High-Resolution Spectroscopy of NGC 7023

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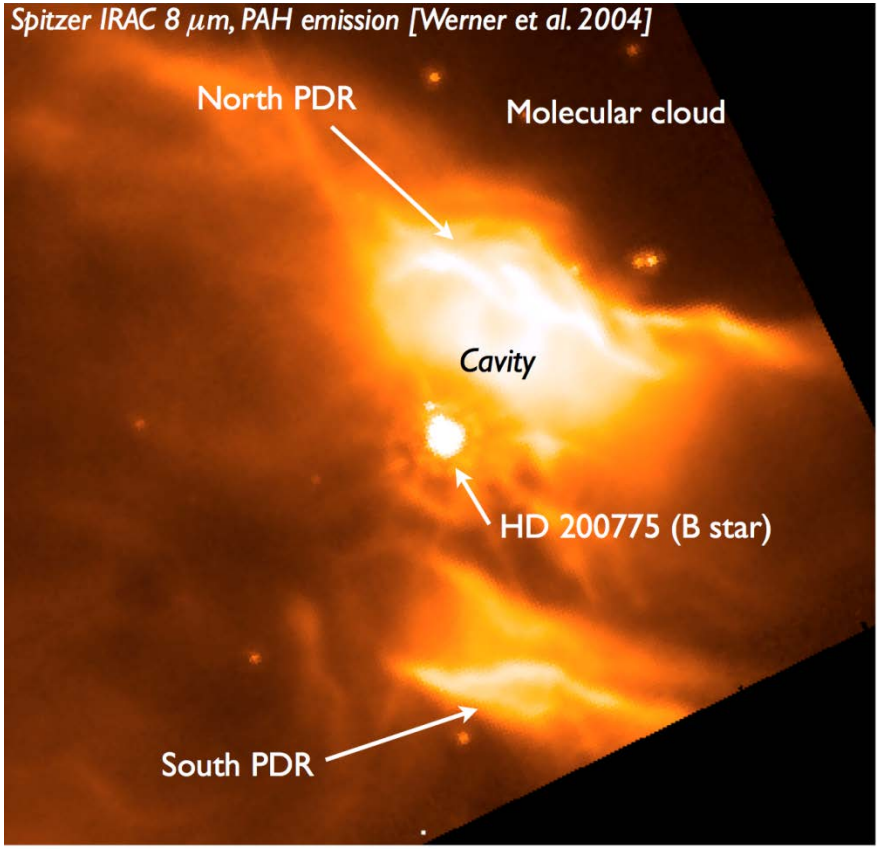
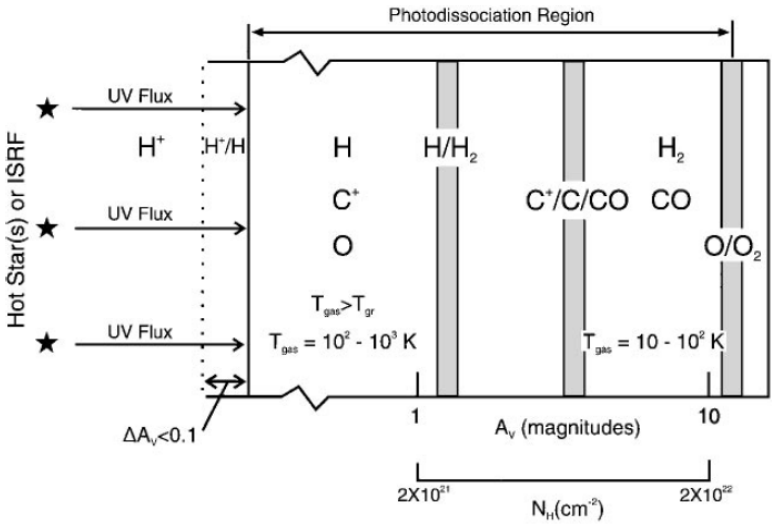
NGC 7023

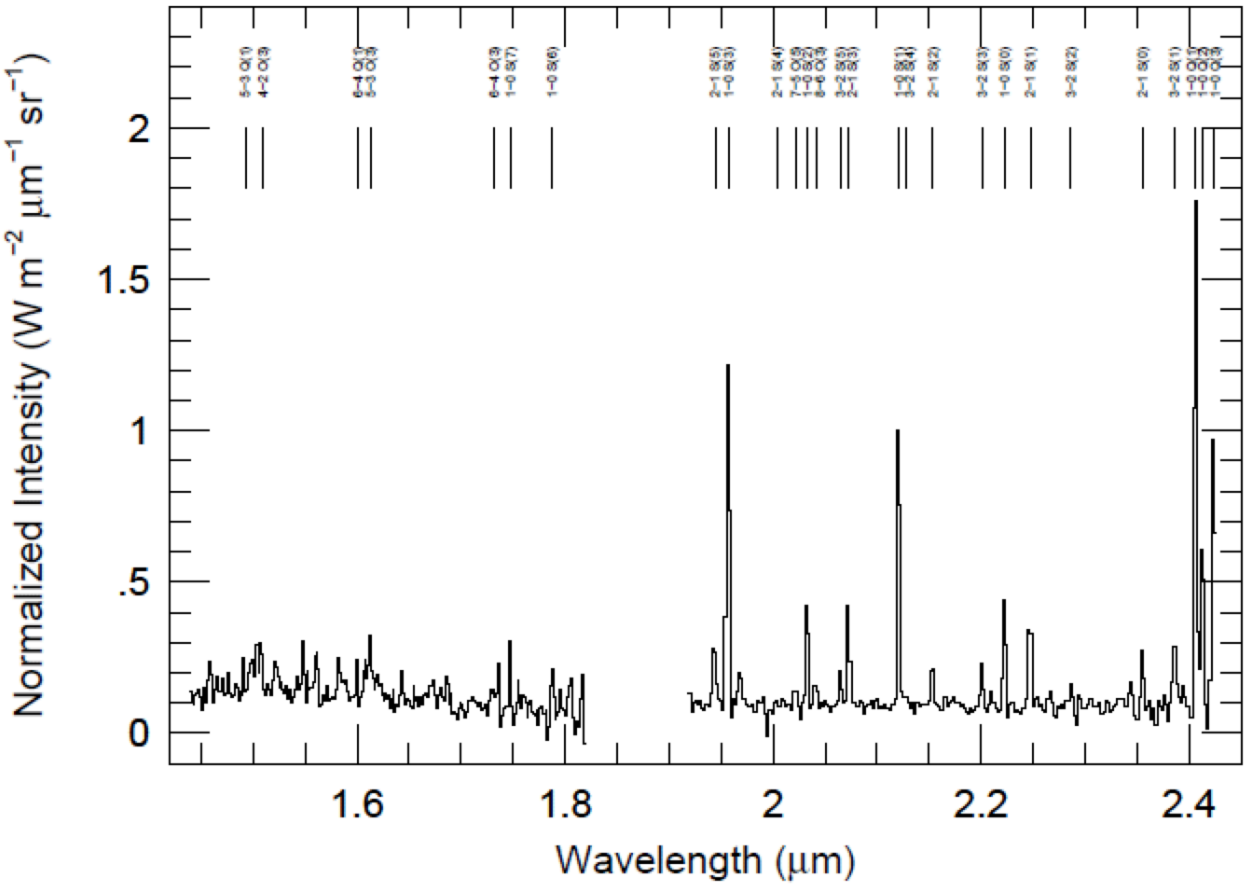


- Cepheus Flare region
- Herbig B3Ve-B5 star HD 200775
- T_{eff} = 17,000 K
- Distance 430 pc

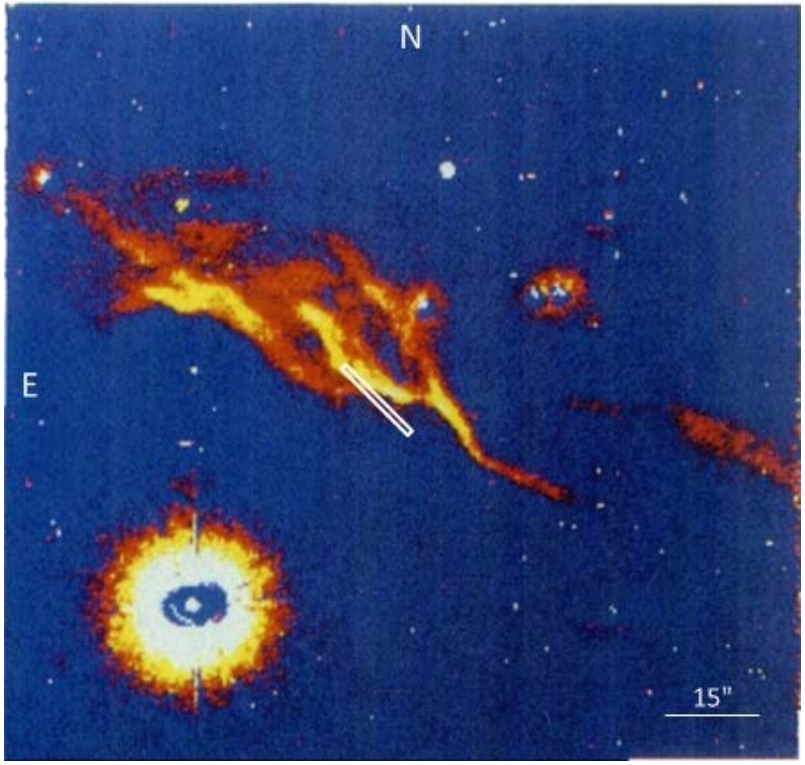


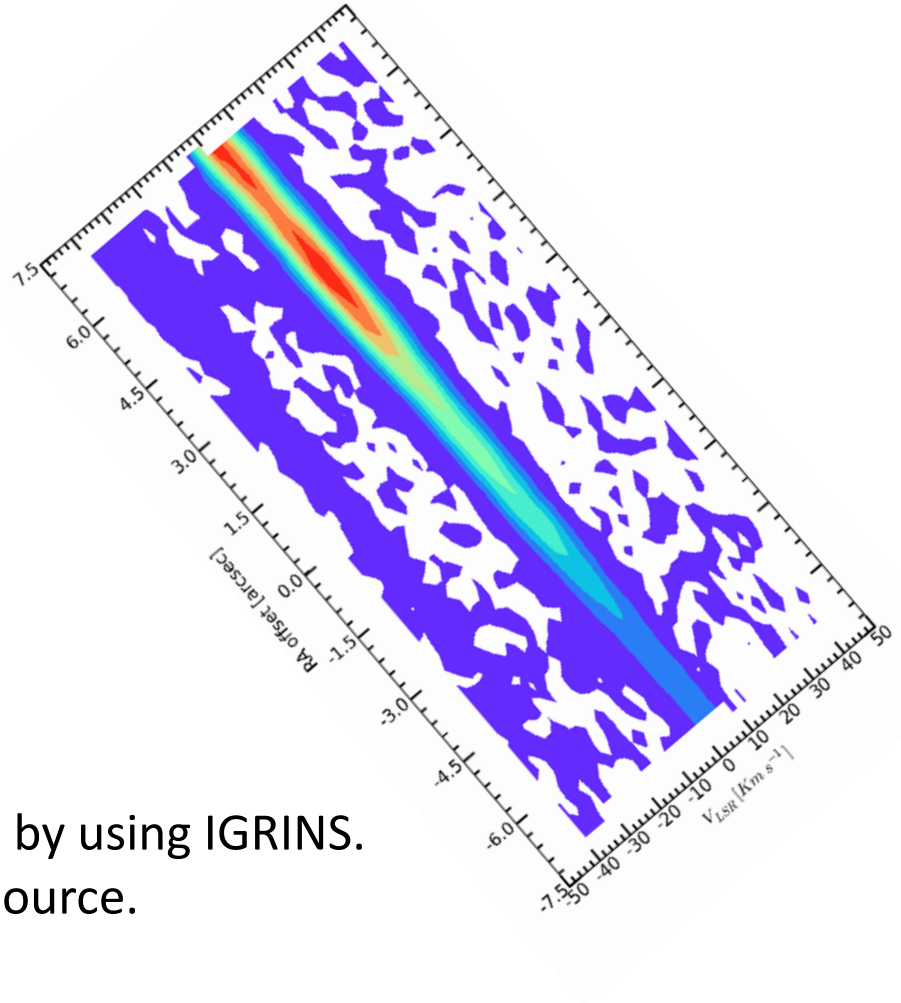
Hollenbach & Tielens (1985)

- Previous NIR spectroscopy study
- Martini et al. (1997, 1999), R ~ 730



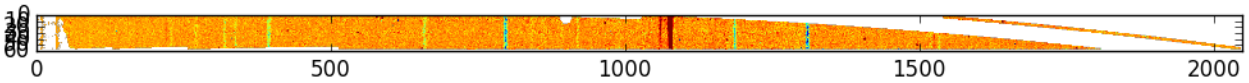
Lemaire et al. (1996)



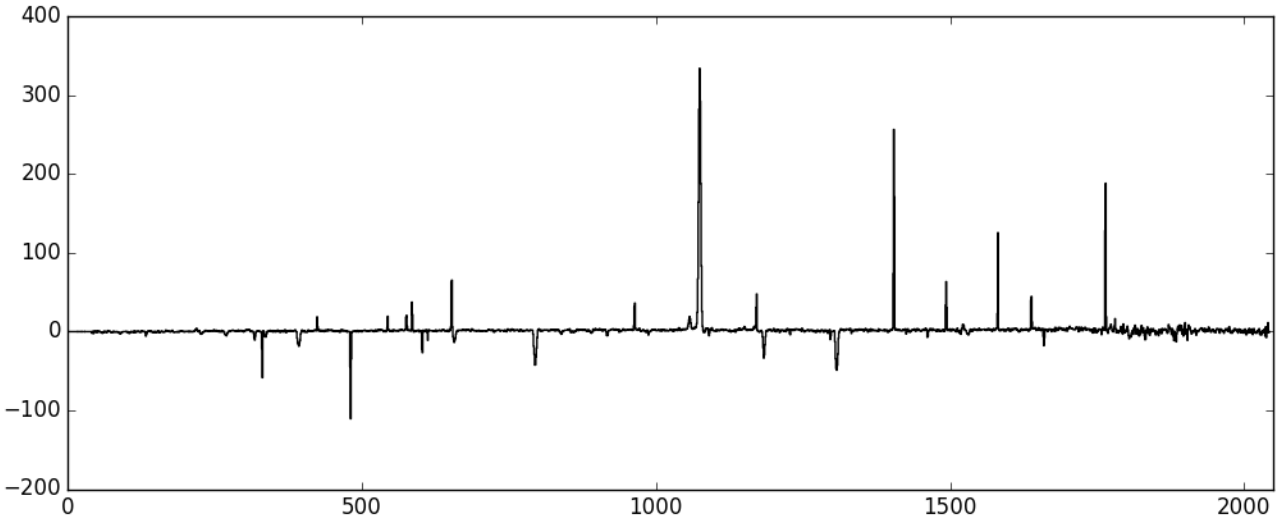


- 2014.07.13- Observations were done by using IGRINS.
- Total exposure time t = 600 s for on-source.
- High Resolution by IGRINS:
  - Study emission features.
  - Improve in understanding detail about the physical conditions.

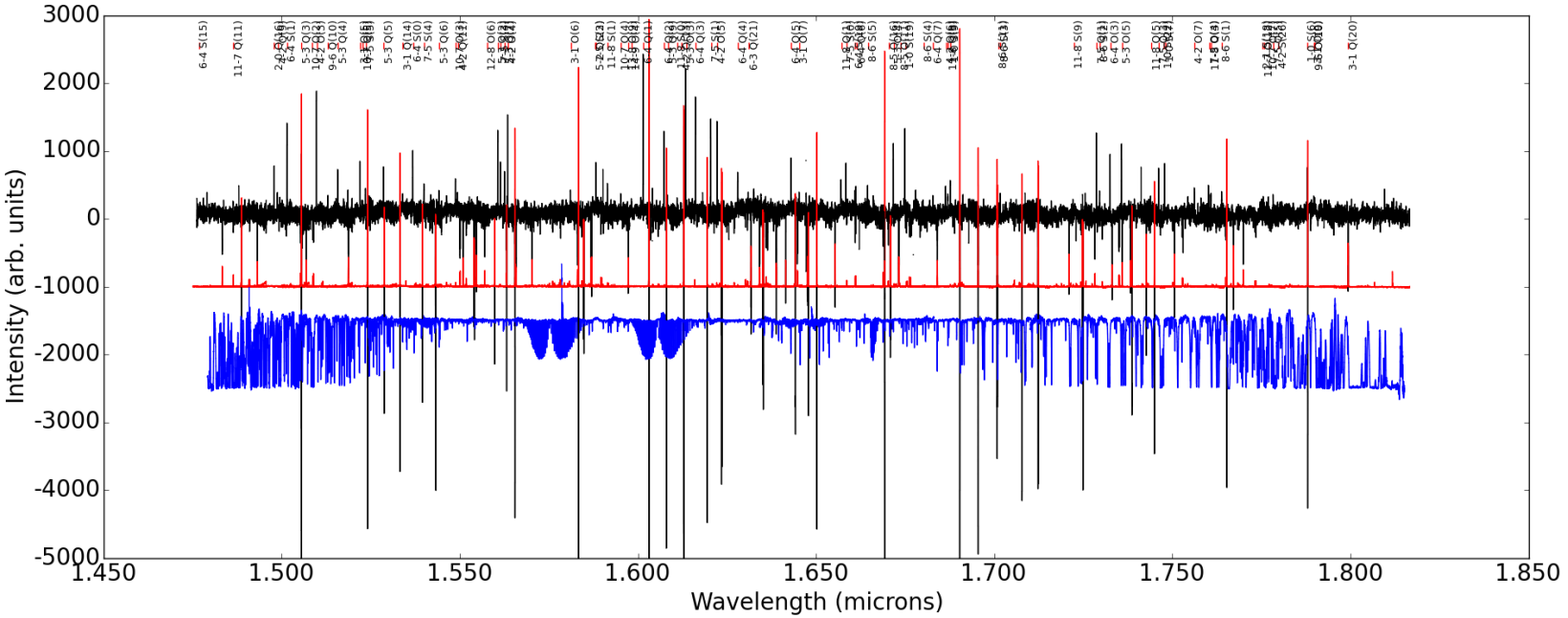
Data process

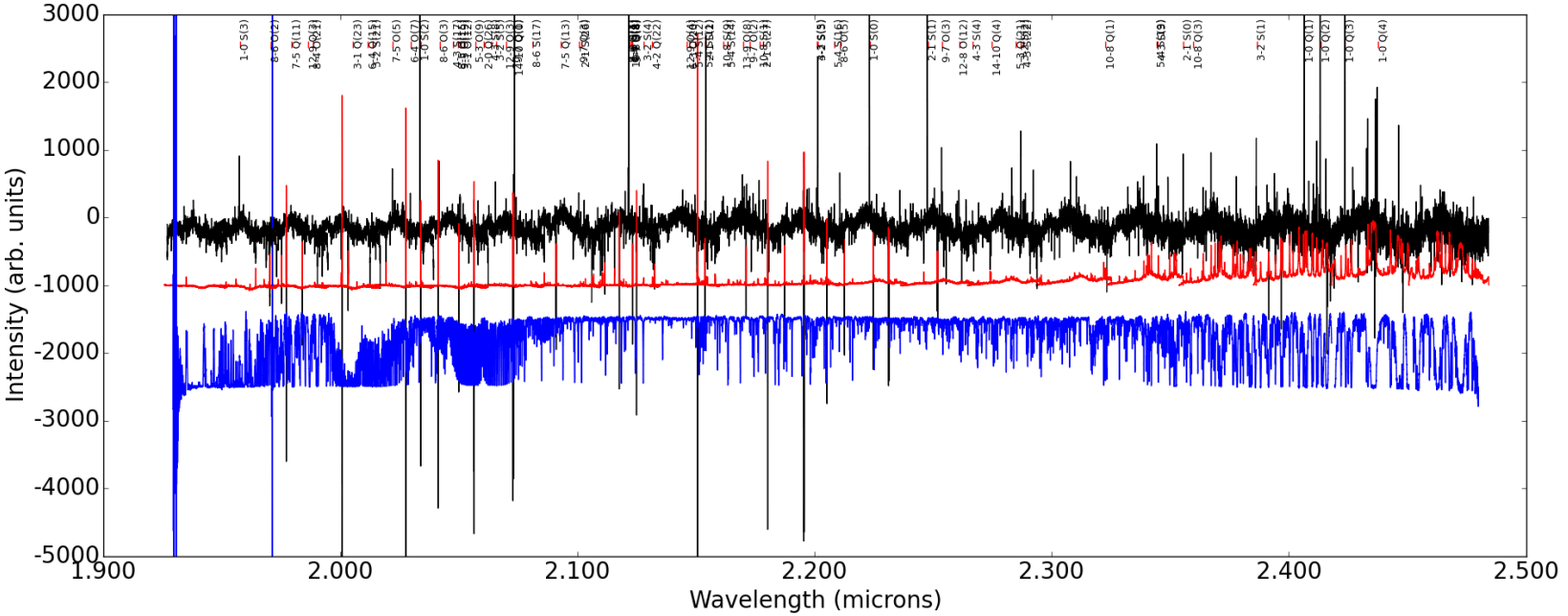


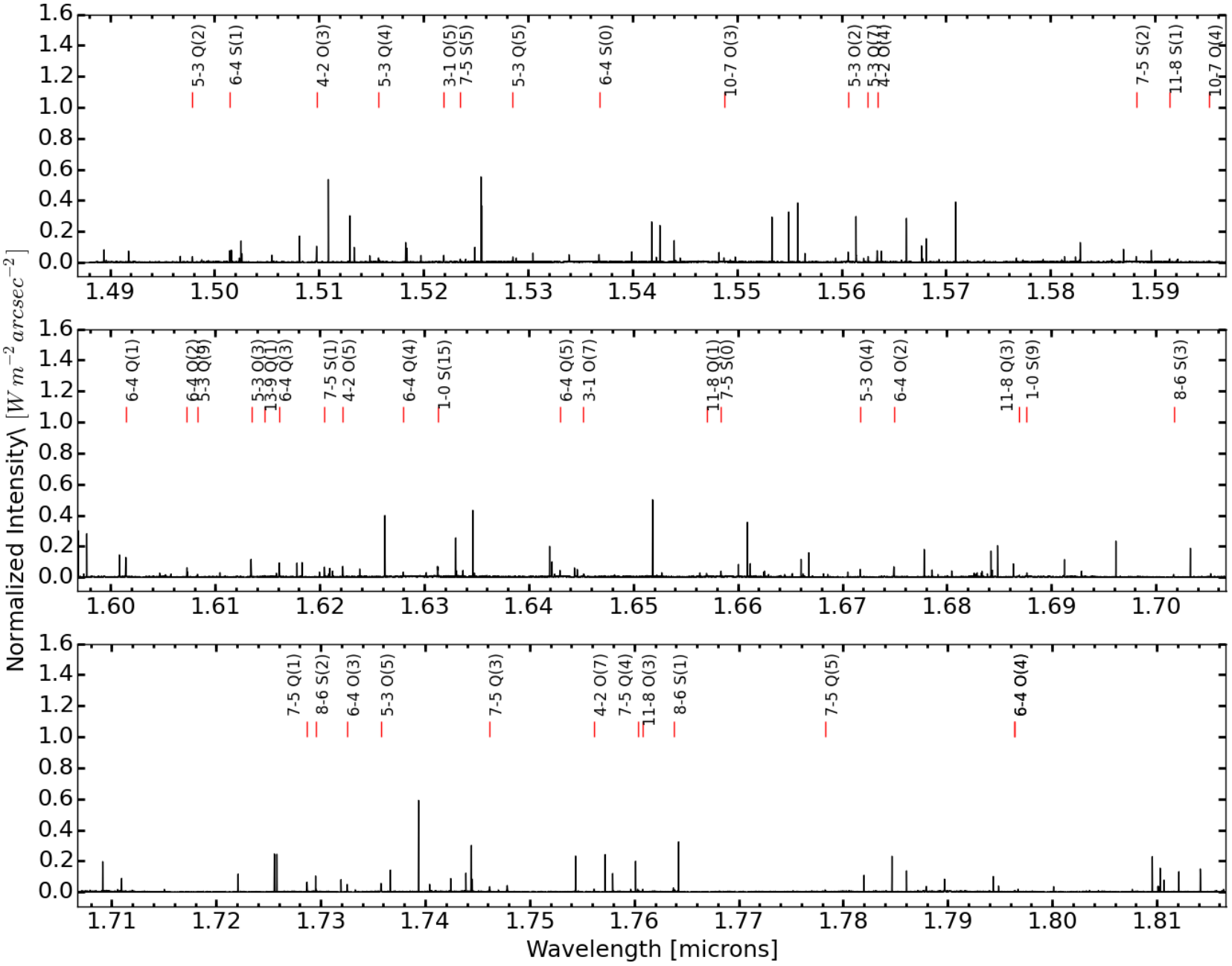
Average along the slit length

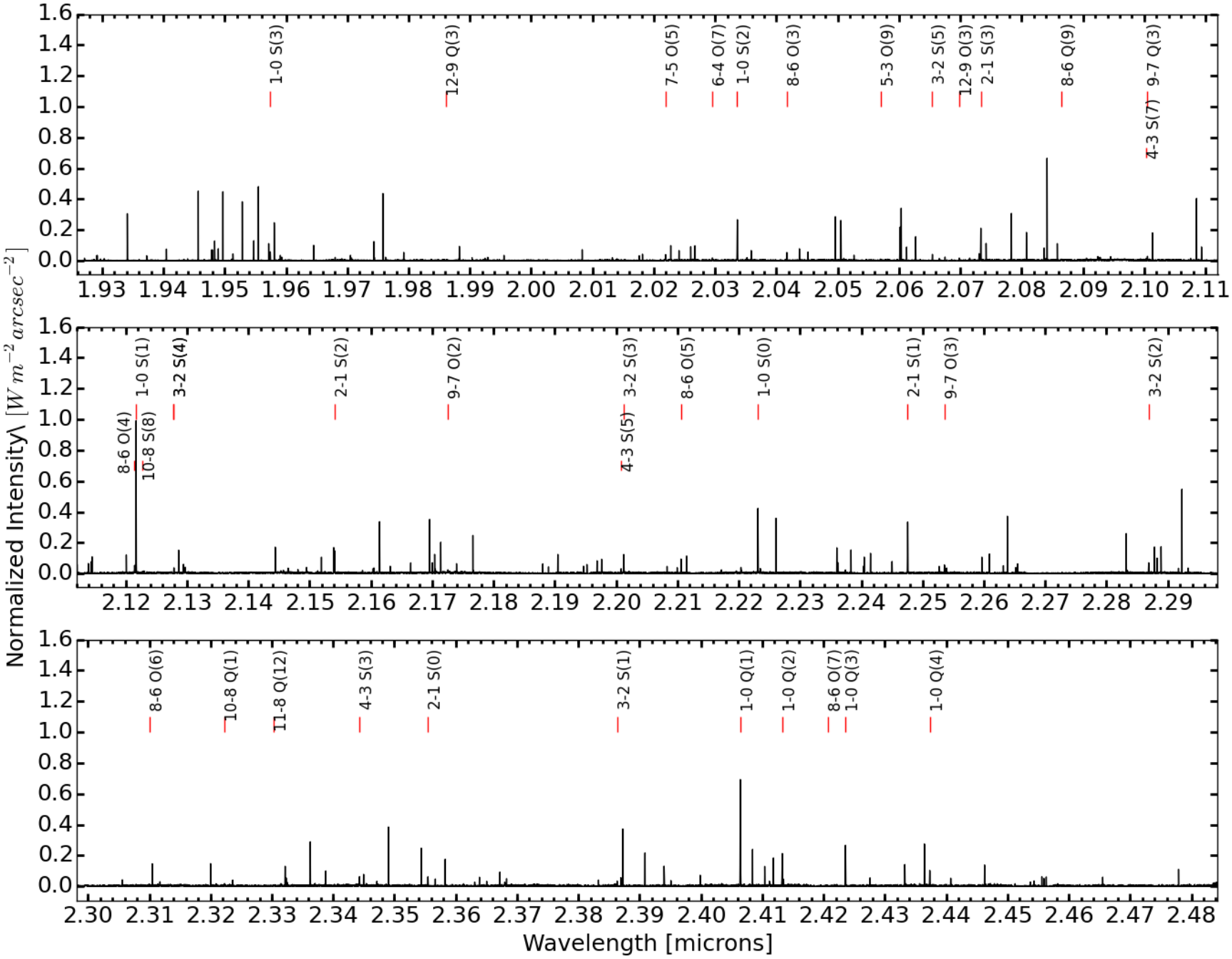


Correct telluric lines and remain OH sky lines






Normalized Intensity\ [$W\,m^{-2}\,arcsec^{-2}$]
Wavelength [microns]
5-3 Q(2)
6-4 S(1)
4-2 O(3)
5-3 Q(4)
3-1 O(5)
7-5 S(5)
5-3 Q(5)
6-4 S(0)
10-7 O(3)
5-3 O(2)
7-5 S(2)
11-8 S(1)
10-7 O(4)
6-4 Q(1)
5-3 Q(3)
6-4 Q(3)
7-5 S(1)
4-2 O(5)
6-4 Q(4)
1-0 S(15)
6-4 Q(5)
3-1 O(7)
11-8 Q(1)
7-5 S(0)
5-3 O(4)
6-4 O(2)
11-8 Q(3)
1-0 S(9)
8-6 S(3)
7-5 Q(1)
8-6 S(2)
6-4 O(3)
5-3 O(5)
7-5 Q(3)
4-2 O(7)
7-5 Q(4)
11-8 O(3)
8-6 S(1)
7-5 Q(5)
6-4 O(4)

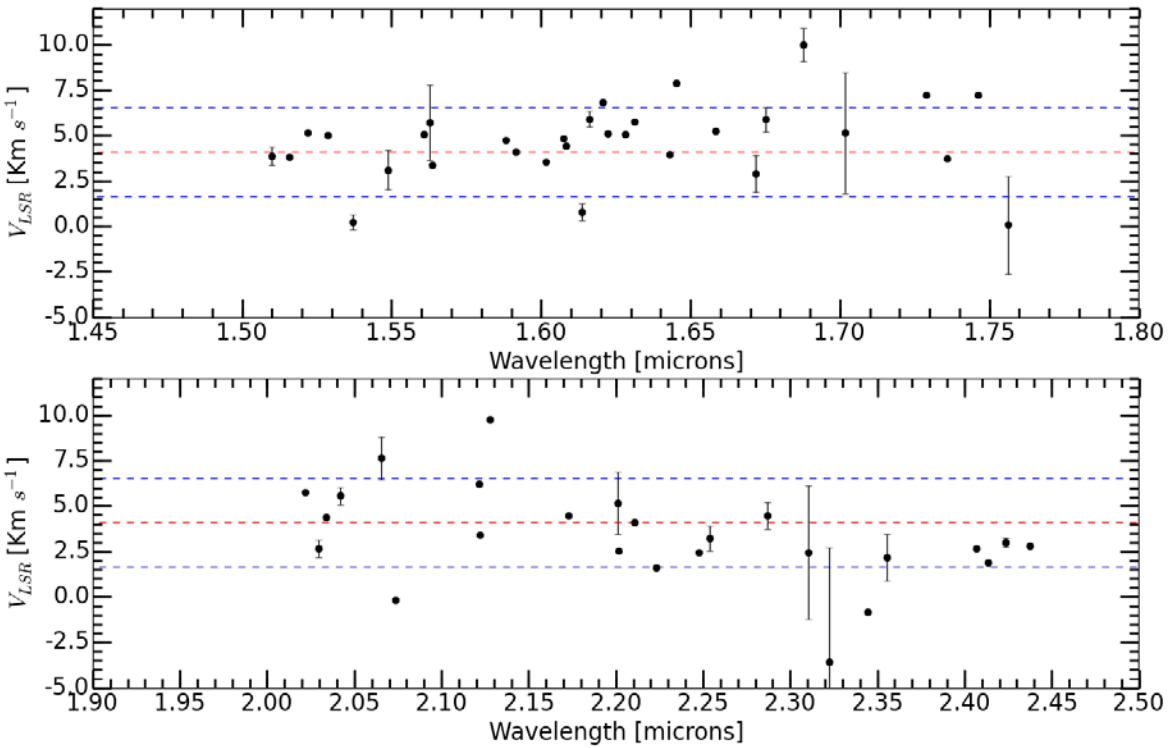

Normalized Intensity\ [$W\,m^{-2}\,arcsec^{-2}$]
Wavelength [microns]
1-0 S(3)
12-9 Q(3)
7-5 O(5)
6-4 O(7)
1-0 S(2)
8-6 O(3)
5-3 O(9)
3-2 S(5)
12-9 O(3)
2-1 S(3)
8-6 Q(9)
4-3 S(7)
9-7 Q(3)
8-6 O(4)
1-0 S(1)
10-8 S(8)
3-2 S(4)
2-1 S(2)
9-7 O(2)
4-3 S(5)
3-2 S(3)
8-6 O(5)
1-0 S(0)
2-1 S(1)
9-7 O(3)
3-2 S(2)
8-6 O(6)
10-8 Q(1)
11-8 Q(12)
4-3 S(3)
2-1 S(0)
3-2 S(1)
1-0 Q(1)
1-0 Q(2)
8-6 O(7)
1-0 Q(3)
1-0 Q(4)

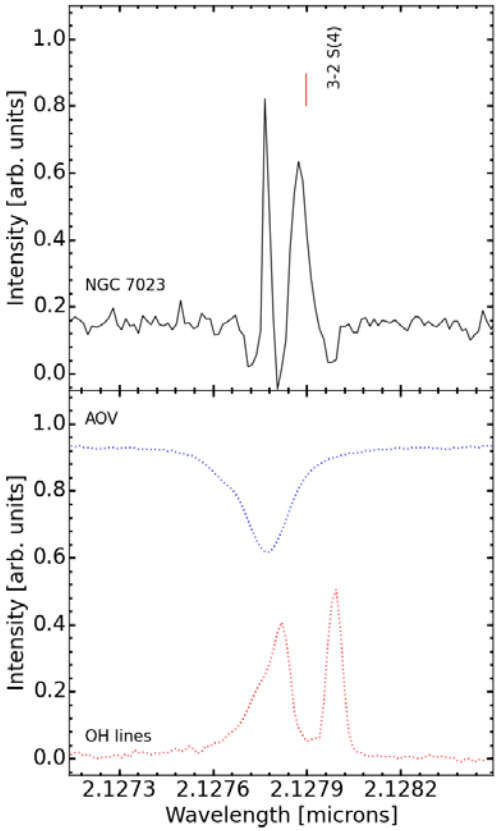
Analyze data

- Reliable emission lines
- Extinction corrections
- Emission line ratios
- H_2 level population

Filtering data:

- Signal-to-Noise of lines (S/N < 5)
- Effects of telluric lines.





- Within ±1σ V_{LSR}

Derive Extinction A_V

$$A_V = \frac{\log\left(\frac{\lambda_{L2} A_{L1} F_{obsL2}}{\lambda_{L1} A_{L2} F_{obsL1}}\right)}{0.1648\left({\lambda_{L1}}^{-1.75} - {\lambda_{L2}}^{-1.75}\right)}$$

E_u/k [K]	Line1	Line2	A_V [mag]	σ_{A_V} [mag]
6471	1-0 Q(2)	1-0 S(0)	30.17	3.29
6951	1-0 Q(3)	1-0 S(1)	25.07	1.67
7584	1-0 Q(4)	1-0 S(2)	19.52	1.69

- A_V = 22 ± 5 [mag]
- High extinction value !
- Dense clump effects (?)

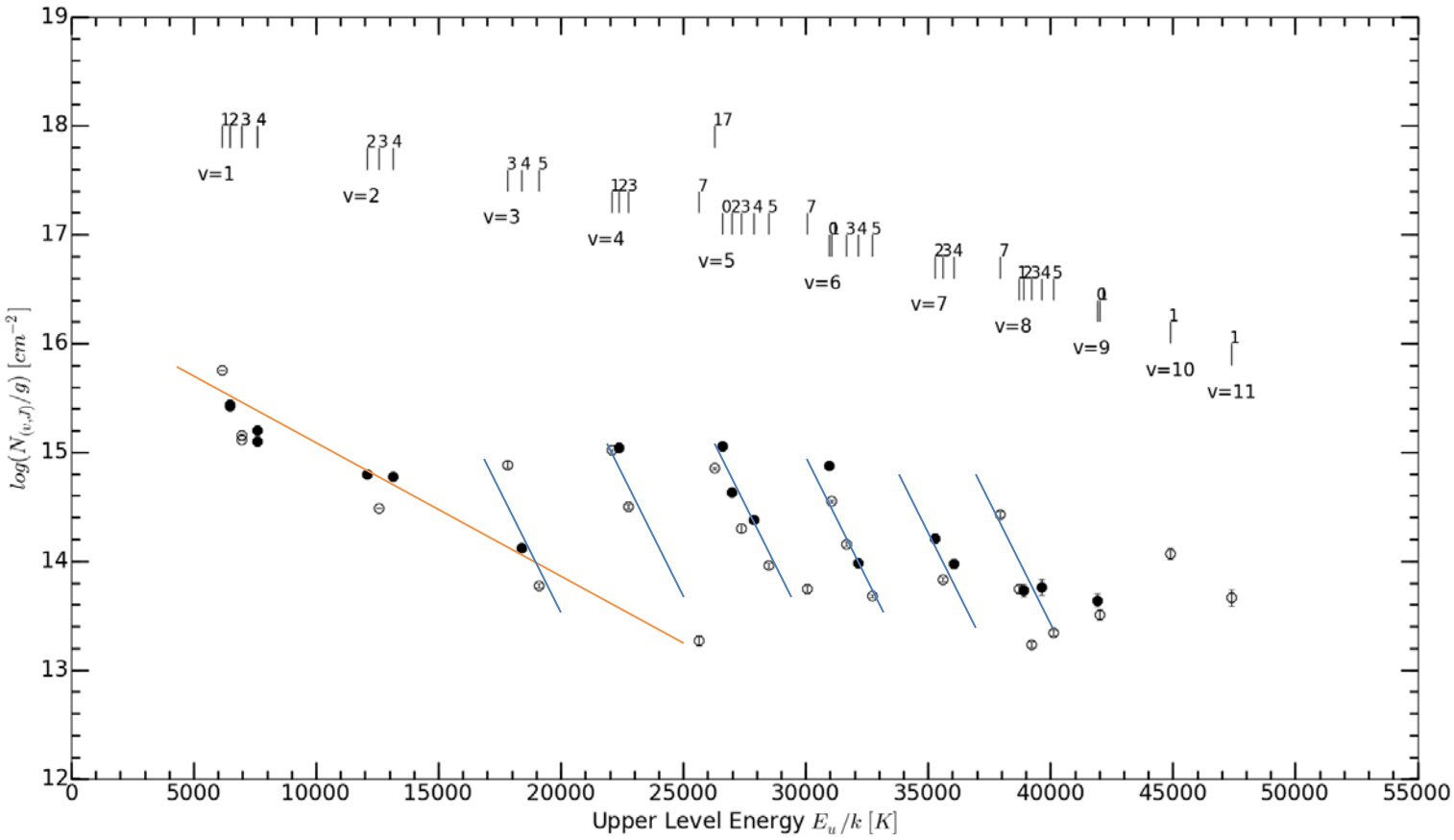
Emission line ratio 2-1 S(1) / 1-0 S(1)

- Thermal by shock heating
  - 2-1 S(1) / 1-0 S(1) < 0.5 (J-shock 30-50km/s)
  - 2-1 S(1) / 1-0 S(1) < 0.3 (low J-shock < 20km/s)
  - 2-1 S(1) / 1-0 S(1) < 0.2 (C-shock)

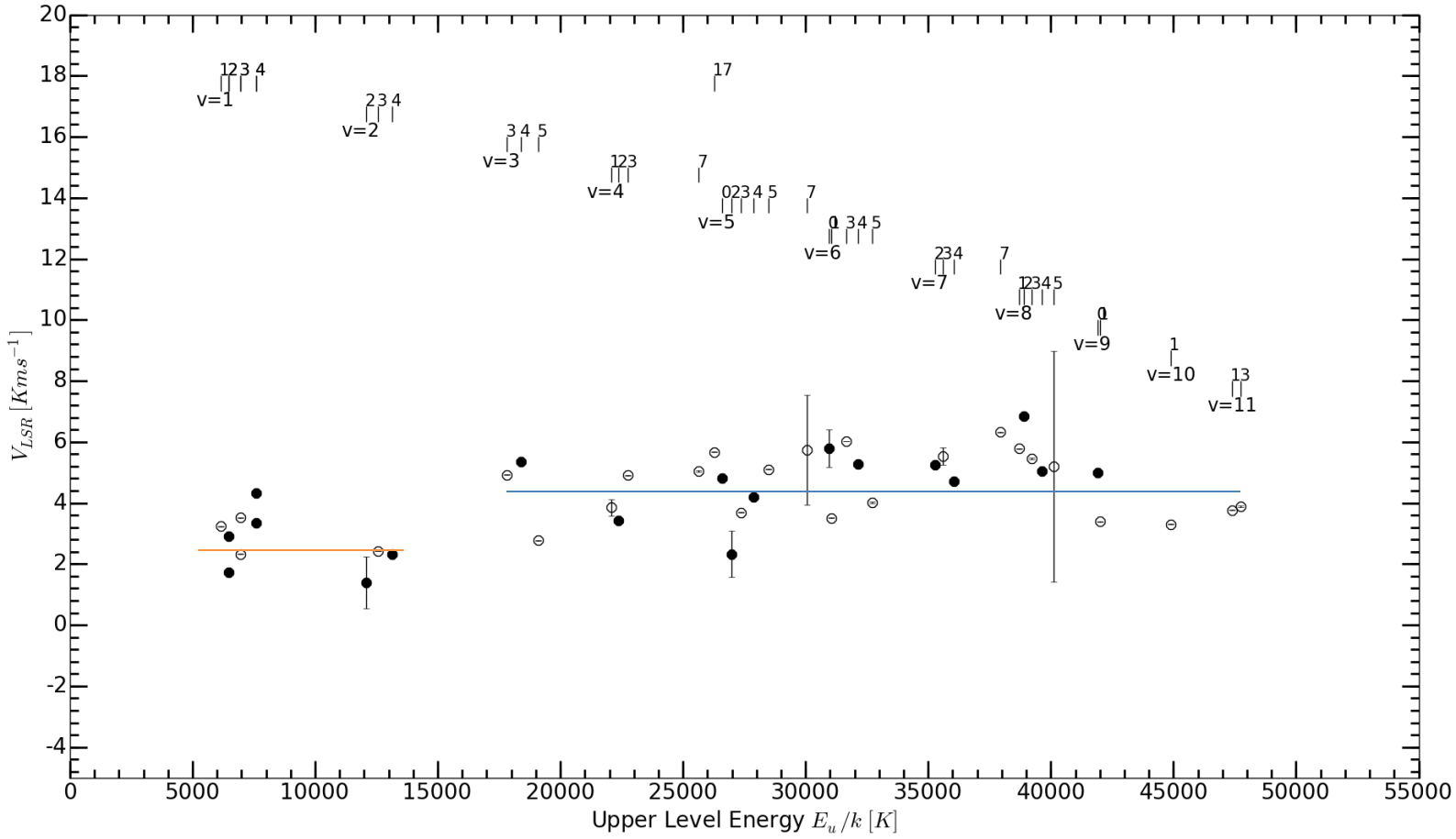
- Non-thermal by Far UV
  - 2-1 S(1) / 1-0 S(1) < 0.6 (Dense PDR)
  - 2-1 S(1) / 1-0 S(1) ~ 0.6 (PDR $N_{H2} < 5 \times 10^4$ cm^{-3})

2-1 S(1) / 1-0 S(1) = 0.32 ± 0.01
Thermal + UV excitations

H_2 level population diagram



- Two temperature components.
- Dense clumps + PDR (?)



- Lines may come from different regions (?)
- V_{LSR} may depend on excitations (?)

Next works

- Compare the intensity line ratios to models of PDRs to determine the densities and UV radiation field strengths for the molecular filament.
- Resolve the line-width of the H2 emission lines, this line-widths can compare with that of radio data, e.g. CO lines … to study the kinematics and turbulences of gas motions in the PDRs.