Photophysics and evolution of cosmic PAHs at the JWST era

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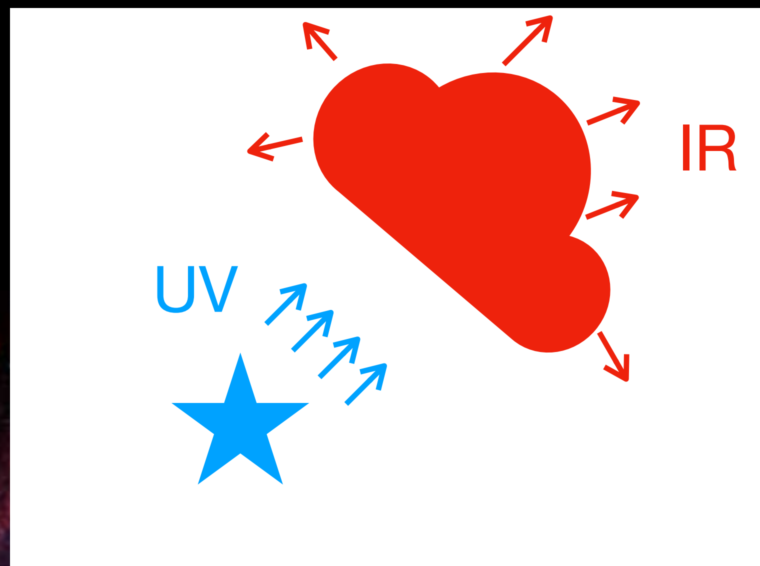
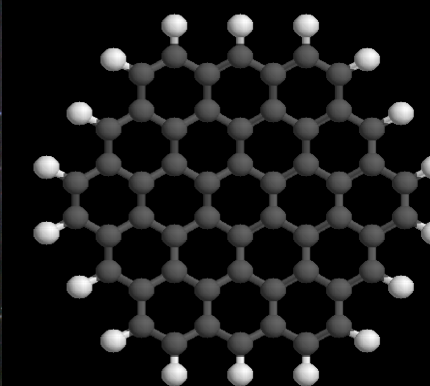
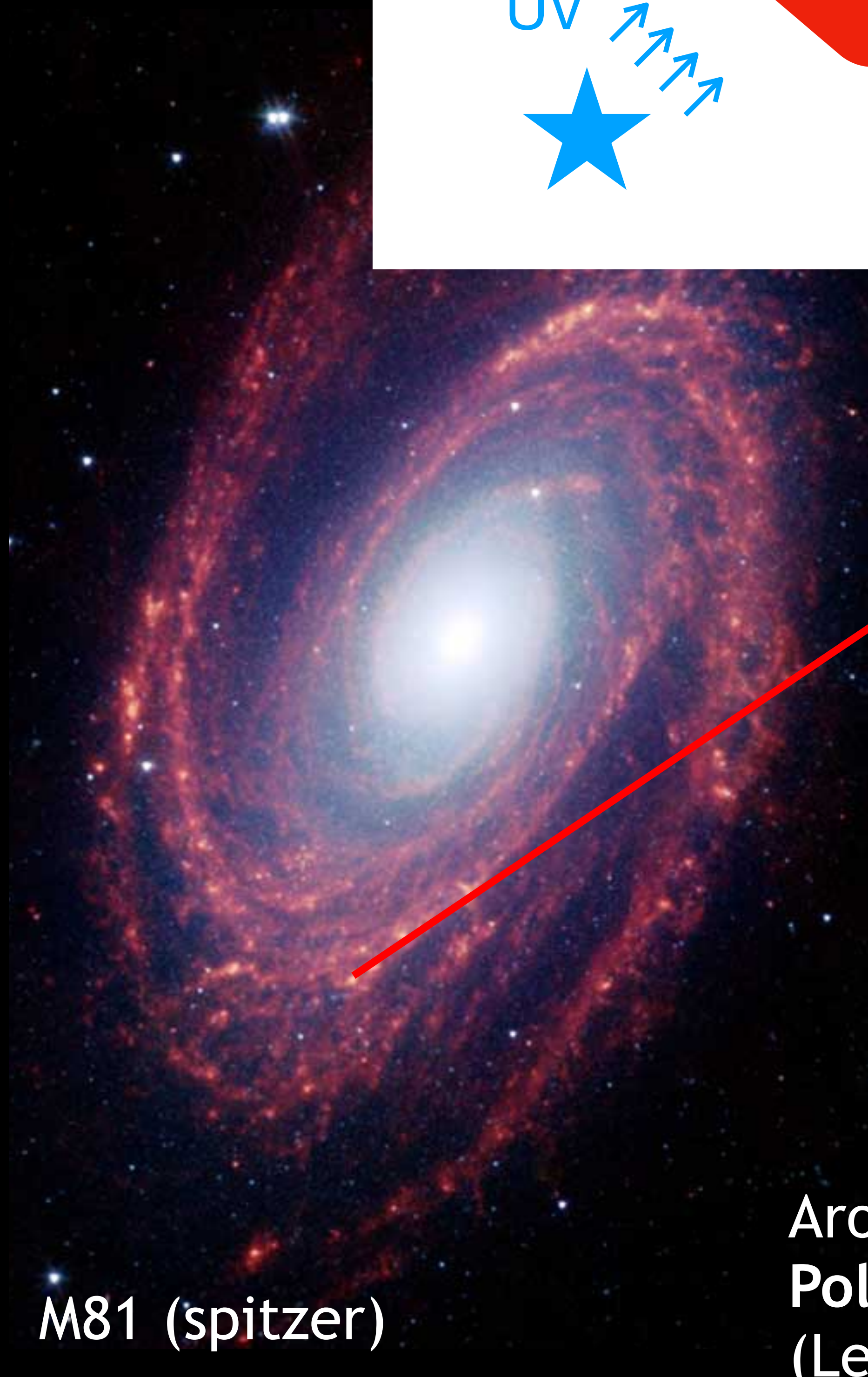
Ph.D. day May 16th 2018
IRAP

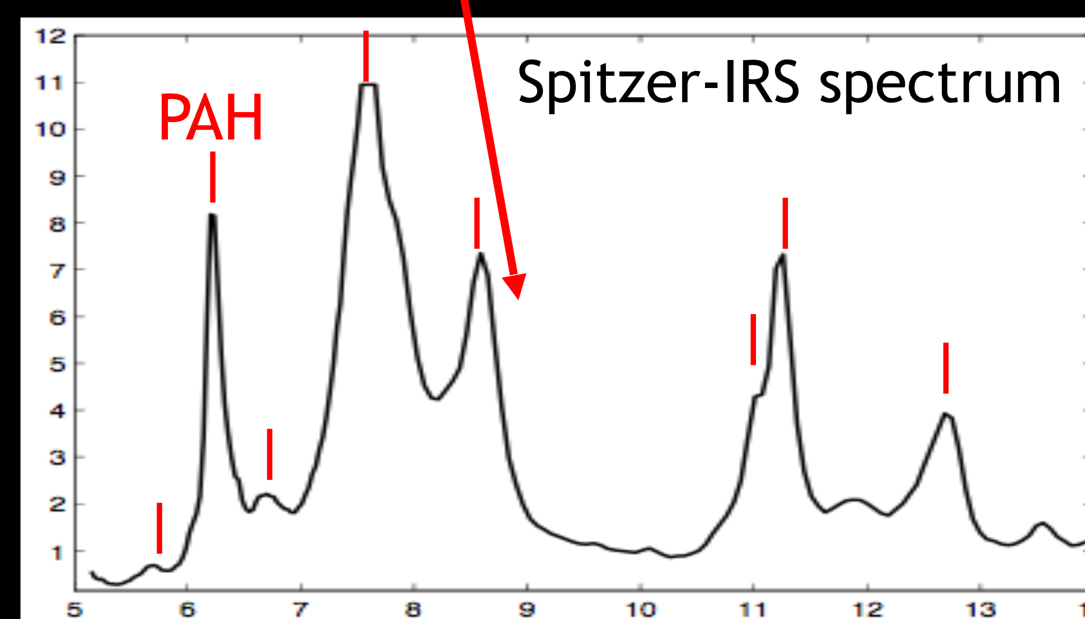
Infrared observation of the interstellar medium



NGC 7023
(© Aurelien Lepanot)



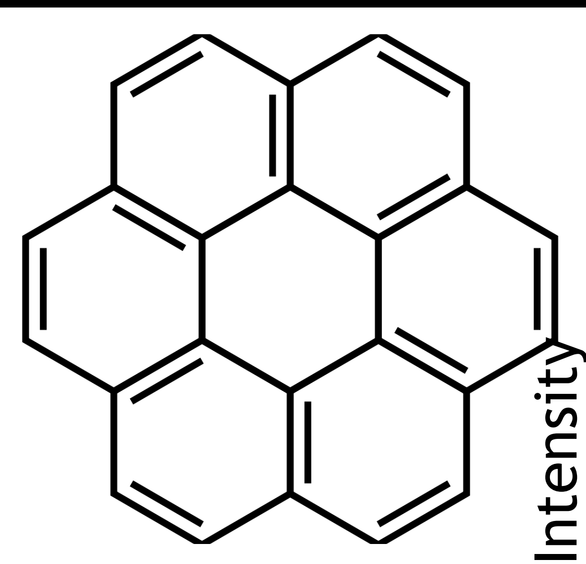

M81 (spitzer)

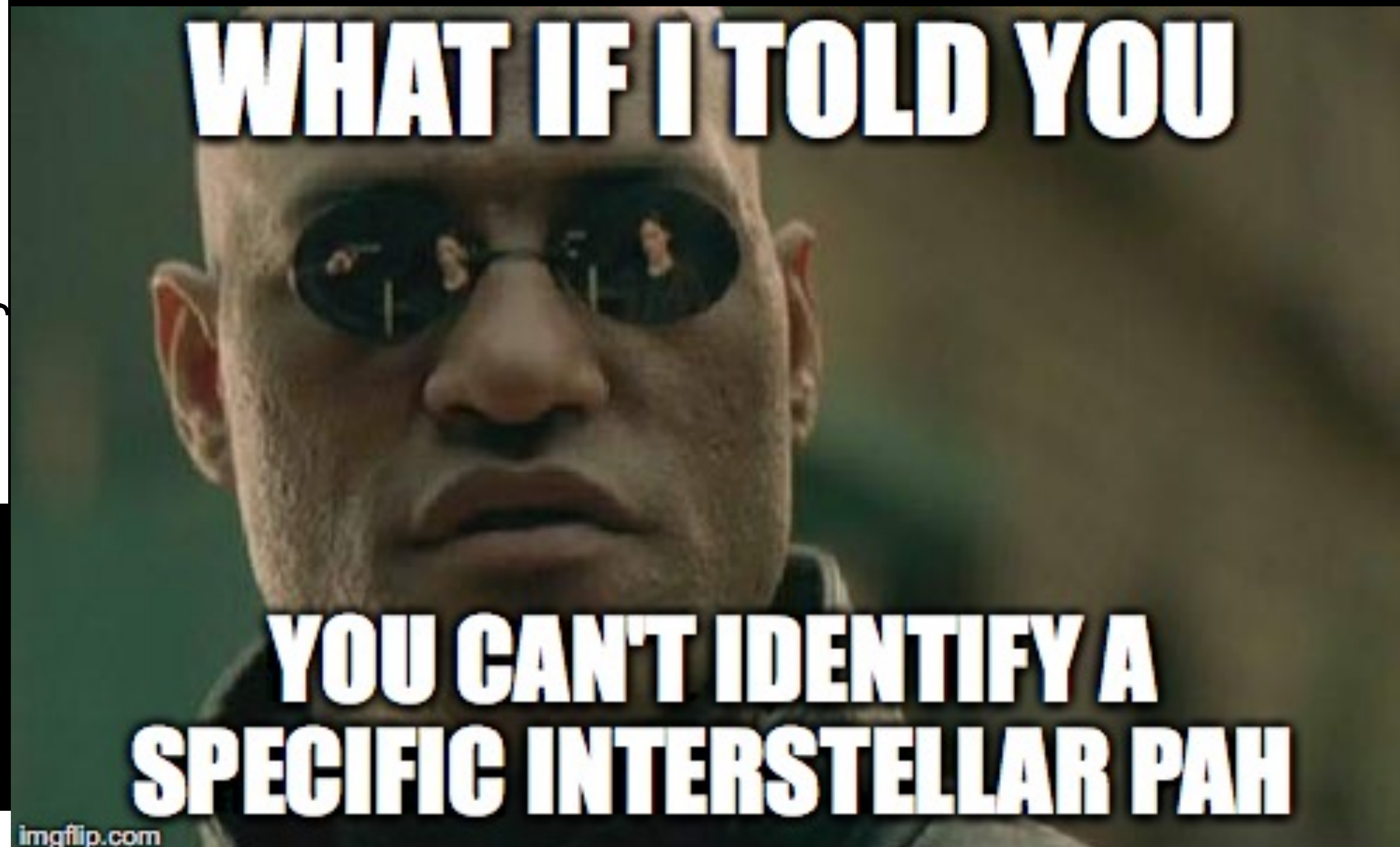


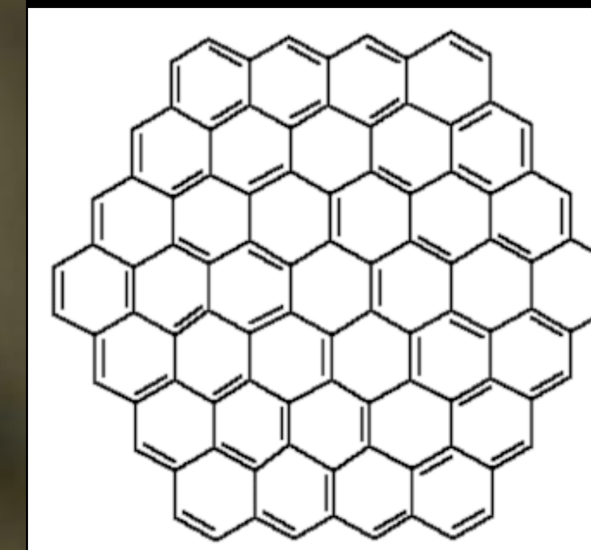
Aromatic Infrared Bands (AIBs) attributed to
Polycyclic Aromatic Hydrocarbons (PAH)
(Leger & Puget 1984, Tielens, Allamandolla & Barker 1985)

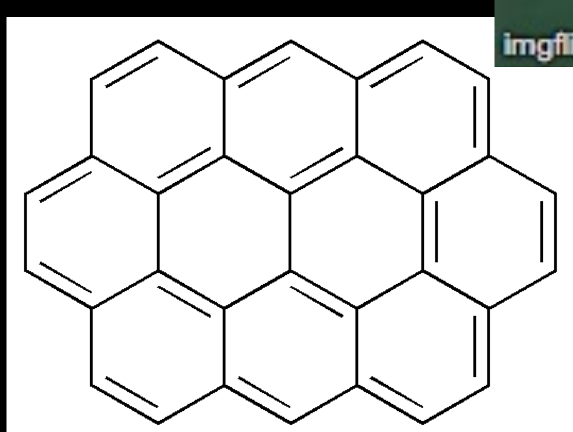
Ubiquitous emission of PAHs

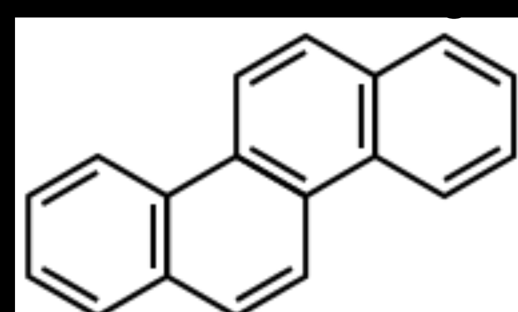
The identification problem in the interstellar medium

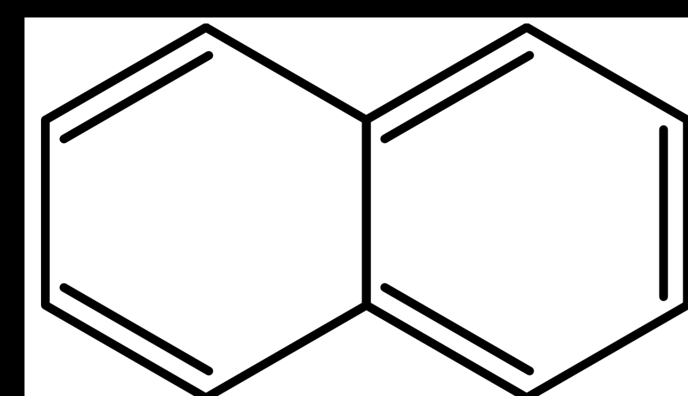






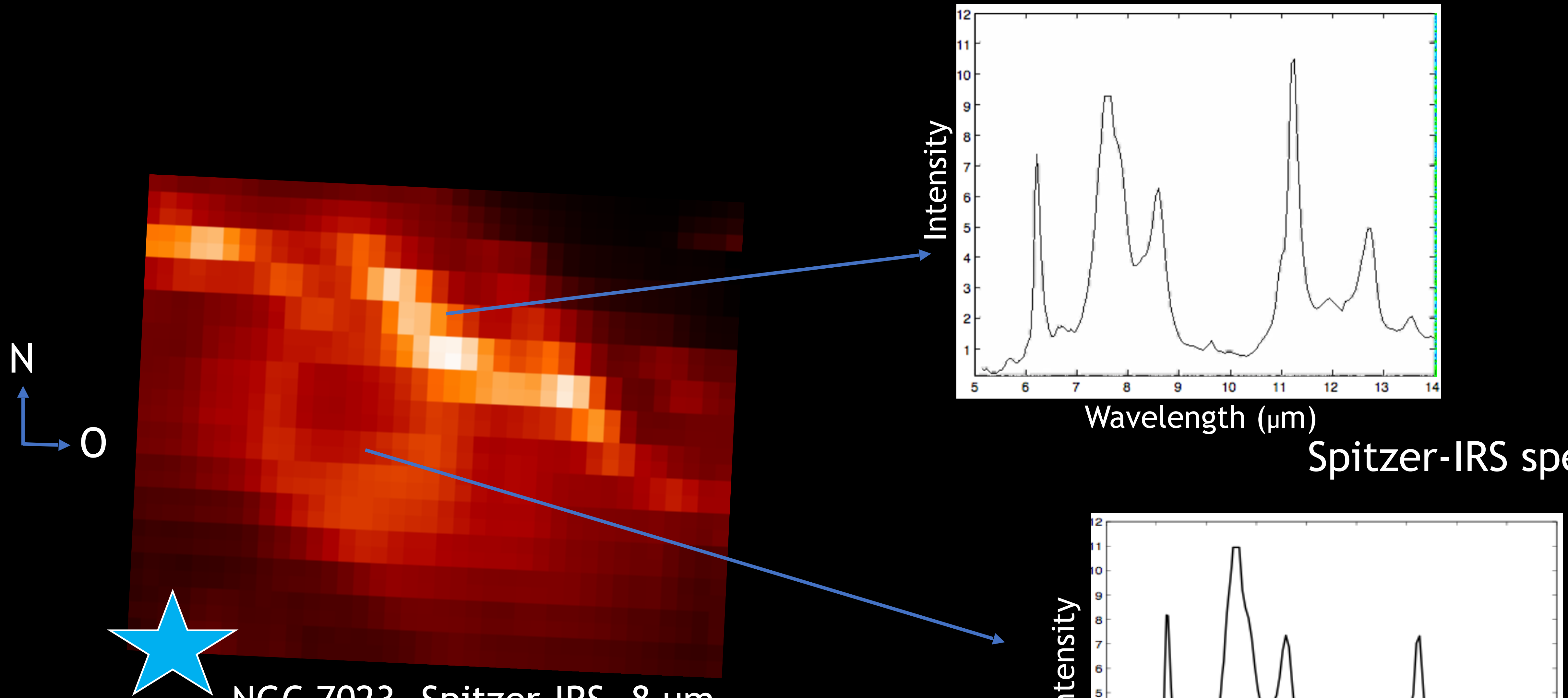






But we can find some tendencies!

Spatial variations of mid-IR spectra

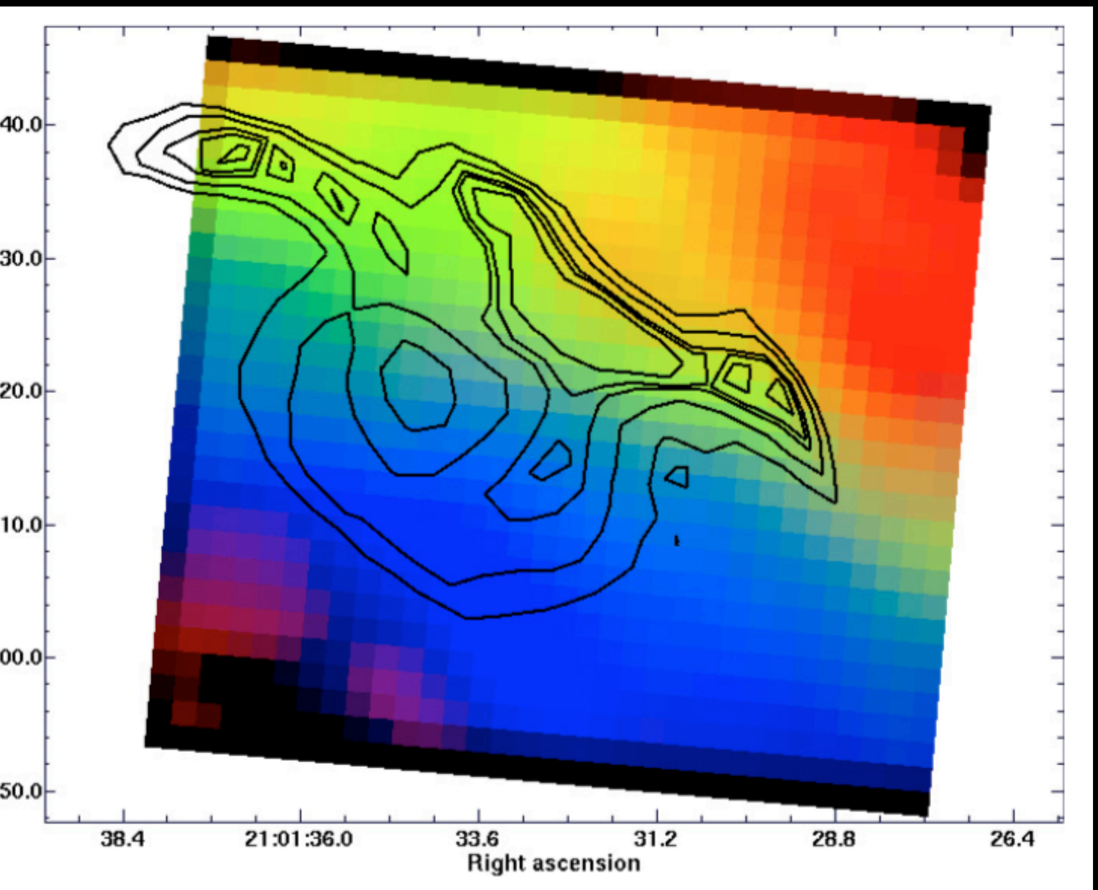


NGC 7023, Spitzer-IRS, 8 μm

Spitzer-IRS spectra

Physical conditions → physicochemical properties of PAHs → Observed variations in mid-IR spectra

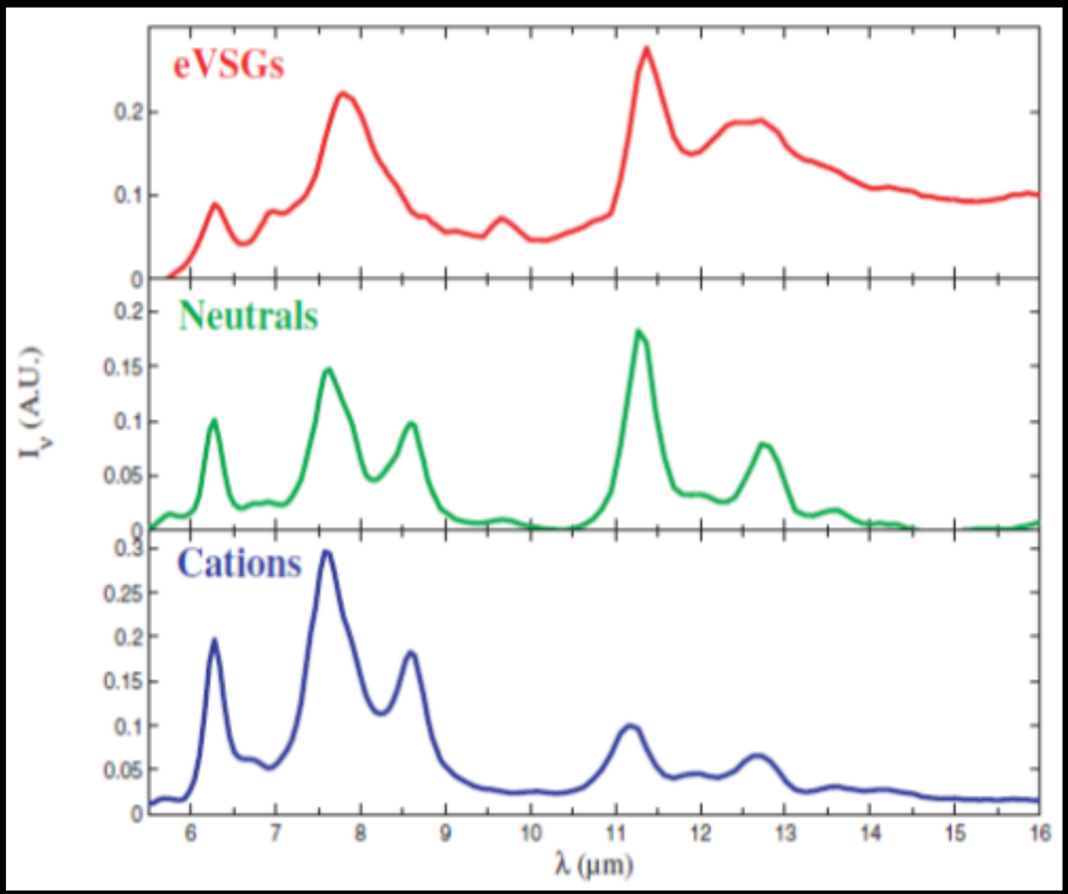
Blind signal separation for astronomical PAH spectroscopy



BSS

Berné et al. 2007

Spitzer-IRS data
R~70
5 to 15 microns



My job until now

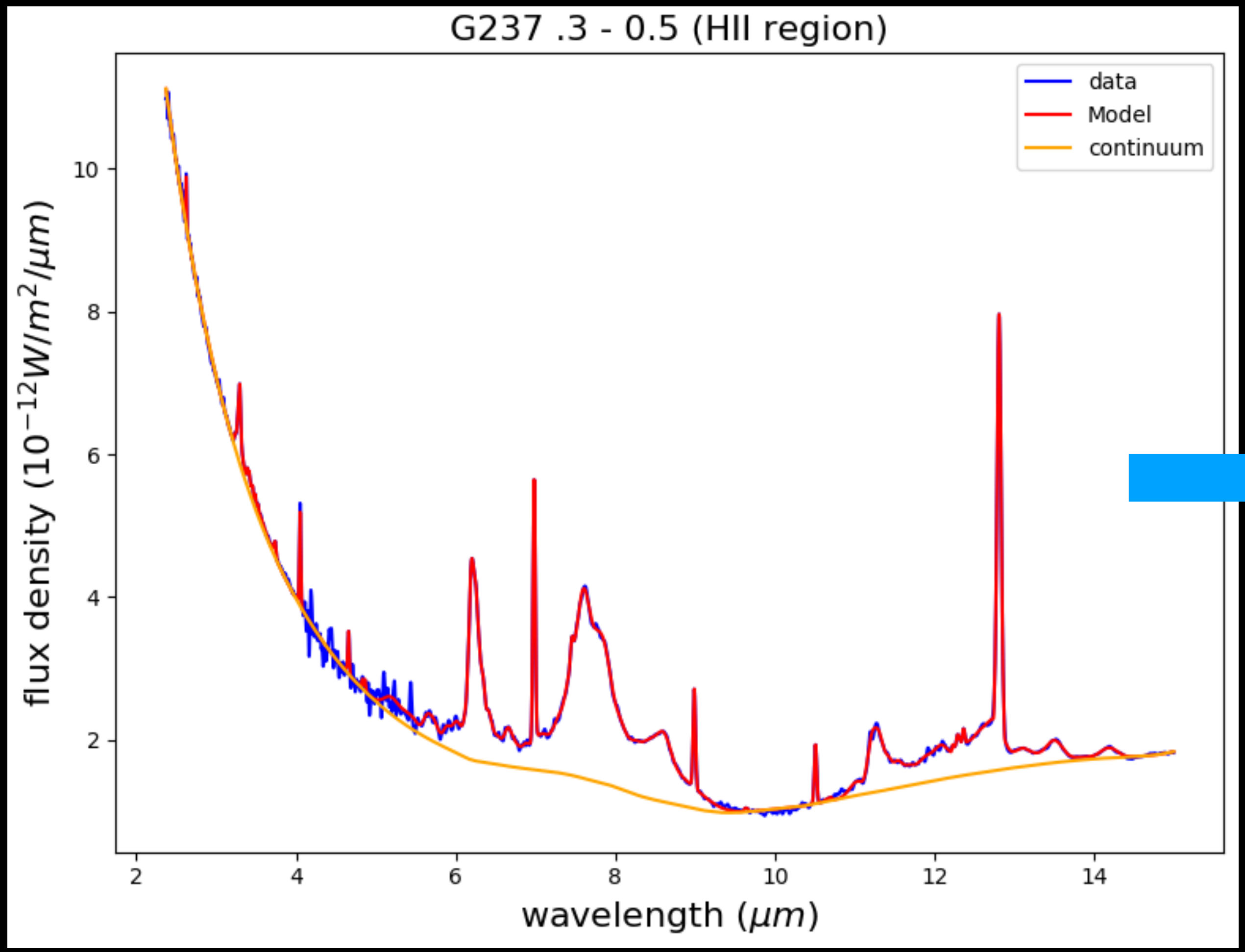
Revisit it on spectra with:

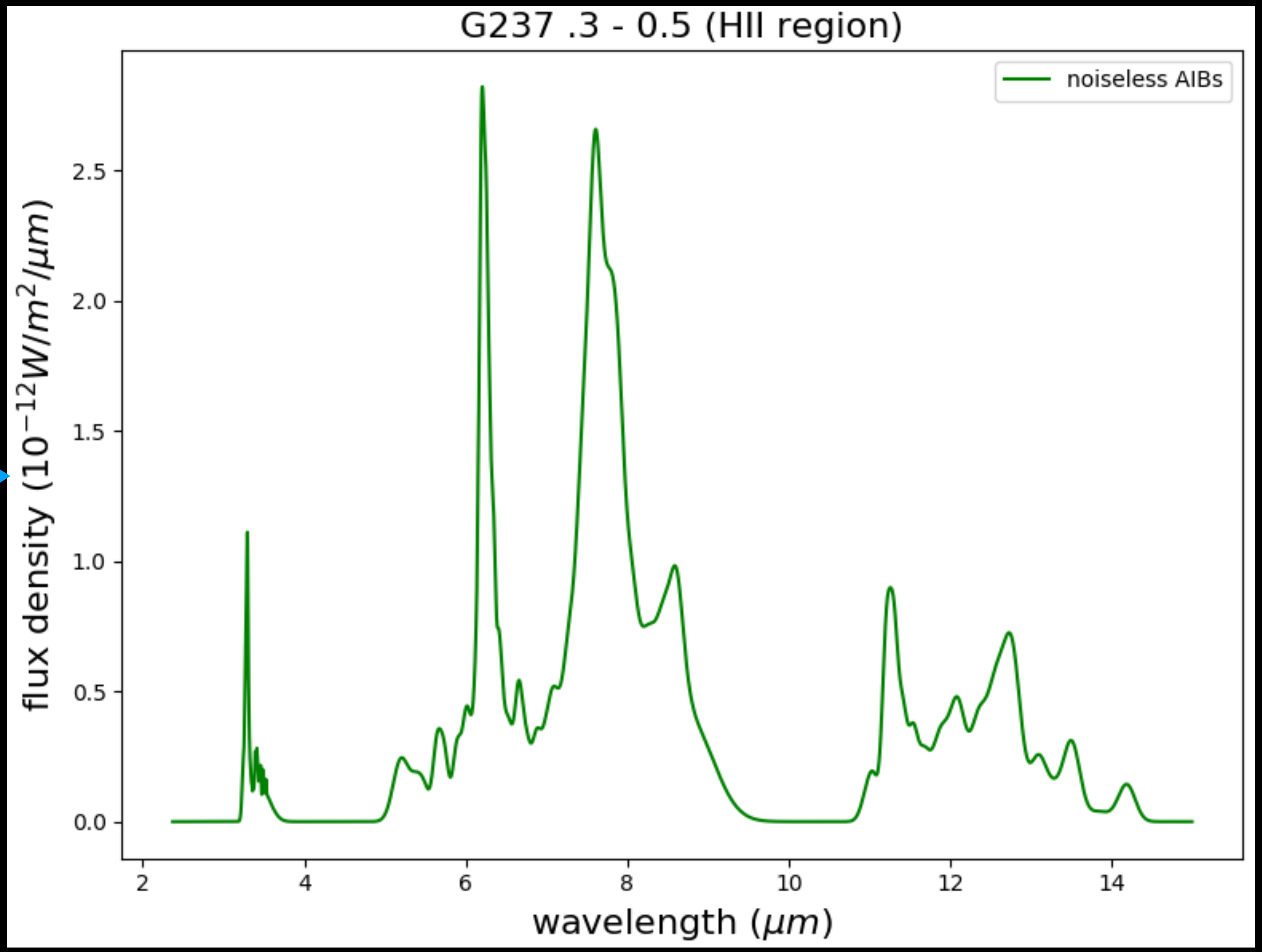
- **Larger** wavelength range
- **Higher** spectral resolution

ISO- SWS spectra:
2.8 to 15 microns
R~260

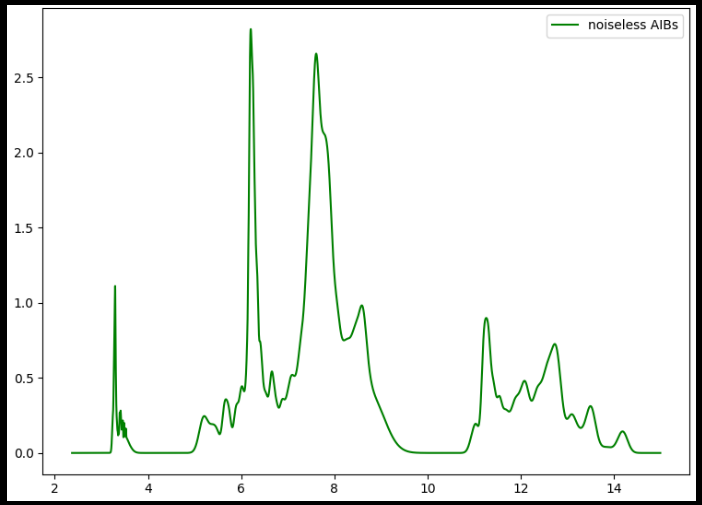
Necessity to pretreat the data

- Not the same spectral resolution and binning in each spectrum
- Gaz lines
- Dust and star continuums
    - Non-negative least square fit to get only the AIBs

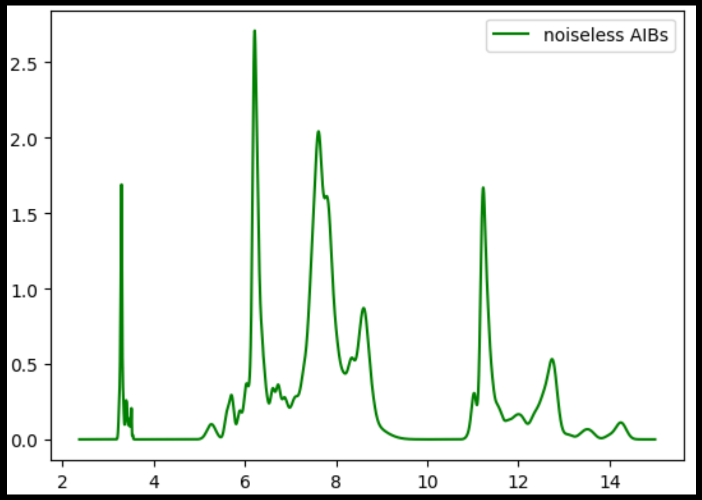




Blind signal separation for astronomical PAH spectroscopy

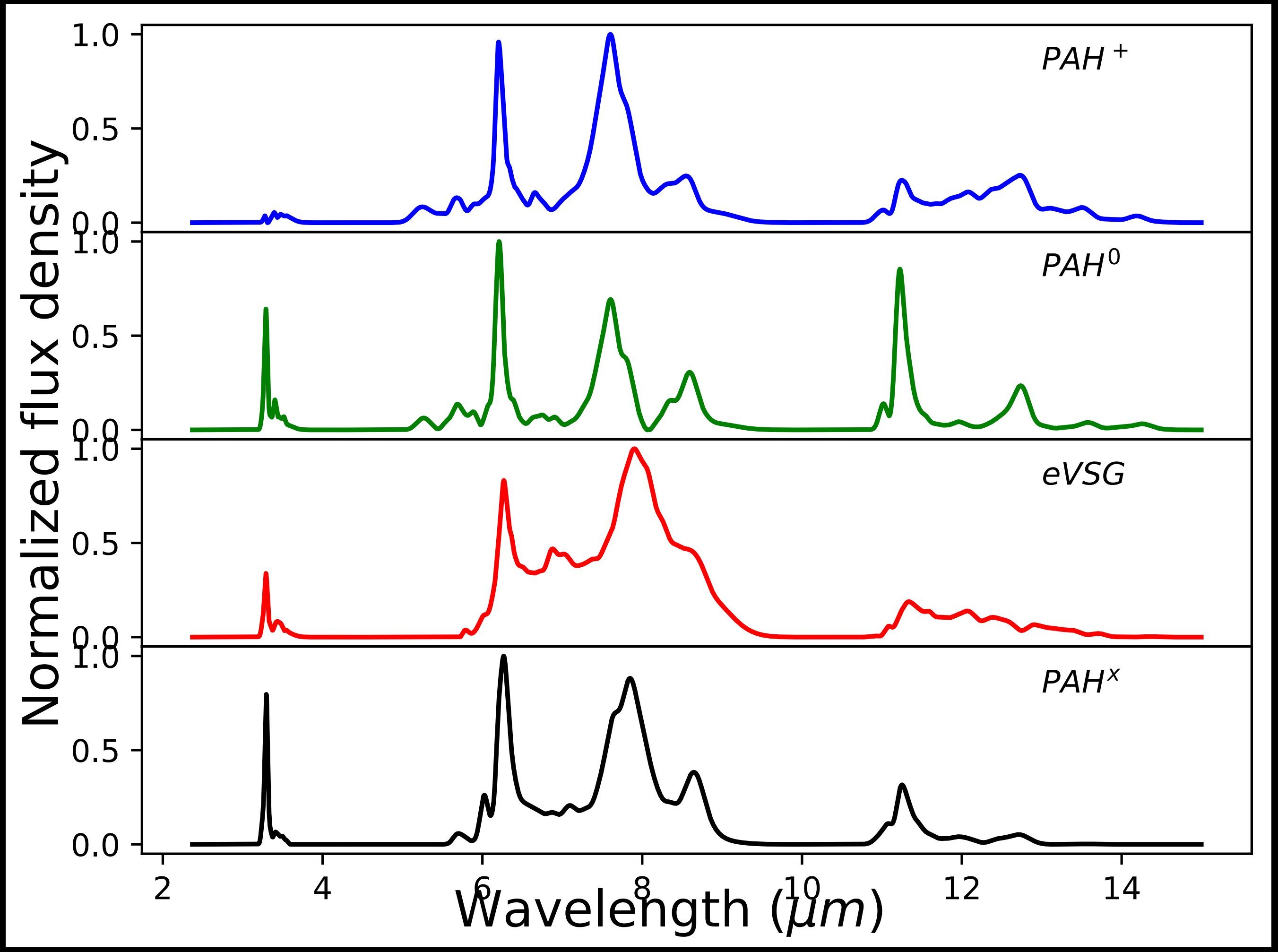


31 spectra ... ...



BSS by MASS-NMF method

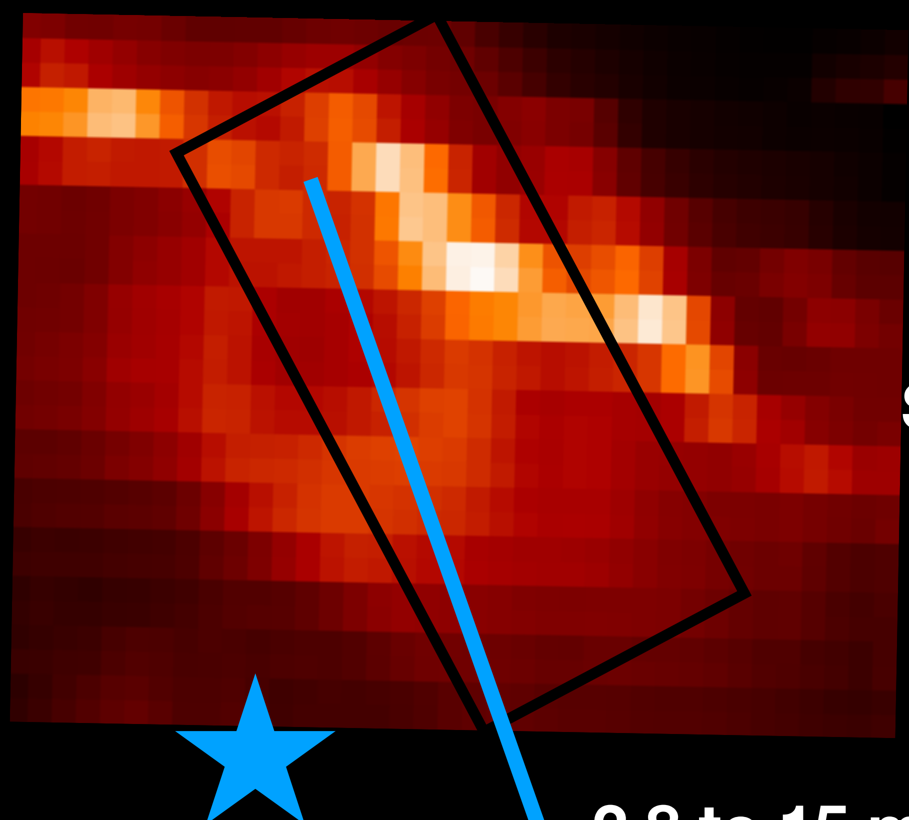
ISO-SWS spectrum



MASS: Maximum Angle Signal Separation
(Boulais et al. (2015), IRAP-SISU, Thesis defence dec. 2017)

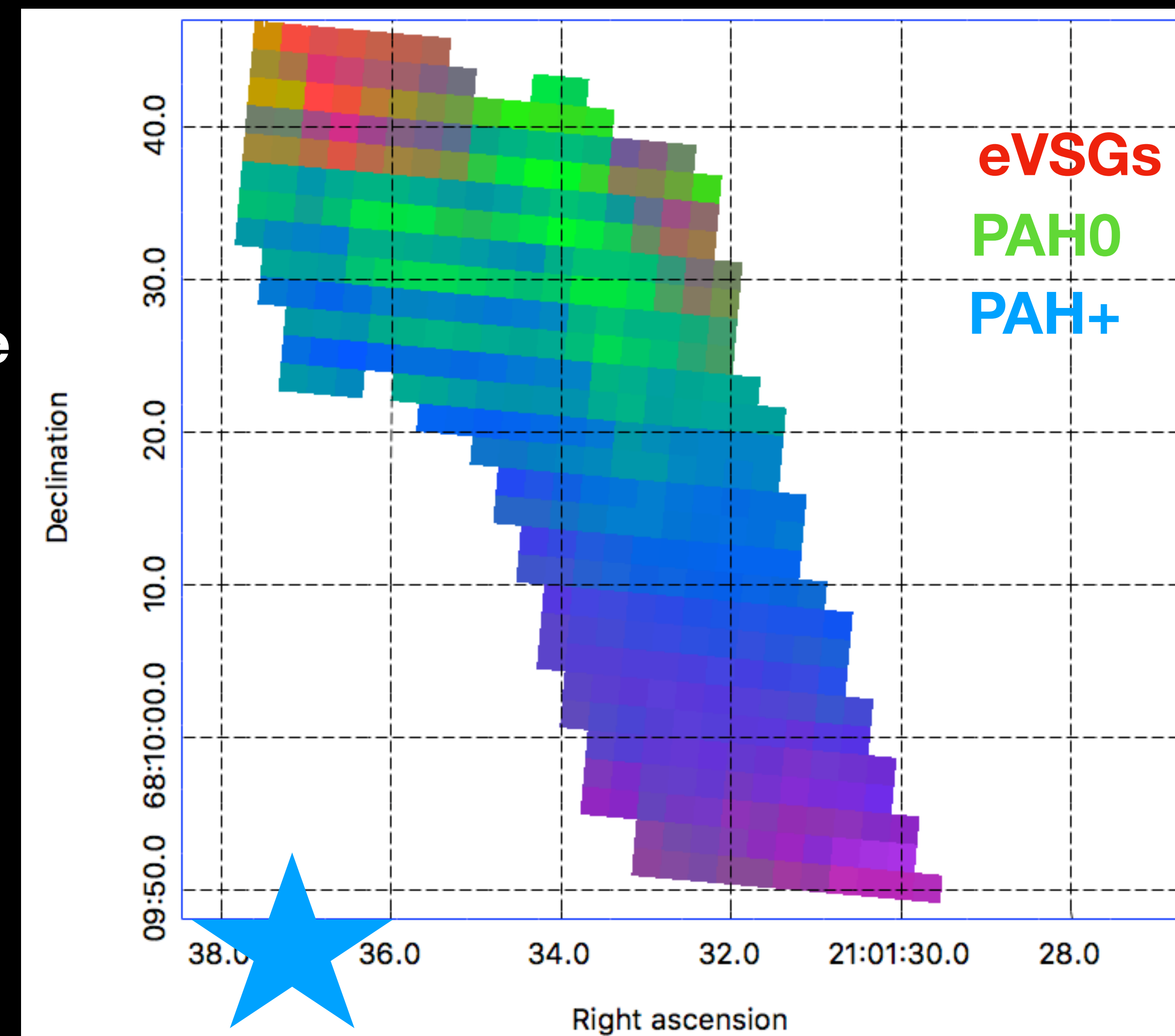
NMF: non-Negative Matrix Factorization
(algorithm used from Lin 2007)

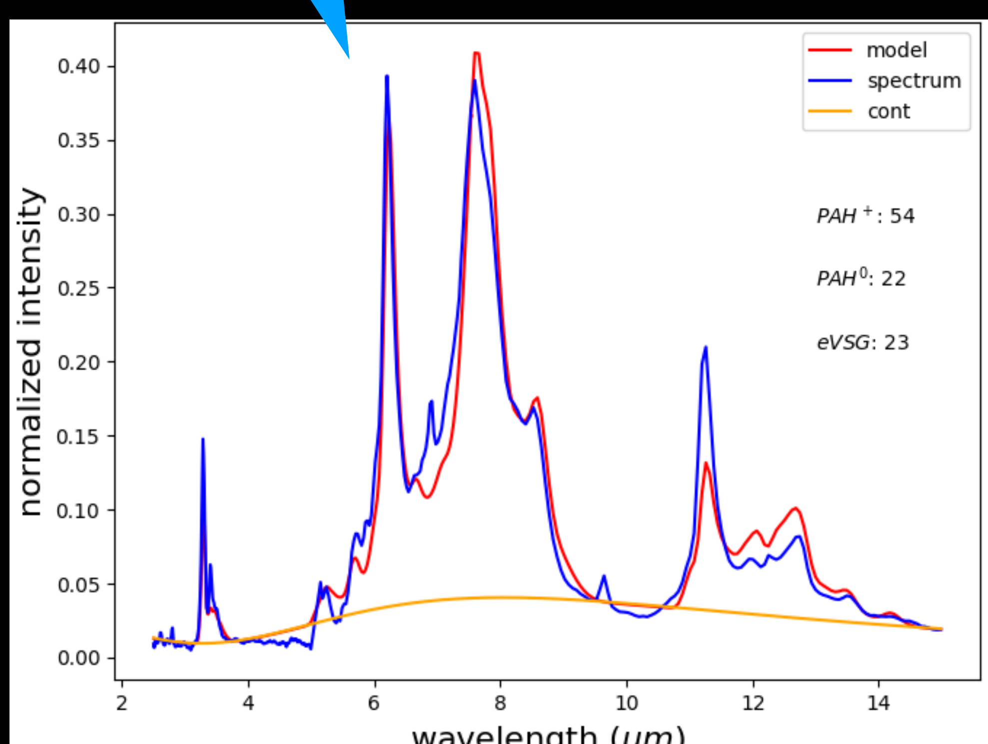
Spectral reconstruction



AKARI-IRC
+
Spitzer-IRS
Spectral cube

2.8 to 15 microns data
R~ 70

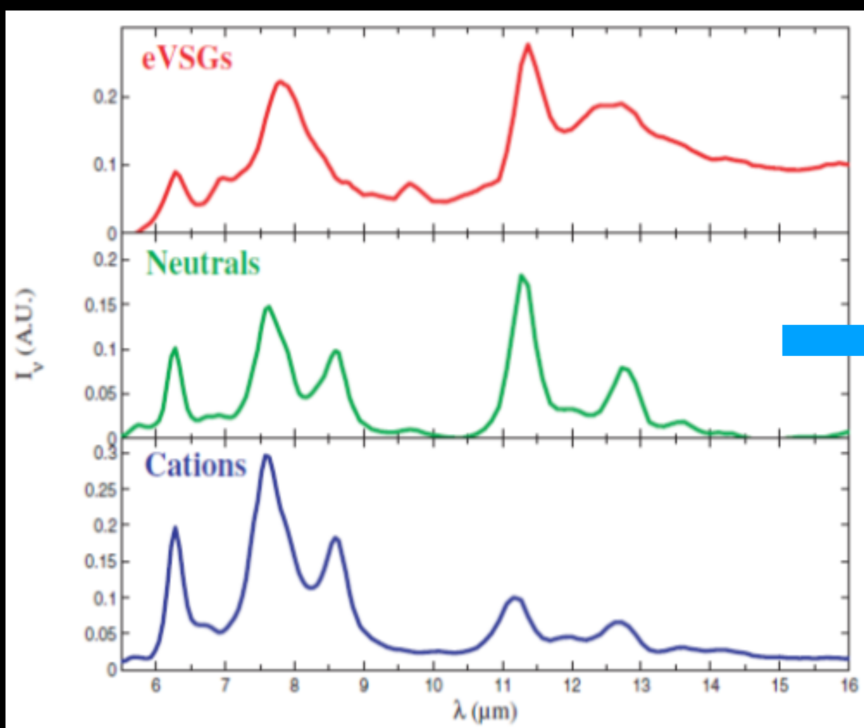




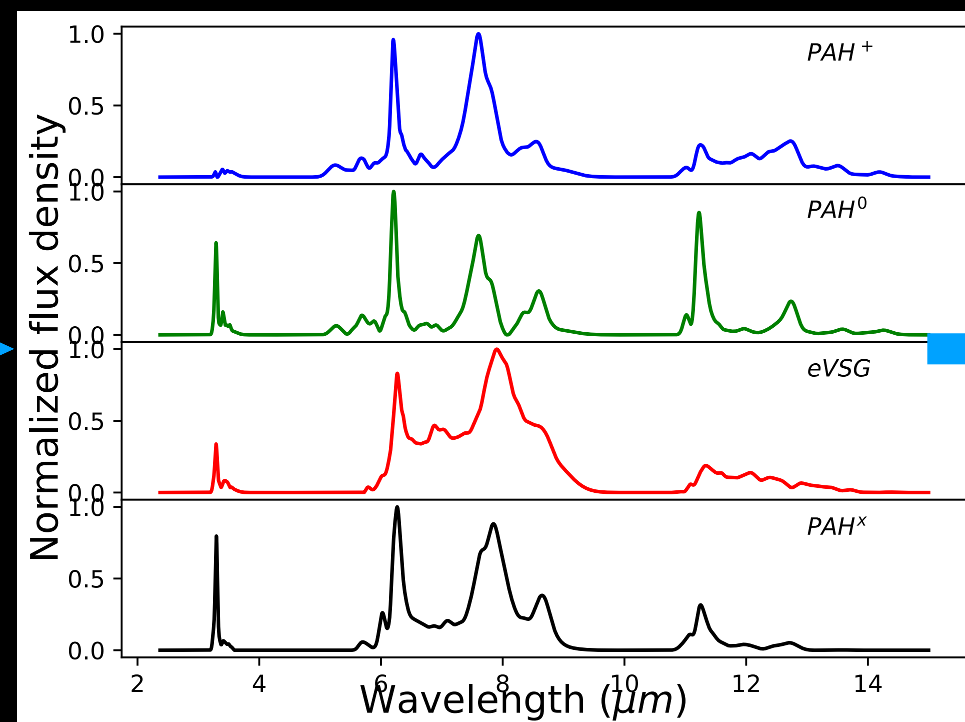
- Emission map in good agreement with previous works (Pilleri et al. 2012, Berné et al. 2007)
- Fit not perfect

Futur work with JWST data

This study was made in preparation of the JWST launch



Spitzer-IRS



ISO-SWS

Who knows?

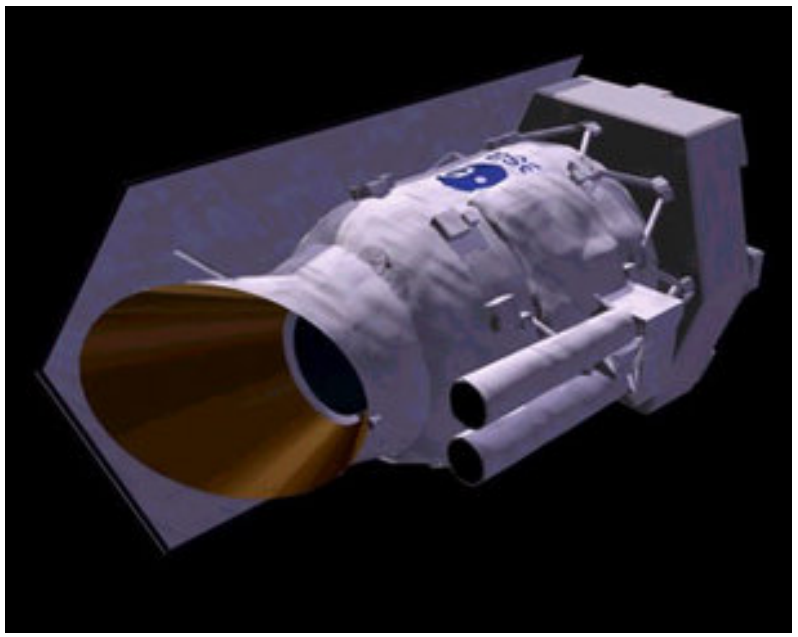
JWST- NIRSpec/MIRI

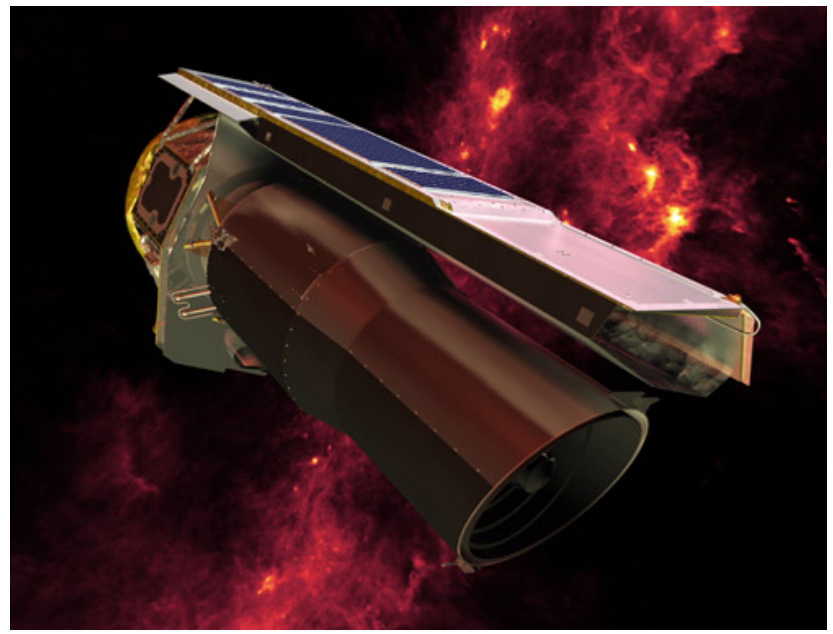
Mission	Spatial resolution	Spectral coverage	Spectral resolution	Diameter (m)
JWST-NIRSpec/MIRI	0.1 ” (at 2 µm)	0.6 - 28 µm	3000	6.5
ISO-SWS	14 x 20 ‘’	2 - 45 µm	260 - 3000	0.6
Spitzer-IRS	3.8” (at 8 µm)	5.5 - 15 µm	70	0.8

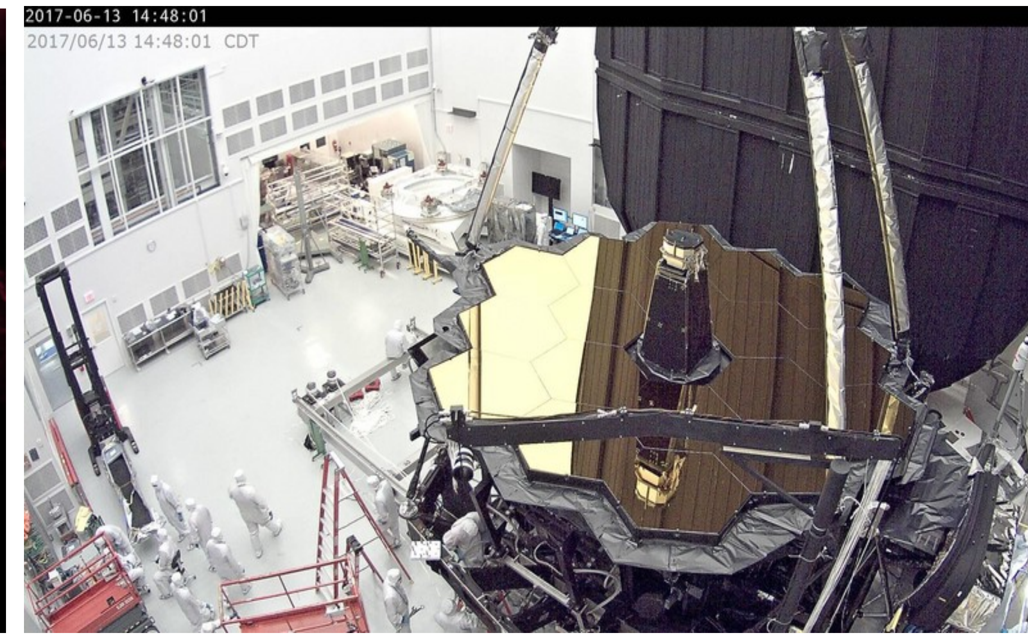
Thank you for your attention!

(Did you find Waldo?)

More slides







Mission	Résolution spatiale	Domaine spectral	Résolution spectrale	Diamètre (m)
JWST-NIRSpec/MIRI	0.1 ” (à 2 μm)	0.6 – 28 μm	3000	6.5
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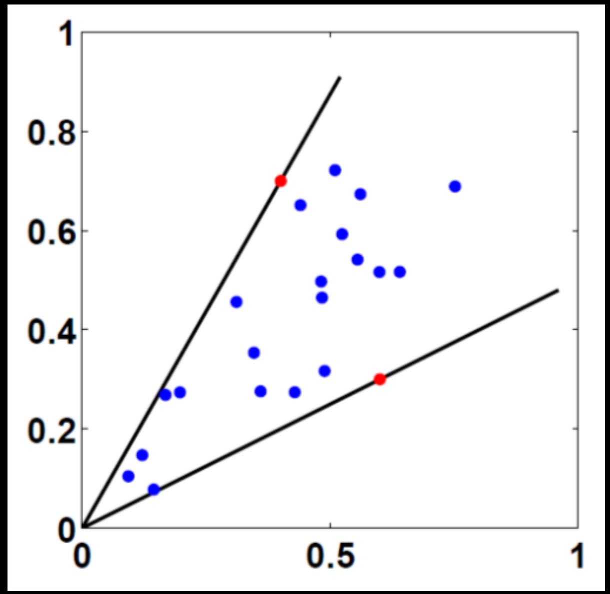
NMF Initialisation with MASS

- Maximum Angle Source Separation, Boulais et al. 2015

→ Allow to determine in the data the vectors that are the most distant in term of angle



→ NMF initialisation with MASS solution near to the expected solution.