JWST Unveils IR Stellar Content of NGC 6822 with NIRCam and MIRI

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IAU S395
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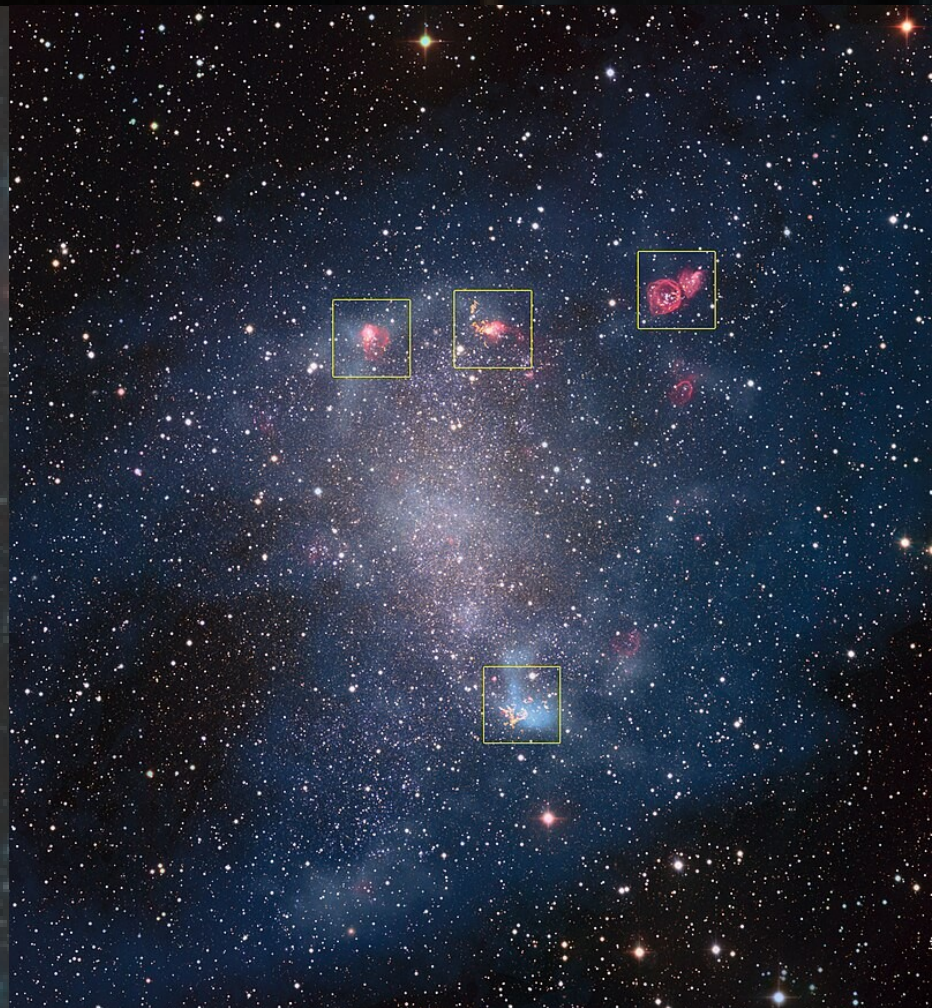
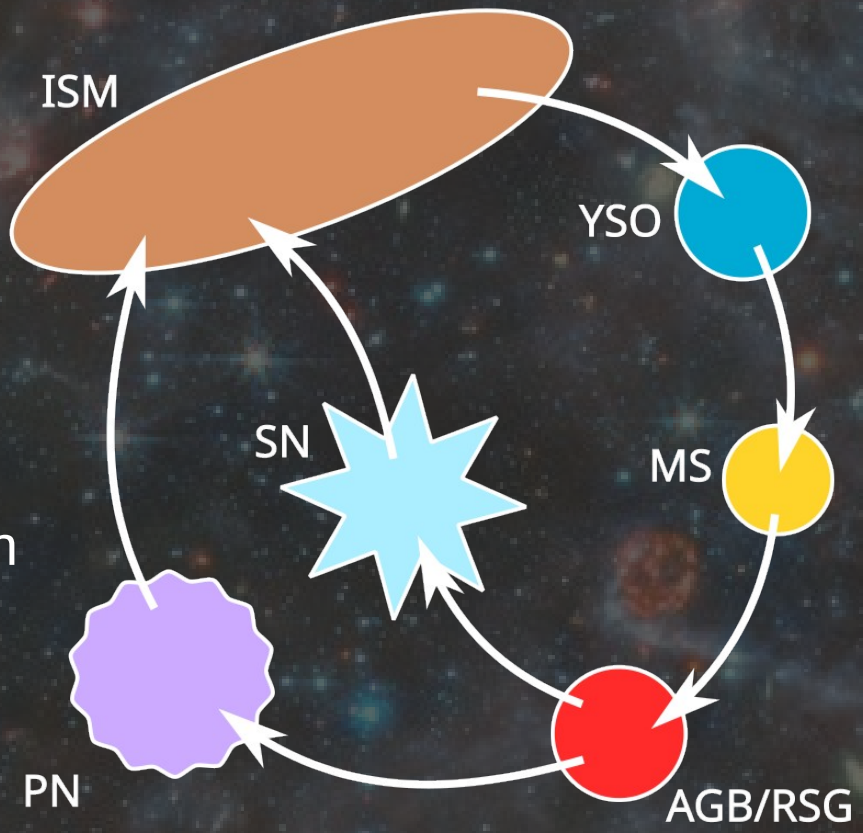
NGC 6822

- Irregular dwarf galaxy
- Nearby (~500kpc)
- Metal poor (~0.2 $Z_{\odot}$)
- Tidally isolated (disputed)
- Home to several massive star forming regions (Hubble + Spitzer regions)
- Rich population diversity offer a good opportunity to study dust in early universe



Dust Life Cycle

- Interstellar medium is the dust bank
- Dust locked up in newly formed stars
- Matter enriched during stellar evolution
- AGBs inject dust back into the ISM
- SN inject dust but also vaporise some of it again
- **The key stages of this cycle are bright in the infrared**



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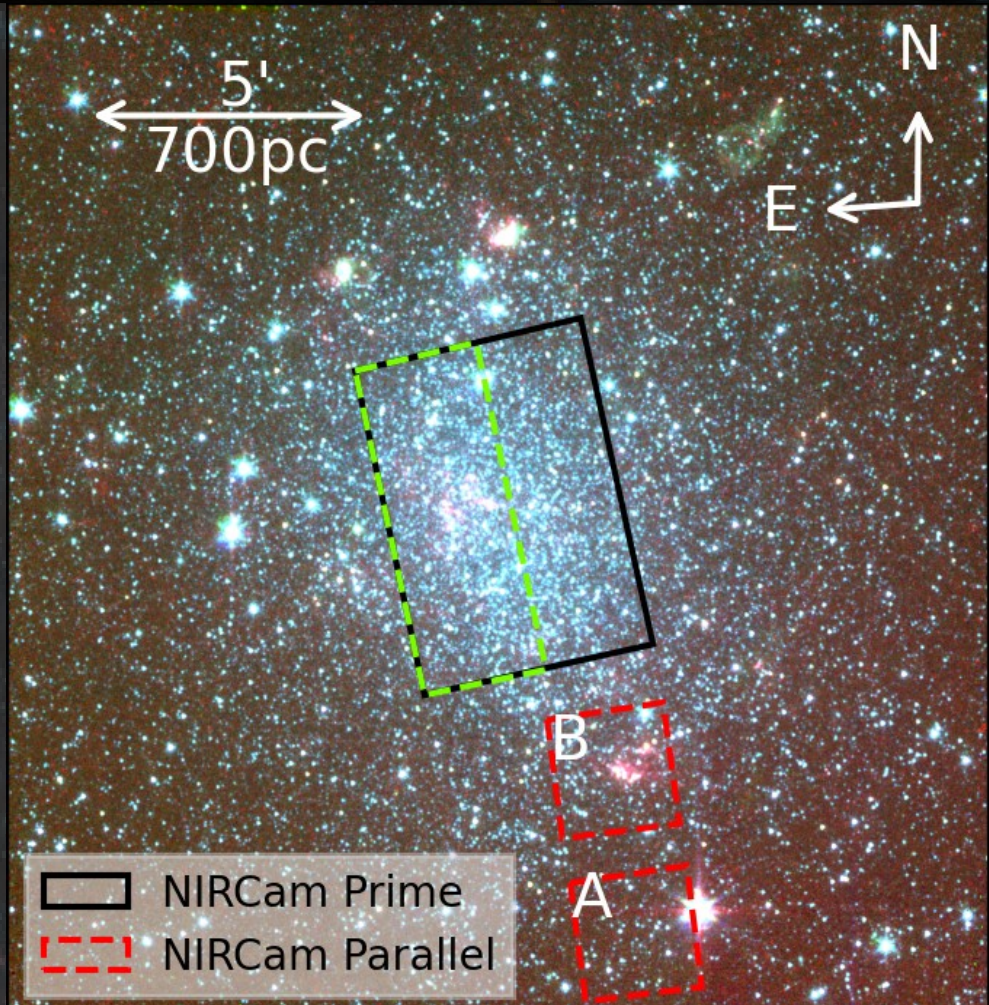
JWST Imaging

- 20 hour JWST imaging program
- 4 NIRCam filters (4 pointings)
  F115W, F200W, F356W, F444W
- 4 MIRI filters (6 pointings)
  F770W, F1000W, F1500W, F2100W
- 2 NIRCam Parallel field pointings
- 1 MIRI Parallel field pointings



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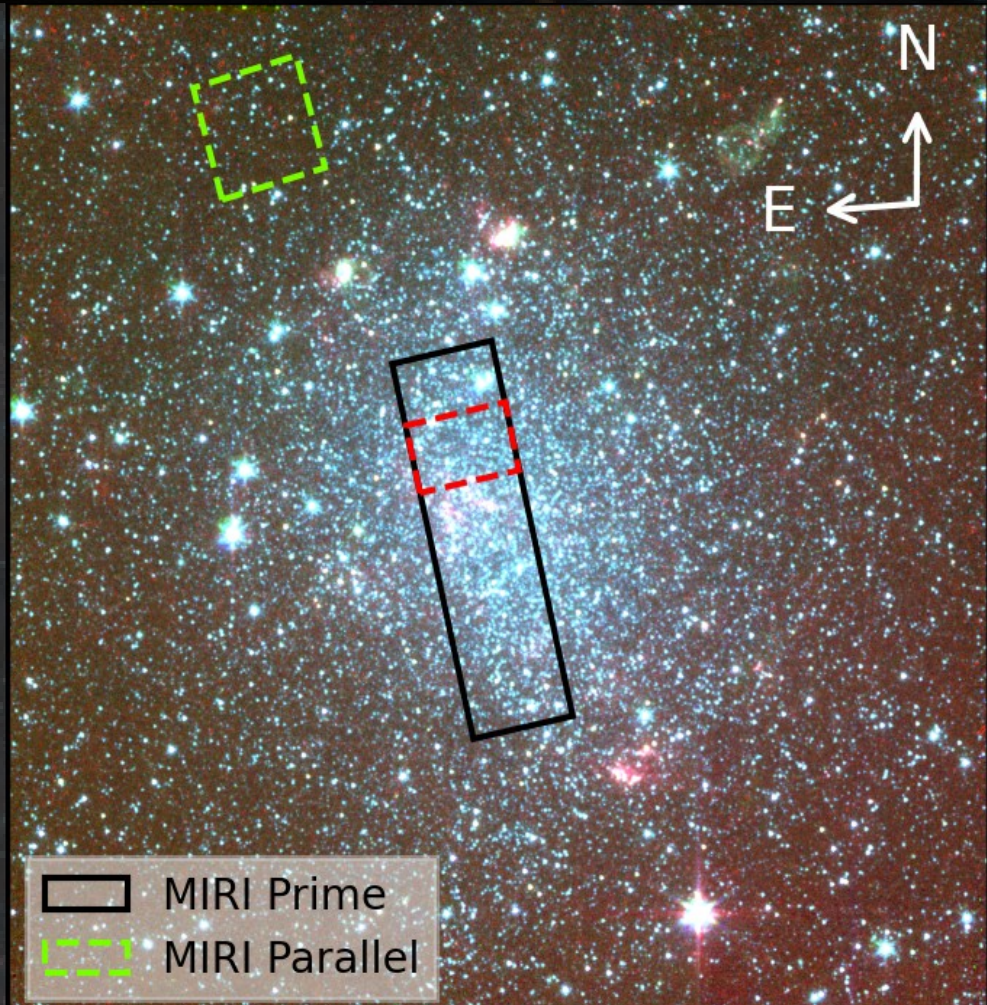

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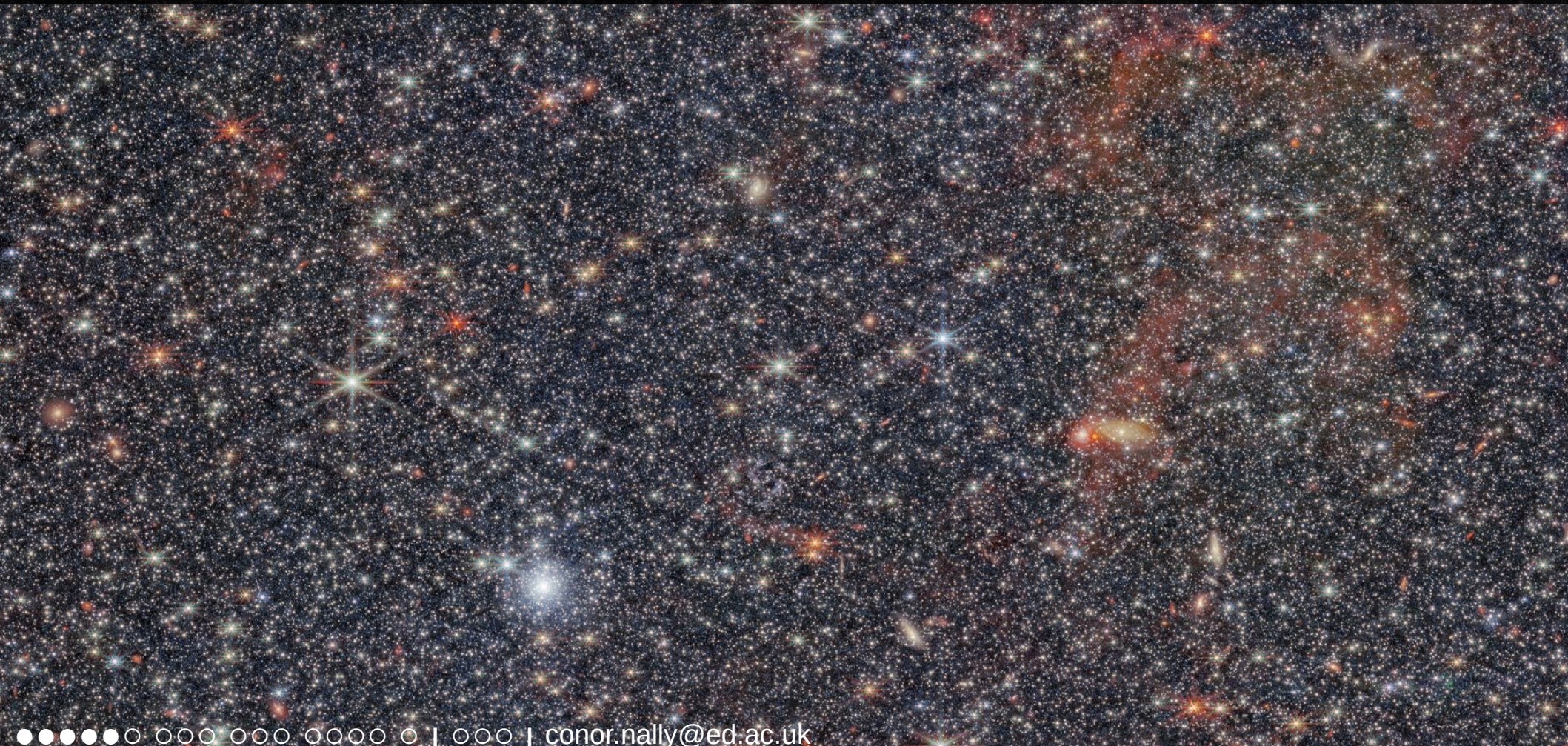
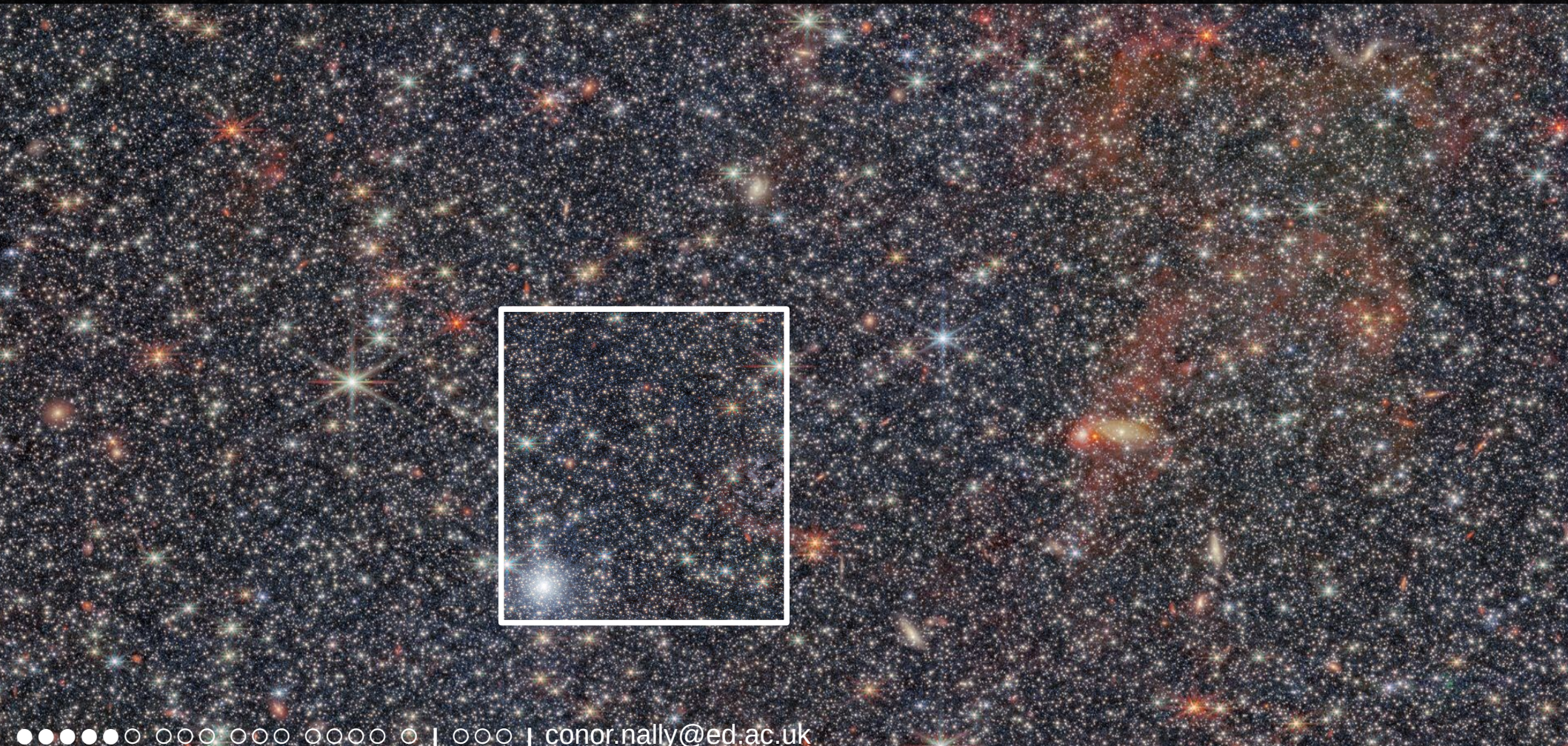
JWST Imaging - NIRCam



JWST Imaging - NIRCam



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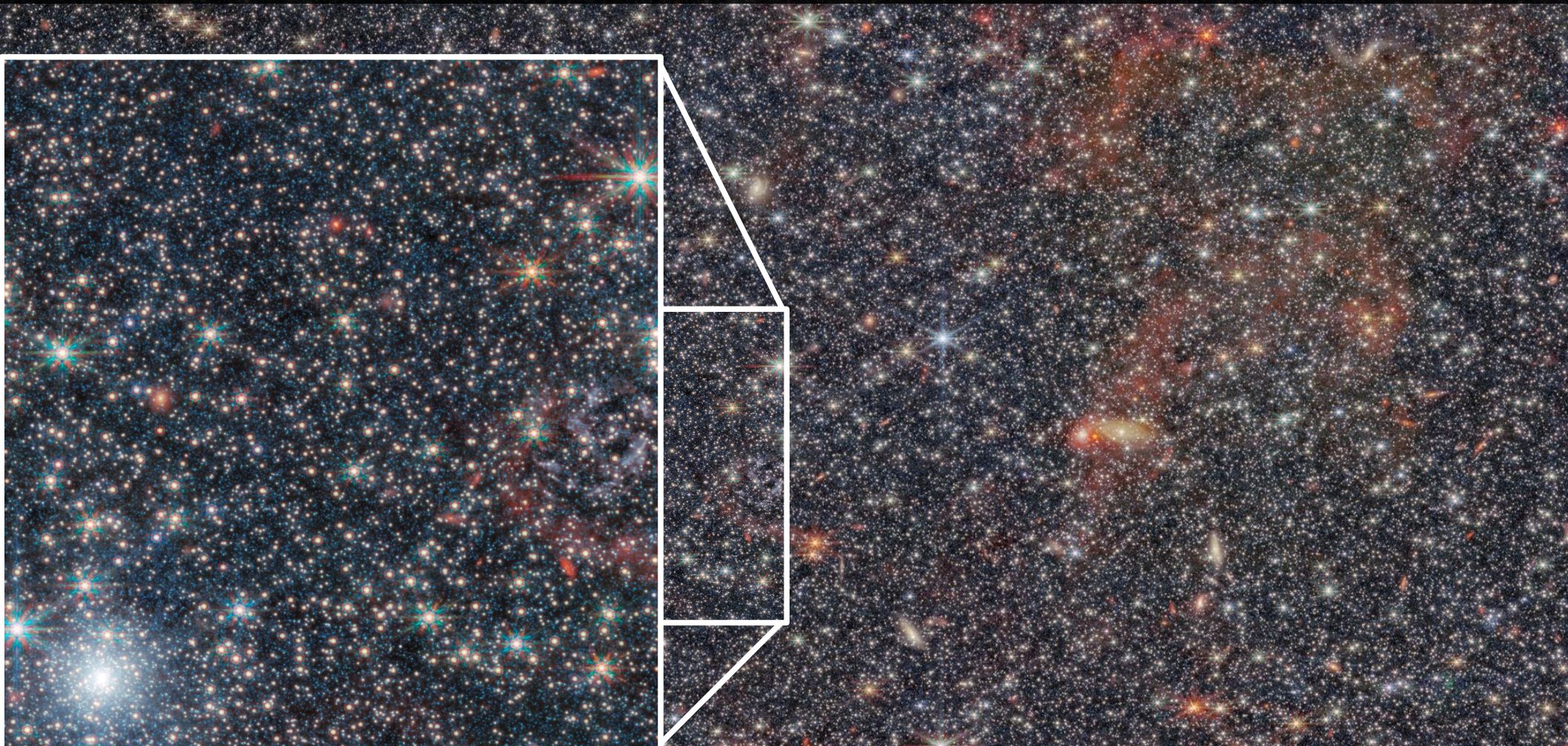
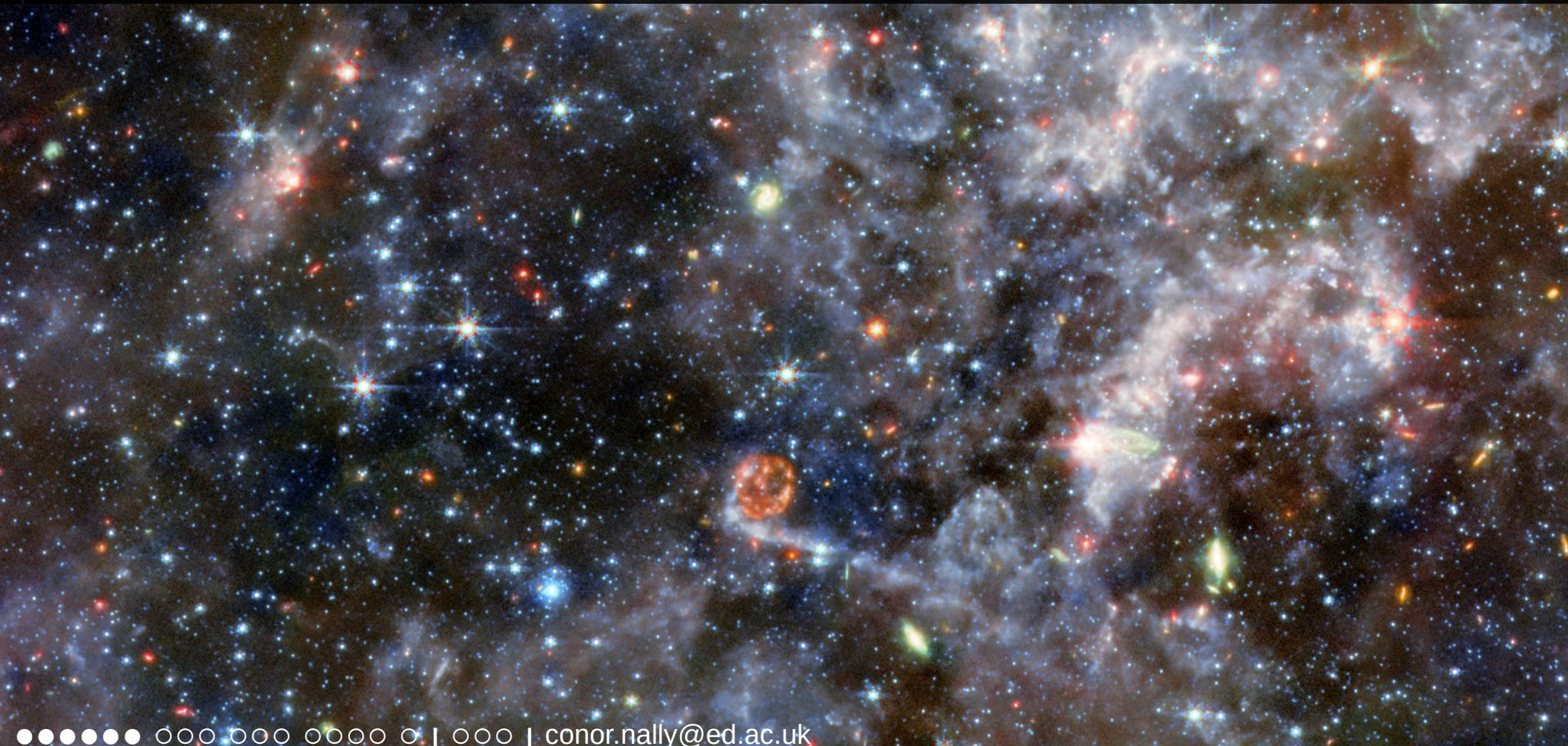


JWST Imaging - MIRI



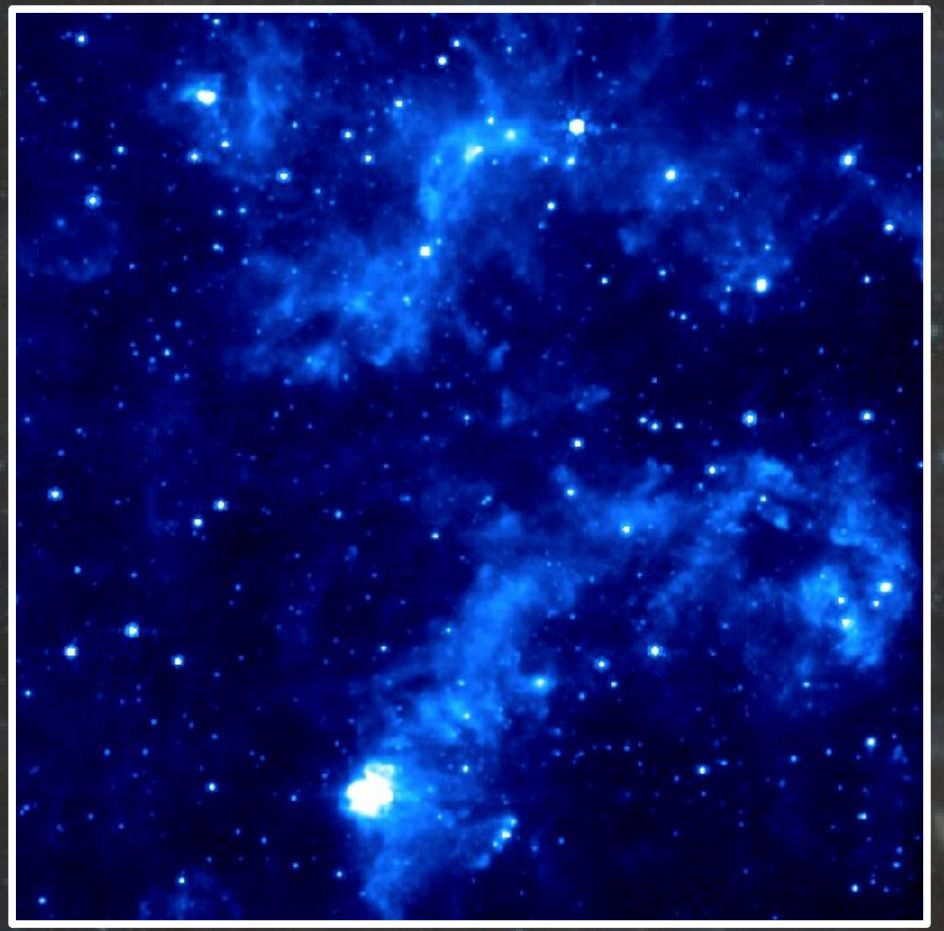
Photometry - StarbugII

- Source crowding
- Dusty diffuse emission contamination
- Large range in PSF FWHM (0.023” – 0.8”)
- Background source contamination
- Large catalogues
- Open source era

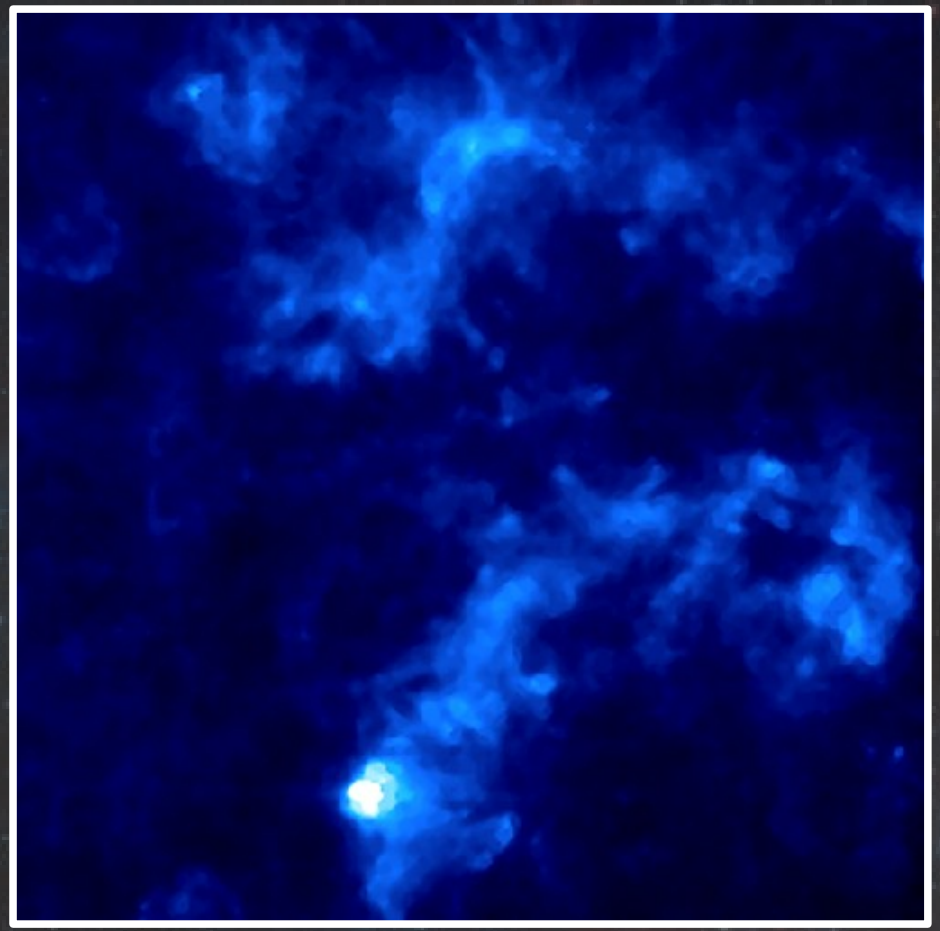
`STARBUGII` [ascl:2309.012]
$~ pip install starbug2

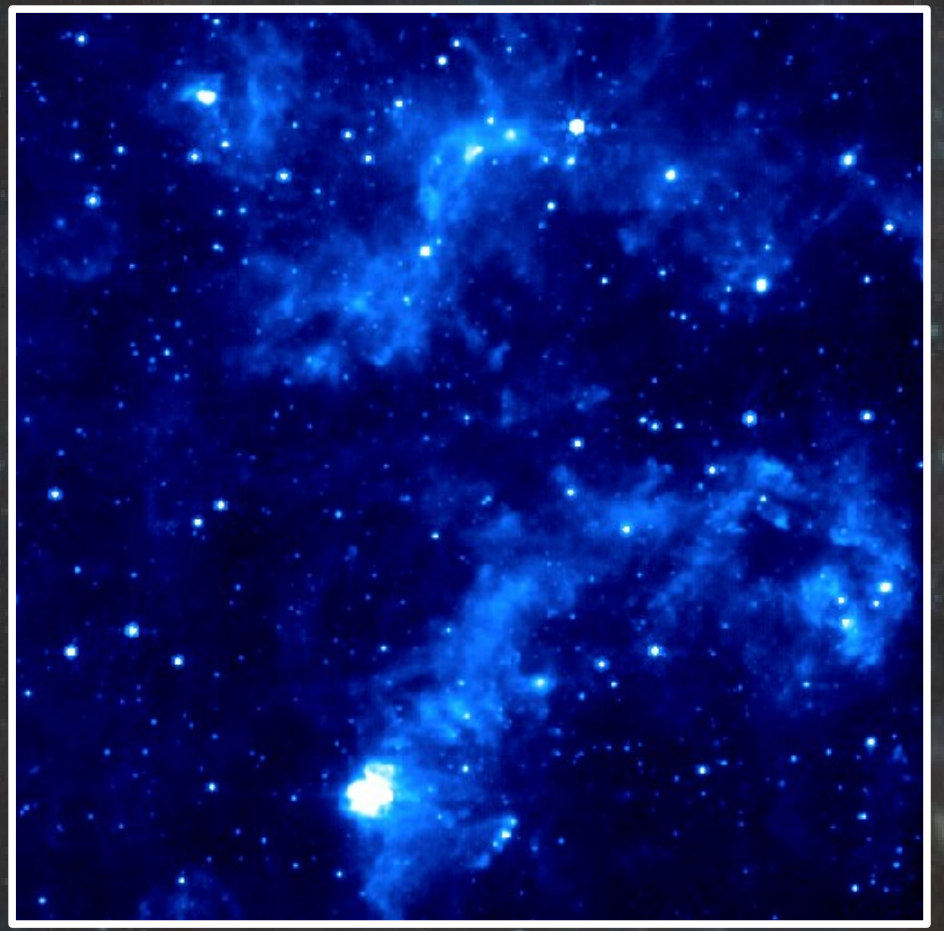
Photometry - Source Detection

- Three fold ensemble of detection methods
- Targetting faint, compact and dust embedded stars
- An order of magnitude greater detection rate than JWST pipeline
- Detection of first extra galactic brown dwarfs (Zeidler et al. 2024)
- Array of tunable parameters to reduce contaminants



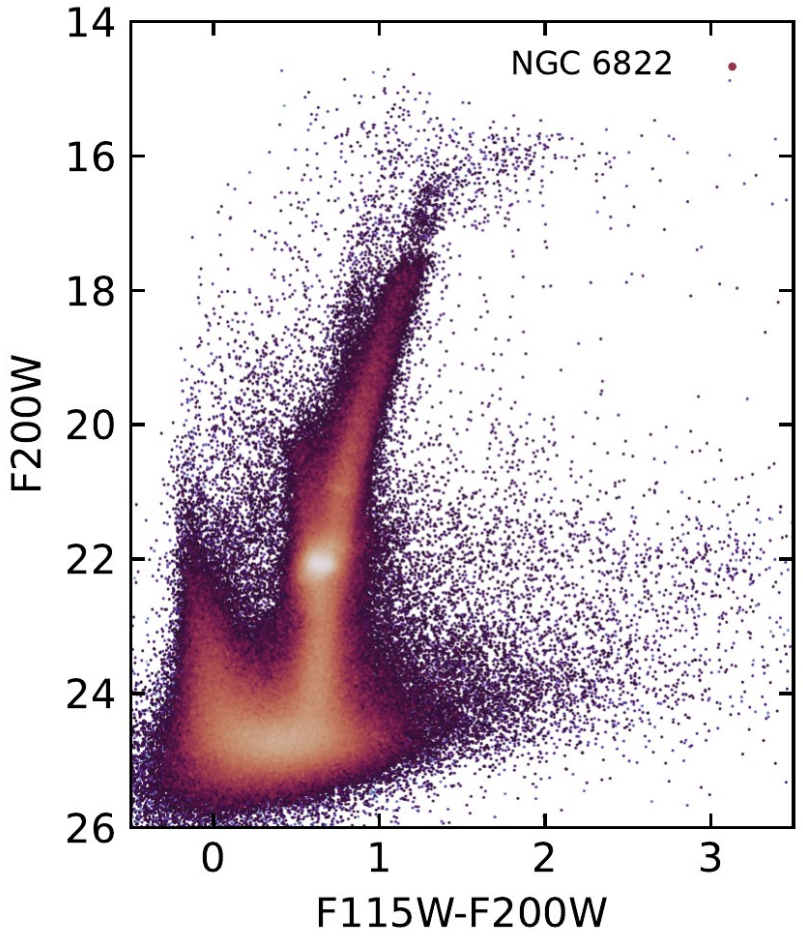
Photometry - Diffuse Emission





NIRCam Catalogue

- ~ 1,000,000 detected sources
- ~ 3 magnitudes below the Red Clump
- ~ 7 magnitudes deeper than comparable IR studies before
- Wide array of spectral types found
- Emergence of the elusive AGB bump



(Nally et al. 2024)

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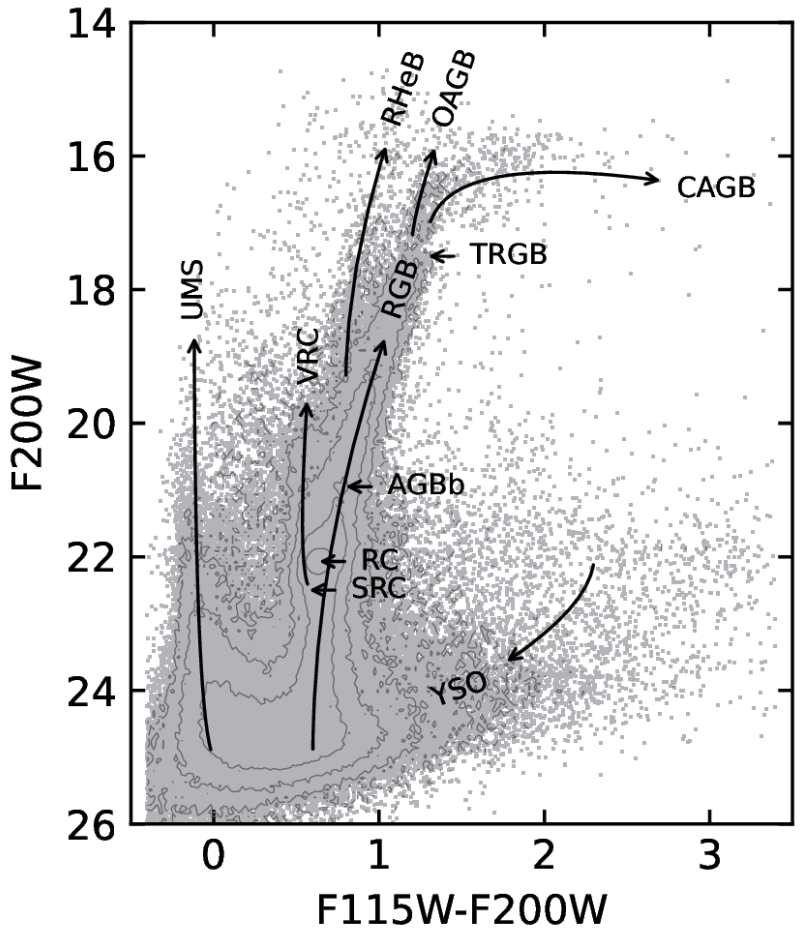
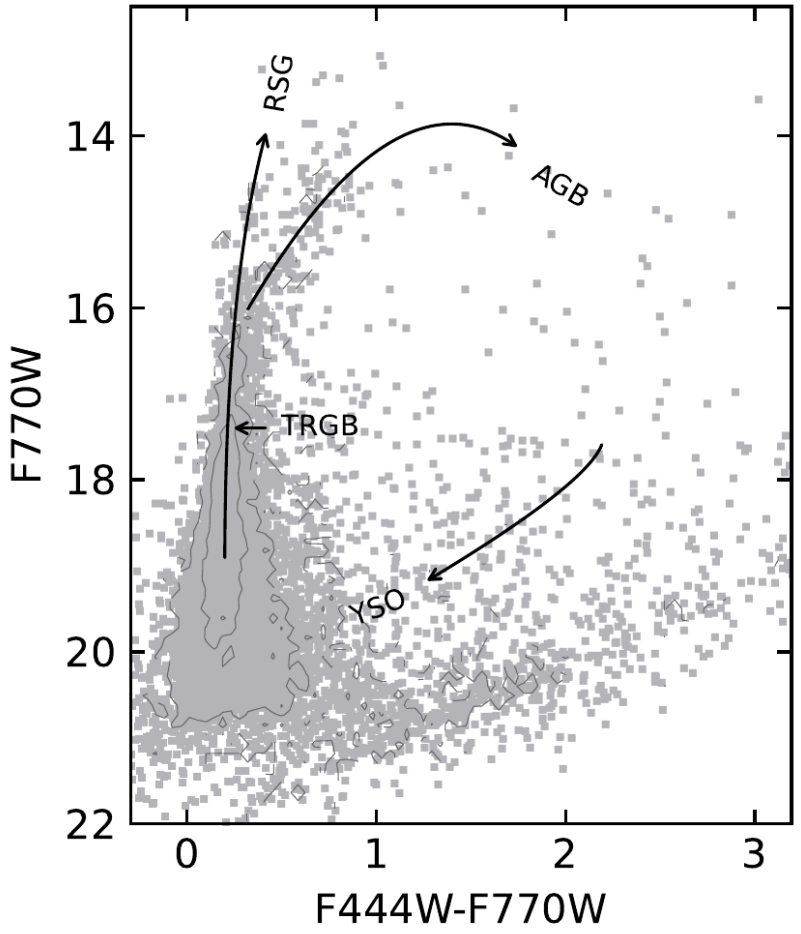


(Nally et al. 2024)

MIRI Catalogue

- ~ 22,000 detected sources
- We match the catalogues across the full wavelength range (1 – 21 microns)
- We identify ~2000 AGB candidates
- Detection of 90 deeply embedded YSOs (Lenkić et al. 2024)



(Nally et al. 2024)

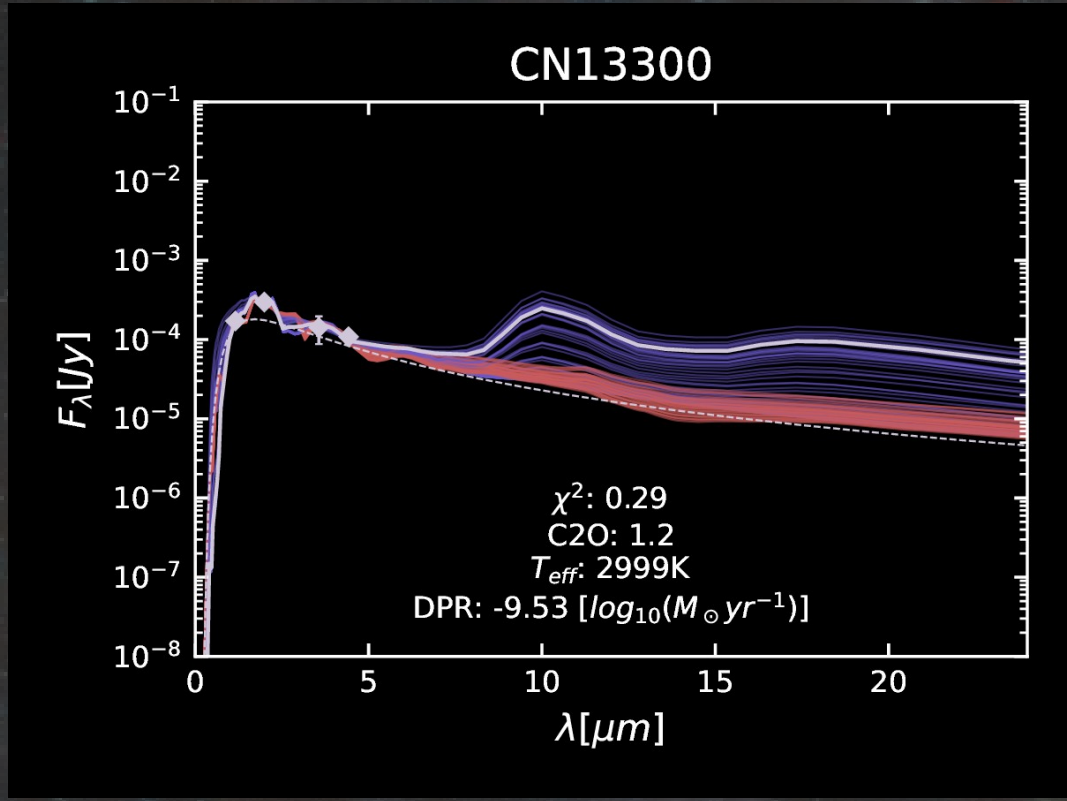
SED Fitting AGB Models

Preliminary

- We fit GRAMS carbon-rich AGB (Srinivasan+2011) and oxygen-rich AGBs (Sargent+2011) to AGB SEDs

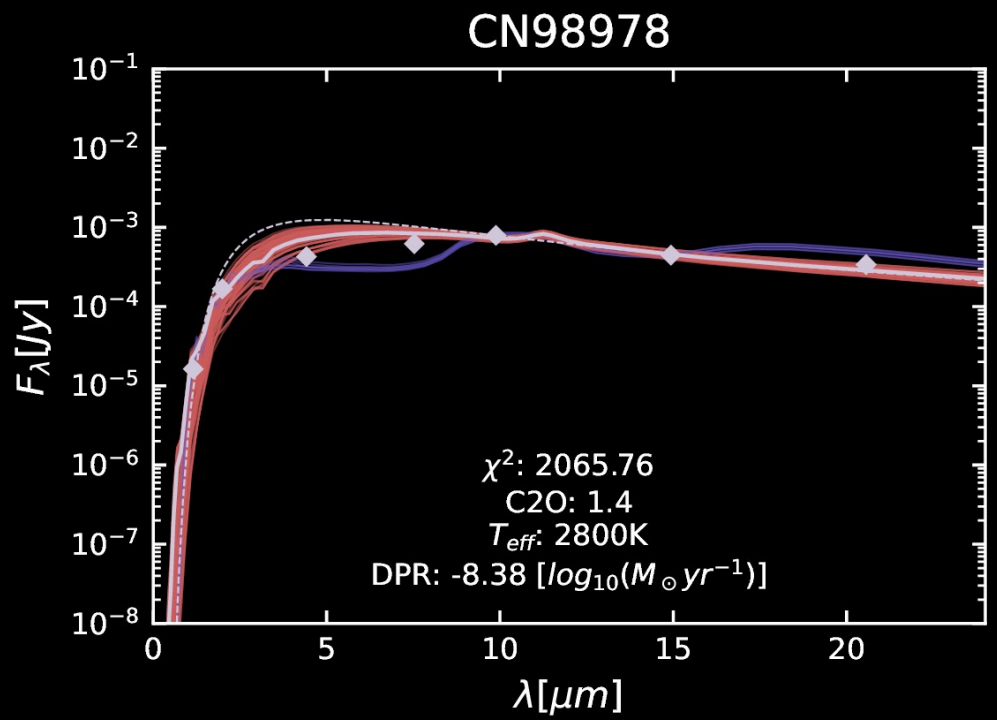
- Determining:
  - Chemical class dominance (C or O)
  - Dust production rate (DPR)
  - Bolometric luminosity
  - Temperature
  - Dust shell properties

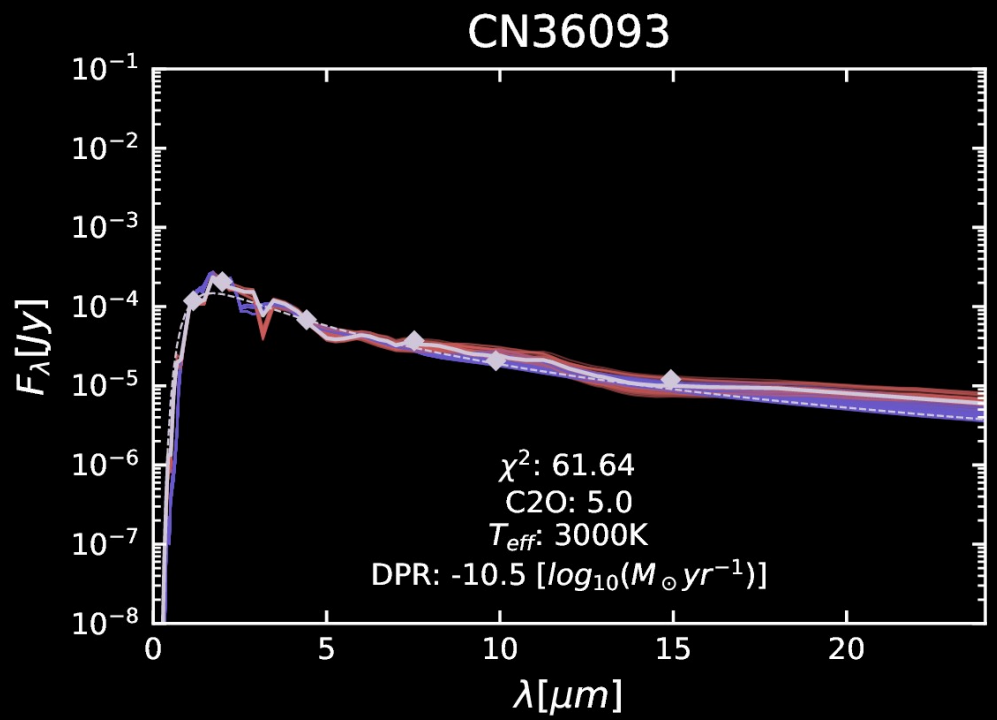
- Long wavelength baseline allows us to constrain dust chemistry



SED Fitting AGB Models

Preliminary



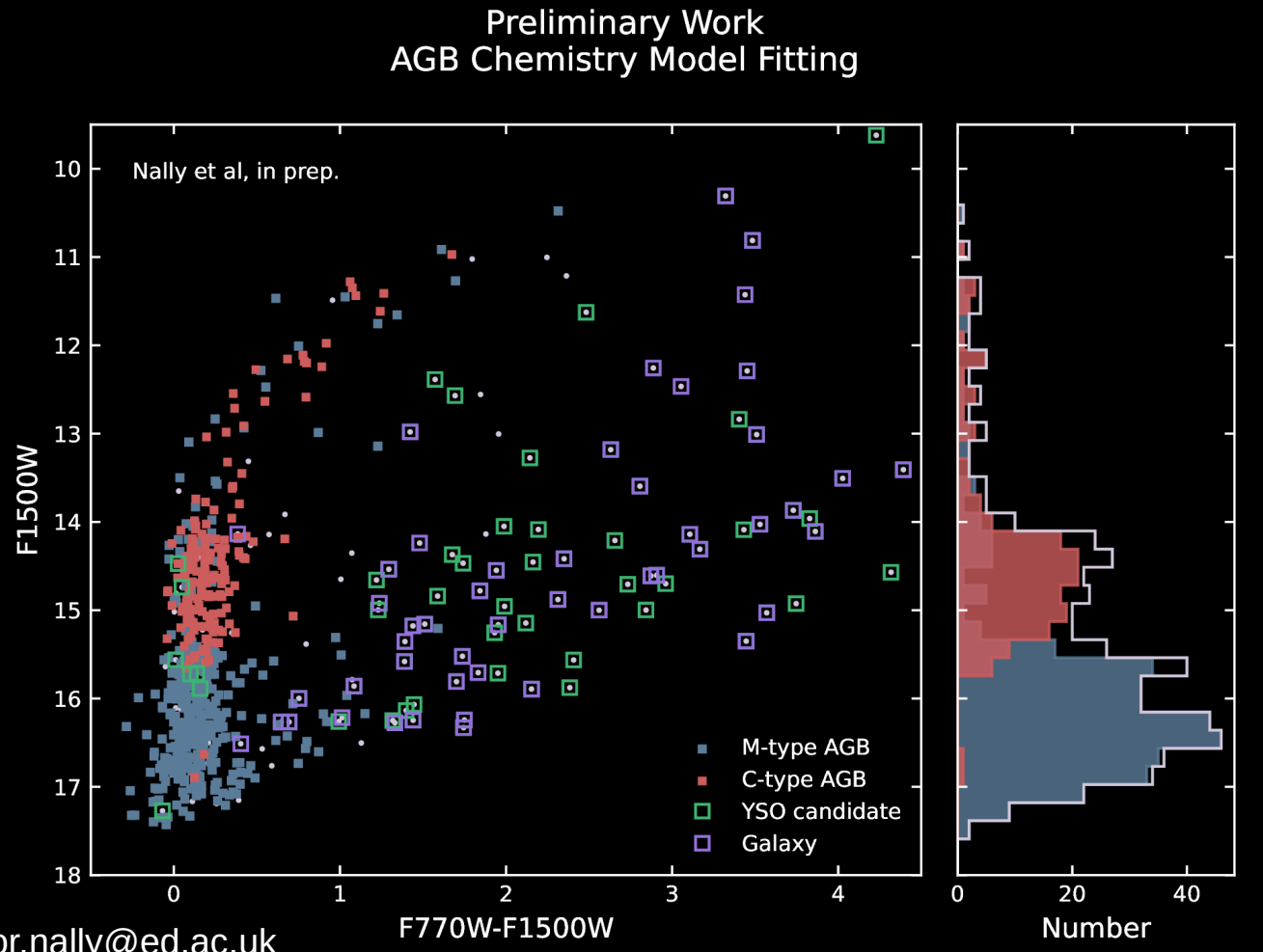


- Determining: Chemical class, Teff, DPR, Lbol and dust shell properties

AGB Chemical Separation

Preliminary

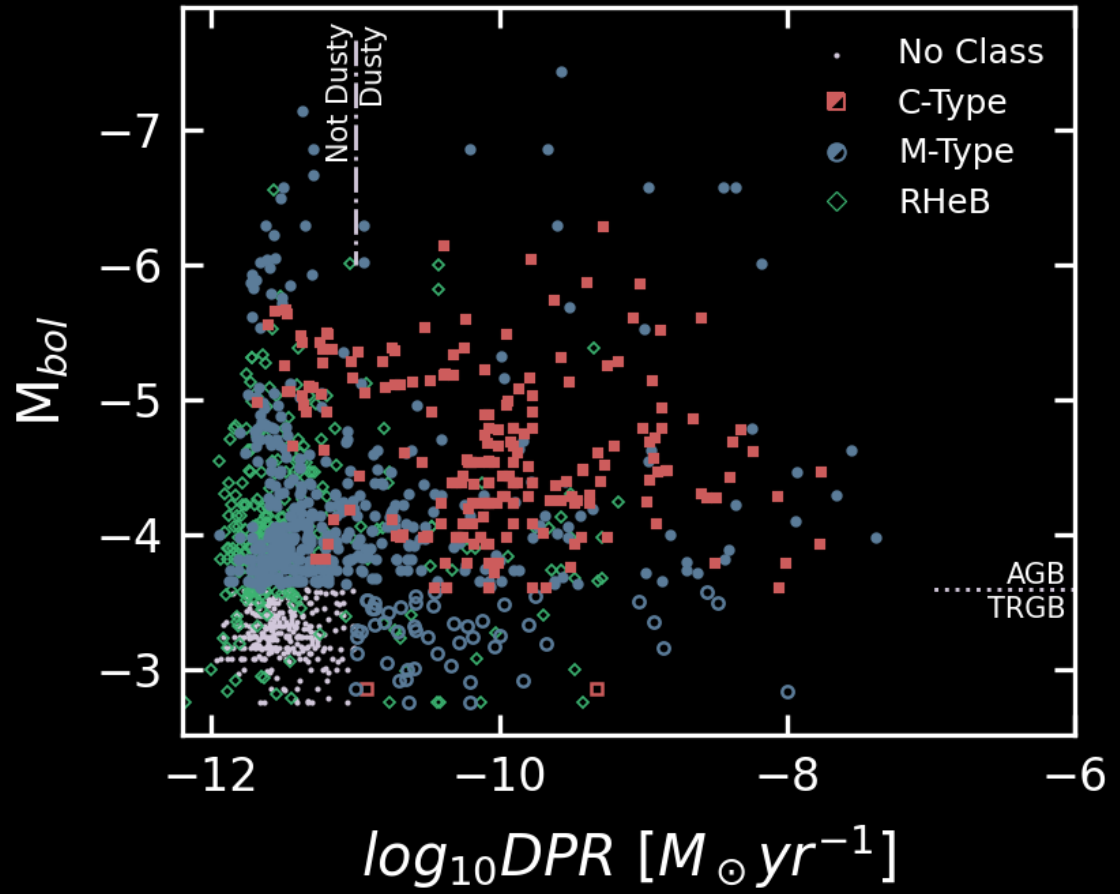
- AGB chemical dominant species
  - Oxygen M-type OAGBs
  - Carbon C-type CAGBs
- We can separate the AGB chemical types (almost)
- We can remove galaxy and YSO contaminants



AGB Dust Production

Preliminary

- Majority of the DPR comes from a few individuals
- Most numerous dusty stars are C-rich AGBs
- The highest mass losing individuals are O-rich AGB
- We find a possible dust producing hot RHeB



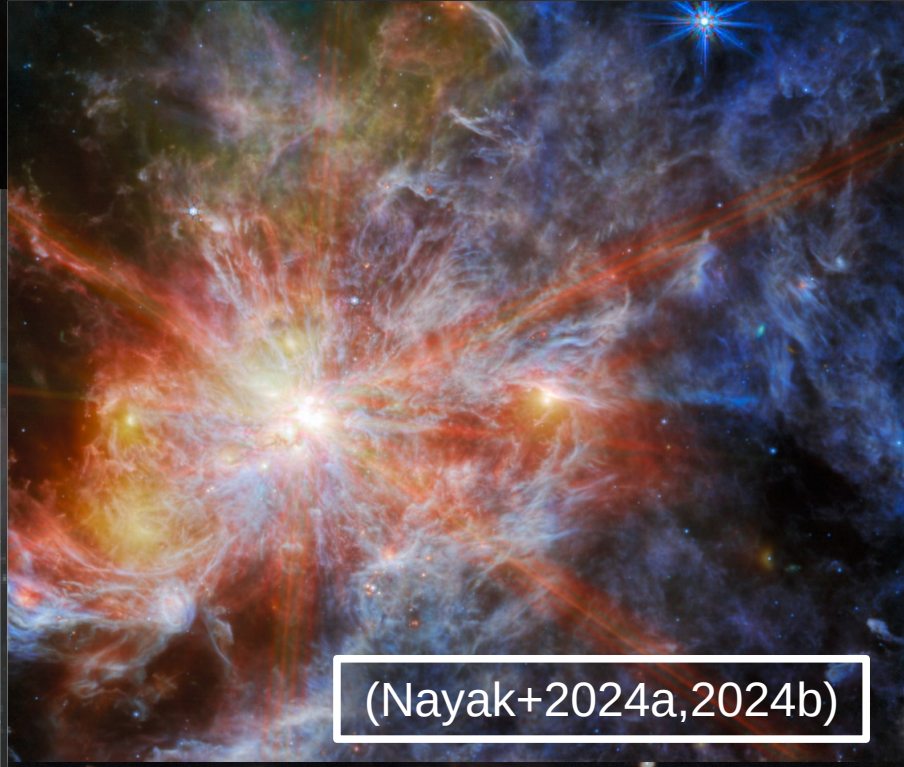
Summary

- STARBUGII is an open-source photometry suite designed for complex crowded source detection and PSF photometry
- We present a near- to mid-IR matched catalogue of NGC 6822, recovering a wide array of stellar populations. We have only just scratched the surface of this data set
- AGB chemical SED modelling shows great CMD space separation
- Carbon dominated AGB dust production but high mass loss OAGB individuals

JWST WINGS

(Jones+2023)

(Habel+2024)



(Nayak+2024a,2024b)

(Bortolini+2024, Hirschauer+2024)

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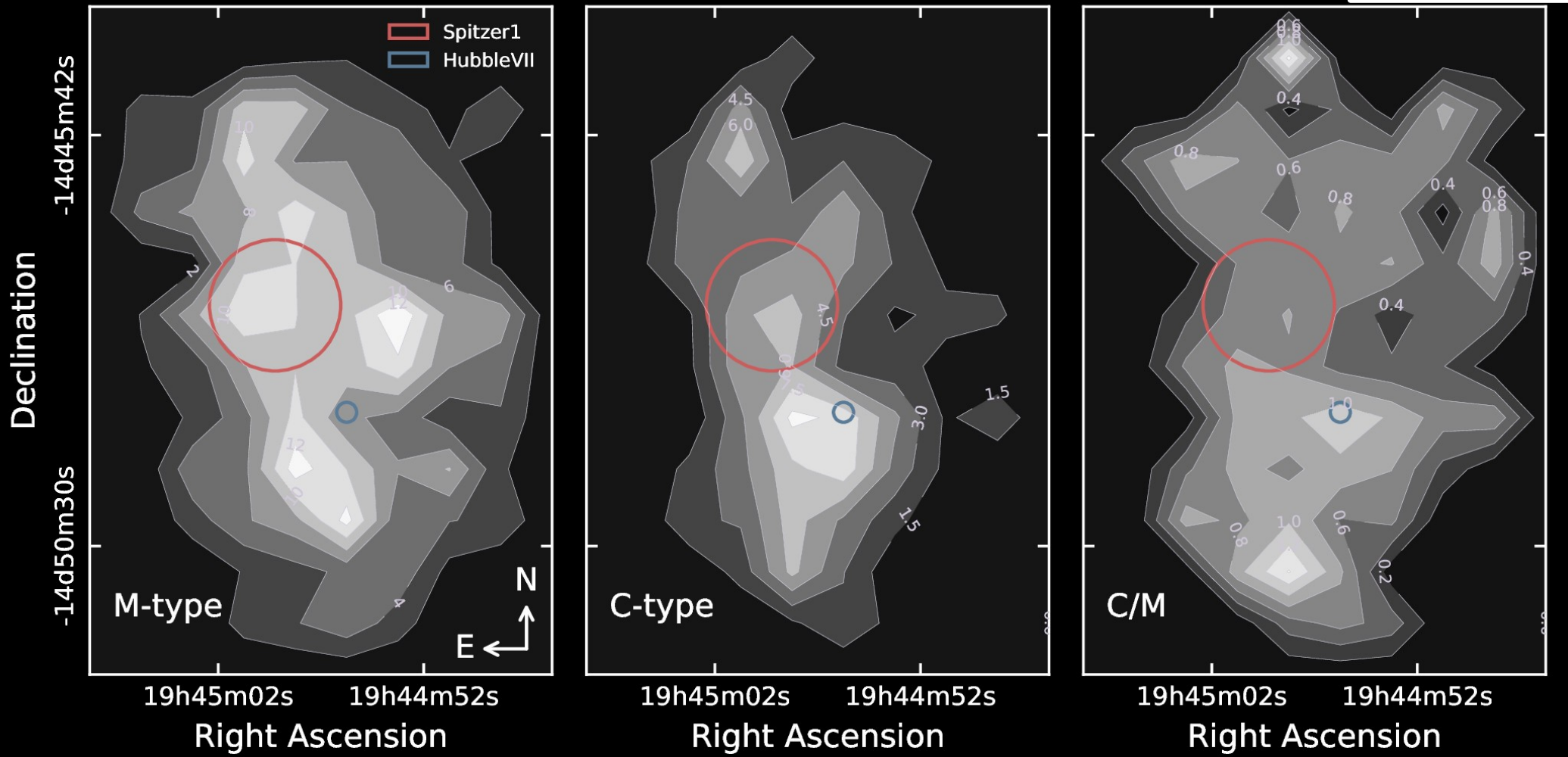
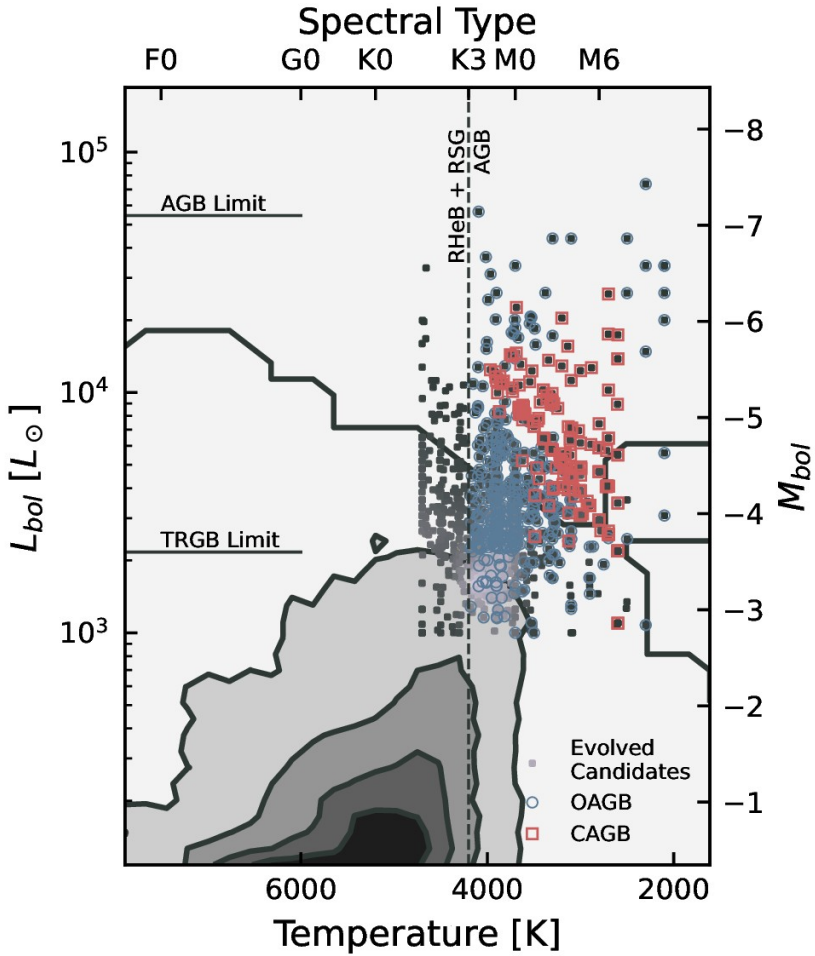
C/O Spatial Distribution

Preliminary



H-R Diagram

Preliminary



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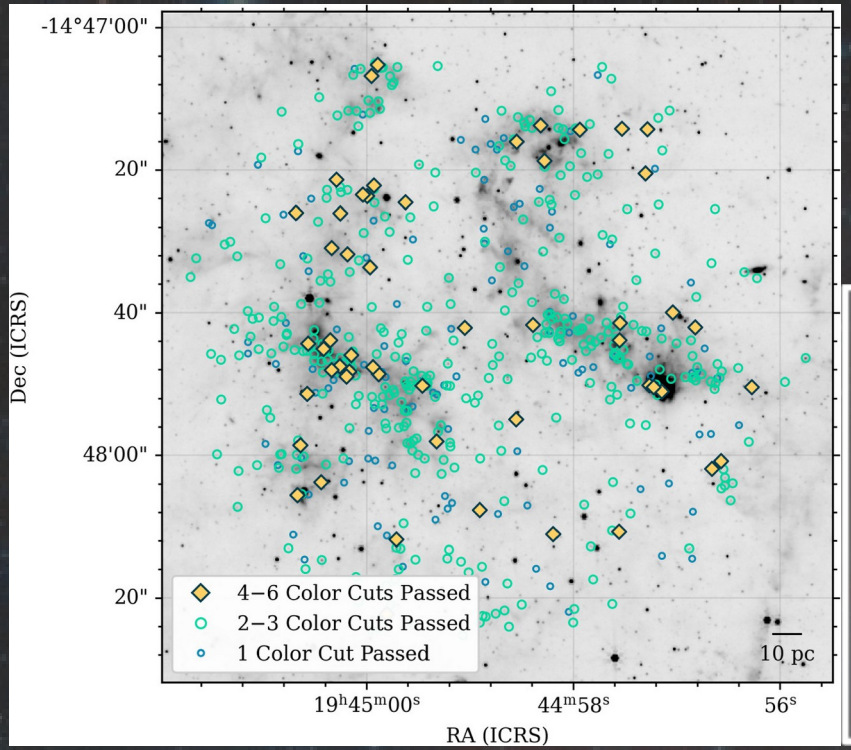
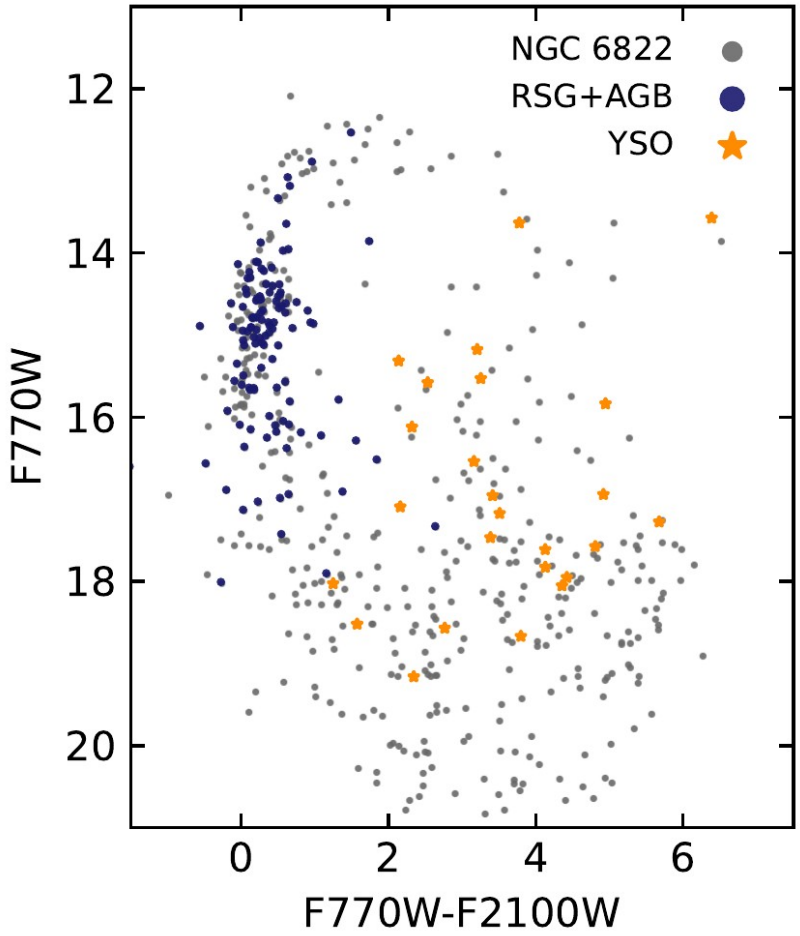
MIRI Catalogue - YSOs

- 90 YSOs closely follow ISM dust structure in SpitzerI massive star forming region



(Lenkić et al. 2024)



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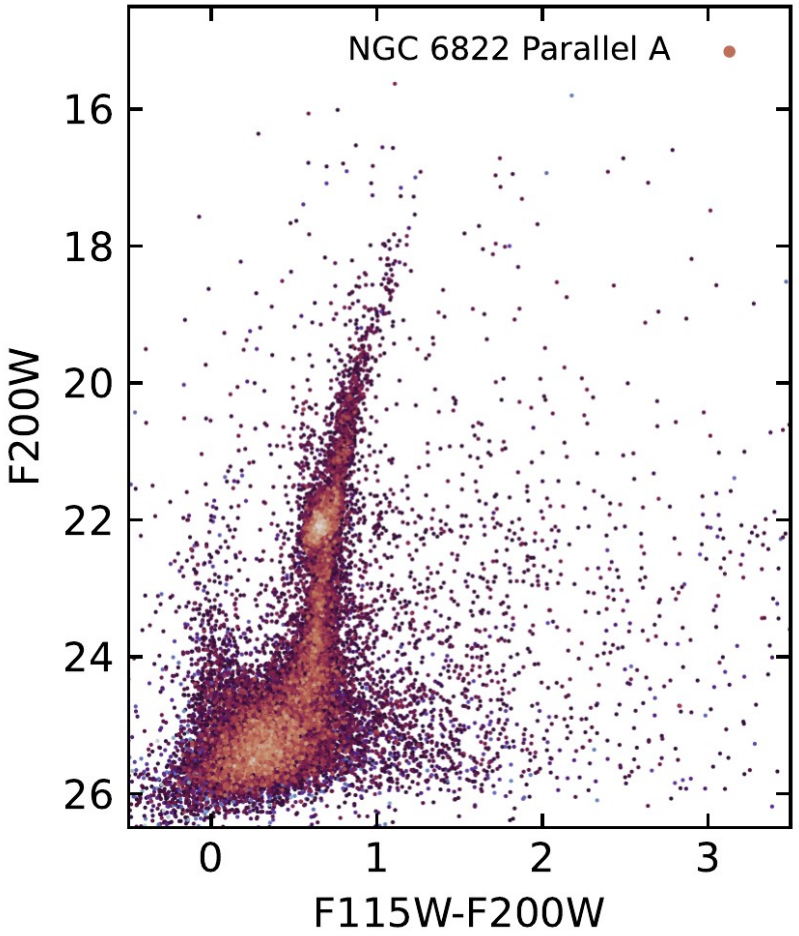
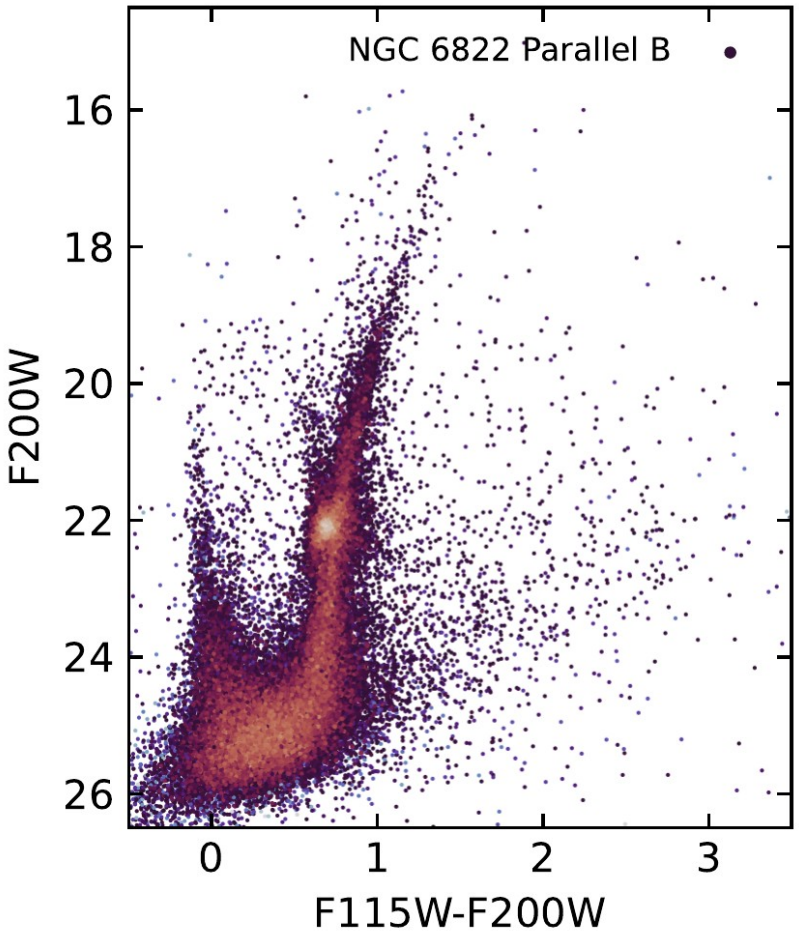
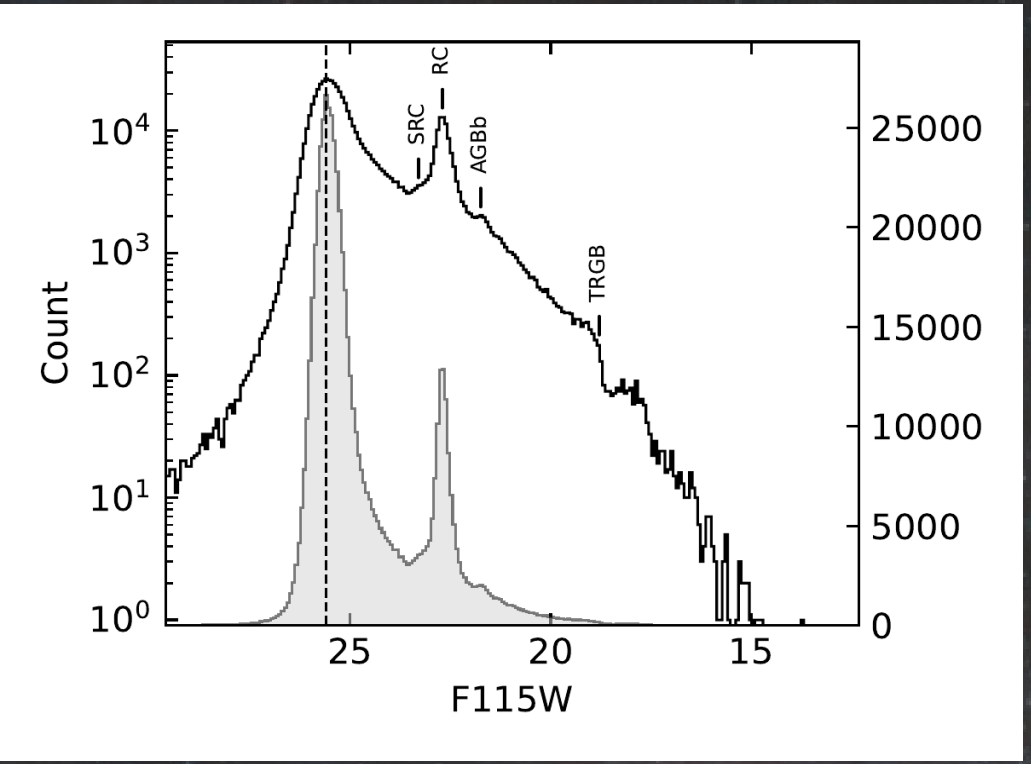
Parallel Fields





TRGB Measurement



Filter	Source count	Completeness [VegaMag]	Bright Limit [VegaMag]	TRGB (error) [VegaMag]
F115W	792424	25.60	15.3	18.79(04)
F200W	539377	24.58	15.0	17.51(03)
F356W	184141	23.21	14.5	17.49(06)
F444W	155327	23.09	14.0	17.65(12)
F770W	97817	20.43	12.5	17.43(19)
F1000W	7098	19.41	11.5	17.40(13)
F1500W	1311	16.80	10.0	–
F2100W	794	16.86	9.0	–