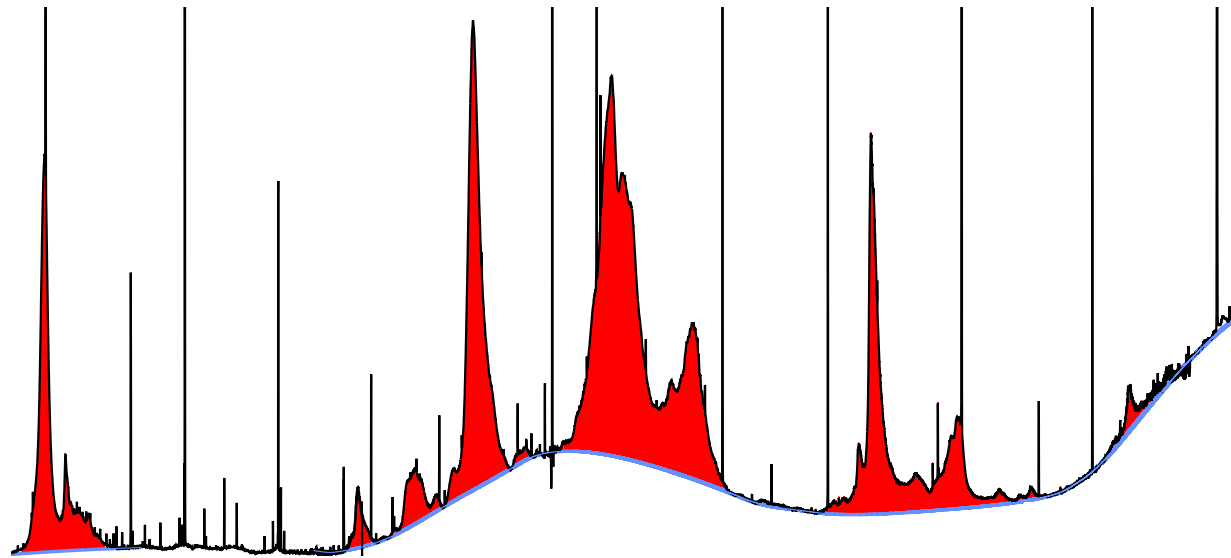


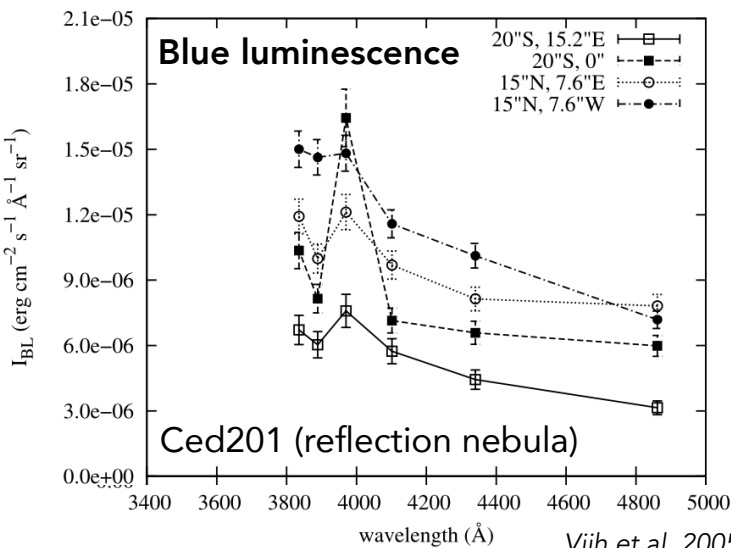
Dust emission in the Milky Way & Local Group

Els Peeters

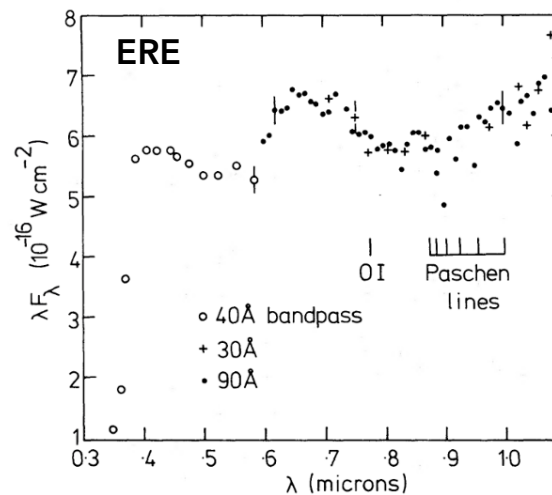


Spectral signatures of dust emission

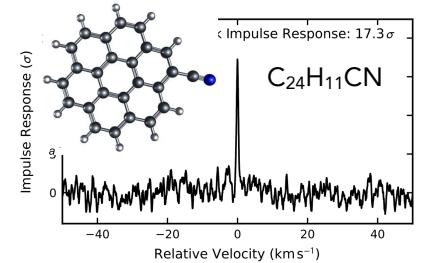
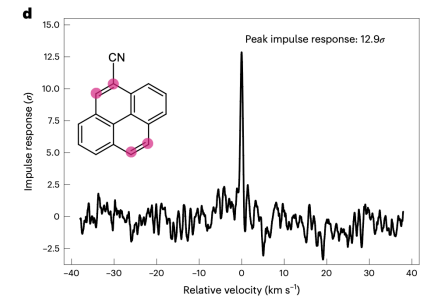
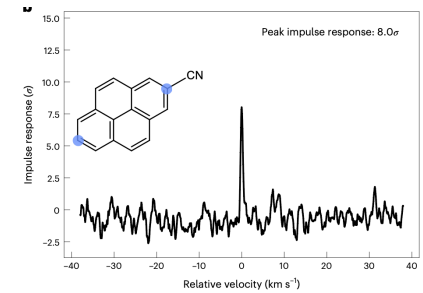
- **Blue Luminescence (BL):** optical emission peaking at 380 nm
- **Extended Red Emission (ERE):** broad optical emission between 500-1000 nm
- **Aromatic Infrared Bands (AIBs)**
- **IR emission from fullerenes**
- **Dust continuum emission:** IR-FIR-submm (carbonaceous species & silicates)
- **Rotational emission from small Polycyclic Aromatic Hydrocarbons (PAHs)**
- **Anomalous Microwave Emission (AME):** excess of emission between 10-50 GHz



Vijh et al. 2005, Witt & Lai 2020, McGuire et al., 2021; Burkhardt et al. 2021; Cernicharo et al. 2021, Wenzel et al. 2024, 2025



TMC1 (dark cloud)



Extended Red Emission (ERE)

- broad optical emission between 500-1000nm
- luminescence process whose intensity depends on the **UV**-optical radiation density
- ERE located in a narrow filament just behind the ionization front (IF)

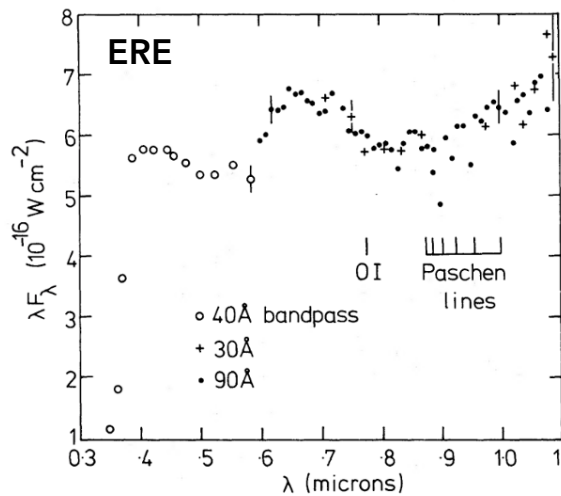
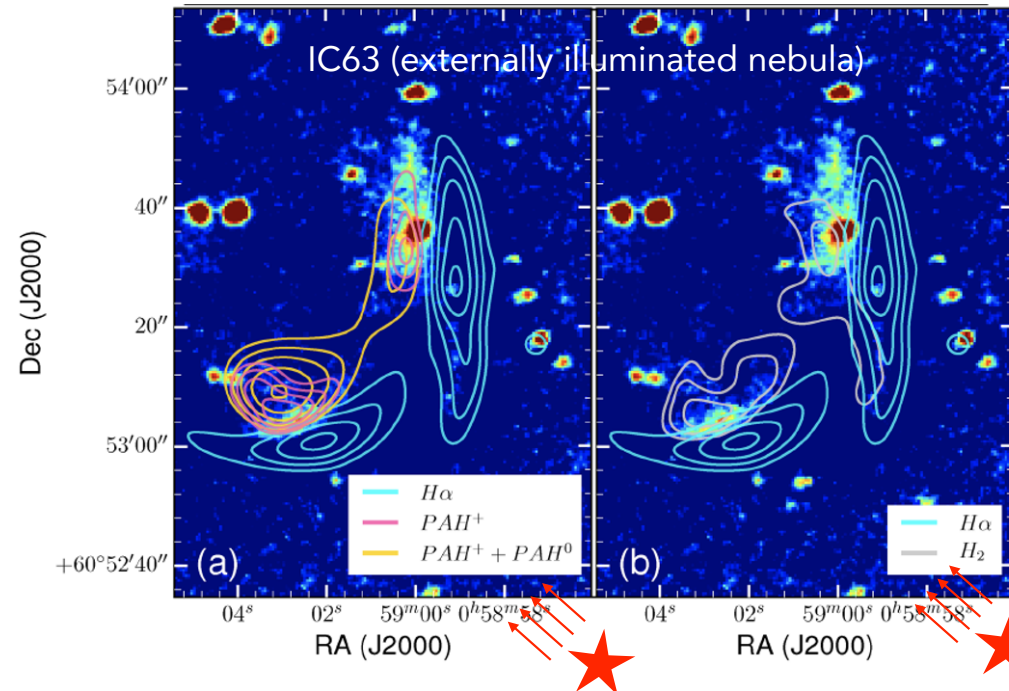


FIG. 4.—The combined spectrophotometry between 0.36 and 1.1 μ . Both axes are linear plots, and representative error bars (1σ of the mean) are indicated, as are the positions of several absorption lines.

image: ERE (R/G)

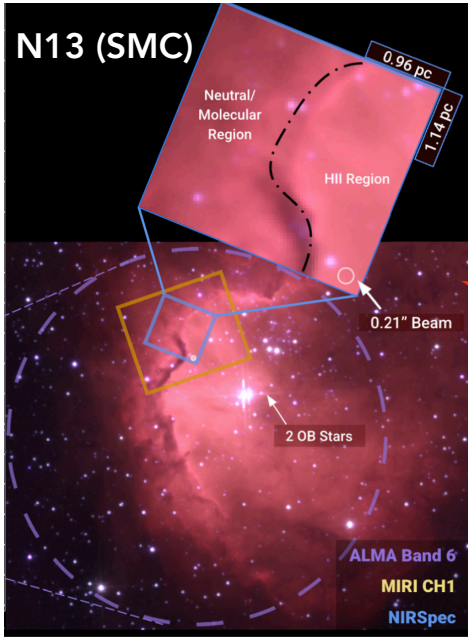
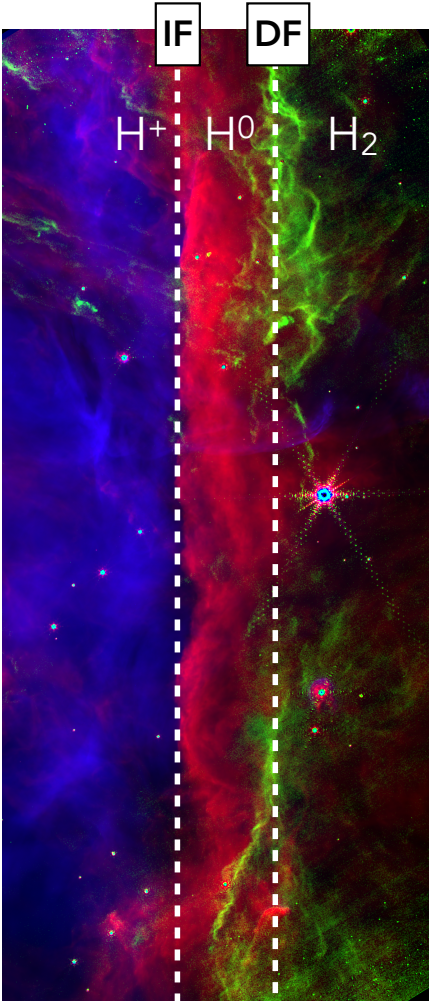


Witt & Lai 2020, Lai et al. 2017

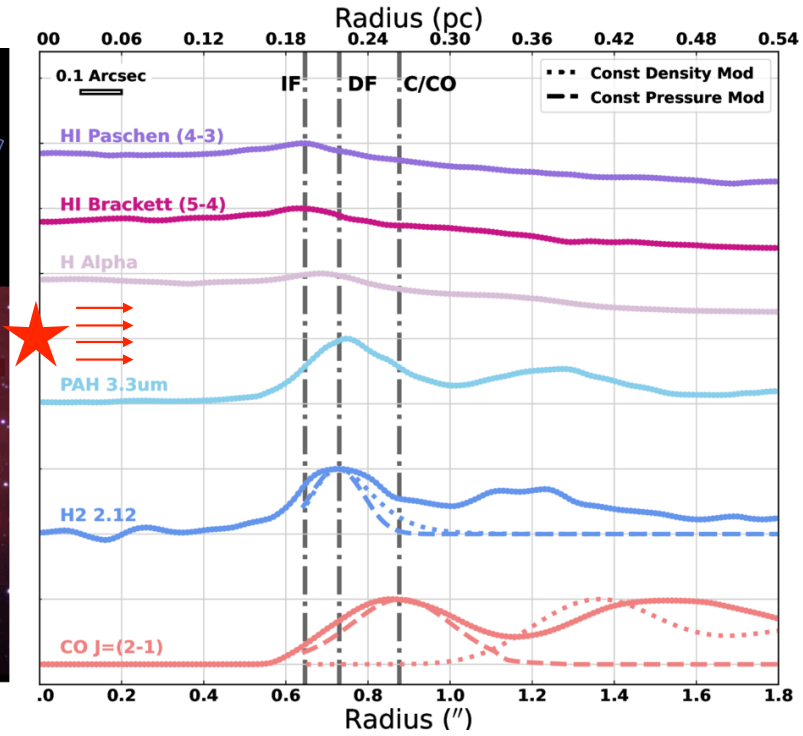
AlBs in photodissociation regions (PDRs)

Orion Bar
(star forming region)

Pa α (blue)
AlBs (red)
H₂ 0-0 S(9)



(star forming region)



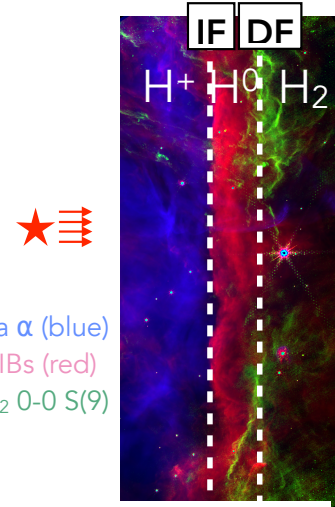
poster
#1

Ilyse Clark

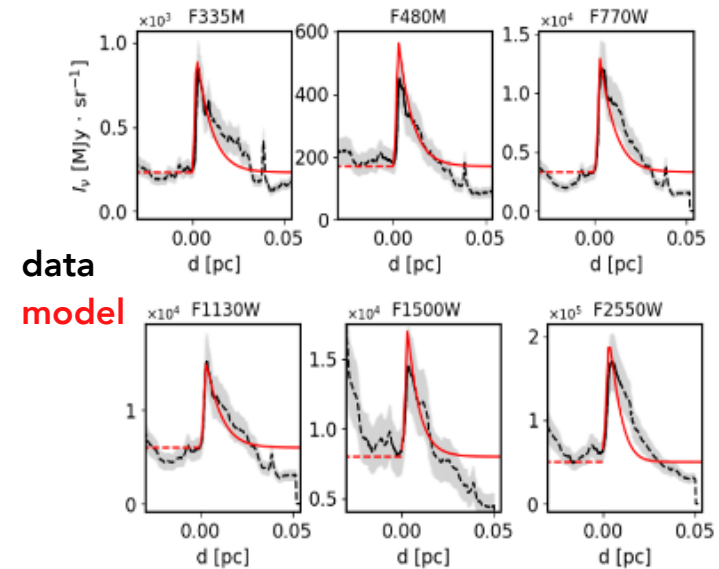
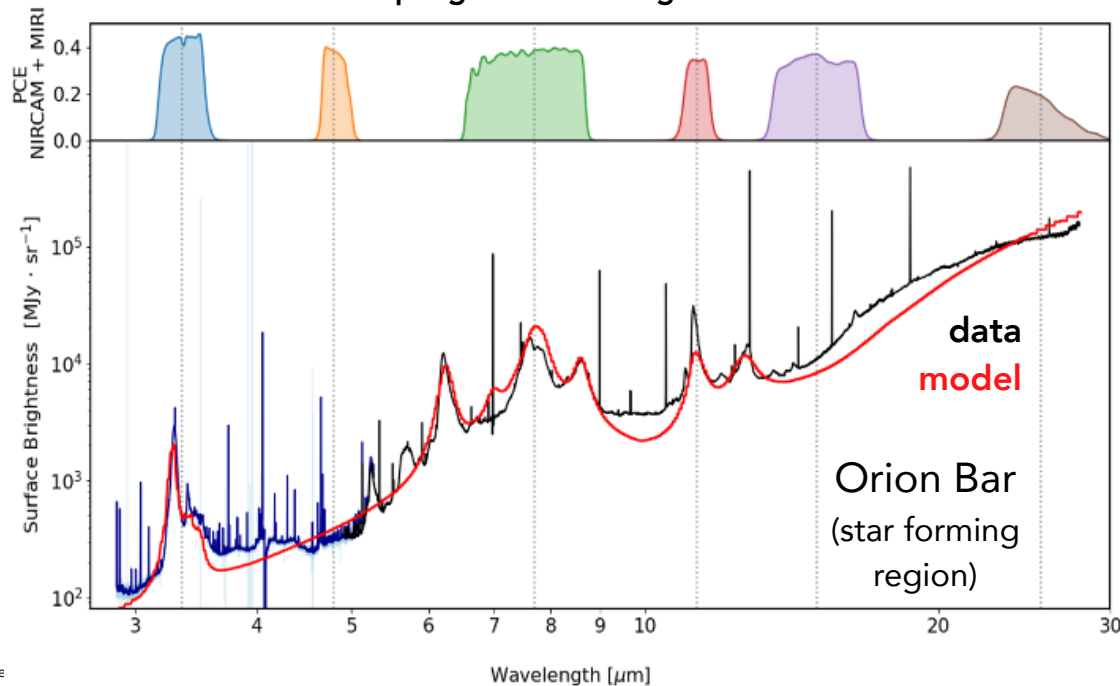
Habart et al. 2024, Clark et al. 2025

First evidence of nano-grain depletion

- JWST allows to spatially resolve the steep density gradient at the PDR front
- Lowest hydrogenation levels in the regions closer to the star → nano-grain photo-processing in PDRs
- Depletion of nano-grains (factor of 15) but similar size distribution wrt diffuse ISM



coupling the THEMIS grain model from IAS with the SOC radiative transfer code.



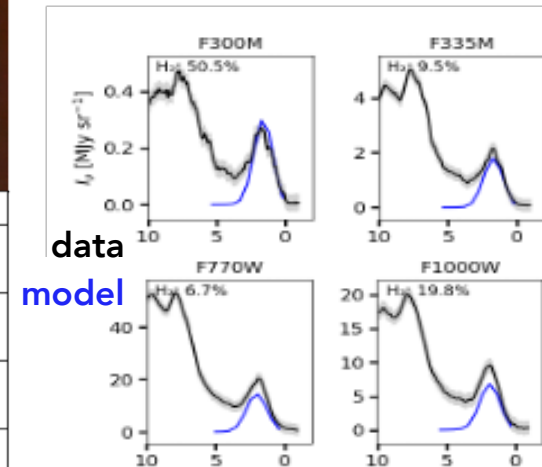
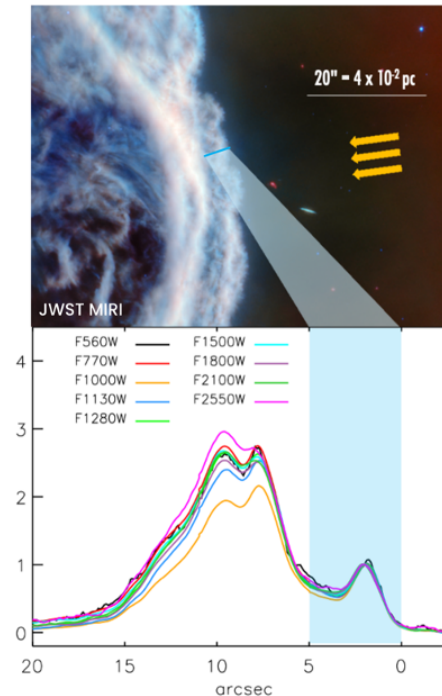
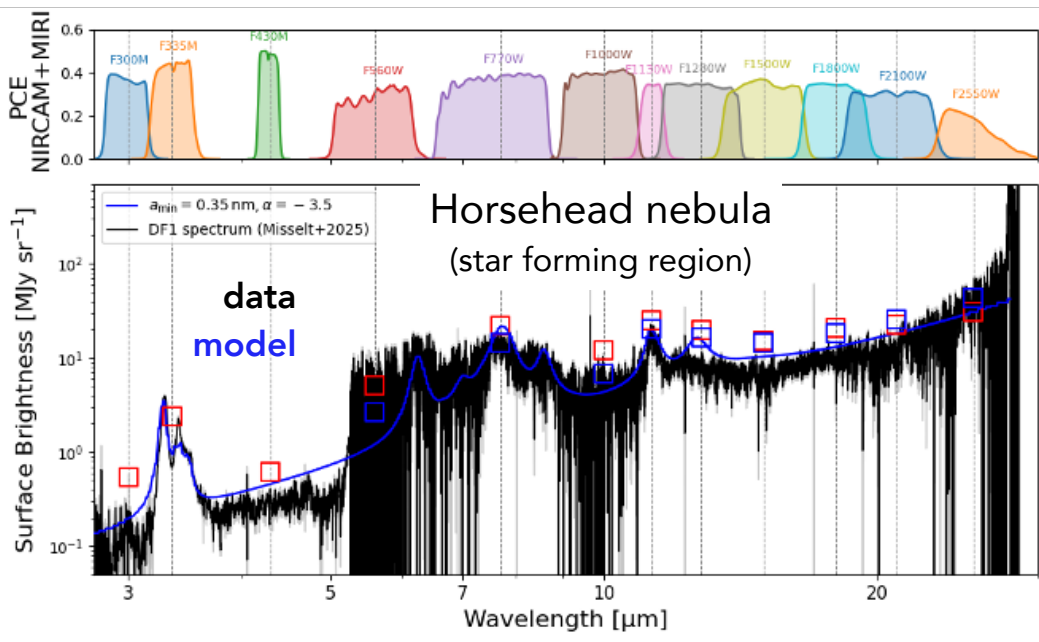
Nano-grain evolution

- High density $n_0 = (4 \pm 1) \times 10^5 \text{ H. cm}^{-3}$ & sharp transition ($< 650 \text{ AU}$) between molecular/ionized gas
- No dehydrogenation (same as diffuse ISM)
- No depletion & nano-grains are on average larger than in the DISM or the Orion Bar



coupling the THEMIS grain model from IAS with the SOC radiative transfer code.

Meriem Elyajouri



Elyajouri et al. 2025

Dusty Universe 2025

Nano-grain properties in PDRs



Orion Bar

$G_0 = 26,000$ • Intense UV Field

Strong UV → DEHYDROGENATION & DEPLETION

15× less abundant than diffuse ISM

→ Strong consequences for estimates of gas T, H₂ formation and intensities of the pure H₂ pure rotational lines



Horsehead

$G_0 = 100$ • Low-Moderate UV Field

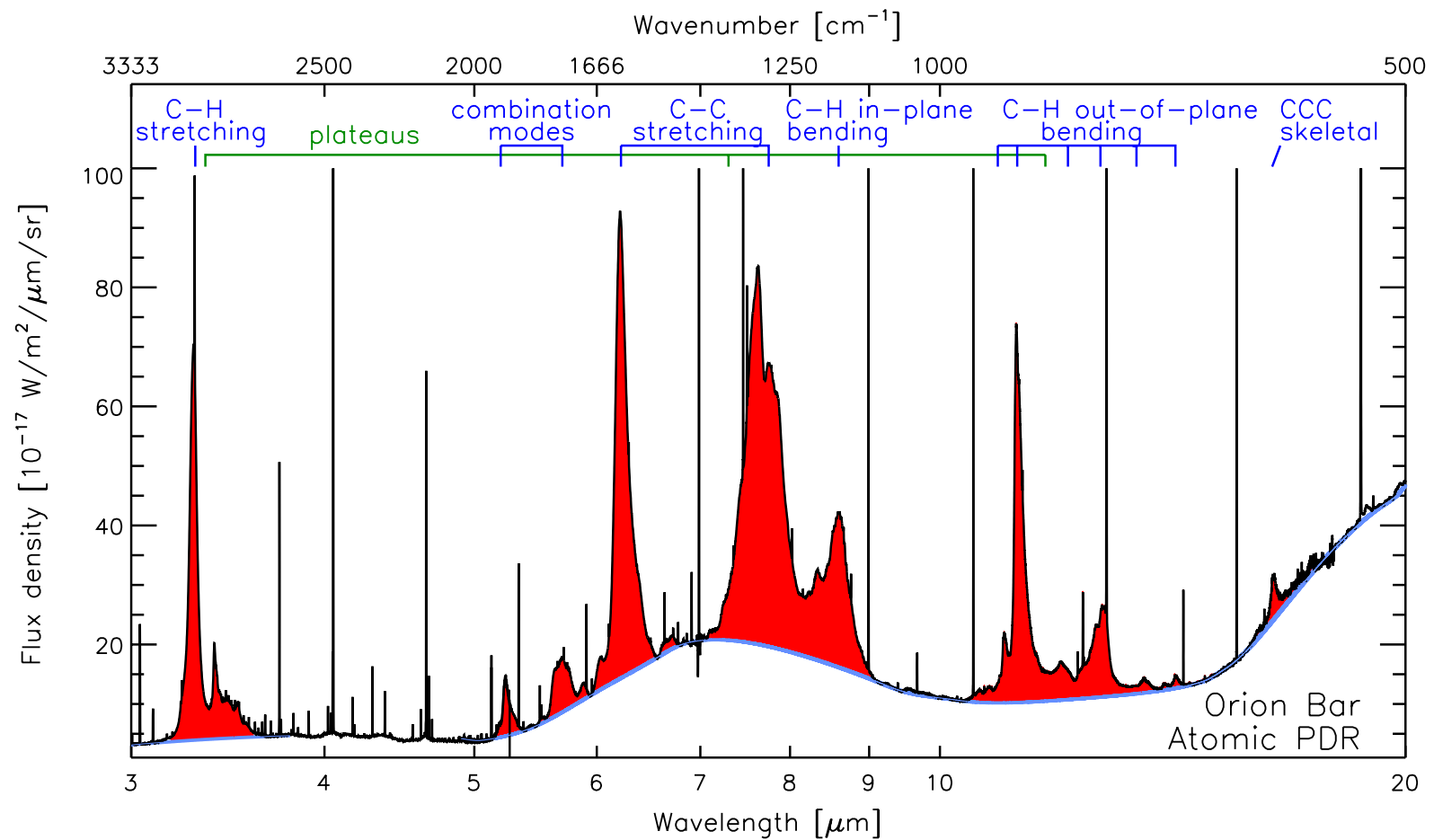
Low UV → NO DEHYDROGENATION & NO DEPLETION

same abundance as in DISM



Meriem Elyajouri

AlB emission



Chown et al. 2024

Spectral characteristics

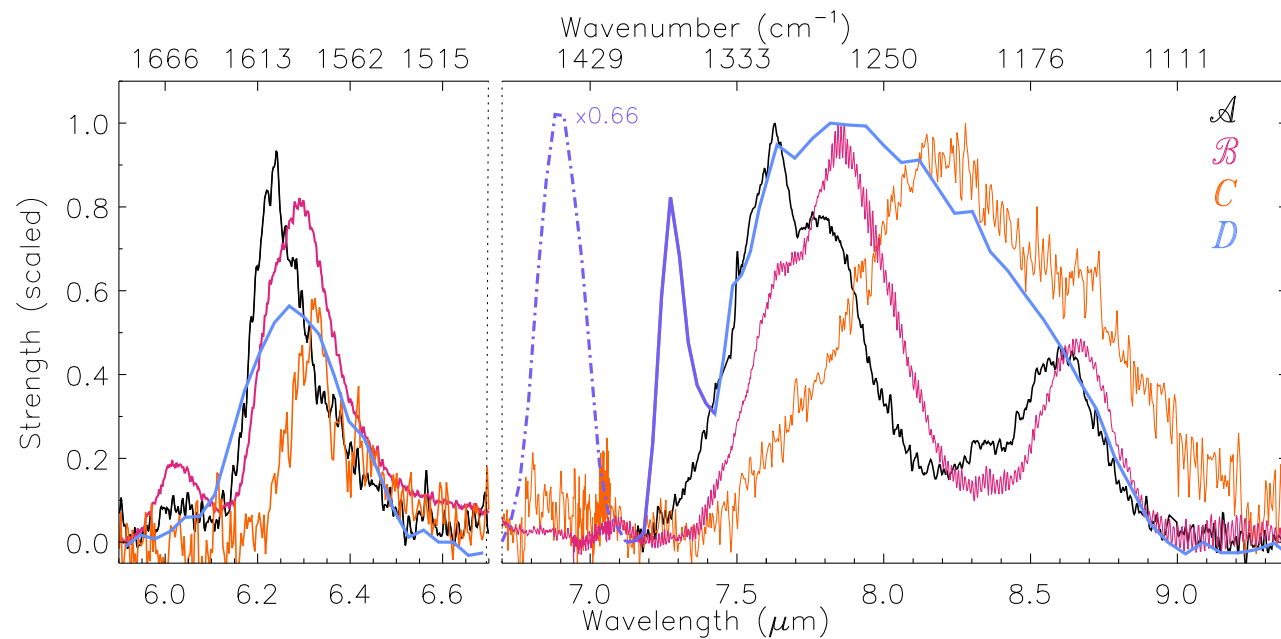
Large diversity in PAH spectral profiles
Related to environment

Interstellar medium
Circumstellar medium

class A
class B, C, D



Greg Sloan

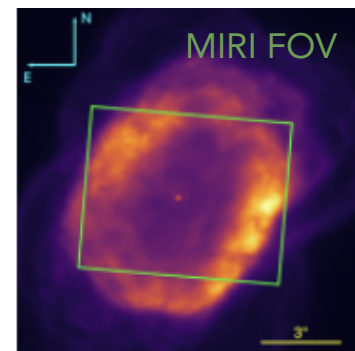


Peeters et al. 2021, 2002, van Dienenhoven et al. 2004, Sloan et al. 2014, Matsuura et al. 2014

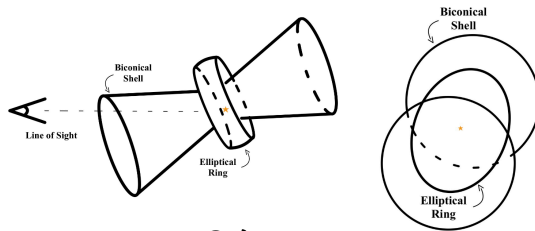
Dusty Universe 2025

Spectral characteristics as a tracer of evolution

JWST observations show variation in spectral profiles & profile classes within extended sources

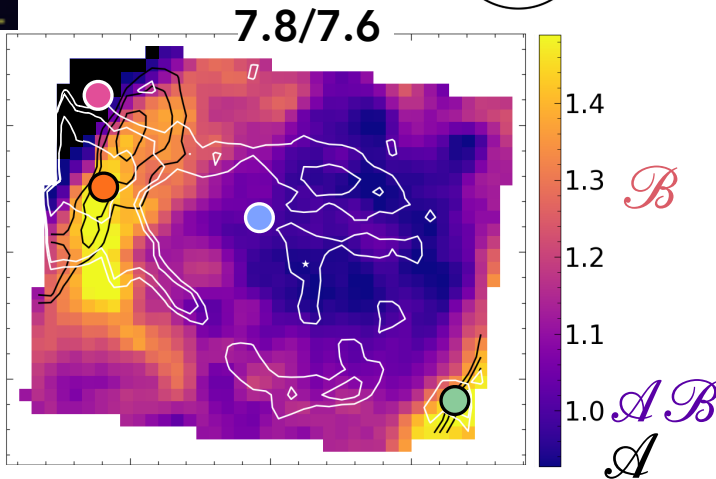


planetary nebula
NGC7027

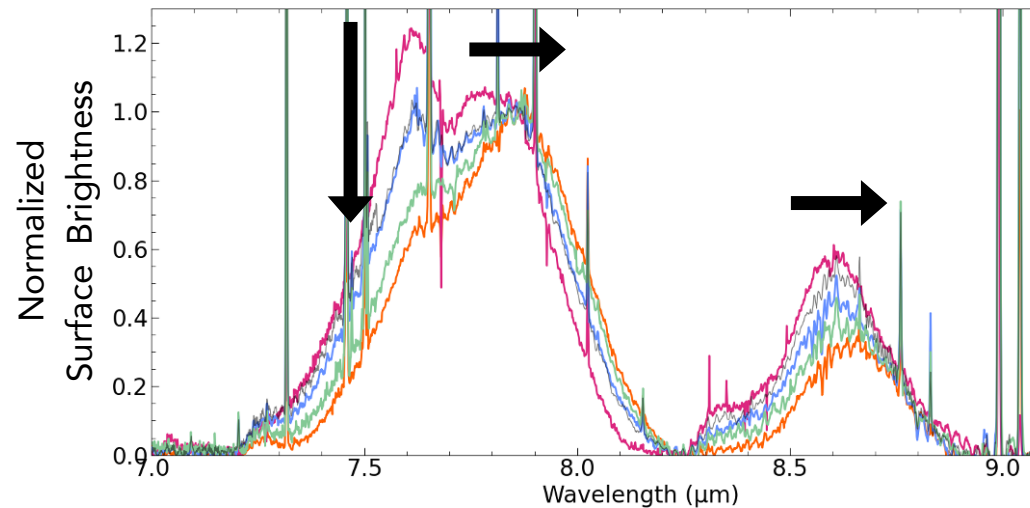


HST/WFC3 NICMOS F212N
NASA/ESA, Latter et al. (2000)

contours:
white: H_2
black: 6.2 AIB



- profile class depends on morphological structure
- carrier of class A is less processed

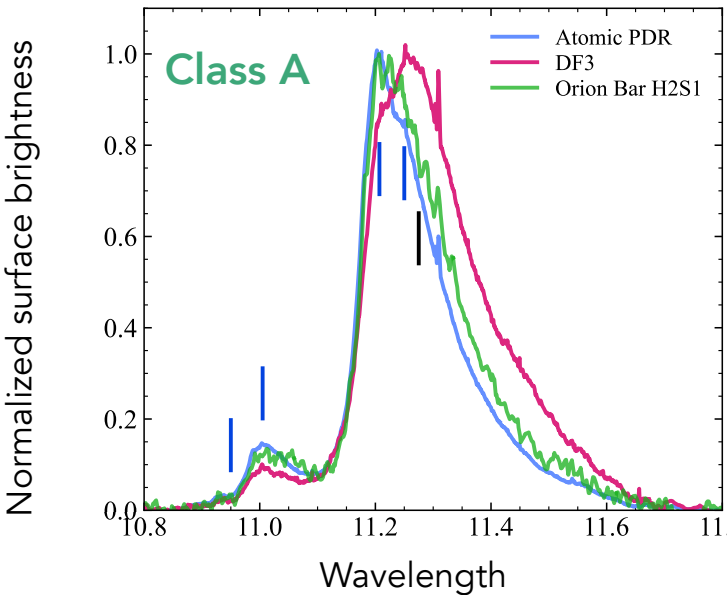


Smith-Perez et al. 2025

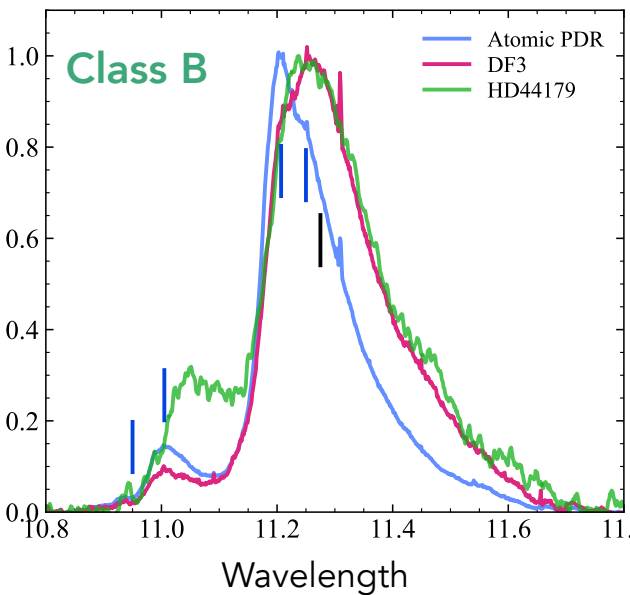
Dusty Universe 2025

Also in the ISM, 11.2 AIB profile class changes

Orion Bar Atomic PDR high UV flux all PAHs: class A
PDRs4All Molecular PDR (DF3) low UV flux 11.2: class B — others: class A

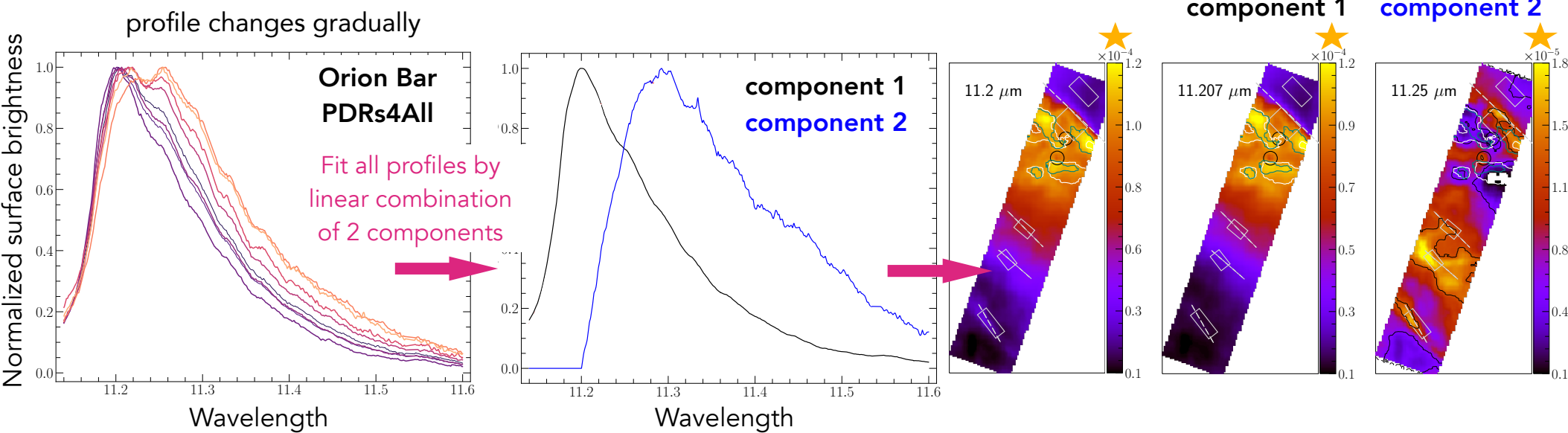


Orion Bar
(star forming region)



Chown et al. 2024, Pasquini et al. 2024, Khan et al. 2025

At least 2 carriers contribute to 11.2 AIB

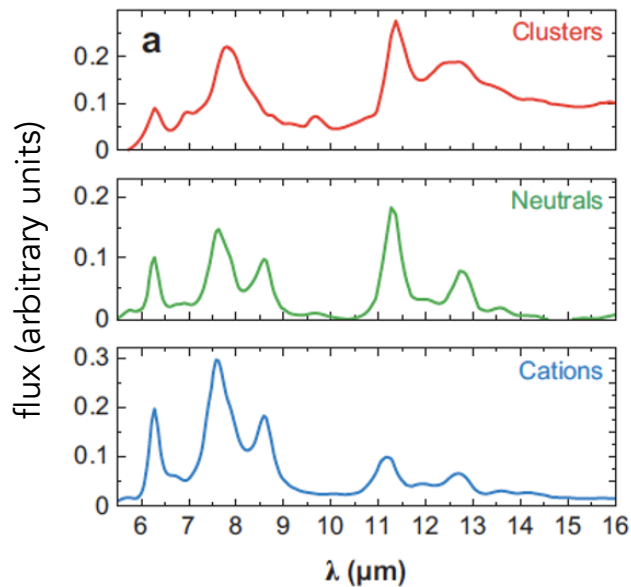


Orion Bar (star forming region)

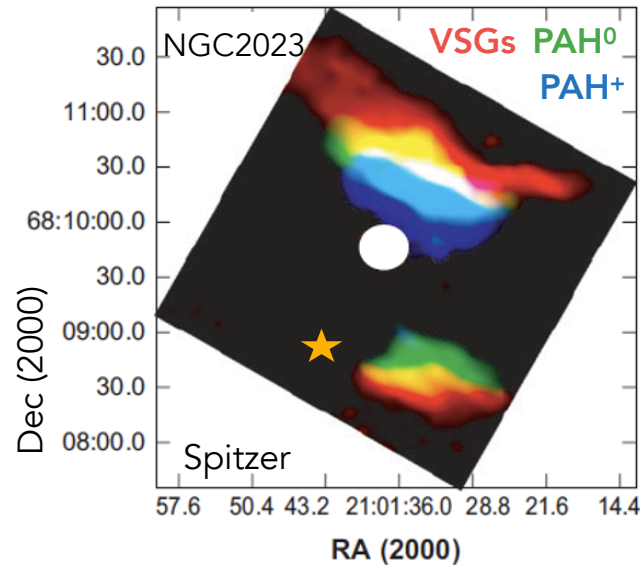
Khan et al. 2025

Very small grains (VSGs) evaporate when subjected to UV radiation

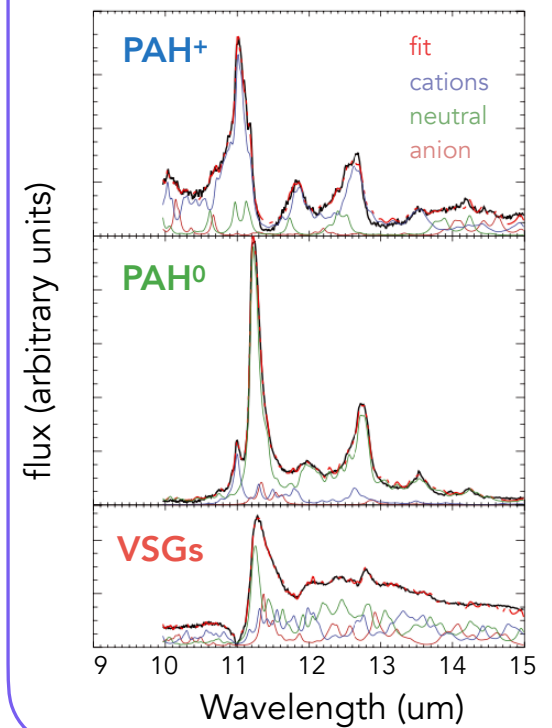
Blind Signal Separation (BSS) decomposition of spectral map in 3 components



NGC2023 (reflection nebula)



Fit of BSS templates with PAHdb

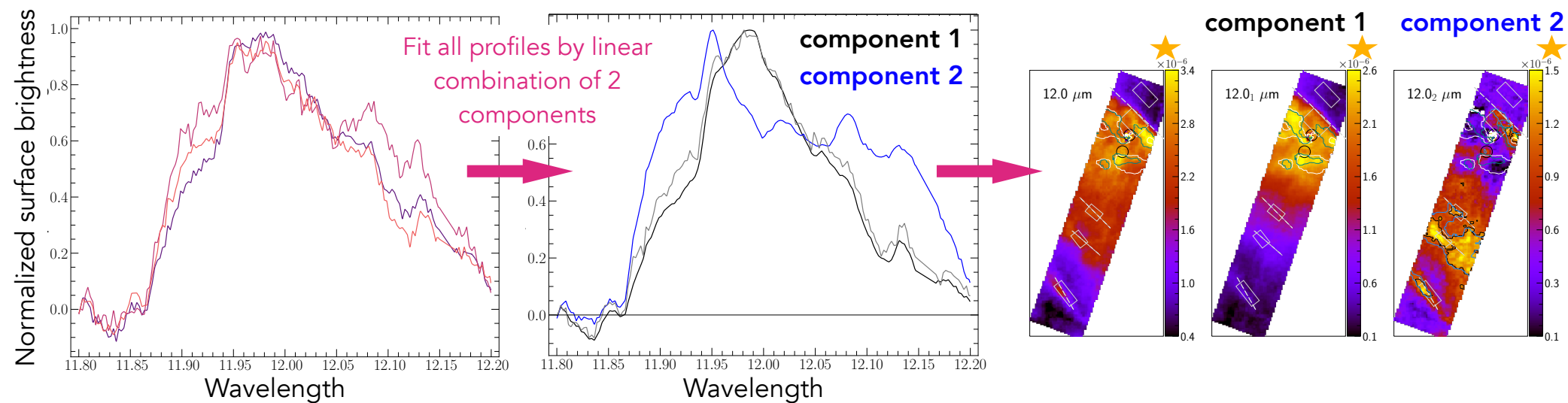


Berné et al. 2007, Rosenberg et al. 2011

Observationally disentangle emission from AIB carriers and VSGs

via spectral decompositions, principal component analysis, etc.

VSGs contribute to 11.2, 12.0, 13.5, and 7-9 AIBs, likely 6.2 AIB

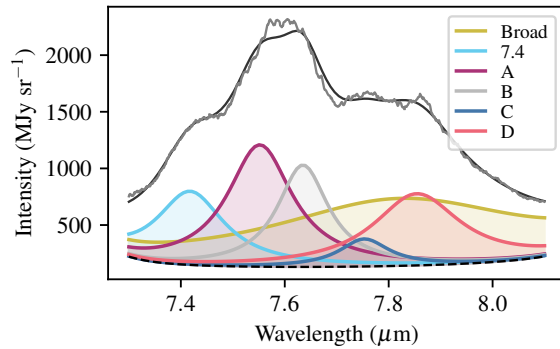


Khan et al. 2025, Khan et al. 2025 in prep., Van De Putte et al. 2025, Van De Putte et al. 2025 in prep., Peeters et al. 2017

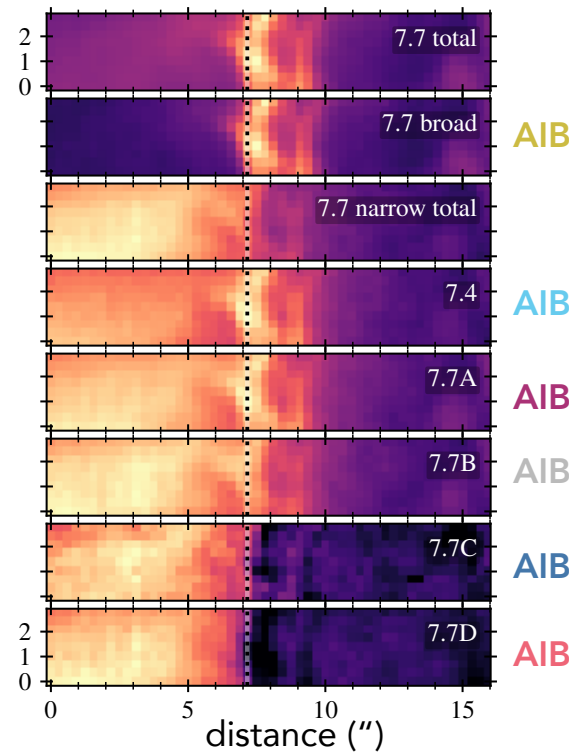
Subcomponents of AIBs have distinct morphologies

NGC7023 (reflection nebula)

7.7 μm decomposition

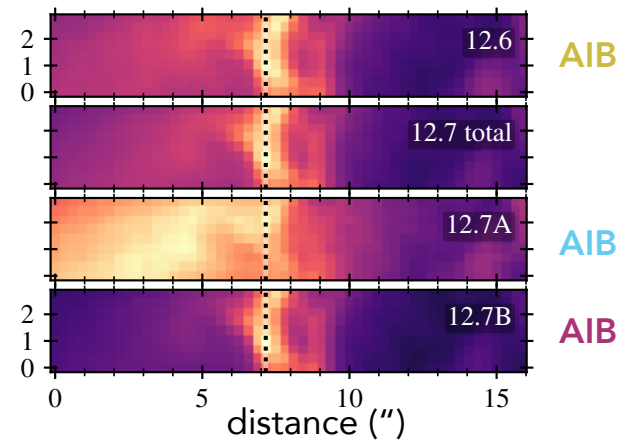
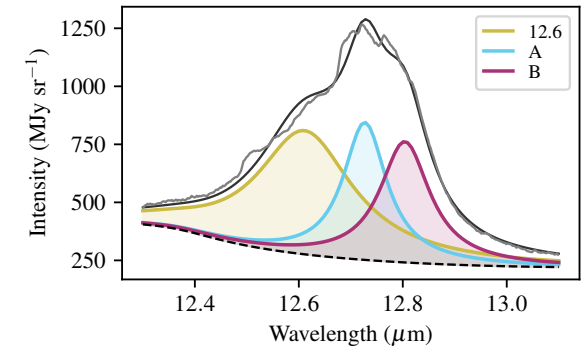


Dries Van De Putte



atomic PDR DF1 DF2

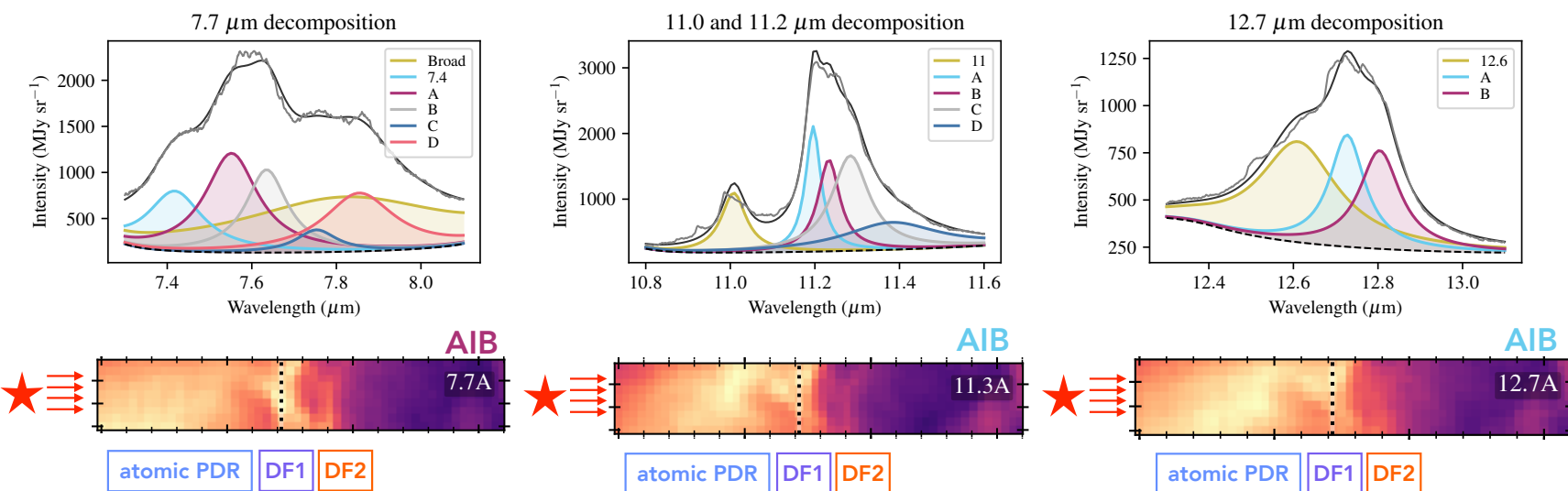
12.7 μm decomposition



atomic PDR DF1 DF2

Van De Putte et al. 2025, Van De Putte et al. 2025 in prep., Khan et al. 2025, Khan et al. 2025 in prep., Guerras et al. 2025 in prep., Peeters et al. 2017

Blue subcomponents of 7.7, 11.2, 12.7 have similar morphologies



NGC7023
(reflection nebula)

Dries Van De Putte



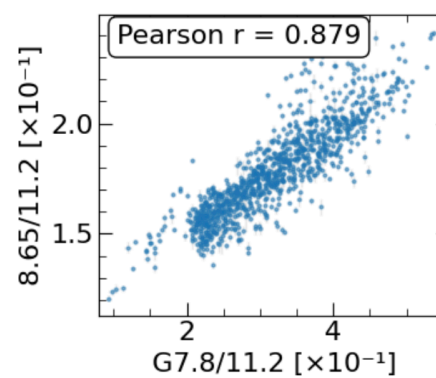
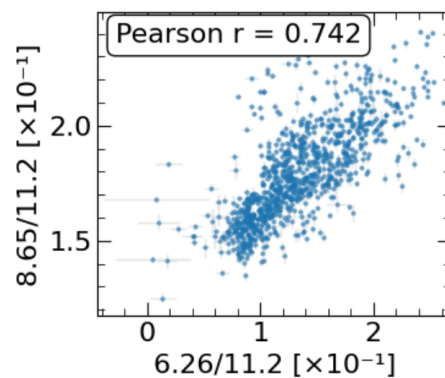
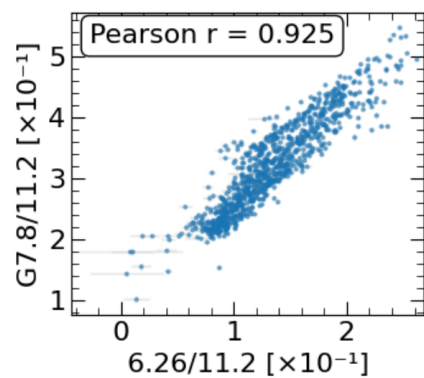
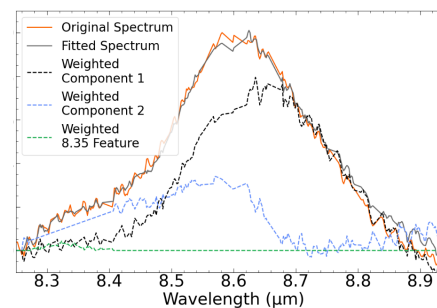
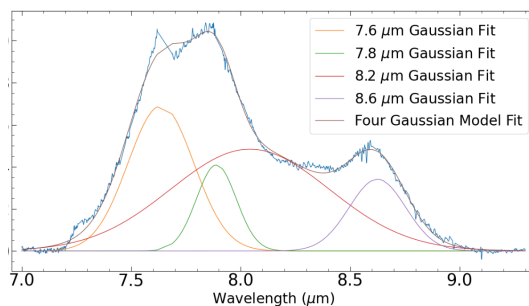
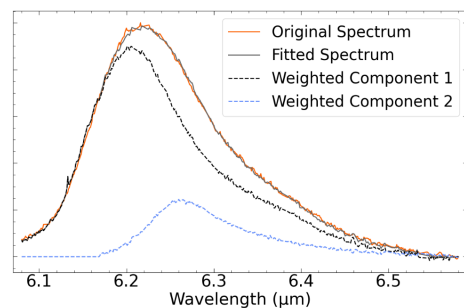
Van De Putte et al. 2025 in prep., Smith-Perez et al. 2025

Dusty Universe 2025

Red subcomponents of 6.2, 7.7, 8.6 AIBs behave similarly

NGC7027
(planetary nebula)

Normalized
Surface Brightness



Smith-Perez et al. 2025

Dusty Universe 2025

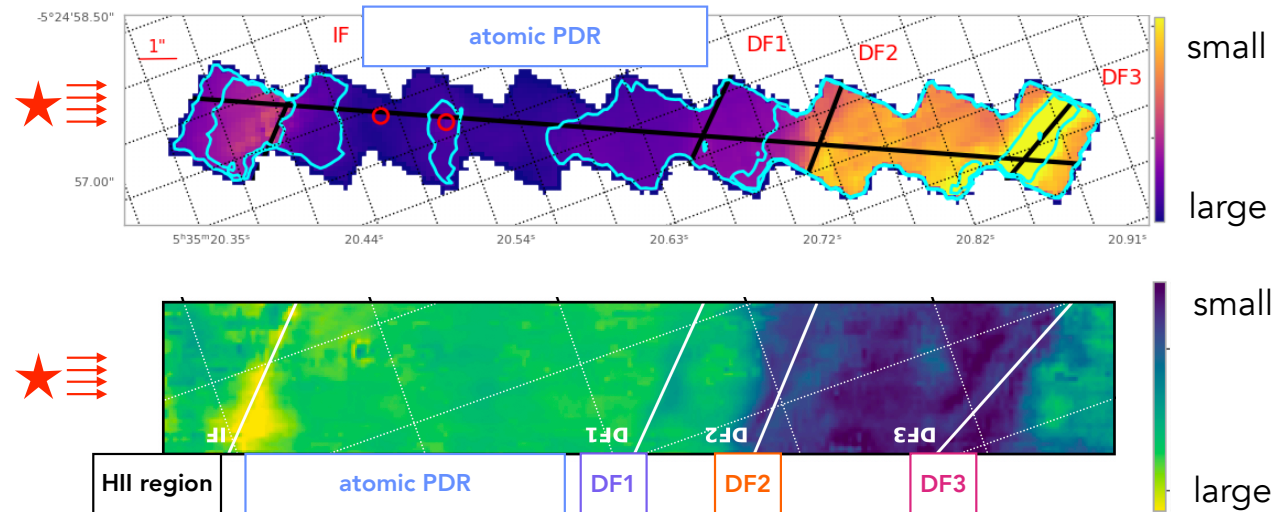
Size: AIB carriers smaller in DFs wrt Atomic PDR

- Intense UV fields lead to increased photo-processing of AIB carriers destroying the smallest species
- Size of AIB carriers ~ UV field

Orion Bar
(star forming region)

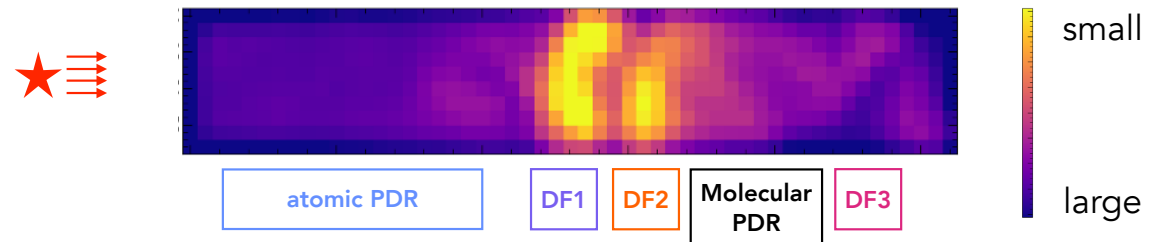
3.3/11.207

average # C-atoms
(PAHdb modeling
of MIRI data)



NGC7023
(reflection nebula)

3.3/11.207

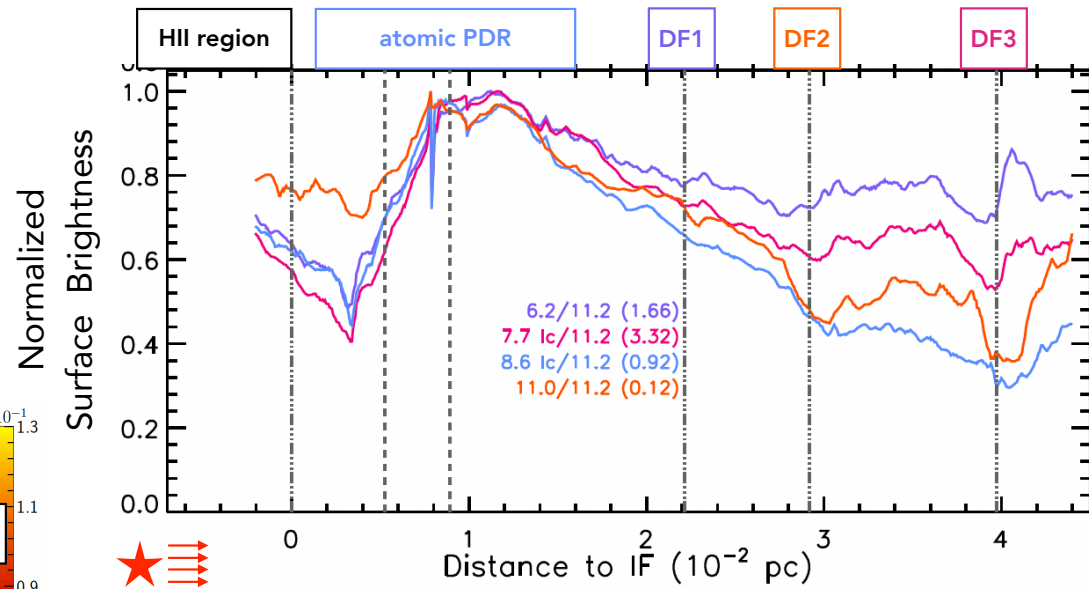
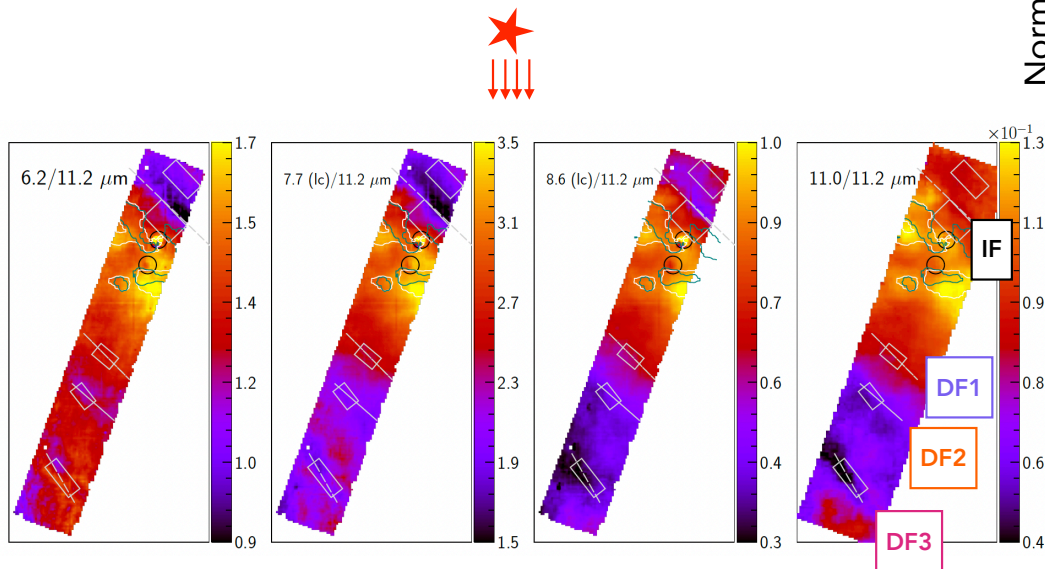


Maragkoudakis et al. 2025, Schefter et al. in prep., Roscoe et al. in prep., Croiset et al. 2016, Knight et al. 2021

Dusty Universe 2025

Charge: 6.2/11.2

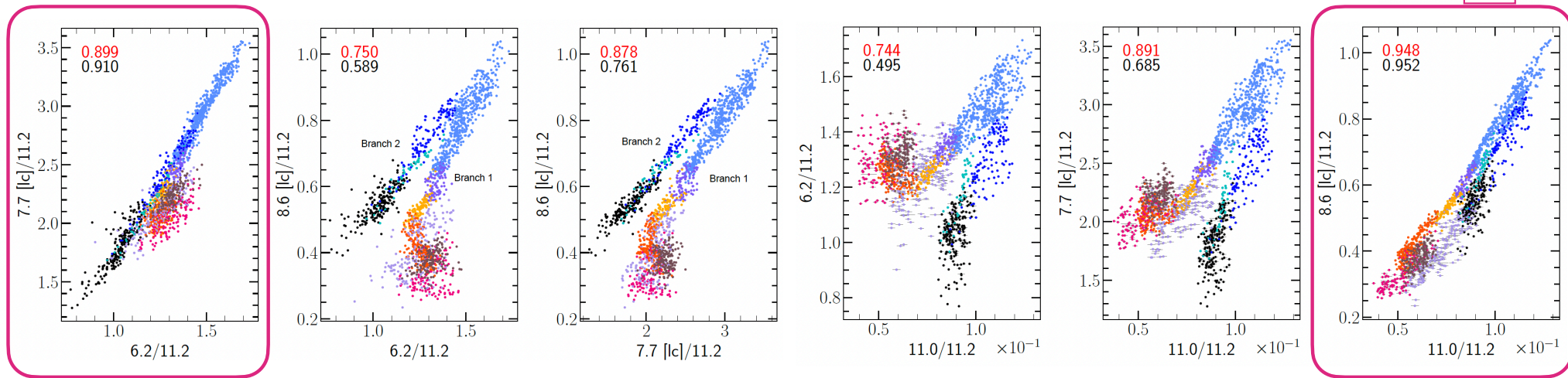
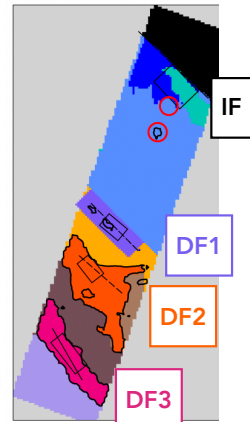
Orion Bar
(star forming region)



Khan et al. 2025, Maragkoudakis et al. 2022, 2025, Khan et al. 2025 in prep.

Cationic size tracer: 6.2/8.6 & 7.7/8.6

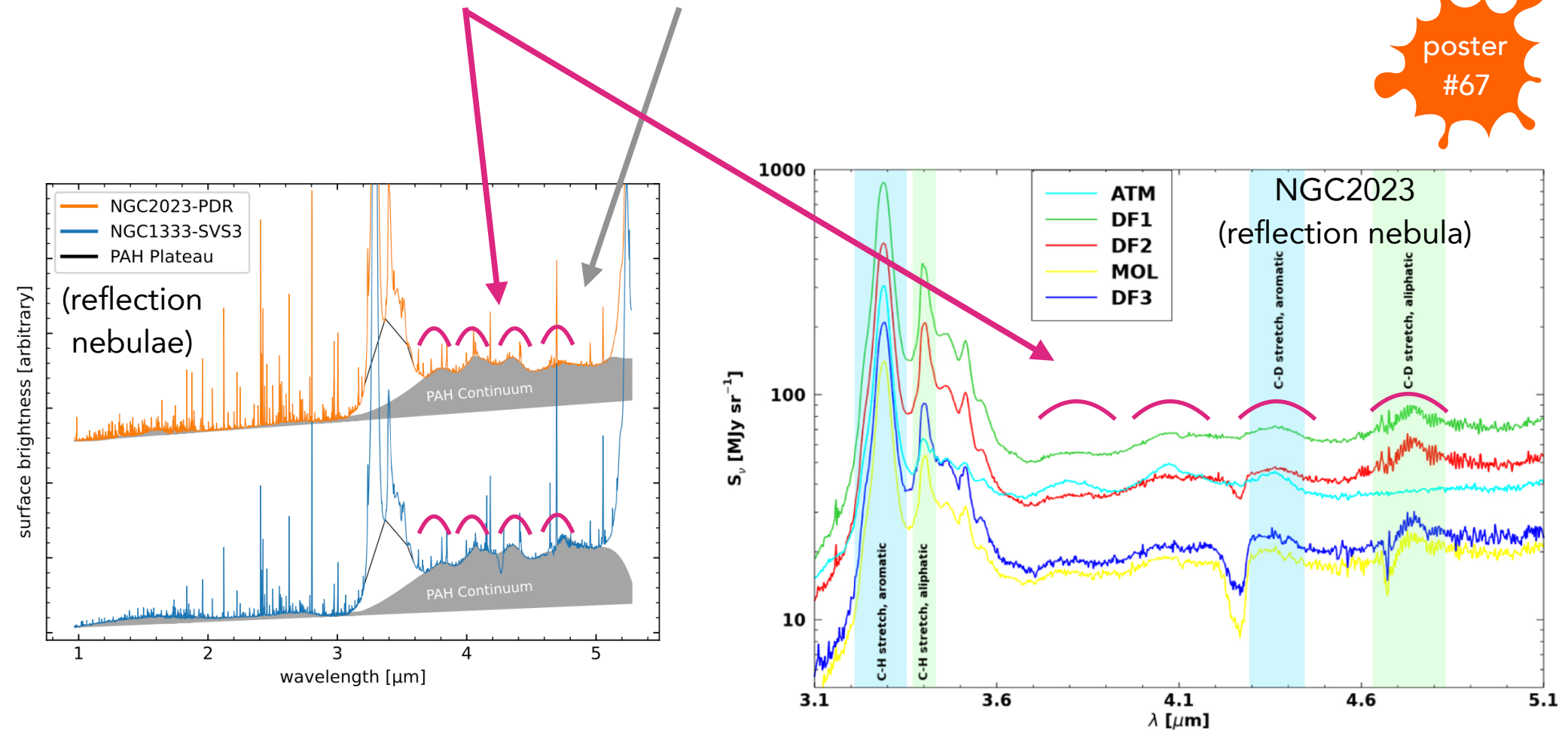
- 6.2 & 7.7 AIBs due to **medium & large-sized** species
- 8.6 AIB only present in **large compact symmetric** PAHs
- 11.0 AIB due to **solo C-H** in **large** PAHs



Khan et al. 2025, Khan et al. 2025 in prep., Bauschlicher et al. 2008, 2009, Ricca et al. 2012

'New' NIR AIBs & continuum excess

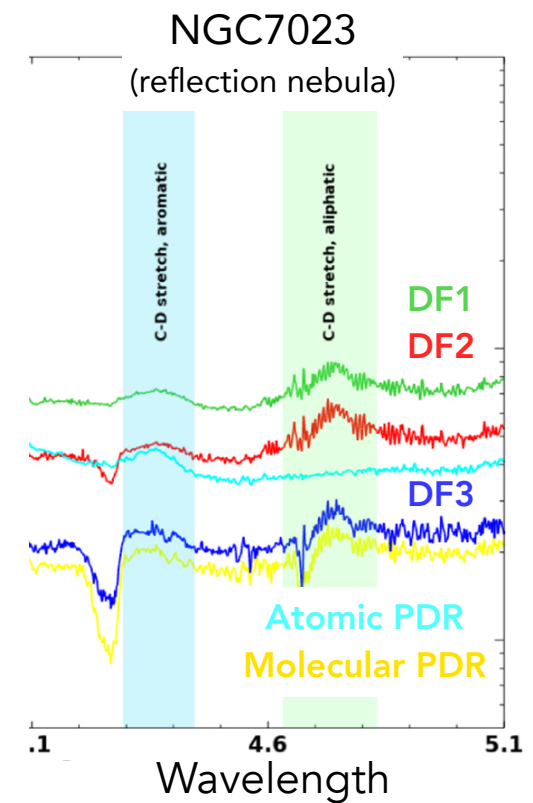
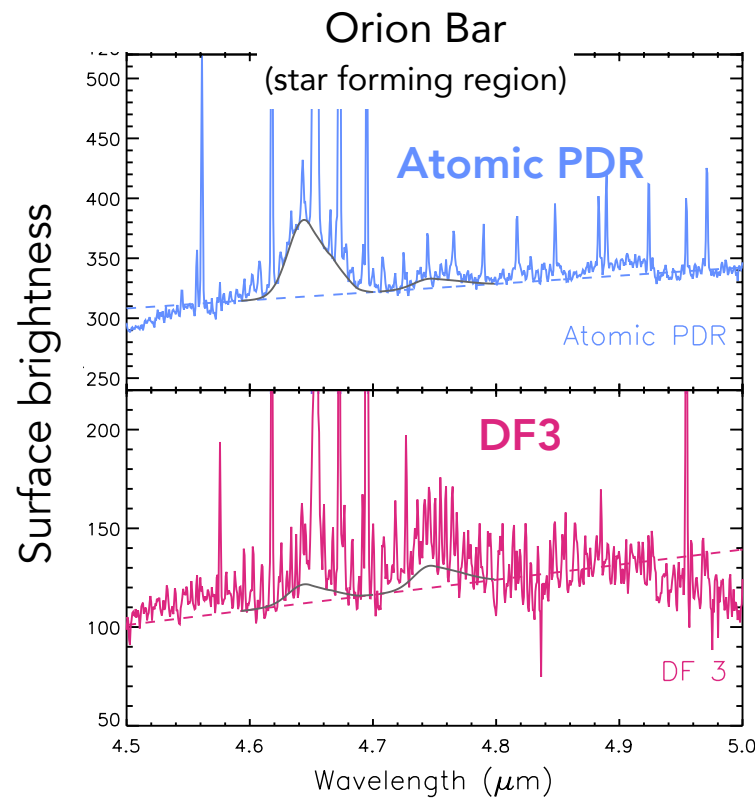
Takashi Onaka



Boersma et al. 2024, Misselt et al. 2025, Peeters et al. 2024, Onaka et al. 2025 in prep.

Deuterated AIBs

- relative intensity (presence) of deuterated AIBs highly variable
- aliphatic D/H is higher than aromatic D/H
- aliphatic D/H anti-correlates with He ionization

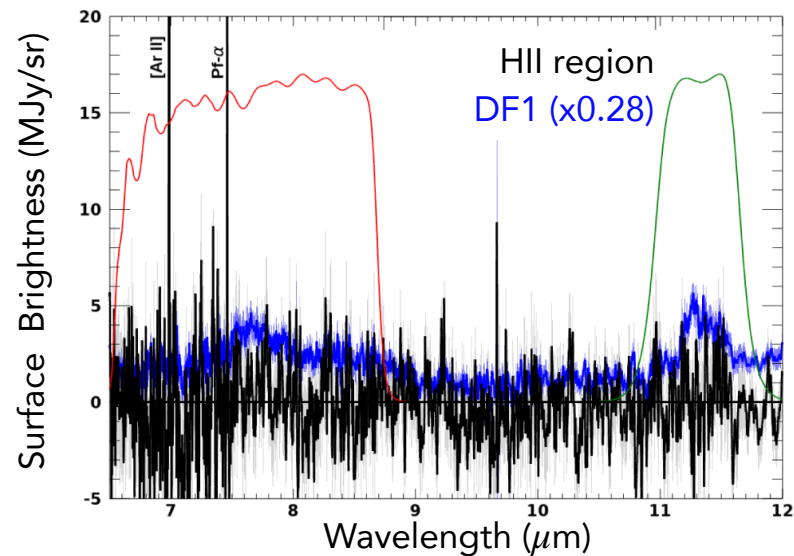
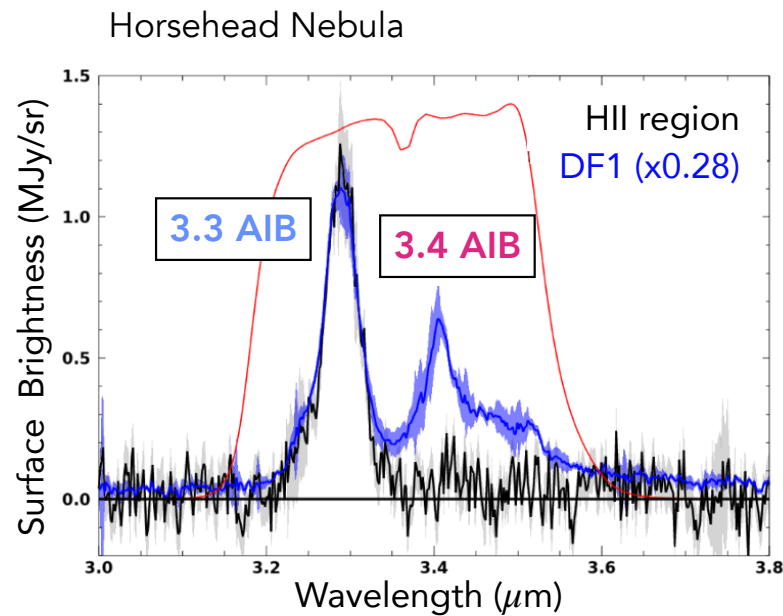


Peeters et al. 2024, Boersma et al. 2024, Misselt et al. 2025, Yang et al. 2025, Draine et al. 2025

Dusty Universe 2025

Dust entrainment in the photo-evaporative flow from PDR front

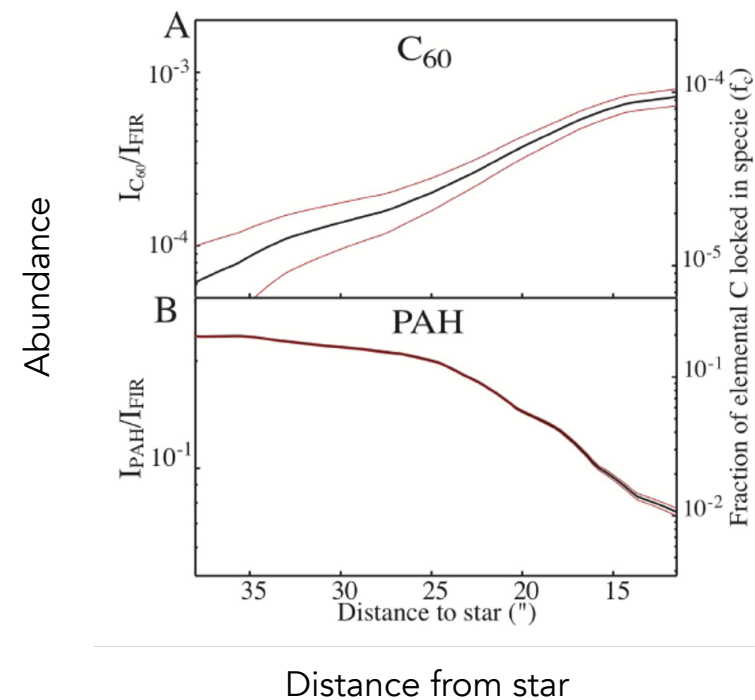
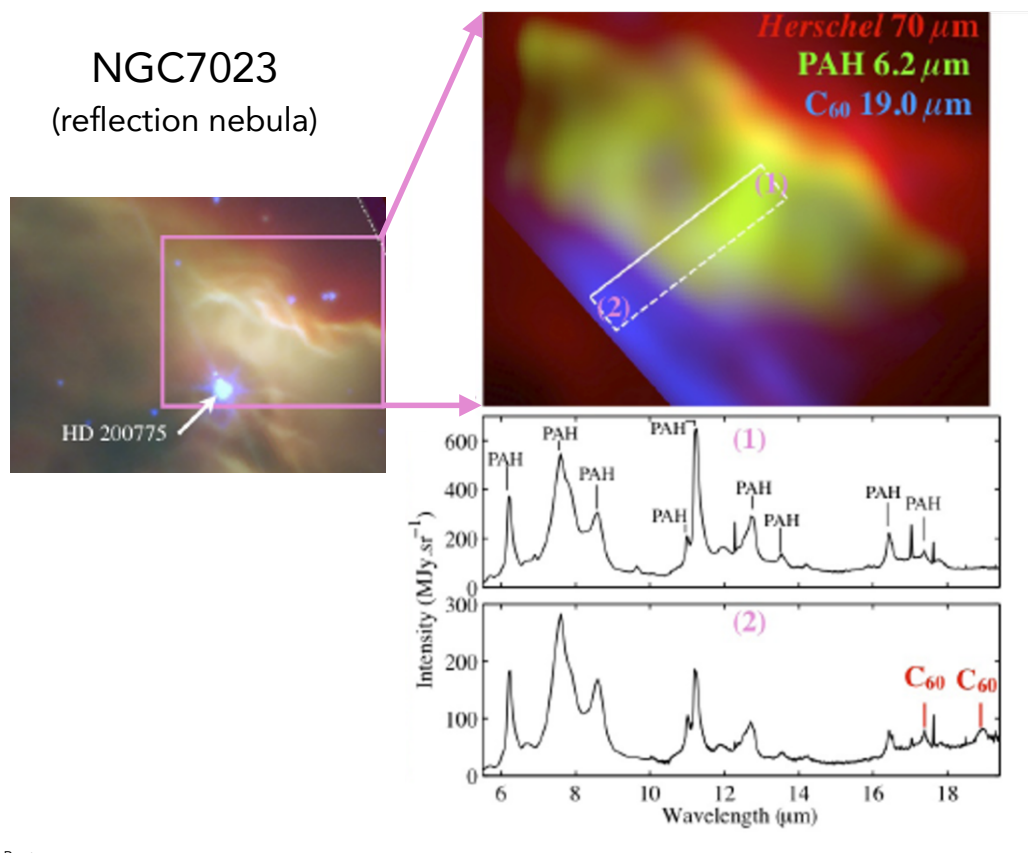
- 3.3 AIB seen in HII region (photo-evaporative flow from Horsehead Nebula PDR)
- no mid-IR AIBs detected in photo-evaporative flow (low S/N data)



Abergel et al. 2024, Misselt et al. 2025

From AIBs to fullerenes - photochemical evolution

Destruction of AIB carriers to form fullerenes



Berné & Tielens 2012

From AlBs to fullerenes - photochemical evolution

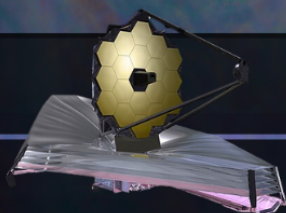
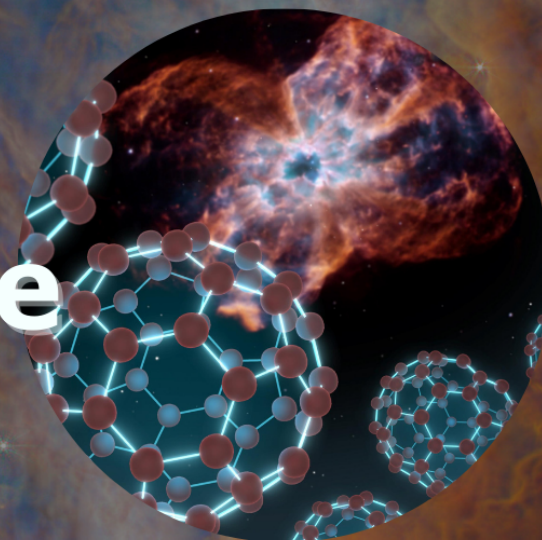
Still awaiting JWST's view ... but



Take-home message

- ▶ JWST allows to probe the photochemical evolution of the AIB carriers, fullerenes, and VSGs/nano-grains
- ▶ (most) AIBs composed of multiple components with distinct morphology/behaviour
- ▶ may complicate diagnostics based on relative intensities

Exploring the aromatic universe in the JWST era



July 6 to 10, 2026

Western University London, Canada



<https://www.aromaticuniverse.space/>

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