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HCN VUV Absorption cross section at high temperature for warm exoplanets

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Context

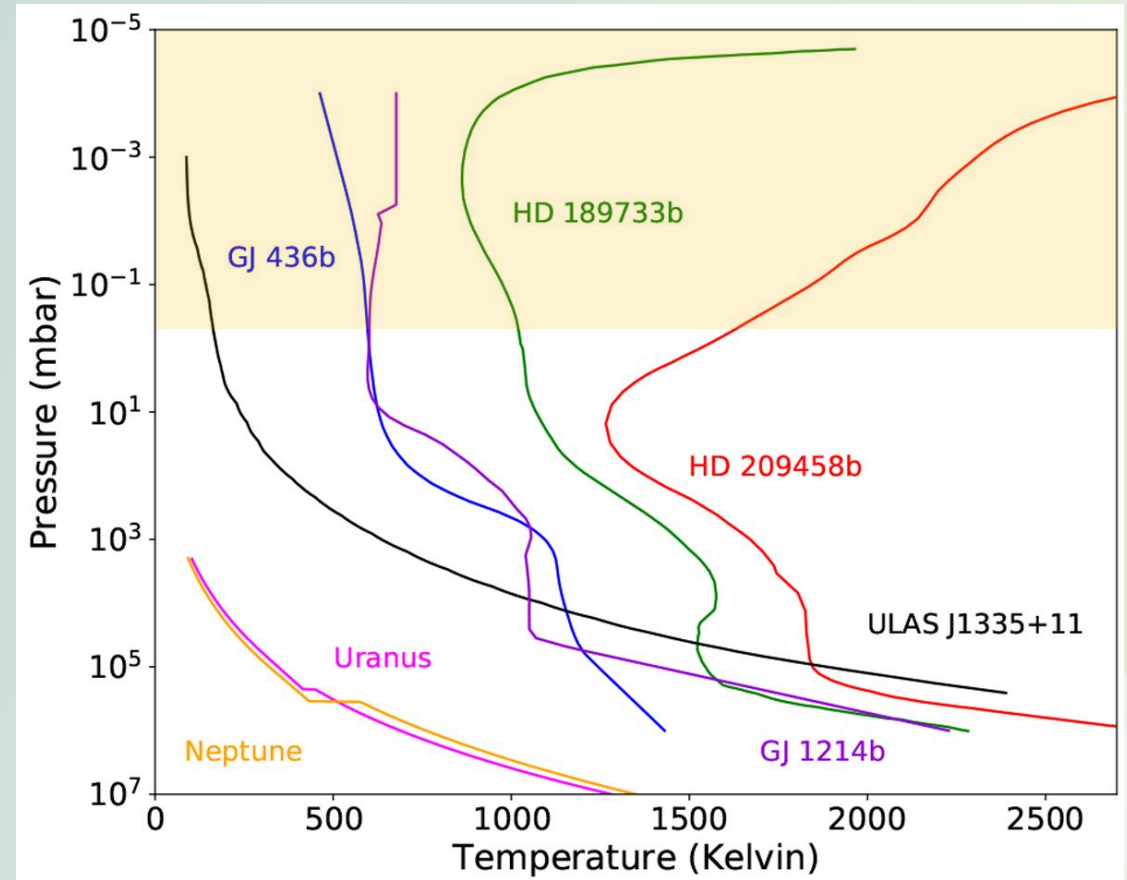
Consequences :



↳ Important photochemistry processes at high temperature

→ To interpret observations made by telescope we use atmospheric model to simulate the photochemistry

BUT...

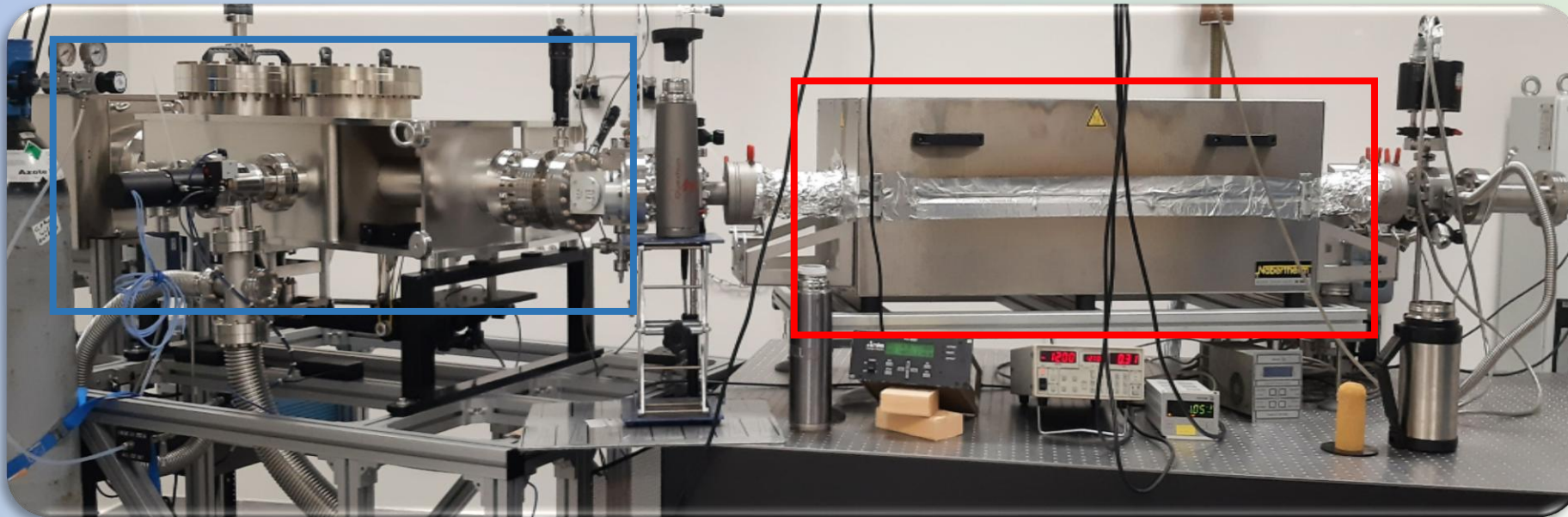


Venot et al, 2019 A&A

AND WE LACK DATA AT HIGH TEMPERATURE !

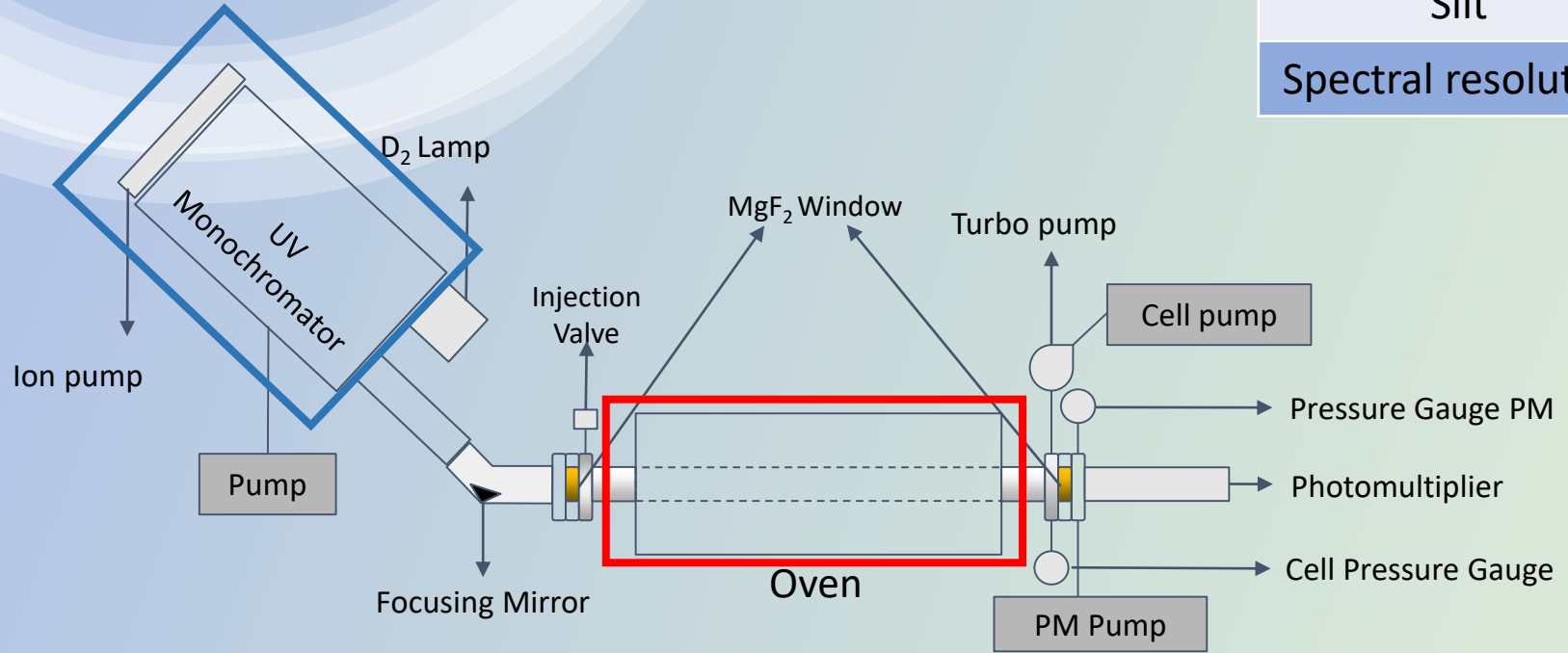
VUV spectroscopic platform

| | |
|-------------|--------------|
| Optic path | 1.65 m |
| Wavelength | 30 - 300 nm |
| Temperature | Up to 1300 K |



Methodology

| | |
|---------------------|--------------|
| Range | 115 – 200 nm |
| Slit | 80 μm |
| Spectral resolution | 0.065 nm |



Beer-Lambert law

$$\sigma(\lambda, T) = \left(\frac{1}{nL} \right) \times \ln \left(\frac{I_0}{I} \right)$$

$\sigma(\lambda, T)$ is the absorption cross section (cm²) at a given wavelength λ and temperature T , L is the optical pathlength (cm), n the volume density of the gas in the cell (cm⁻³),

Results : HCN absorption cross section

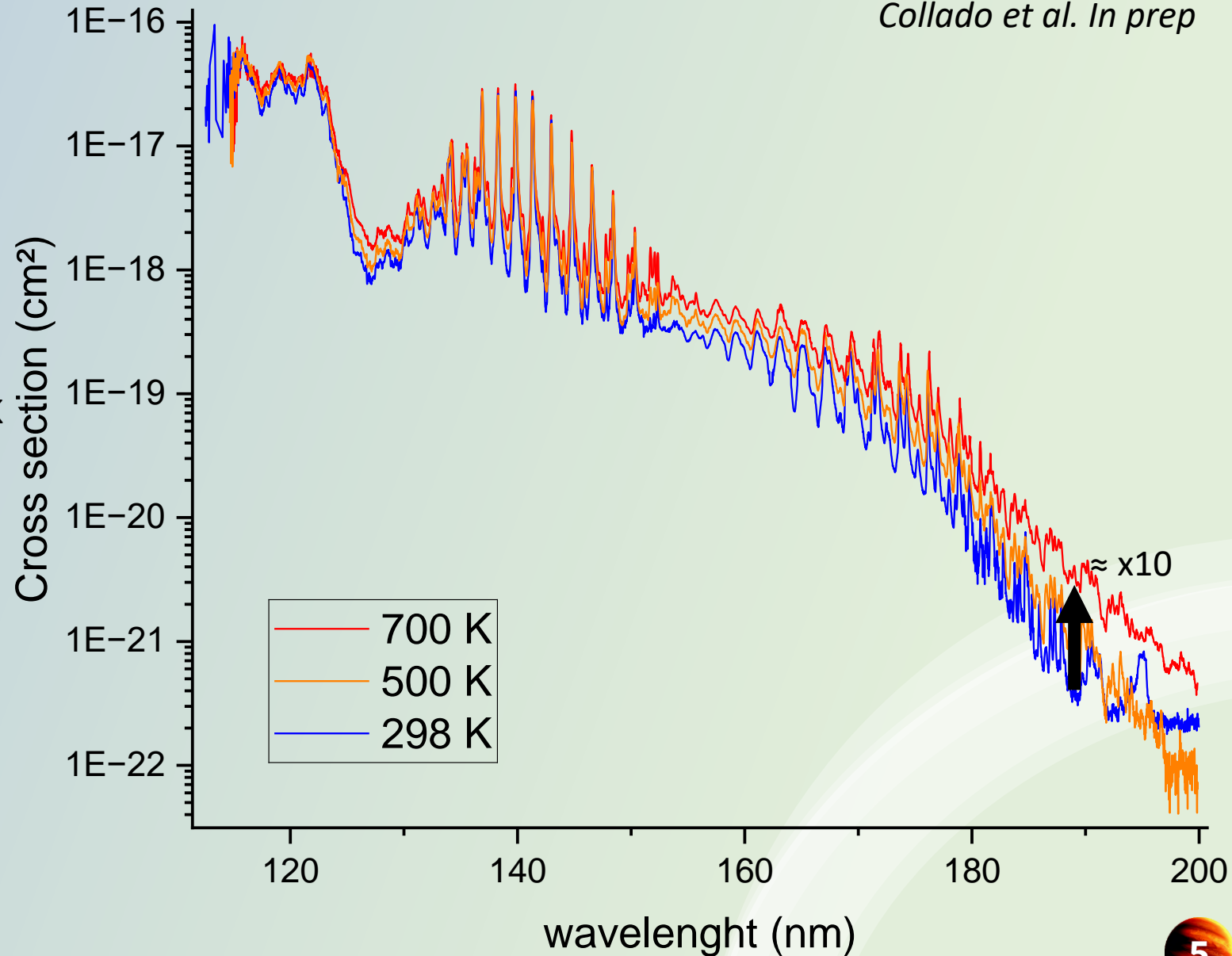
Collado et al. In prep

Impact of the temperature on the absorption cross section of HCN

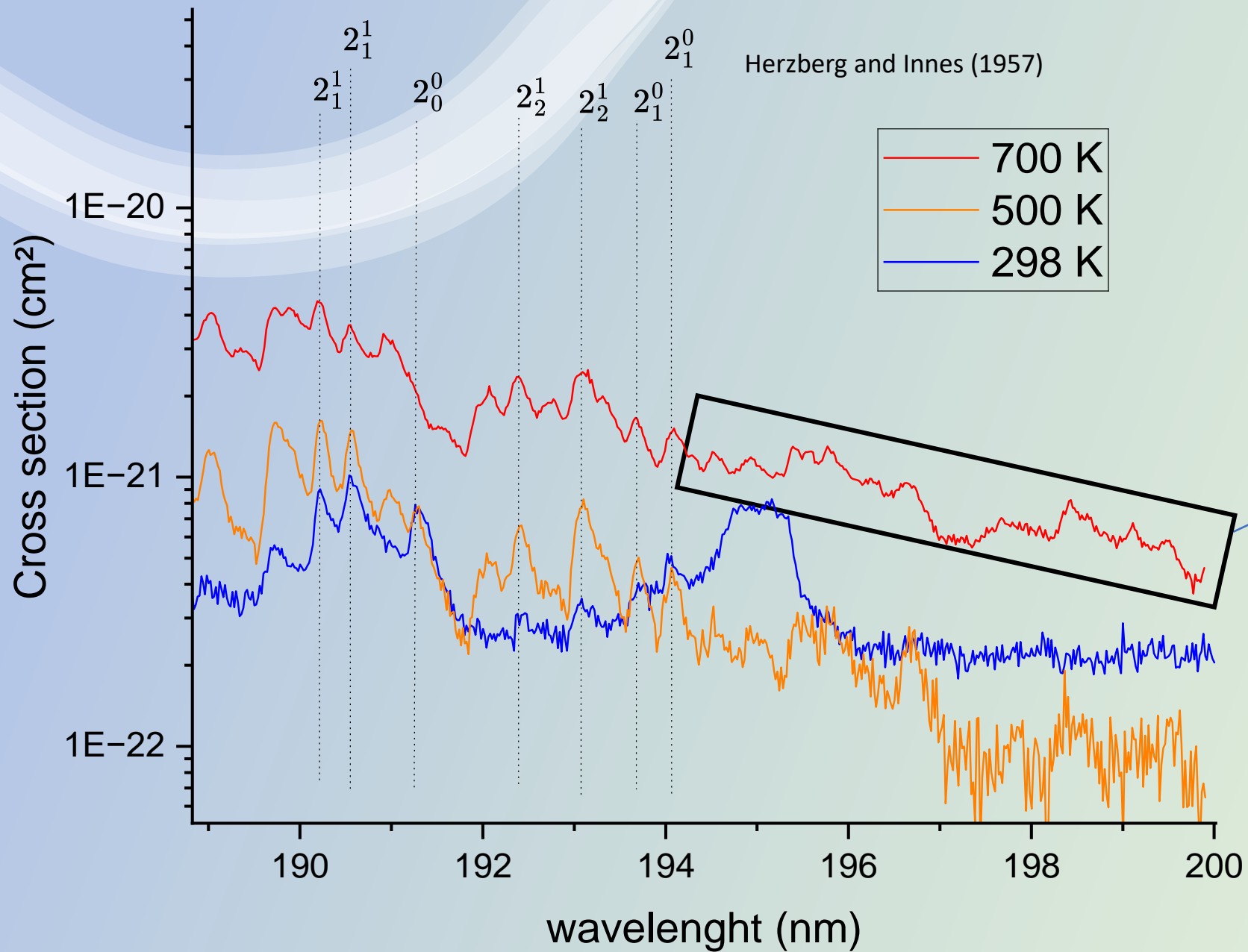
As temperature increases

- Absorption cross section increases
- Factor of 10 between 298 K and 700 K

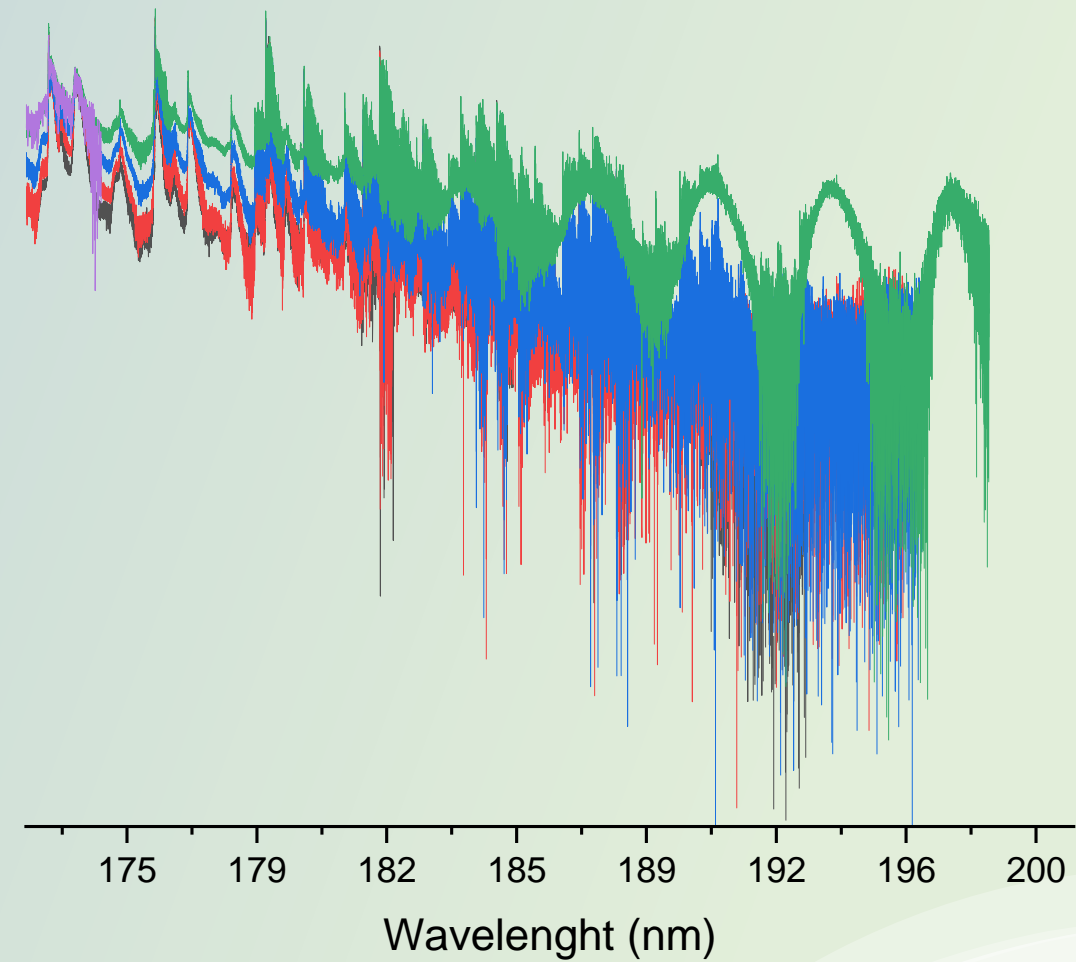
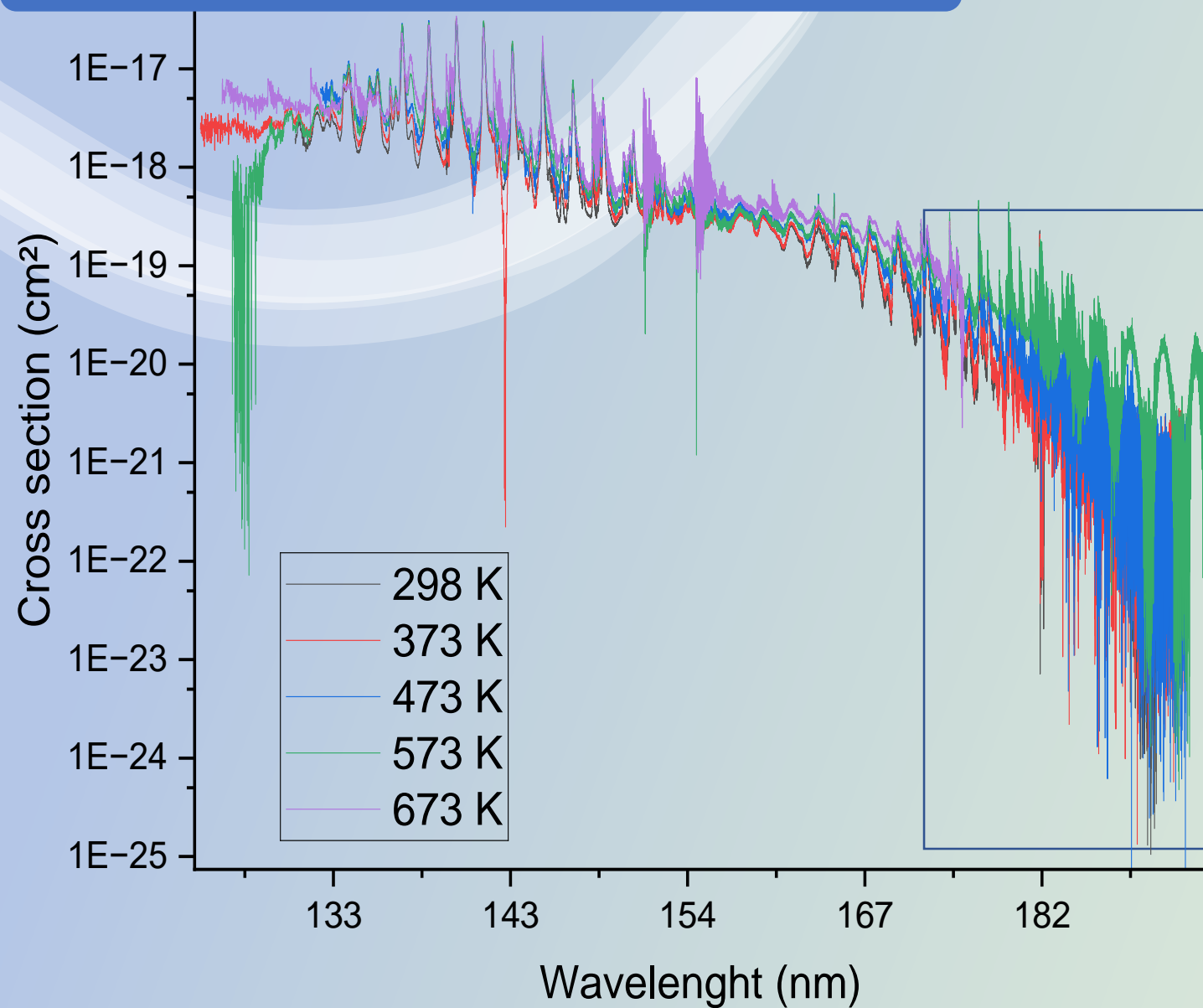
Result consistent with other molecules
(CO₂, Venot et al. 2018; C₂H₂, Fleury et al. 2025)



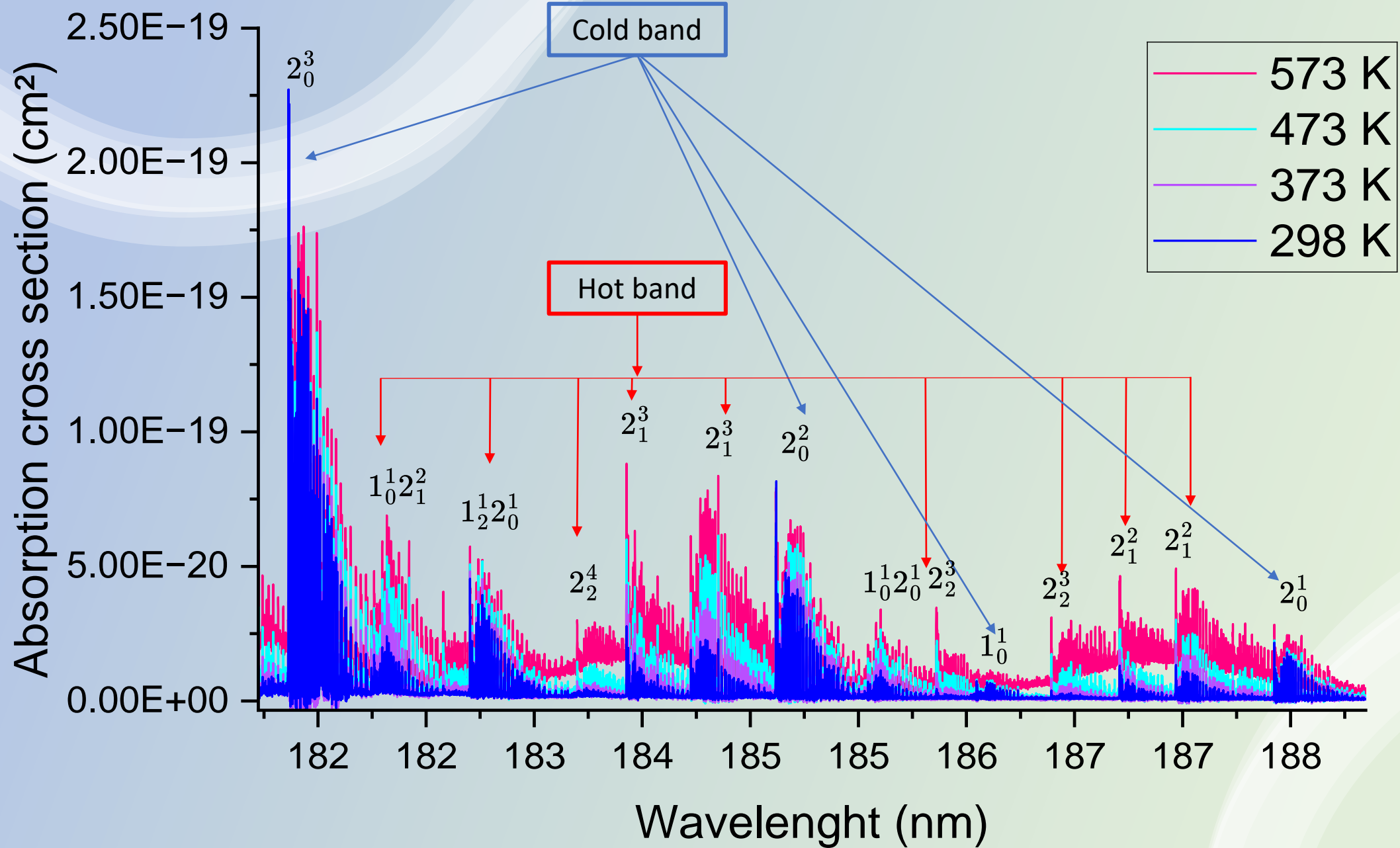
Result : HCN absorption cross section : A – X transition



Result : Synchrotron Soleil 2017

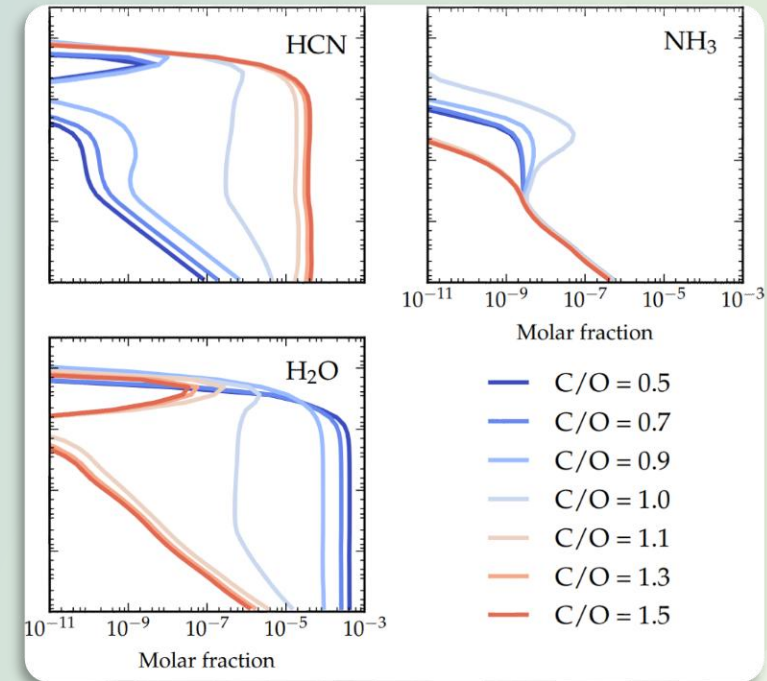
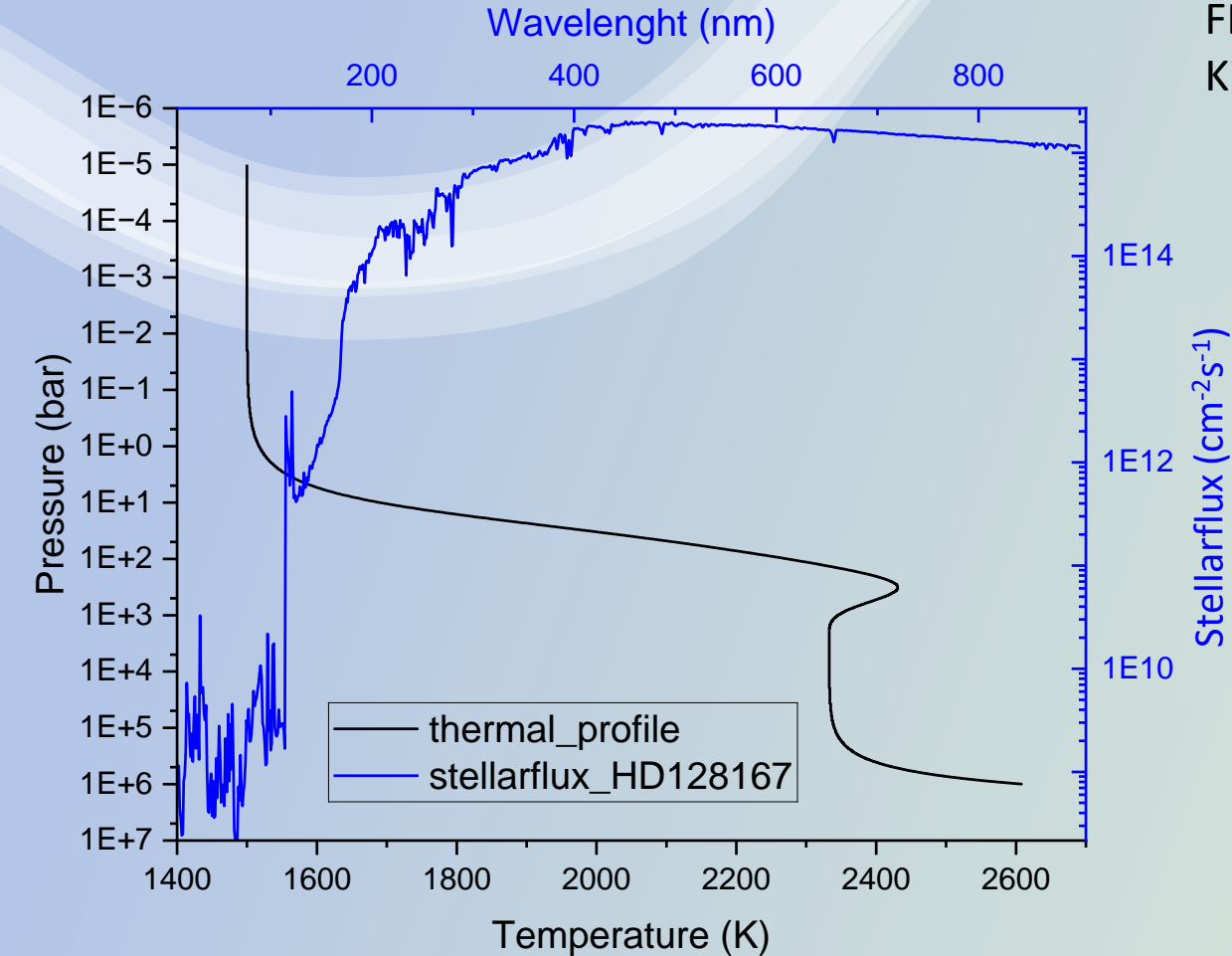


Result : Synchrotron Soleil 2017



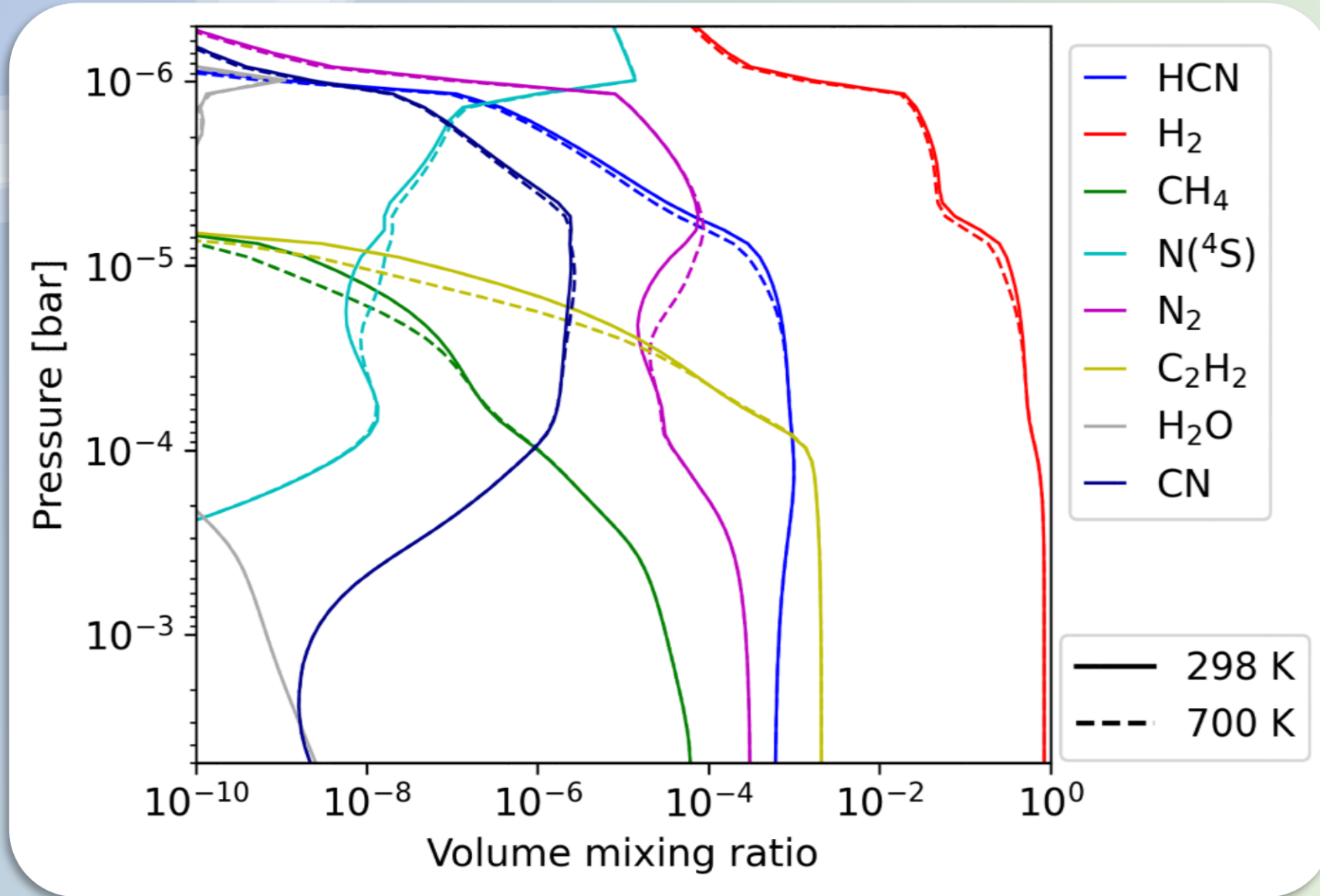
Modelling – FRECKLL

FRECKLL → 1D thermo-photochemical model (Al-Refaie et al., 2024)
 Kinetic network → C/H/O/N (Veillet et al., 2024)



Rocchetto et al 2016 ApJ **833** 120

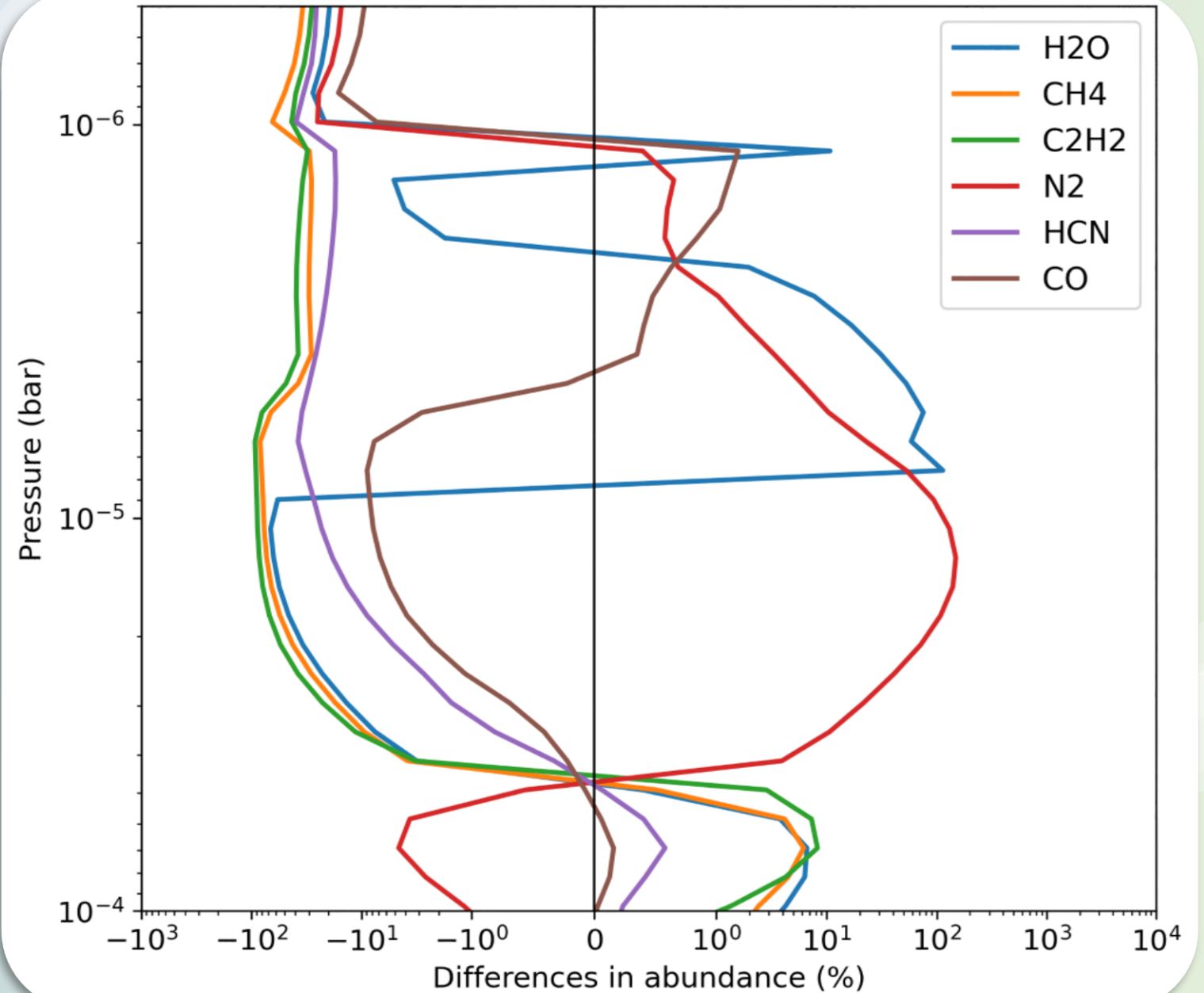
| Thermal profile | Stellar flux | M (solar) | K_{zz} (cm^2s^{-1}) | C/O | D (ua) | $R(R_j)$ | Go (m/s^2) |
|-----------------------------|-------------------------------------|-----------|---|-----|--------|----------|-------------------------|
| V15b Venot et al. (2015) | HD128167 (F) Venot et al. (2013) | 10 | 10^7 | 1.5 | 0.047 | 0.56 | 9.5395 |

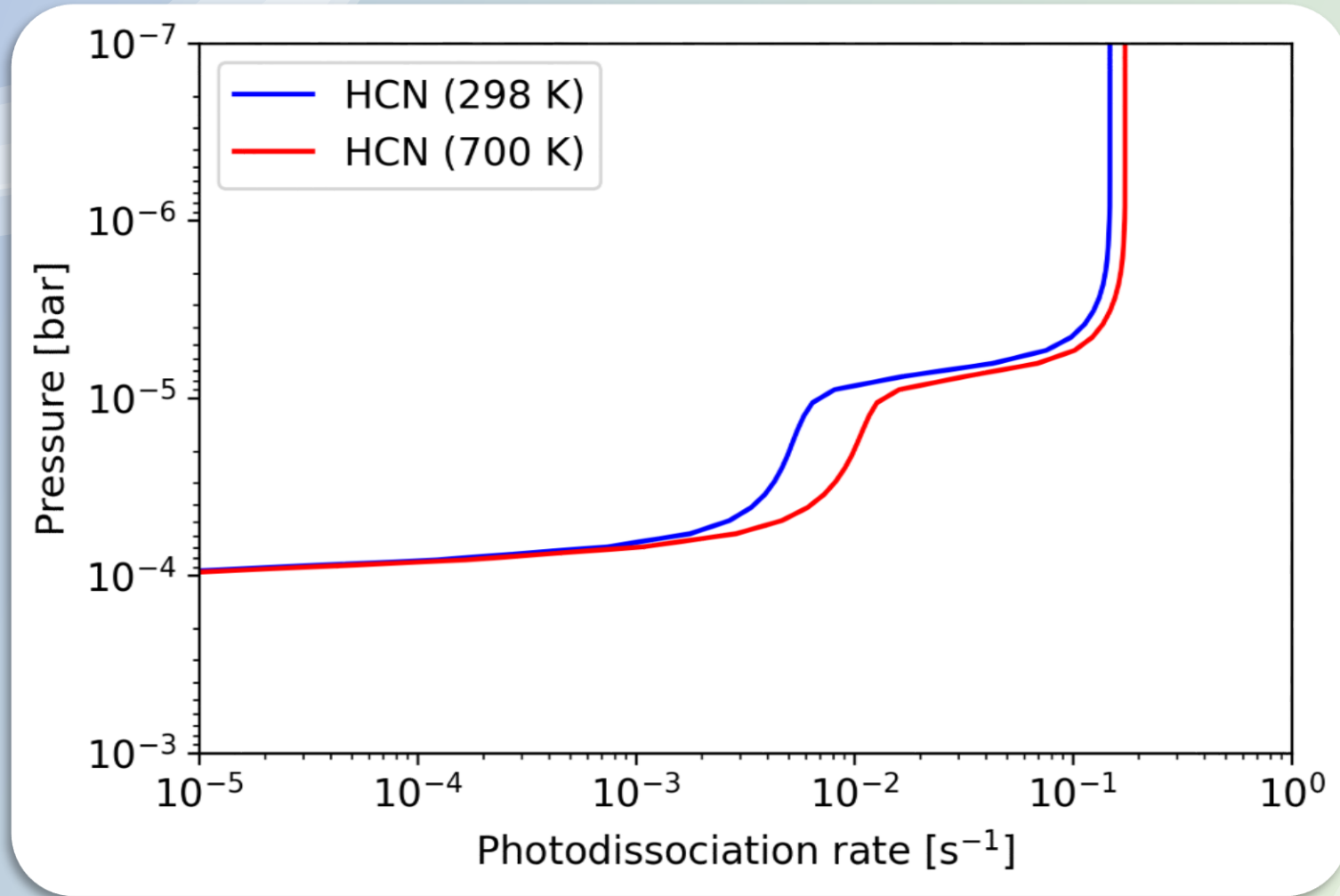


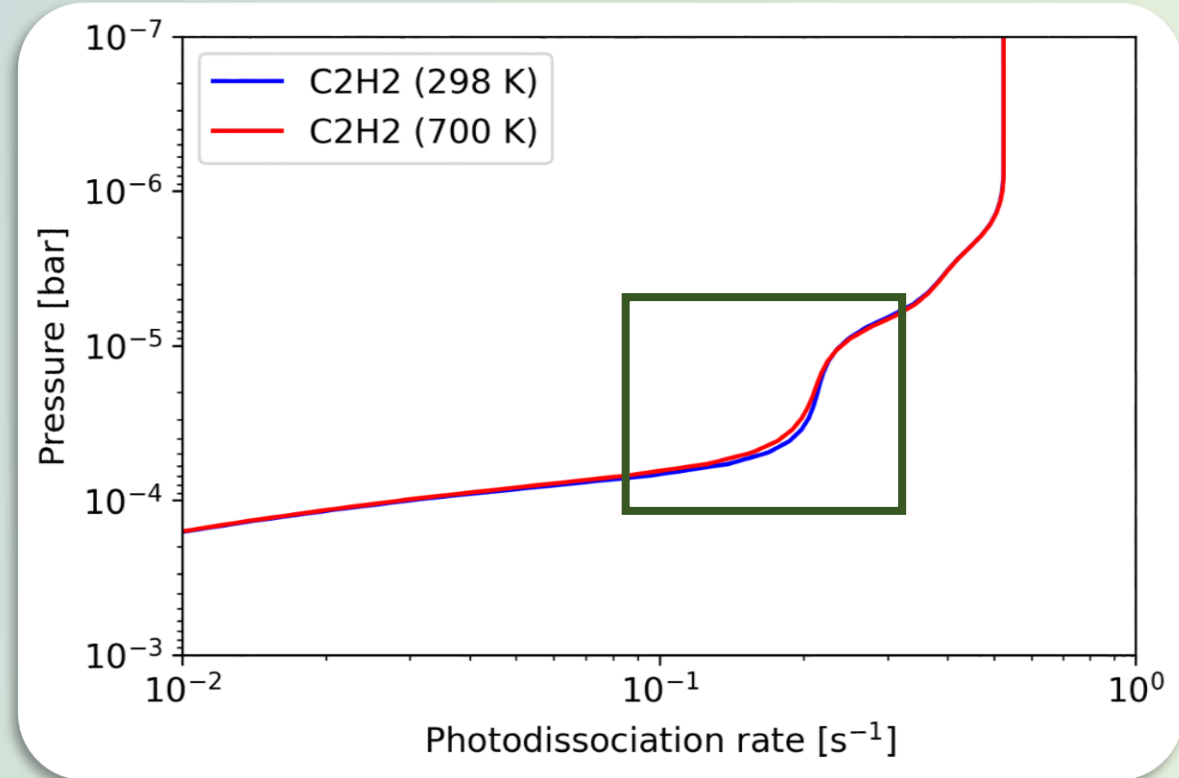
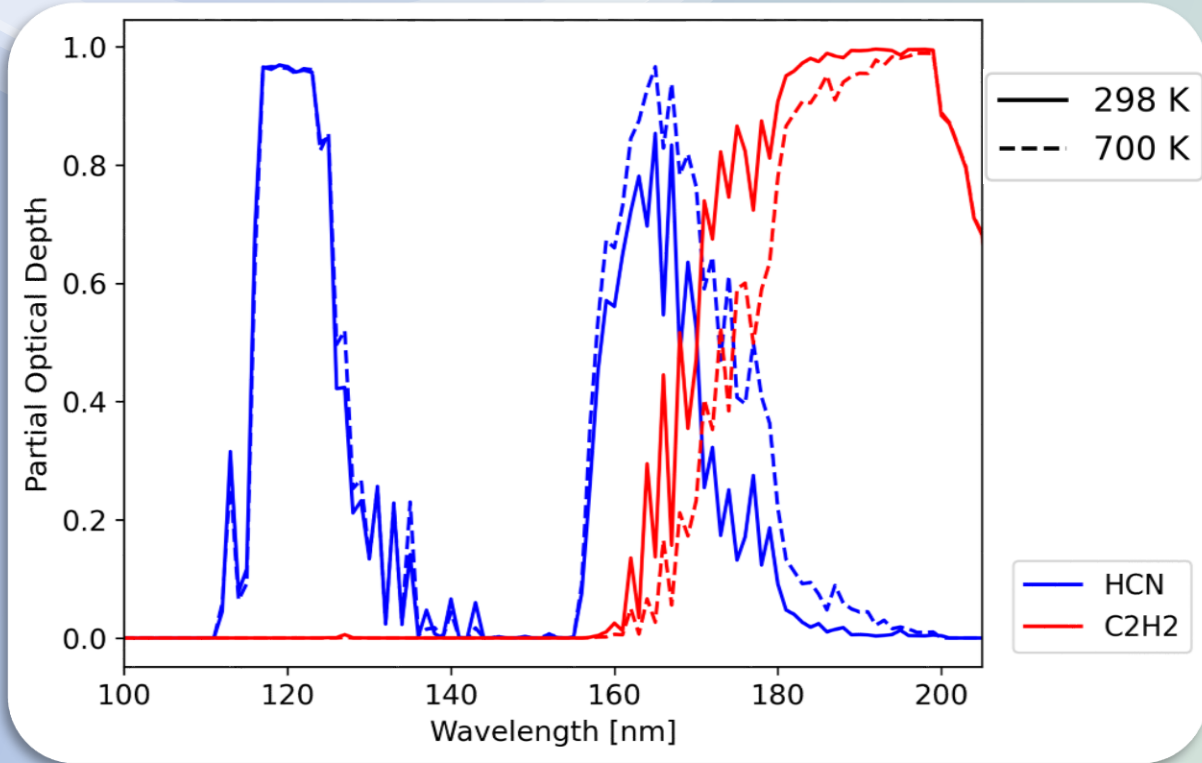
Modelling – FRECKLL

Abundance with the 700 K cross section

Abundance with the 300 K cross section







Contribution of molecules to the opacity of the atmosphere (level $\tau=1$)

Conclusion and discussion

- Measurements of HCN VUV absorption cross section between **115** and **200 nm** up **700 K**
- HCN VUV cross section shows **thermal dependence** → critical for modeling hot exoplanet atmospheres.
- Expand the measurements to sulfur molecules (**SO₂**, **H₂S**, **CH₃SH**)

Thanks for your attention !



