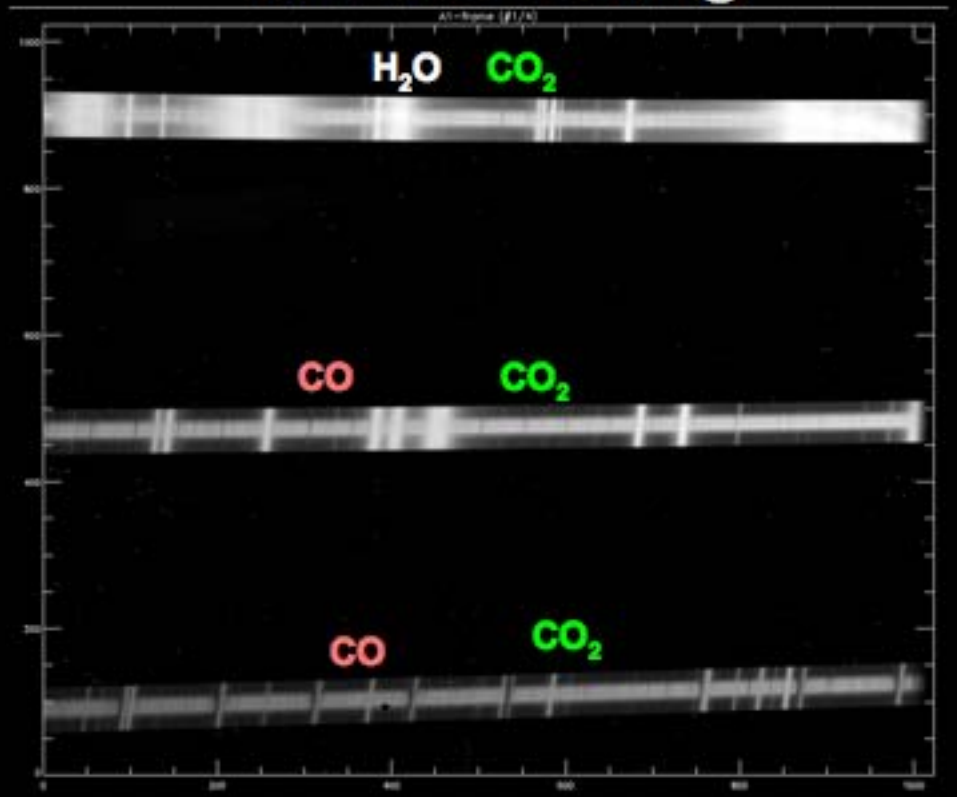
Data taken on March/22/2003 (L_S=155)

NIRSPEC 3 setting



Range: 7200-8800 cm^{-1} (1.1-1.4μm)

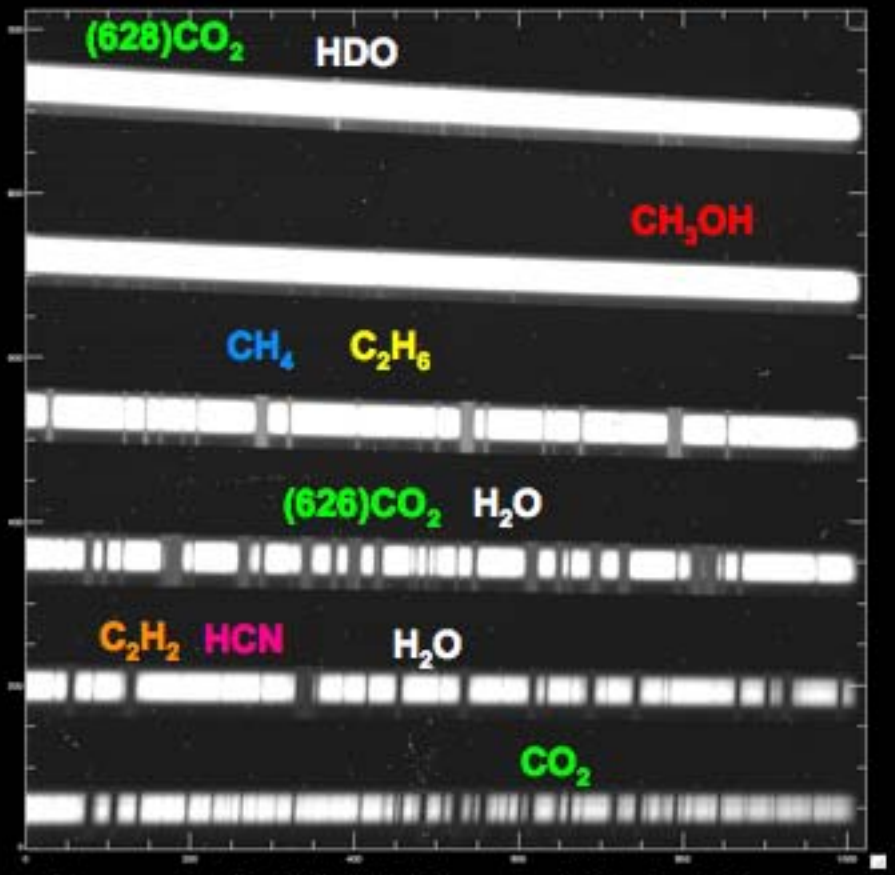
M-Wide setting



Range: 1800-2200 cm^{-1} (4.6-5.4μm)

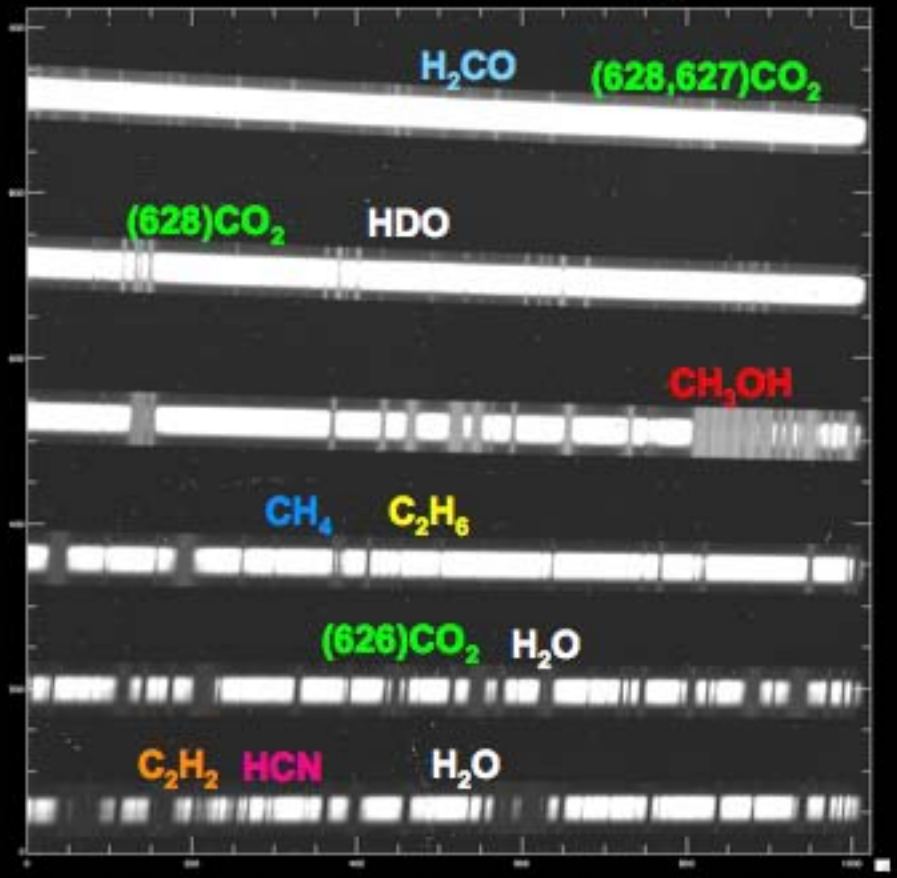
Data taken on March/21/2003 (L_S=155)

KL 1 setting



Range: 2700-3390 cm^{-1} (3.0-3.7μm)

KL 2 setting



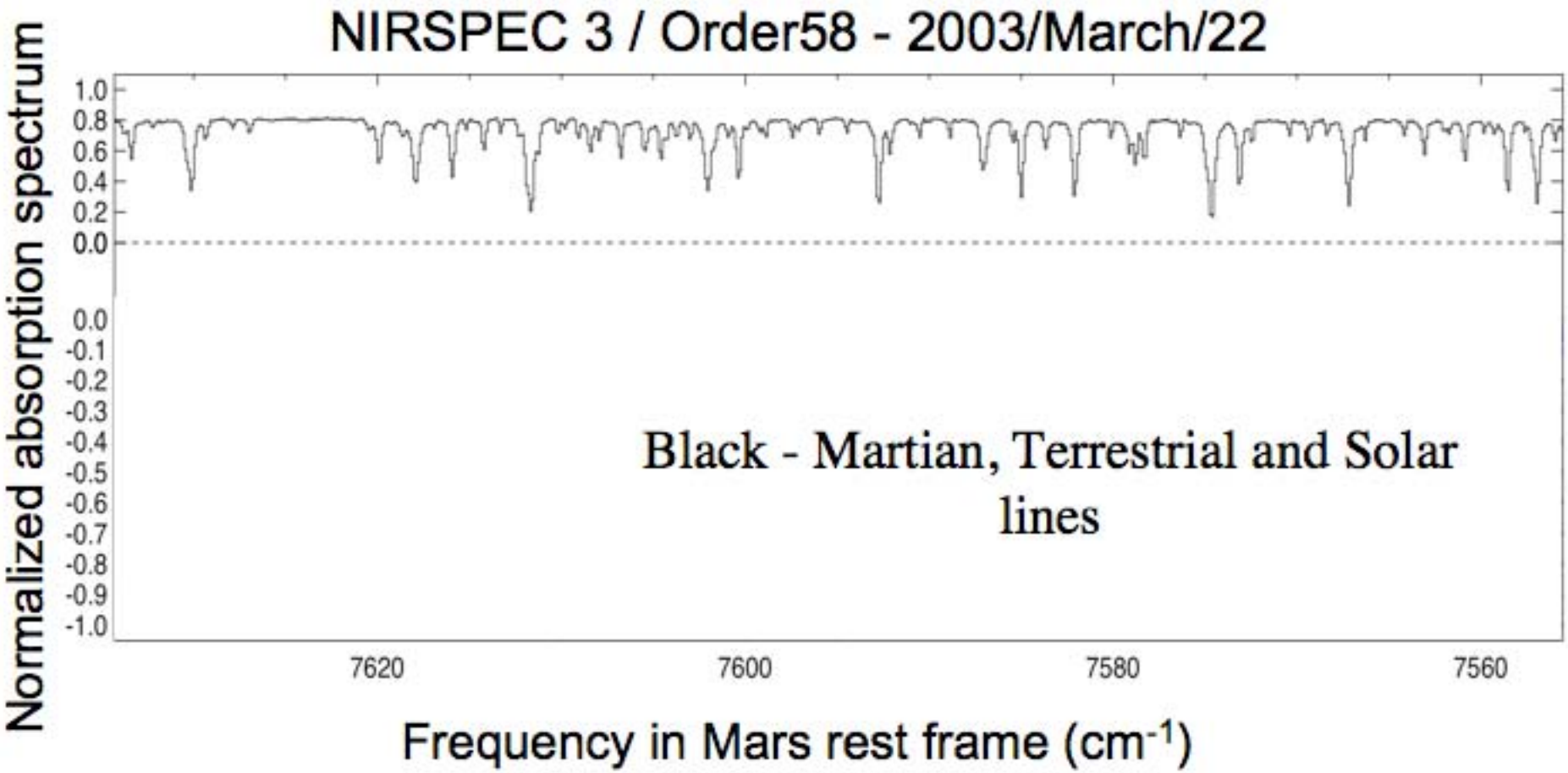
Range: 2750-3450 cm^{-1} (2.9-3.6μm)

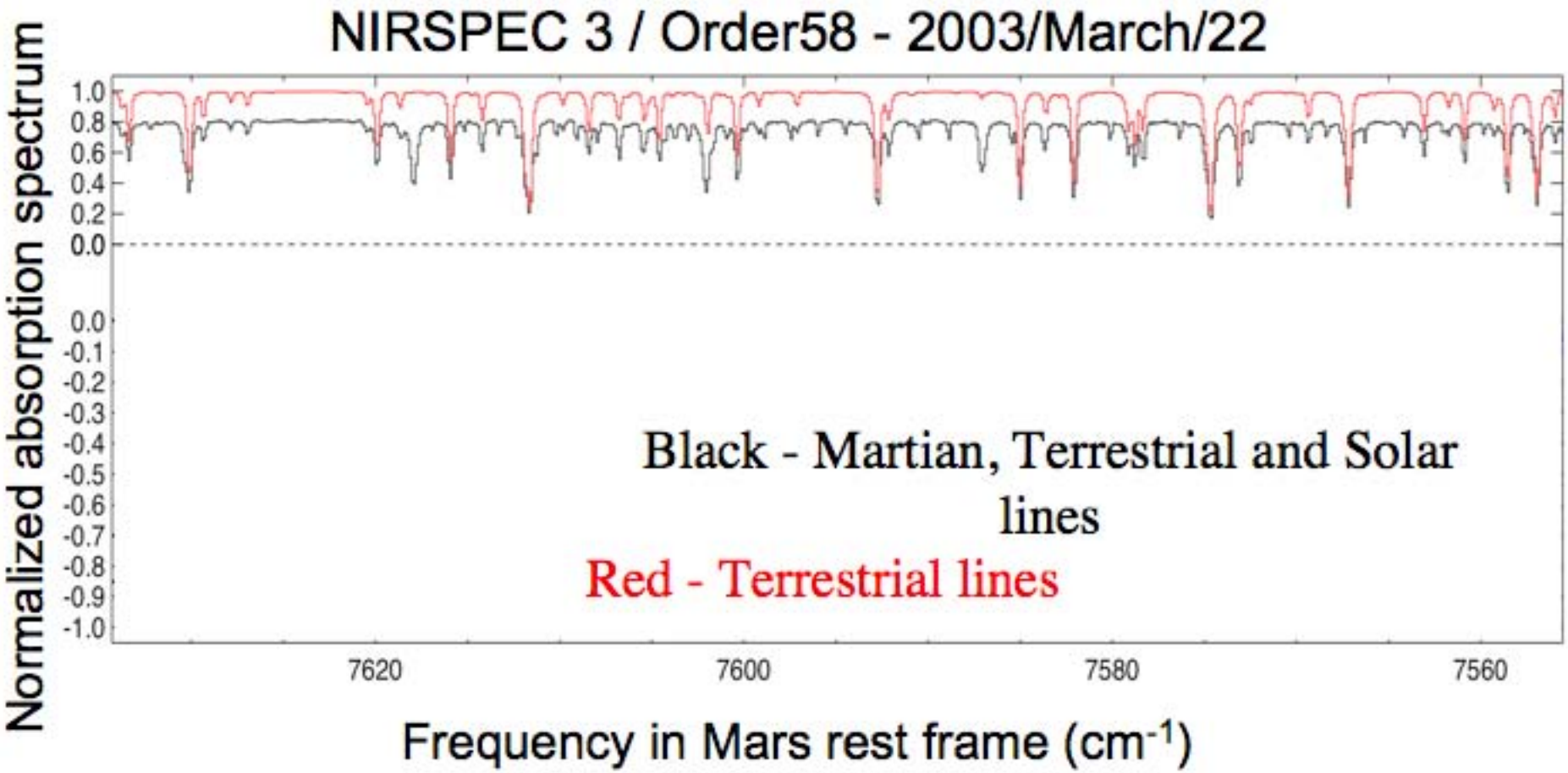
Processing spectra

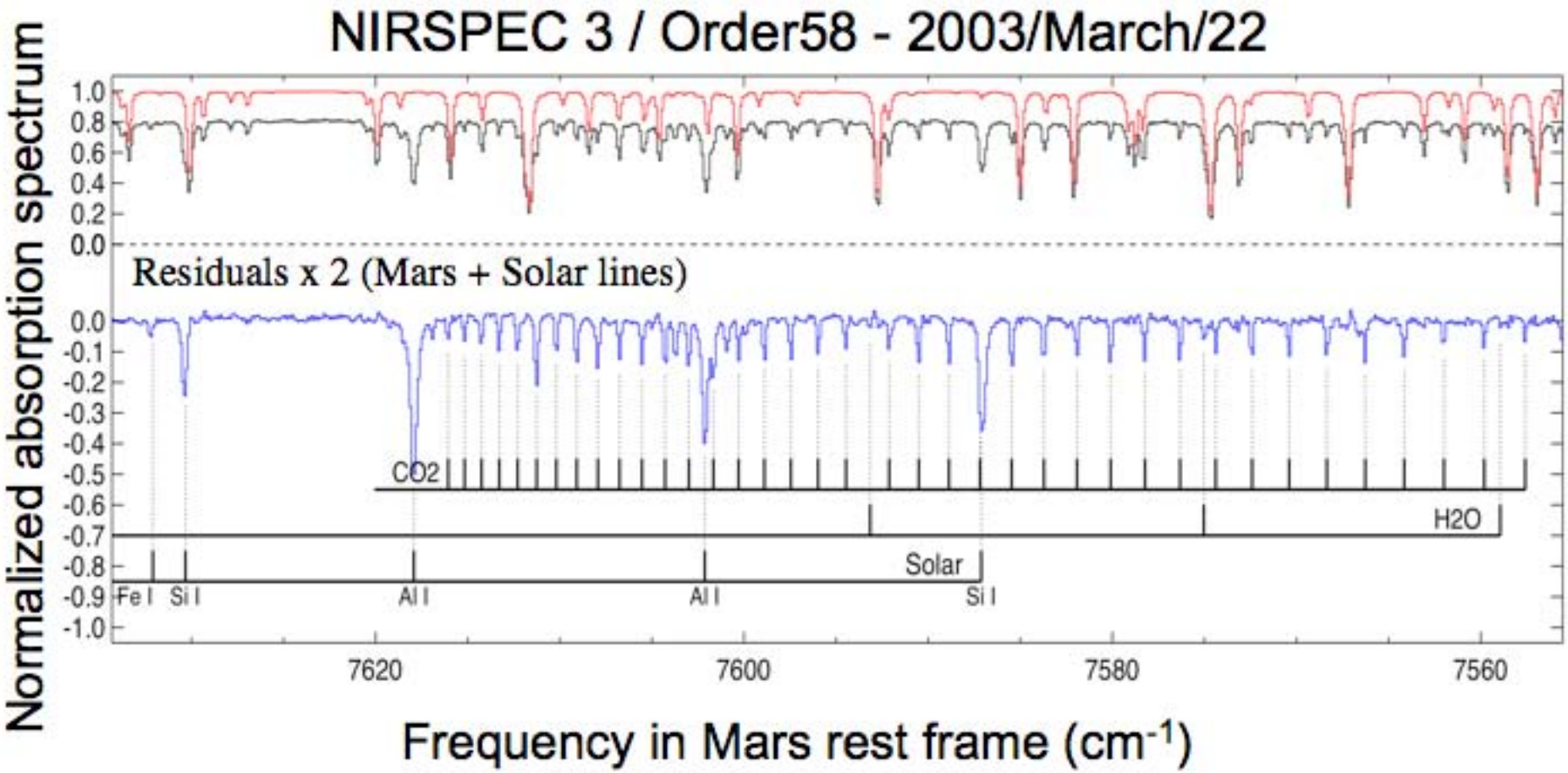
- ***Data processing***
  - Organize and crop order of interest
  - Clean bad pixels
  - Straighten the order spatially and spectrally
  - Calibrate frames and store results

- ***Residual Analysis***
  - Define observing geometry
  - Calculate local atmospheric conditions
  - Extract Martian residuals
  - Extract molecular column densities

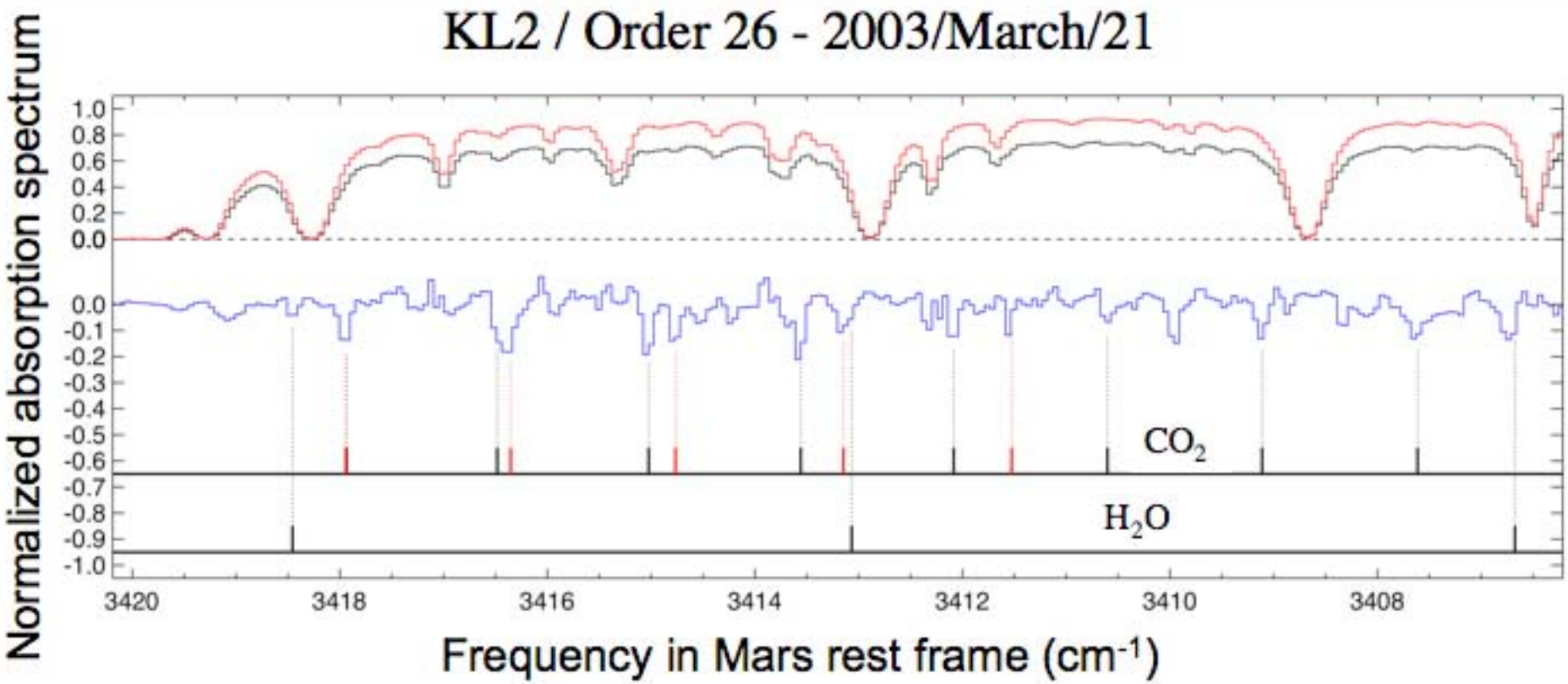
3. Results

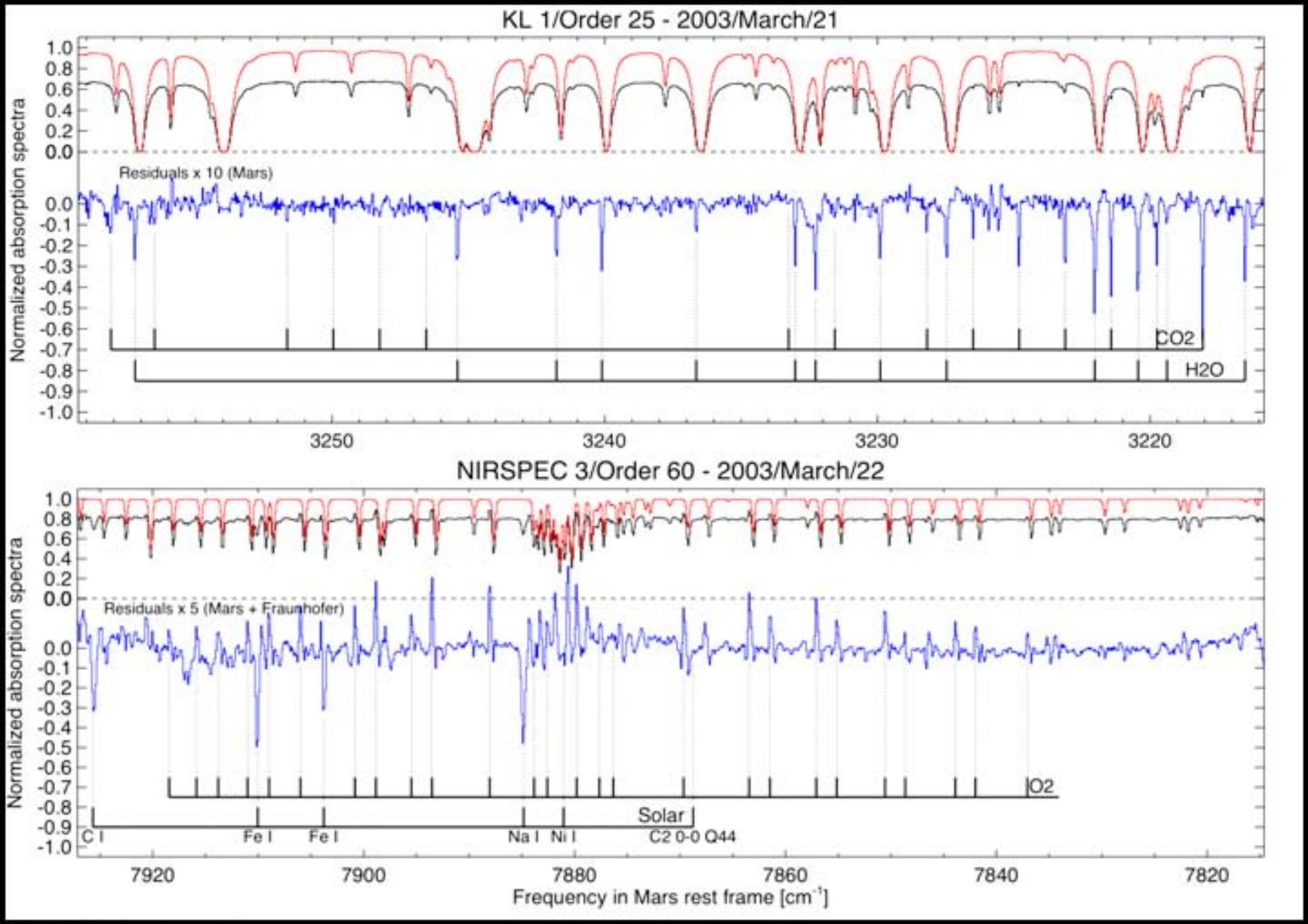

NIRSPEC 3 / Order58 - 2003/March/22
Normalized absorption spectrum
1.0
0.8
0.6
0.4
0.2
0.0
0.0
-0.1
-0.2
-0.3
-0.4
-0.5
-0.6
-0.7
-0.8
-0.9
-1.0
Black - Martian, Terrestrial and Solar lines
7620
7600
7580
7560
Frequency in Mars rest frame (cm-1)


NIRSPEC 3 / Order58 - 2003/March/22
Normalized absorption spectrum
1.0
0.8
0.6
0.4
0.2
0.0
0.0
-0.1
-0.2
-0.3
-0.4
-0.5
-0.6
-0.7
-0.8
-0.9
-1.0
Black - Martian, Terrestrial and Solar lines
Red - Terrestrial lines
7620
7600
7580
7560
Frequency in Mars rest frame (cm-1)


NIRSPEC 3 / Order58 - 2003/March/22
Normalized absorption spectrum
Residuals x 2 (Mars + Solar lines)
CO2
H2O
Solar
Fe I
Si I
Al I
Al I
Si I
1.0
0.8
0.6
0.4
0.2
0.0
-0.1
-0.2
-0.3
-0.4
-0.5
-0.6
-0.7
-0.8
-0.9
-1.0
7620
7600
7580
7560
Frequency in Mars rest frame (cm-1)

New CO_2 band


KL2 / Order 26 - 2003/March/21
Normalized absorption spectrum
1.0
0.8
0.6
0.4
0.2
0.0
0.0
-0.1
-0.2
-0.3
-0.4
-0.5
-0.6
-0.7
-0.8
-0.9
-1.0
CO2
H2O
3420
3418
3416
3414
3412
3410
3408
Frequency in Mars rest frame (cm-1)



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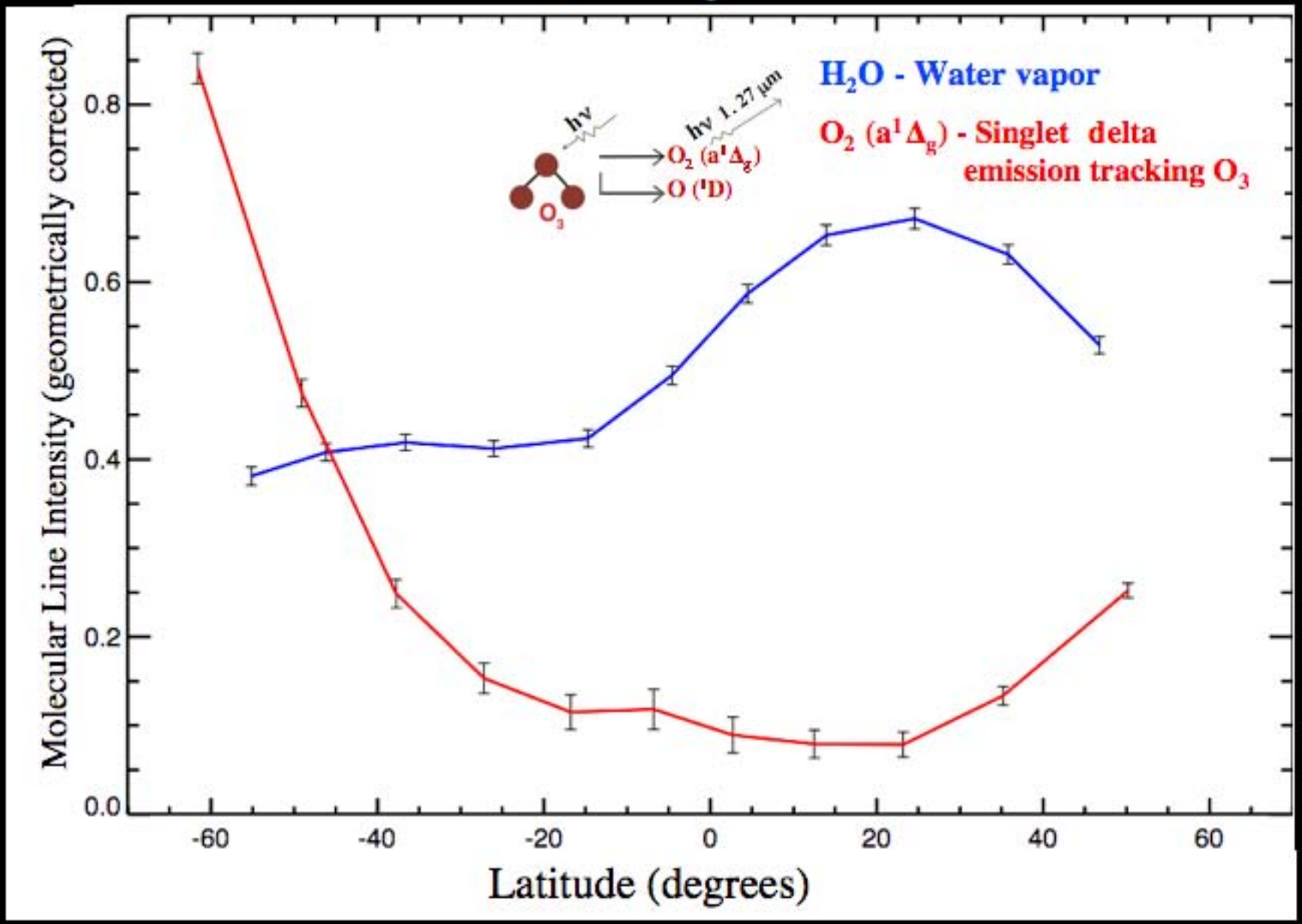
H_2O and O_2 ($a^1\Delta_g$) abundances



Acknowledgements

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