Modelling spectra of ultracool dwarfs:

a) First results of fits to Palle's telluric spectrum.

b) New horisons of the "deuterium test".

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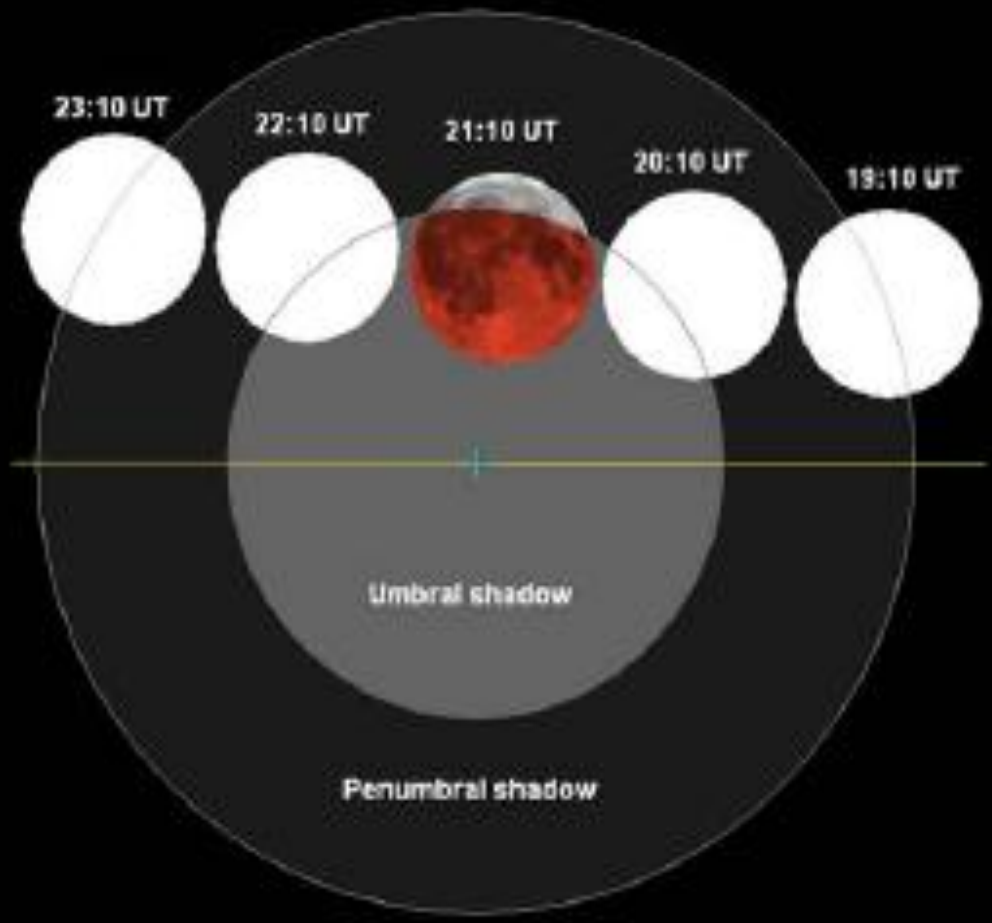
modelling

Generally, the process of representing a real-world object or phenomenon as a set of mathematical equations. More specifically, the term is often used to describe the process of representing 3-dimensional objects in a computer.


23:10 UT
22:10 UT
21:10 UT
20:10 UT
19:10 UT
Umbral shadow
Penumbral shadow

Procedure II. Telluric spectra modelling

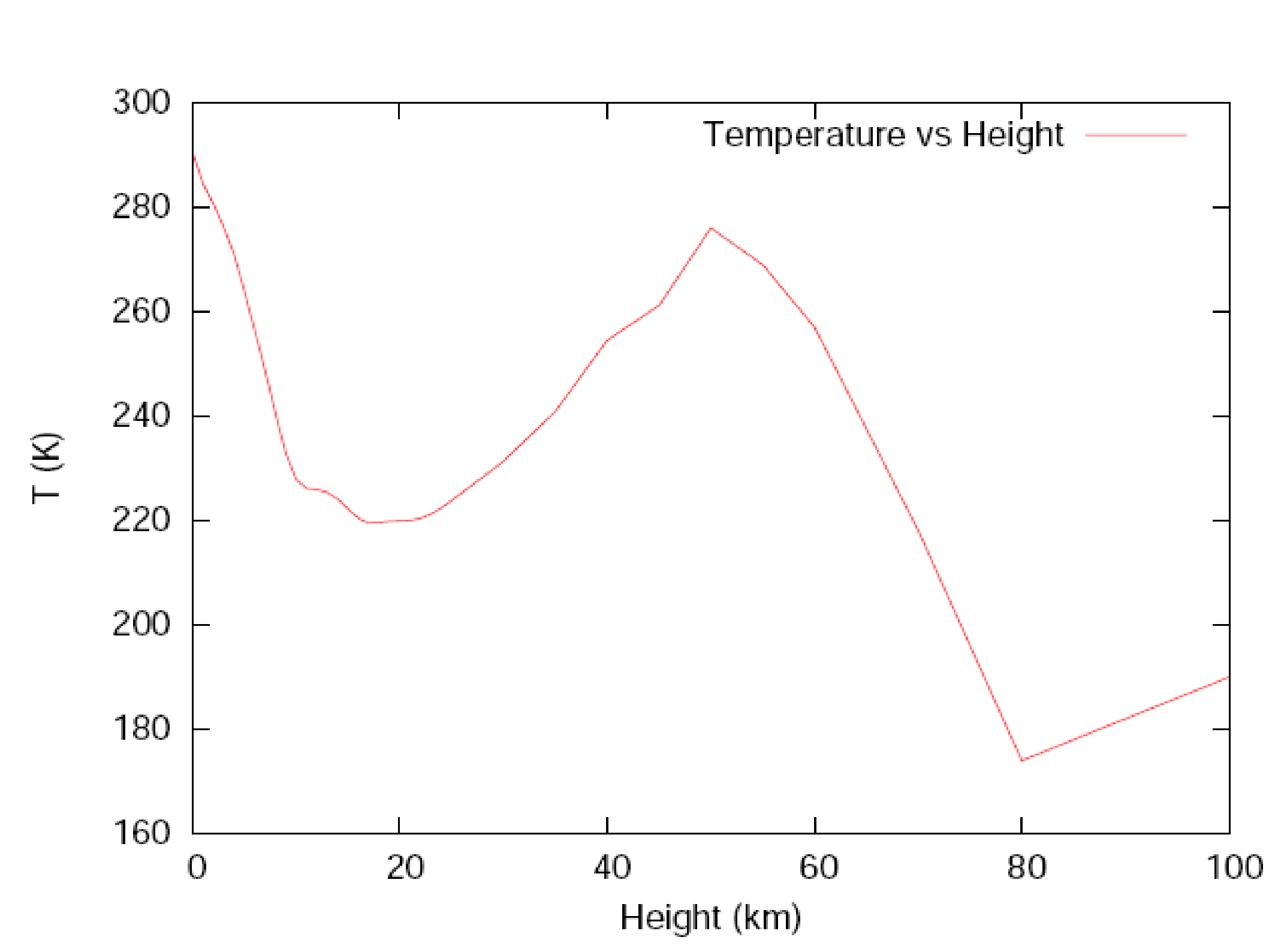
- High temperatures
- Thick atmosphres
- H- dominates
- TiO, VO, H2O, methane
- Strong atomic lines
- Dust

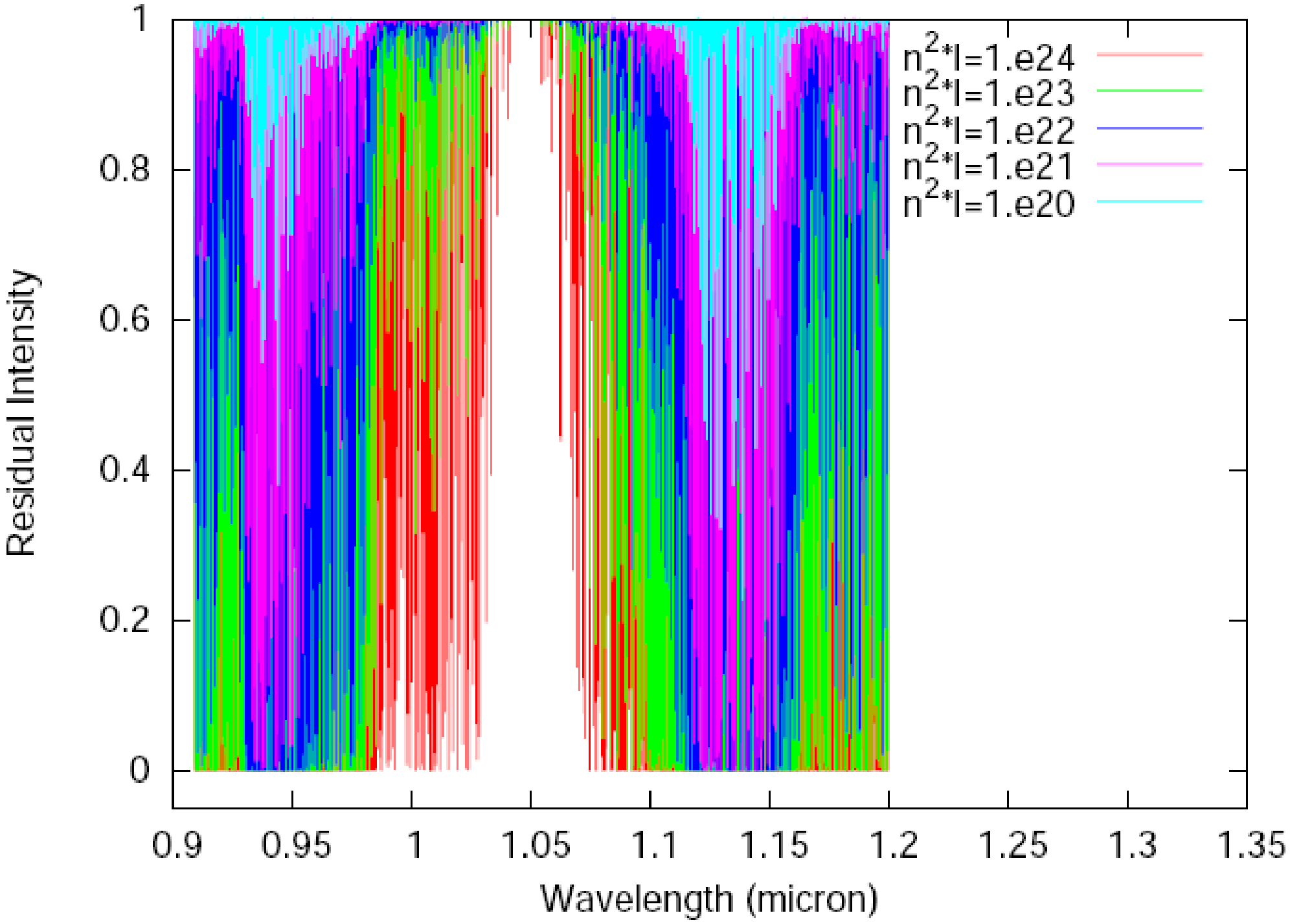
- Low temperatures
- Thin atmosphrere
- Line of H2O, CO2, methane, O2, N2....
- Photochemical processes
- Aerosols
- Photochemical processes

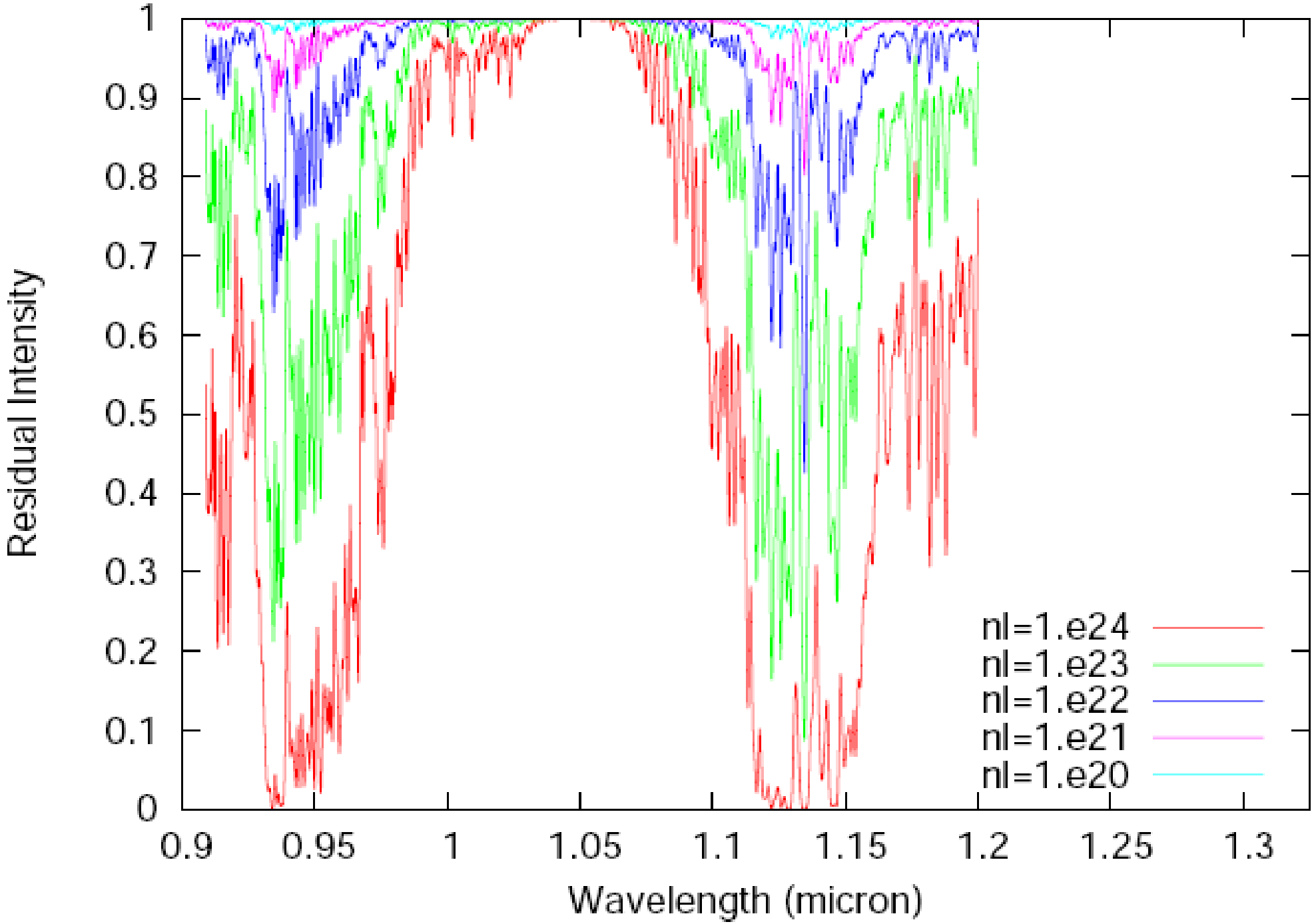
Modelling spectra

- One slab model atmosphere
- Line by line computations (TASS)
- Absorption by lines is treated explicitly (Voigt profiles, damping constants... etc.)

- Model atmosphere
- Model of molecular bands (MODTRAN):: smoothed opacities
- Low resolution spectra


Temperature vs Height
T (K)
300
280
260
240
220
200
180
160
0
20
40
60
80
100
Height (km)


Residual Intensity
1
0.8
0.6
0.4
0.2
0
0.9
0.95
1
1.05
1.1
1.15
1.2
1.25
1.3
1.35
Wavelength (micron)
n2*l=1.e24
n2*l=1.e23
n2*l=1.e22
n2*l=1.e21
n2*l=1.e20


Residual Intensity
Wavelength (micron)
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1
0.9
0.95
1
1.05
1.1
1.15
1.2
1.25
1.3
nl=1.e24
nl=1.e23
nl=1.e22
nl=1.e21
nl=1.e20

Conclusions I.

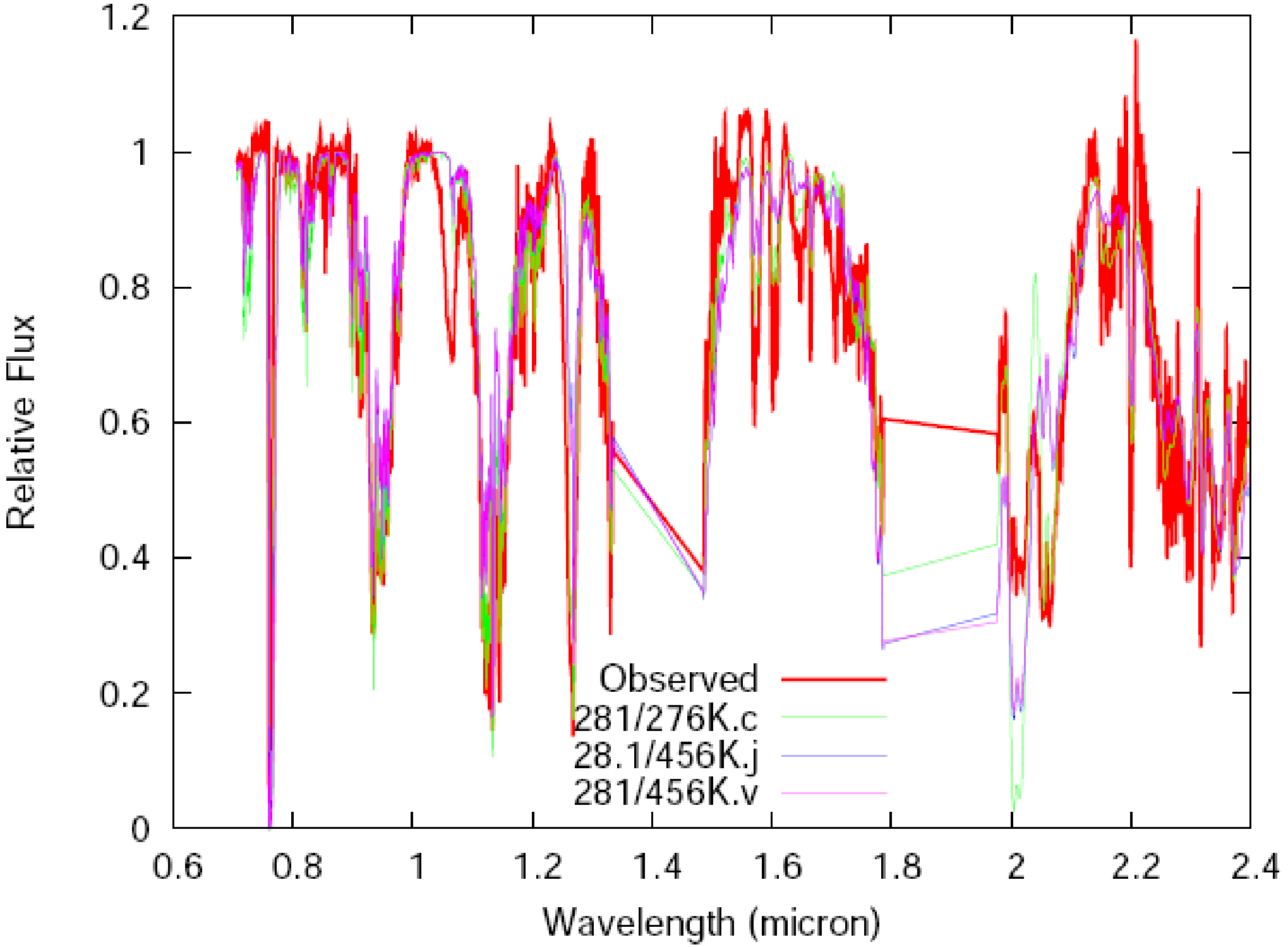
- Palle et al. (2009) observed really transmitted and reflected light of the telluric atmosphere.
- Earth is the first rocky planet discovered spectrospicvally.
- If something is possible at once, it can be repeated many times...

ANY SPECTRUM CAN BE **and** MUST BE CONVERTED INTO NUMBER(s)

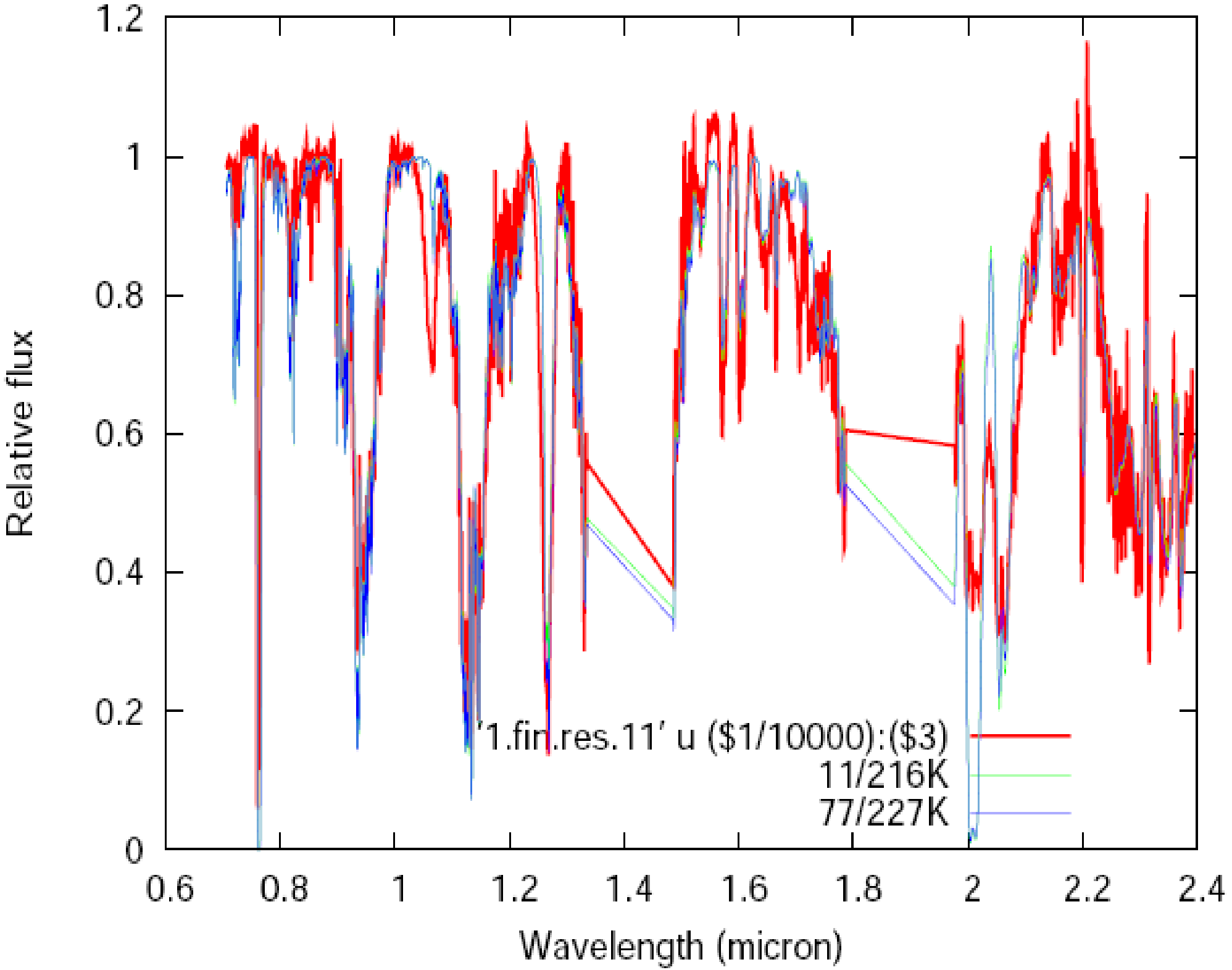
Minimisation procedure

- Zero order densities.
- Compute spectrum
- Compute s
  $= \blacklozenge(1 - F_i/F_obs)^2$
- Density of i-species increased/decreased by factor X
- If S_j-1 > S_j < S_j+1 then we try another specie.

- Process iterates till a convergence for ALL species.


Relative Flux
Wavelength (micron)
Observed
281/276K.c
28.1/456K.j
281/456K.v
0
0.2
0.4
0.6
0.8
1
1.2
0.6
0.8
1
1.2
1.4
1.6
1.8
2
2.2
2.4

	281/456K	28.1/456K	281/276K	
	68.66v	68.61j	47.01c	
1	1.000E+00	1.000E+00	1.000E+00	H2O
2	4.647E-01	5.111E-01	1.096E+00	CO2
3	3.459E-03	3.805E-03	3.356E-03	N2O
4	6.879E-09	1.364E-08	1.535E-03	CO
5	8.256E-03	8.092E-03	6.554E-03	CH4
6	2.043E+04	1.483E+04	1.904E+04	O2
7	8.358E-06	1.351E-06	6.072E+00	NO
8	3.940E-11	7.201E-11	2.928E-24	NH3
9	1.212E-07	1.801E-07	5.733E-11	OH
10	3.412E-04	7.610E-04	2.175E-12	HF
11	2.128E-02	2.294E-02	3.147E-02	HCl
12	6.335E-01	1.490E-01	5.575E-01	HBr
13	2.524E-01	1.659E-01	3.921E-02	HI
14	8.198E-10	2.548E-10	8.392E-22	C2H2


Relative flux
Wavelength (micron)
'1.fin.res.11' u ($1/10000):($3)
11/216K
77/227K
0
0.2
0.4
0.6
0.8
1
1.2
0.6
0.8
1
1.2
1.4
1.6
1.8
2
2.2
2.4

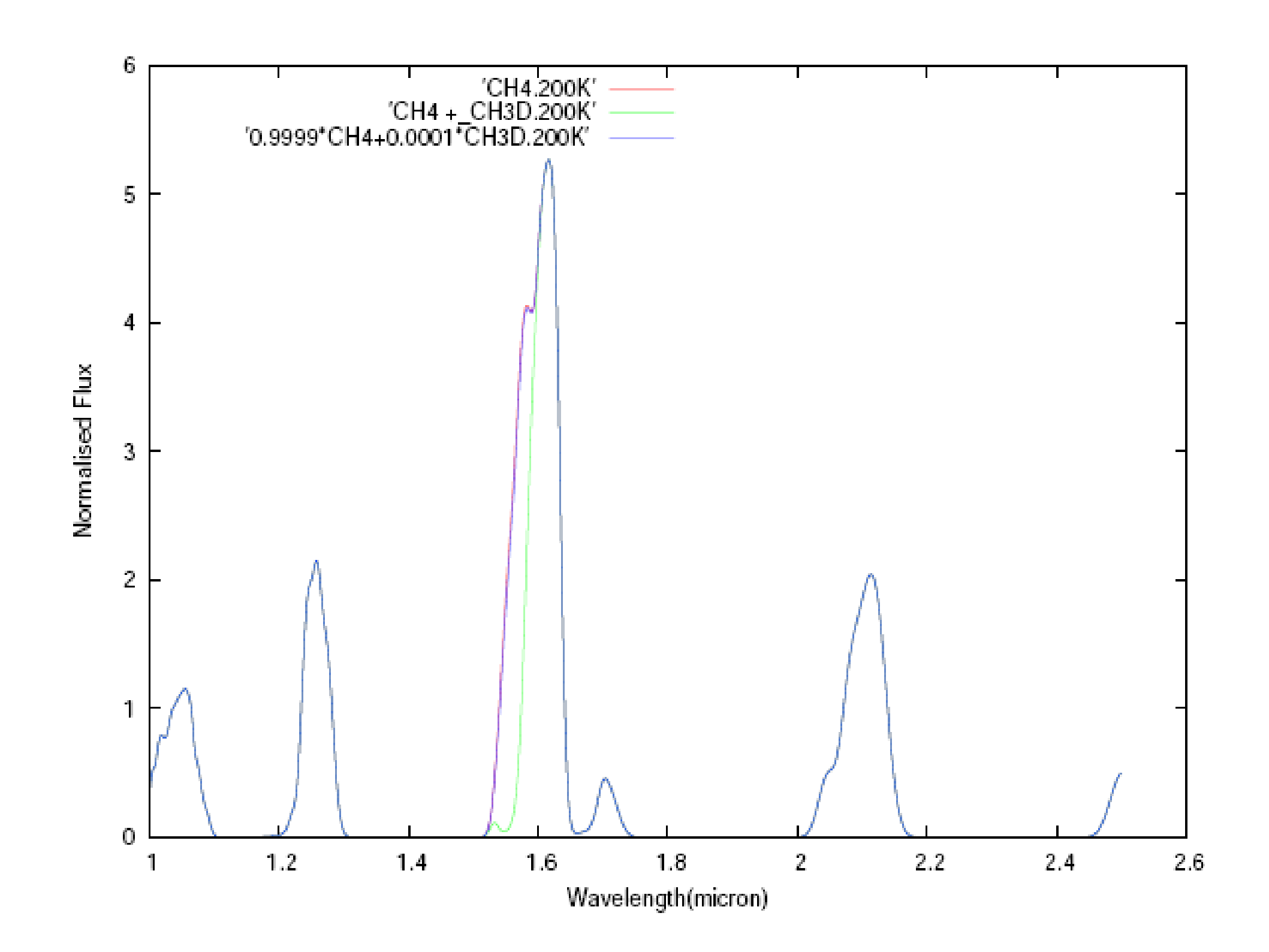
P/T	77/226K	11/216k	
S	49.61v	50.37j	
1	1.000E+00	1.000E+00	H2O
2	1.046E+00	1.150E+00	CO2
3	2.306E-03	2.536E-03	N2O
4	6.949E-04	1.911E-04	CO
5	5.504E-03	5.394E-03	CH4
6	1.362E+04	9.889E+03	O2
7	5.224E-07	1.201E-06	NO
8	1.330E-10	1.920E-10	NH3
9	1.346E-08	1.441E-06	OH
10	5.207E-09	9.513E-05	HF
11	2.128E-02	2.294E-02	HCl
12	1.425E+00	1.132E+00	HBr
13	5.916E-03	2.074E-02	HI
14	2.882E-11	8.494E-11	C2H2

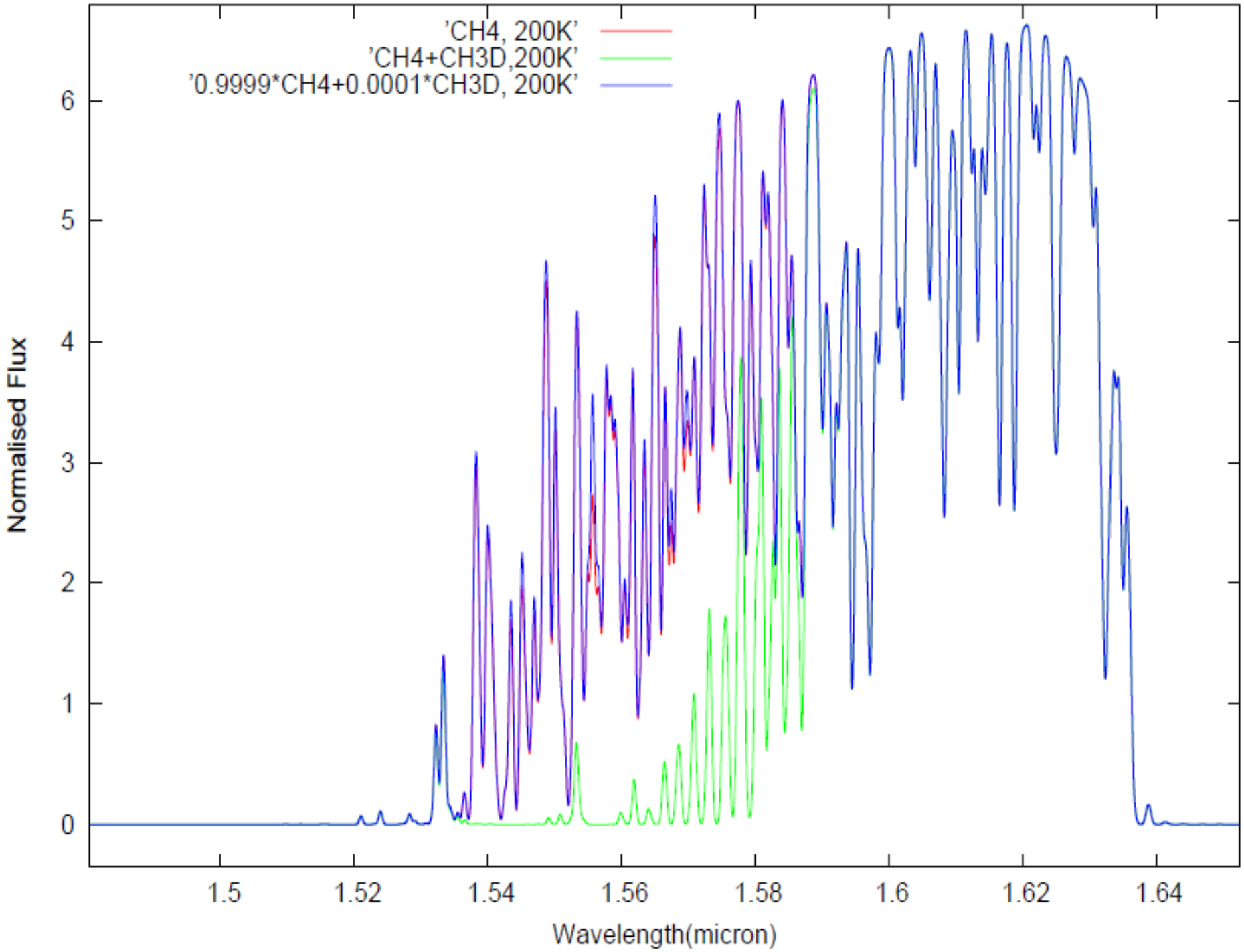
Summary II.

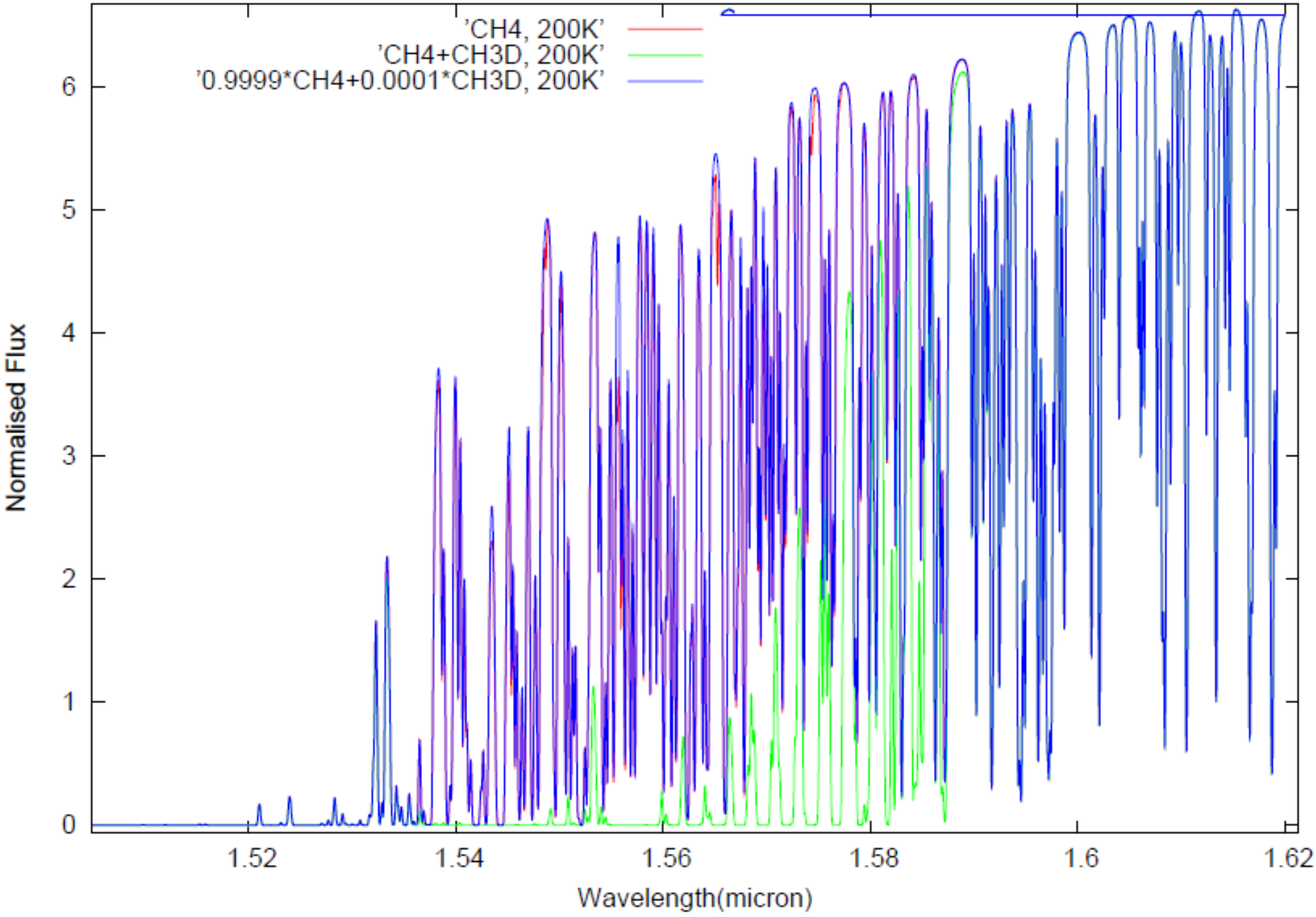
- All features are identified.
- Different molecules provides different sensitivity on T and P.
- Our procedure provides reliable fits:)
- Abundances can be obtained ONLY if temperature is known.
- UNFORTUNATELY, WE CANNOT MODEL OUR OWN ATMOSPHERE:(

Methane and heavy methane spectra in the “deuterium test”

- Bejar et al. (1999) idea of the ``deuterium test''.
- CH4, CH3D, H2O line lists from HITRAN
- 1D slab model atmosphere of T = 200 K.
- Line by line computations of fluxes.
- Spectral resolutions were adopted 1.6 A, 6 A, 80A (R=10000, 2000, 200 at 1.6 micron).


'CH4.200K'
'CH4 + _CH3D.200K'
'0.9999*CH4+0.0001*CH3D.200K'
Normalised Flux
Wavelength(micron)
0
1
2
3
4
5
6
1
1.2
1.4
1.6
1.8
2
2.2
2.4
2.6


'CH4, 200K'
'CH4+CH3D,200K'
'0.9999*CH4+0.0001*CH3D, 200K'
Nomalised Flux
0
1
2
3
4
5
6
1.5
1.52
1.54
1.56
1.58
1.6
1.62
1.64
Wavelength(micron)


'CH4, 200K'
'CH4+CH3D, 200K'
'0.9999*CH4+0.0001*CH3D, 200K'
Normalised Flux
0
1
2
3
4
5
6
1.52
1.54
1.56
1.58
1.6
1.62
Wavelength(micron)

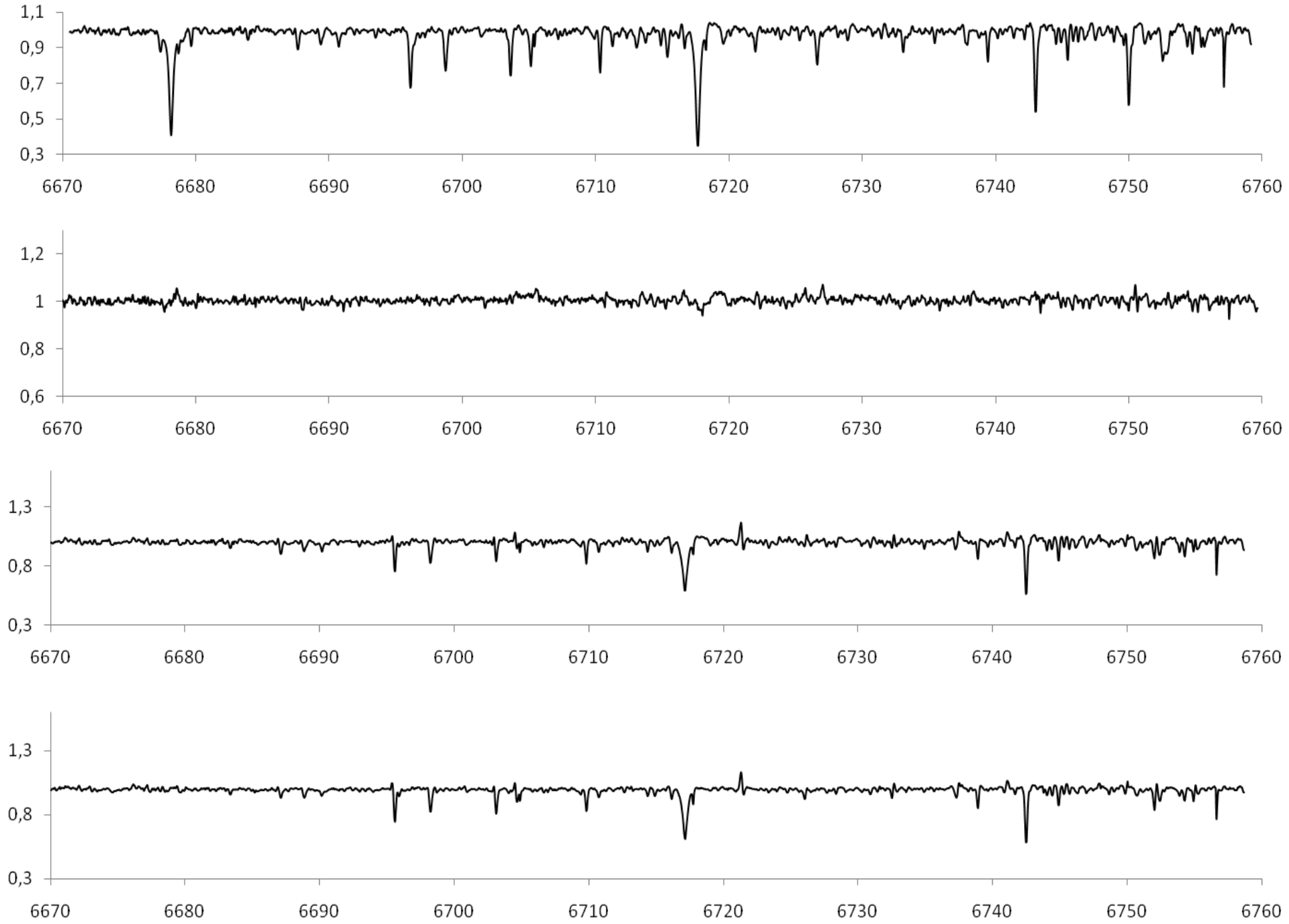
Summary

- The situations looks like with H2O/HDO
- Task for future ELT?
- Another species should be tested...

Solar twin spectra

Comparison of spectra of solar twins (Motives by Martin et al. 2002, ApJ, 579, 437).

ADS103a, ADS103b



Summary

- To be continued...