# Using JWST to identify and characterise point sources

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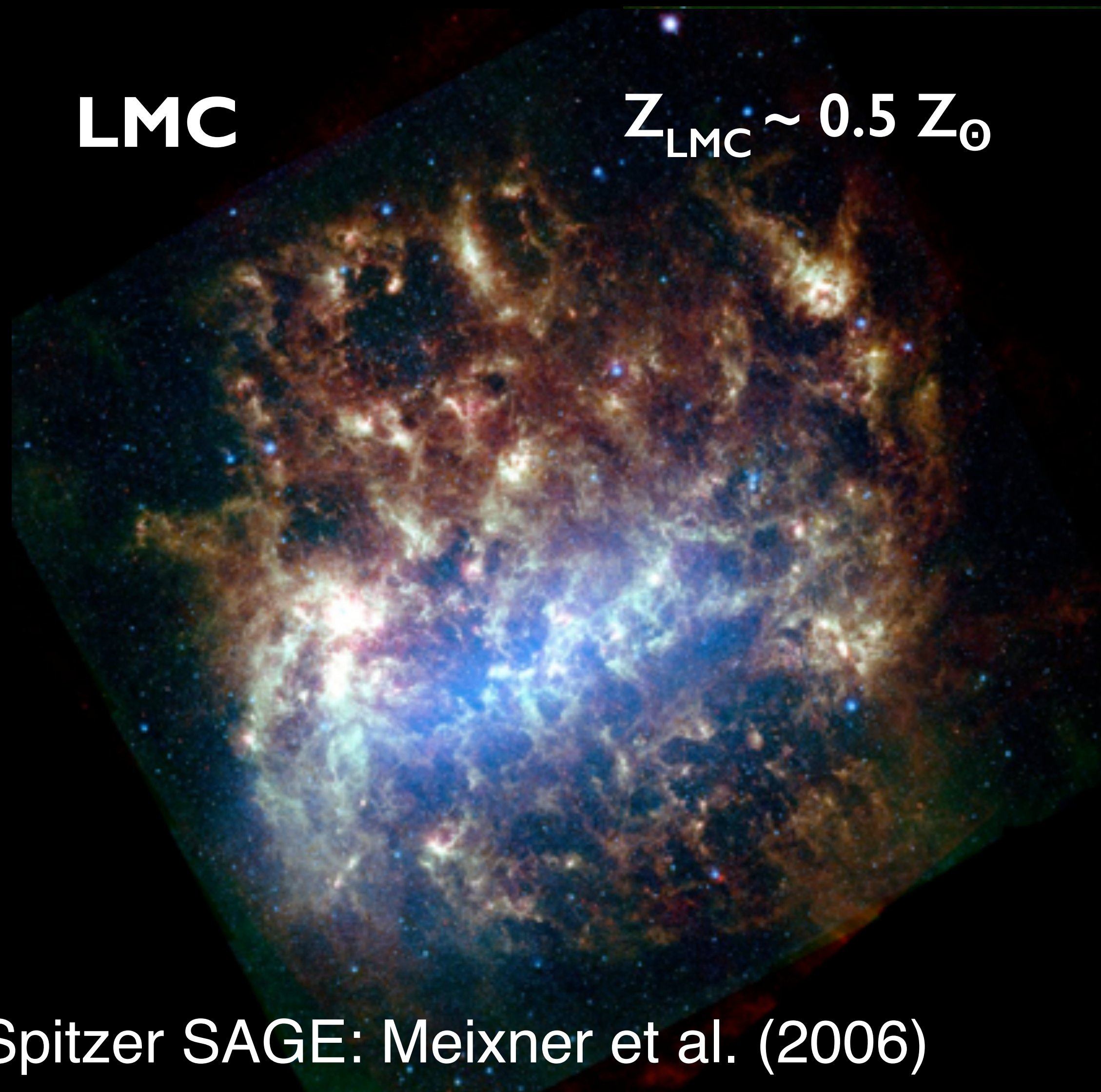
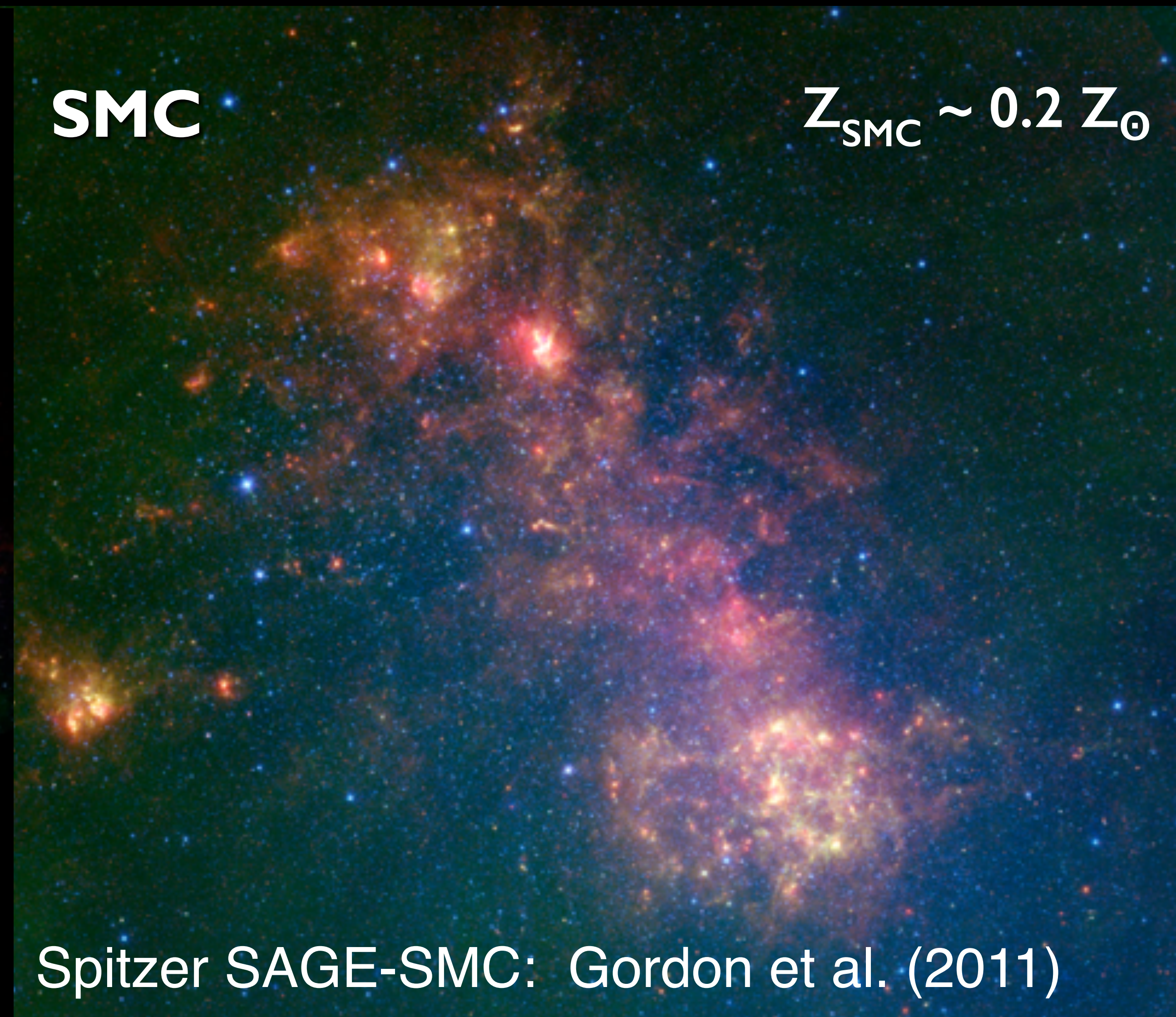
# An infrared census of the Magellanic Clouds



Spitzer SAGE: Meixner et al. (2006)



Spitzer SAGE-SMC: Gordon et al. (2011)

SAGE: >10.5 million point sources photometrically detected

SAGE-Spec: 1250+ *Spitzer* IRS spectra in the MCs

Determined dust budget of metal poor galaxies.

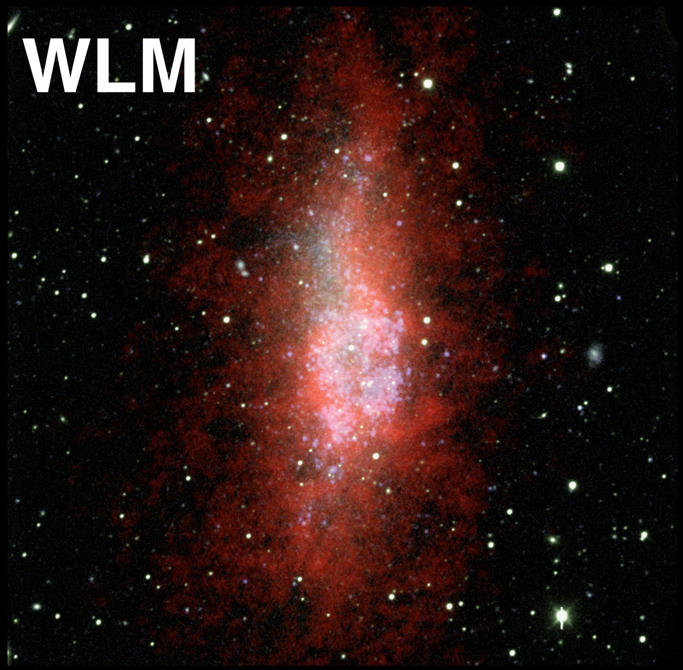
# An infrared census of evolved stars in the Local Group

DUSTiNGS: Imaged ~50 dwarf galaxies within 1.5 Mpc, down to [Fe/H] ~ -2.4
Found > 500 metal-poor dust-producing AGB stars (Boyer+2015).

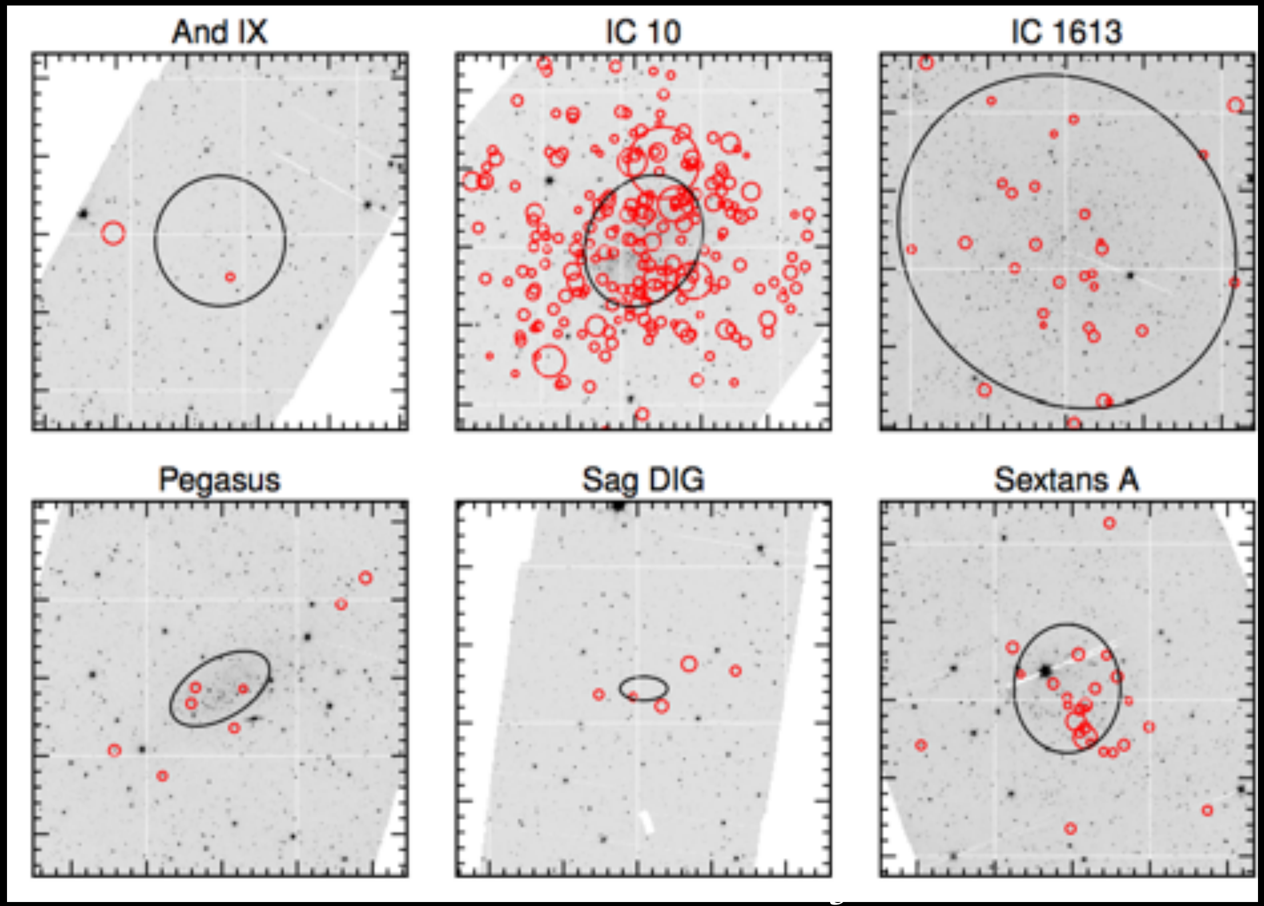
M33

McQuinn et al. (2007), Javadi et al. (2013)

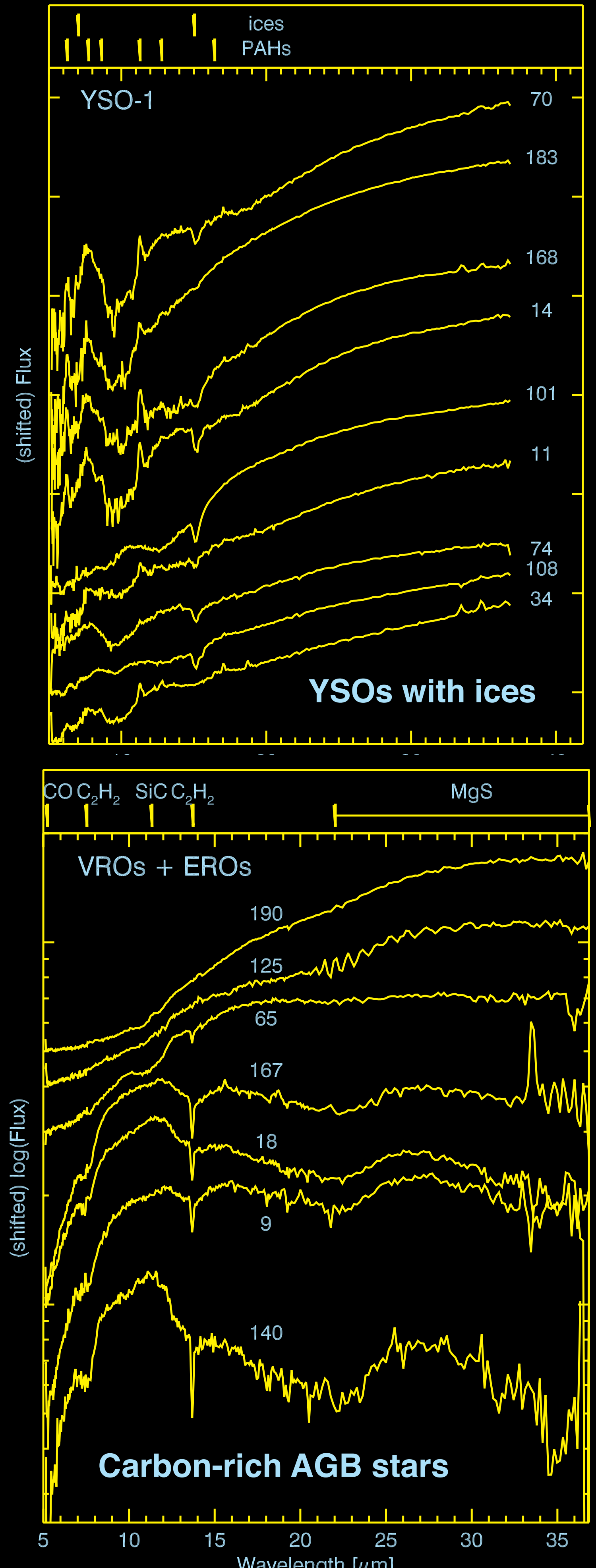

Jones et al. (2015a)




Jackson et al. (2007)




Boyer et al. (2015a)

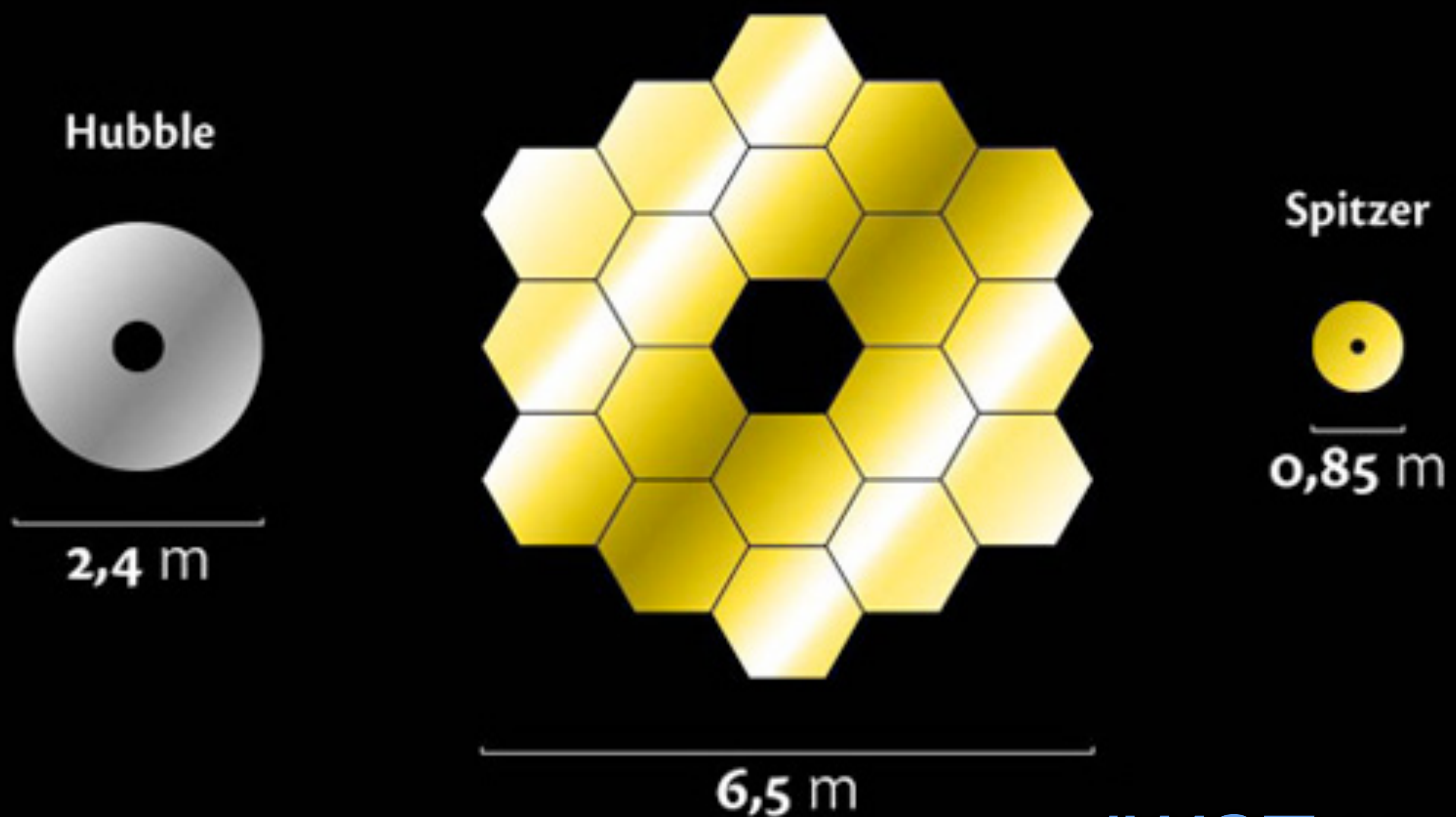



# SAGE-Spec: Point source classification

- Classified **ALL** 1250+ *Spitzer* IRS spectra in the LMC & SMC
- Identified: Young Stellar Objects, Red SuperGiants, HII regions, AGB stars, post-AGB stars, Planetary Nebulae, Background galaxies
- Spectra & classifications an ideal **empirical library** of template spectrum

**Kemper et al. (2010) Woods et al. (2011) Ruffle et al. (2015) Jones et al. (2017b)**

# JWST

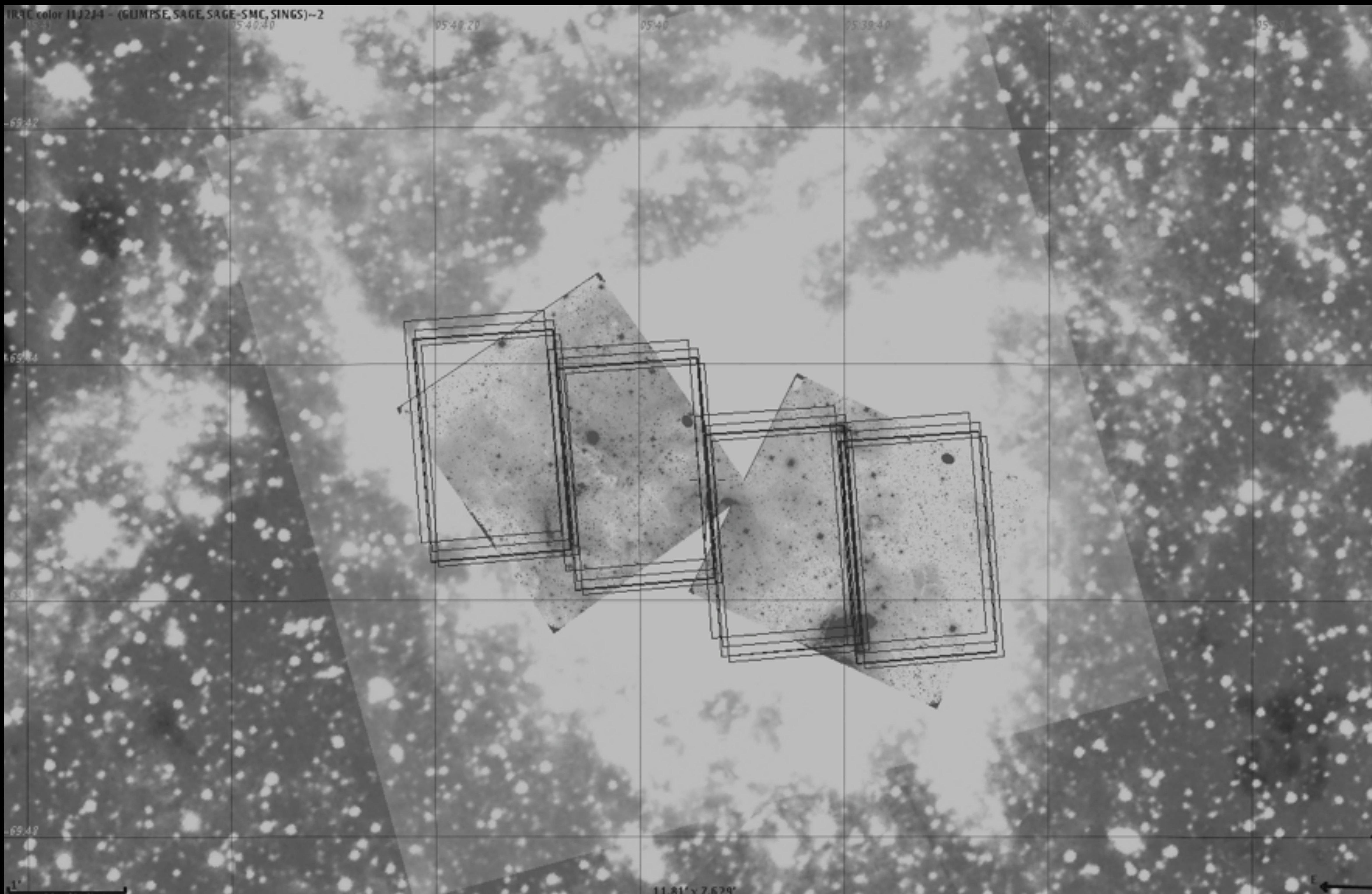



JWST can measure a spectrum of any source detected with Spitzer (few seconds to 2 hours + overheads)

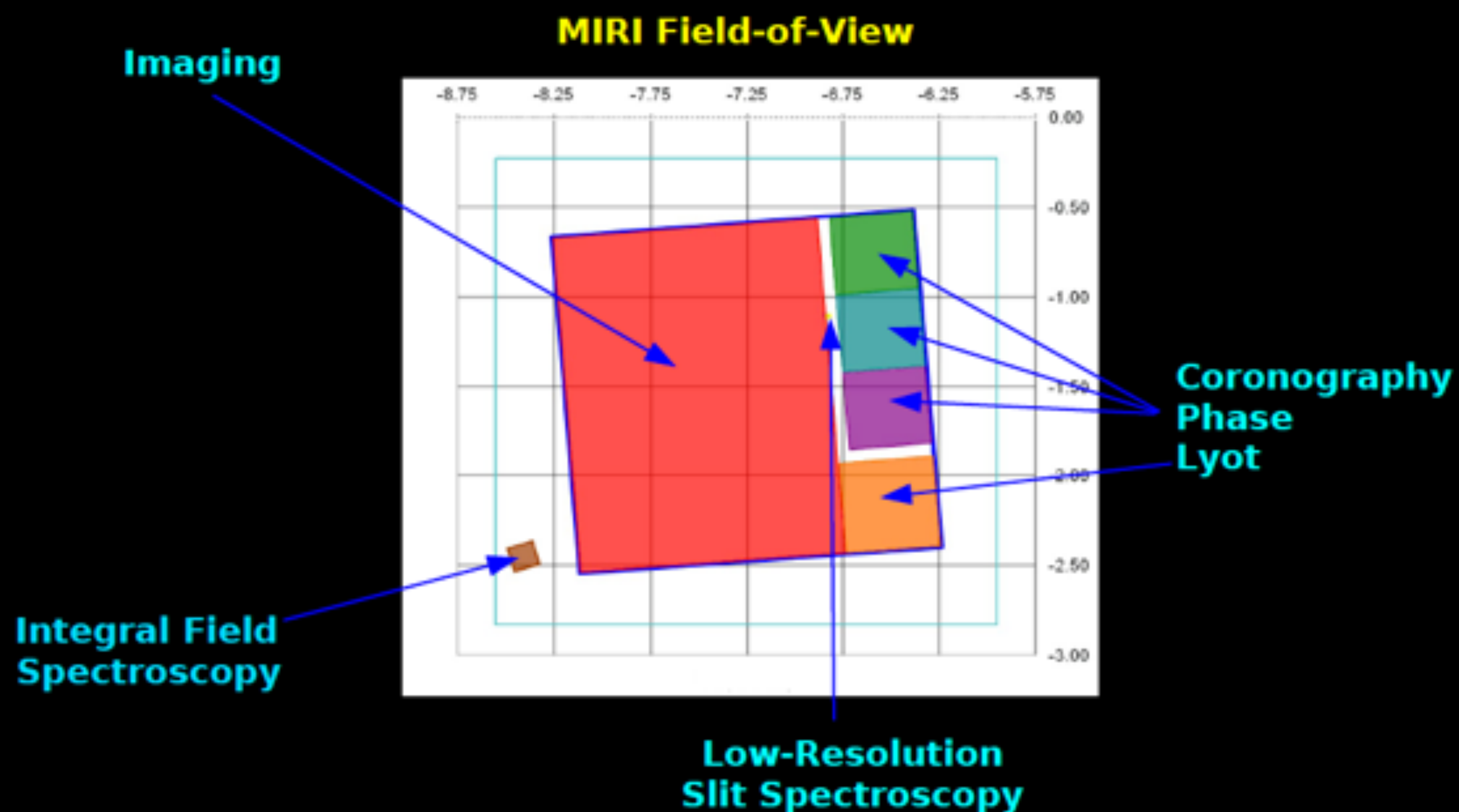
*JWST* 10-100x sensitivity over *HST* / *Spitzer* at higher resolution

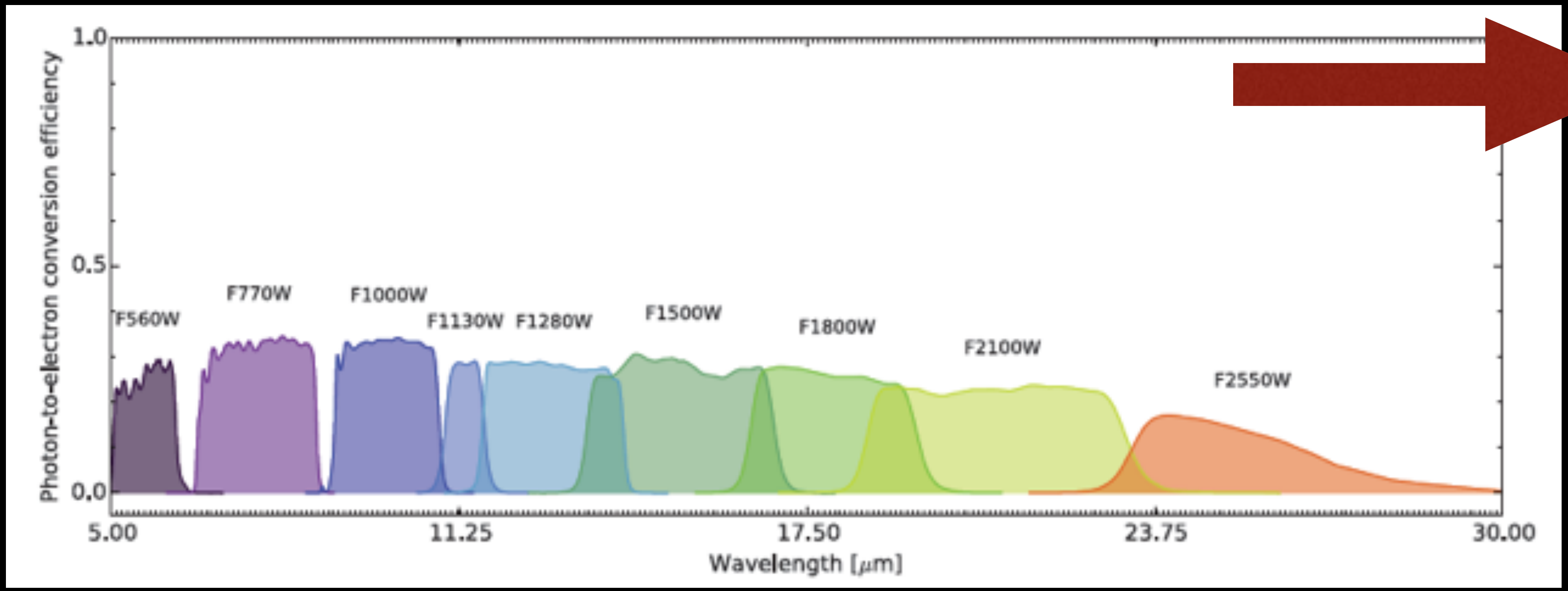
# Star forming regions - A case study

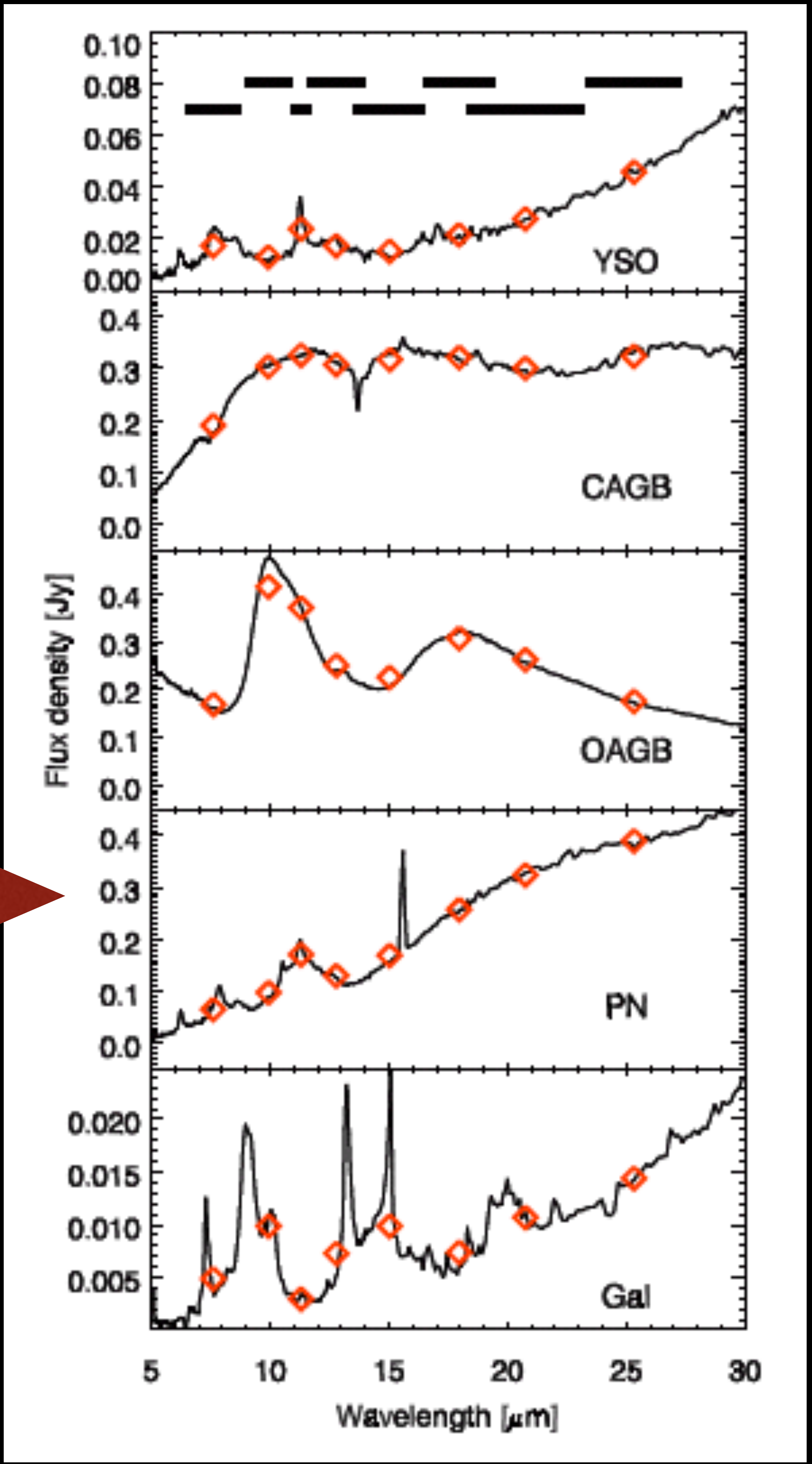
# *Spitzer* vs *JWST: LMC-N159*



# MIRI (only instrument observing from 5-28 microns)

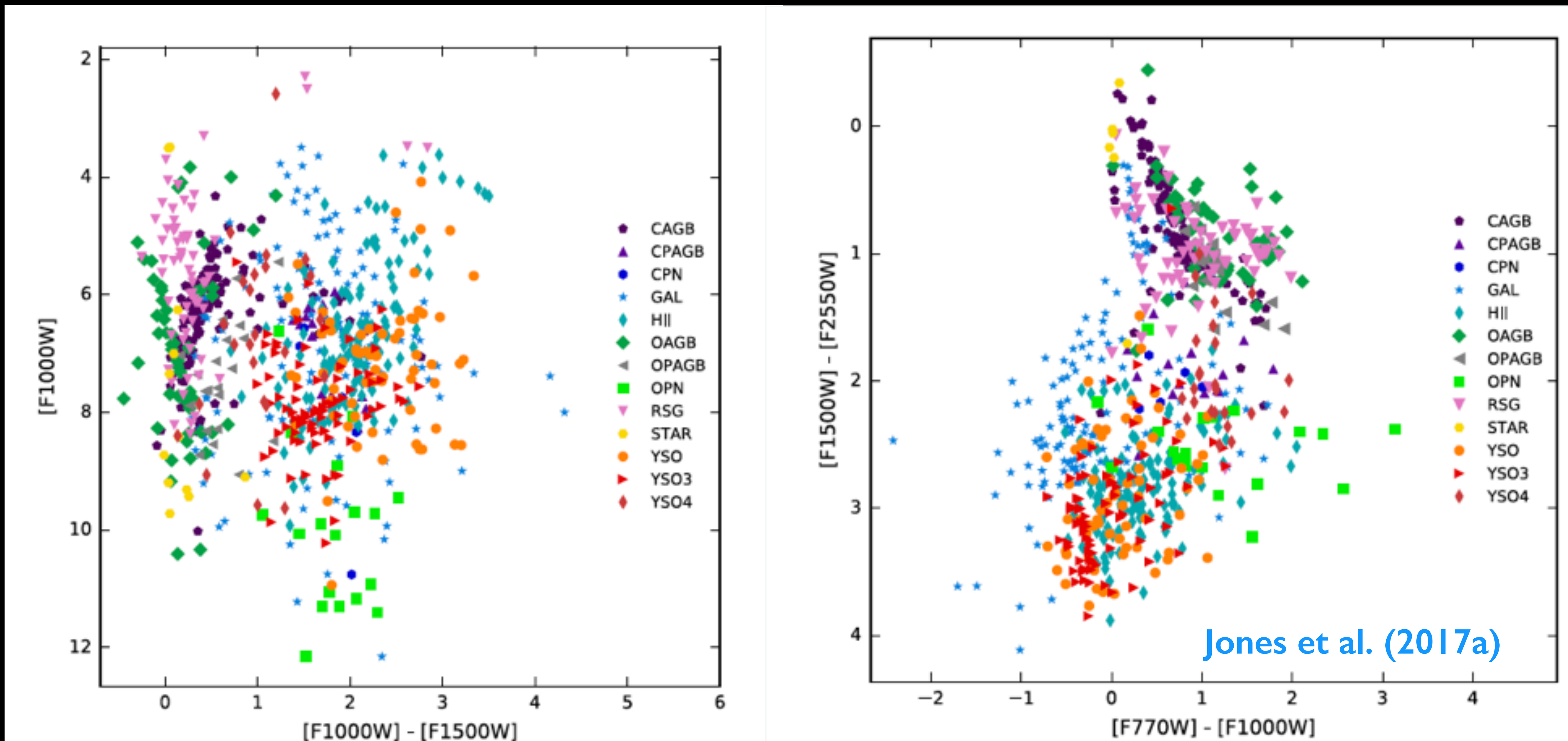



Glasse et al. (2015)

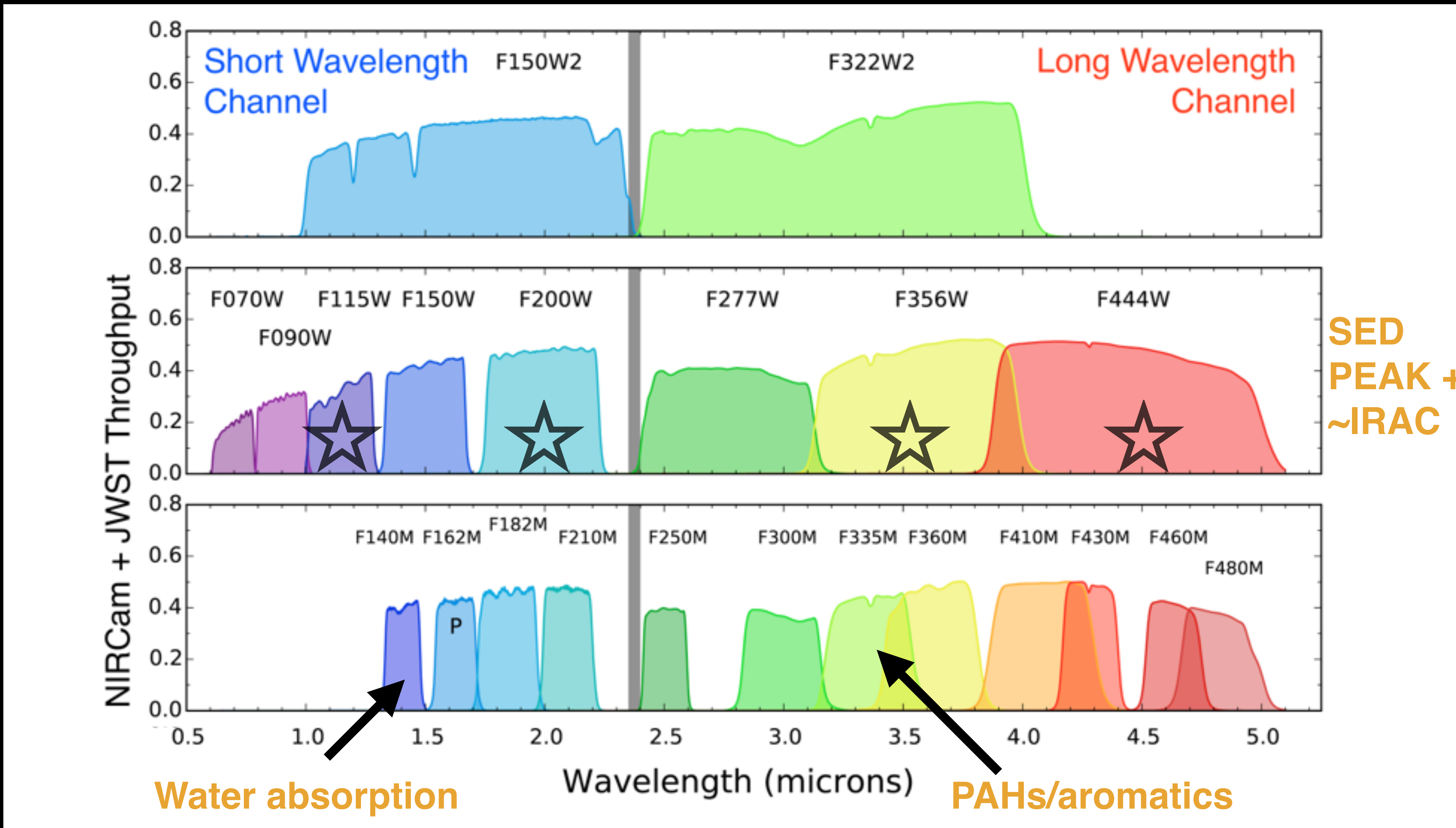
# Choice of MIRI filters for stellar populations



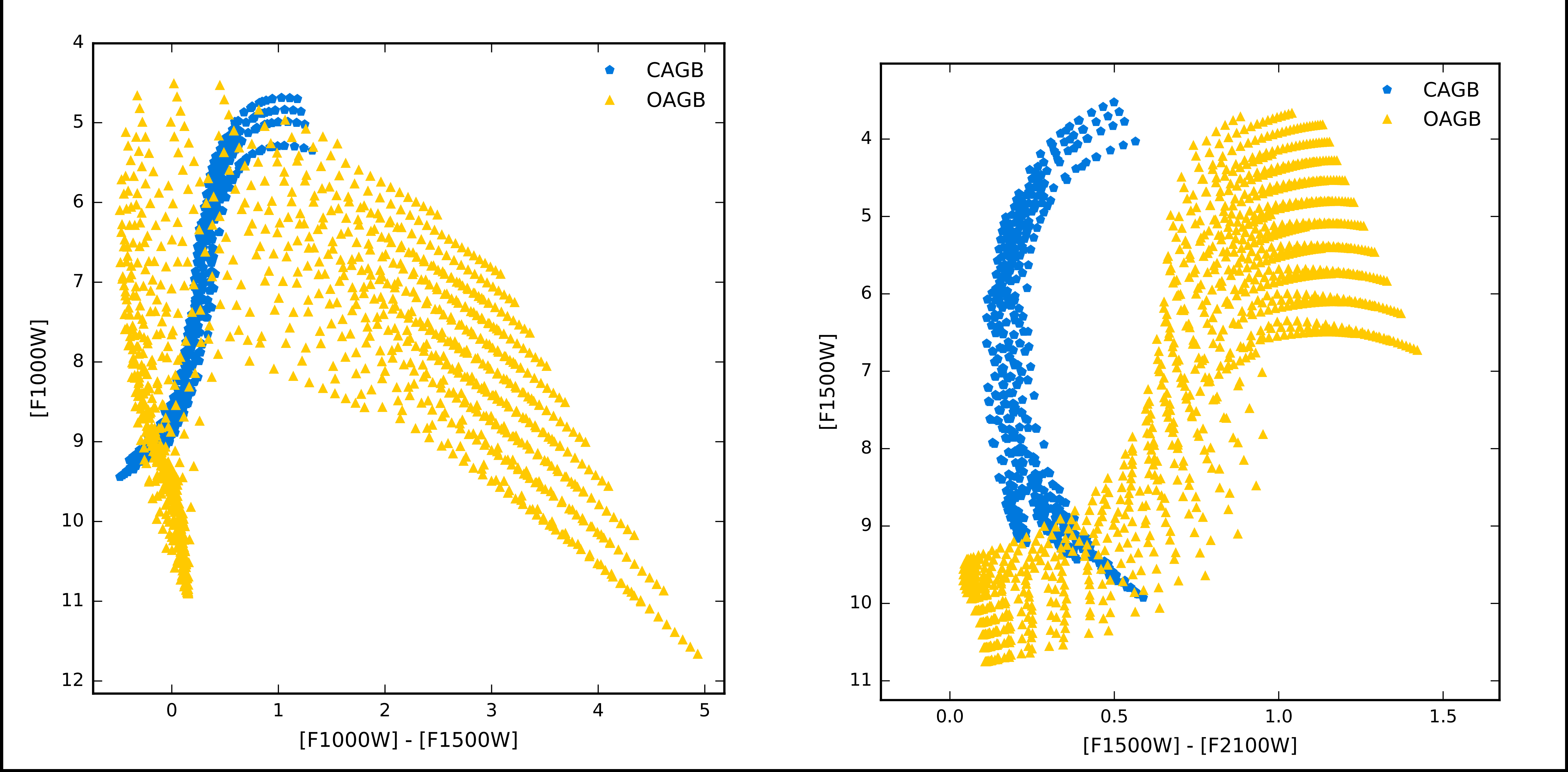

**Filter selection depends on the science goals but the [F770W], [F1000W], [F1500W] and [F2100W] filters are a good bet for stellar populations!**

Plus **NIRCam** observations covering the **photosphere** and **molecules!**

# NIRCam filters for stellar populations



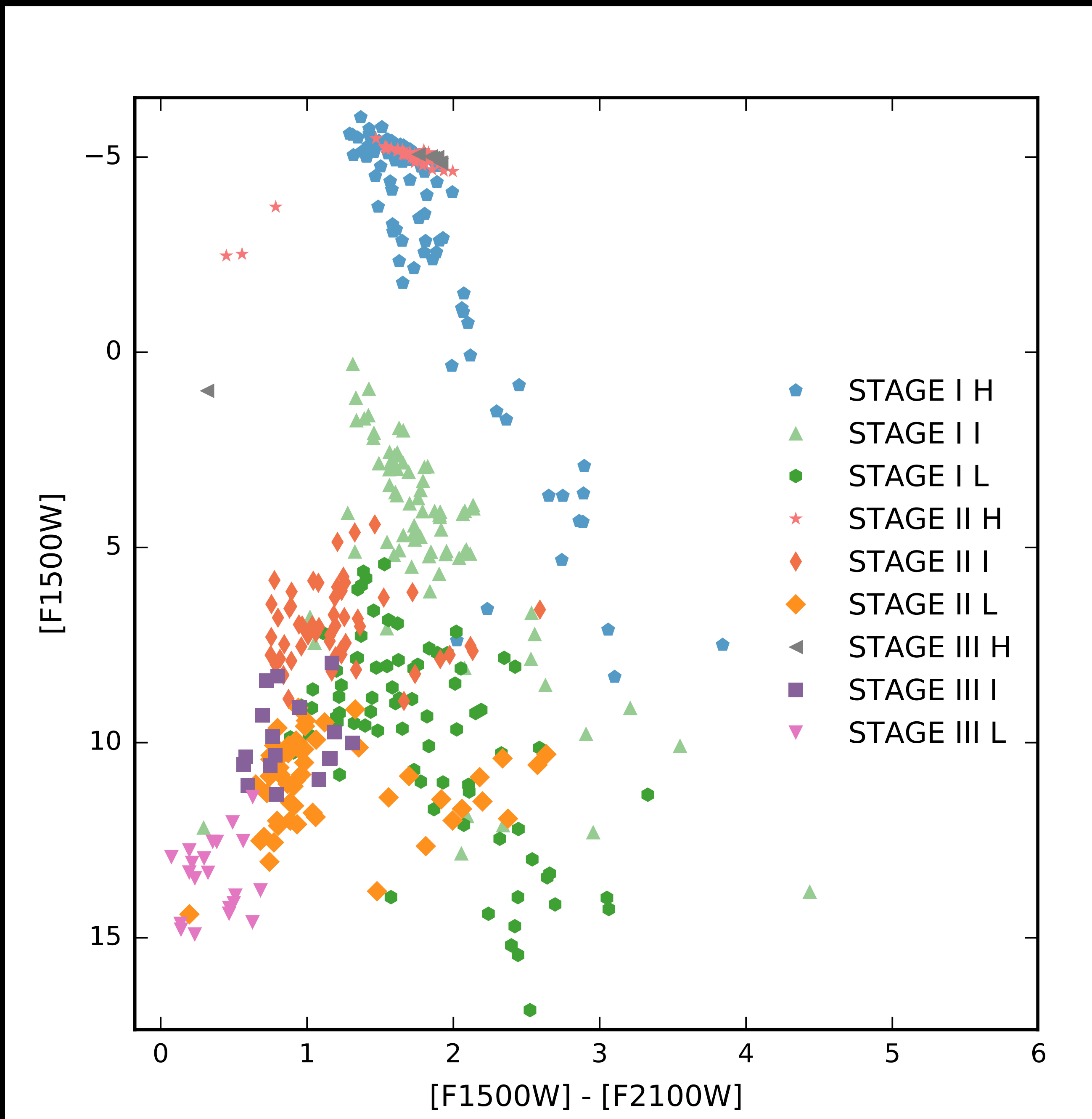
# Choice of MIRI filters for stellar populations: Evolved Stars - GRAMS

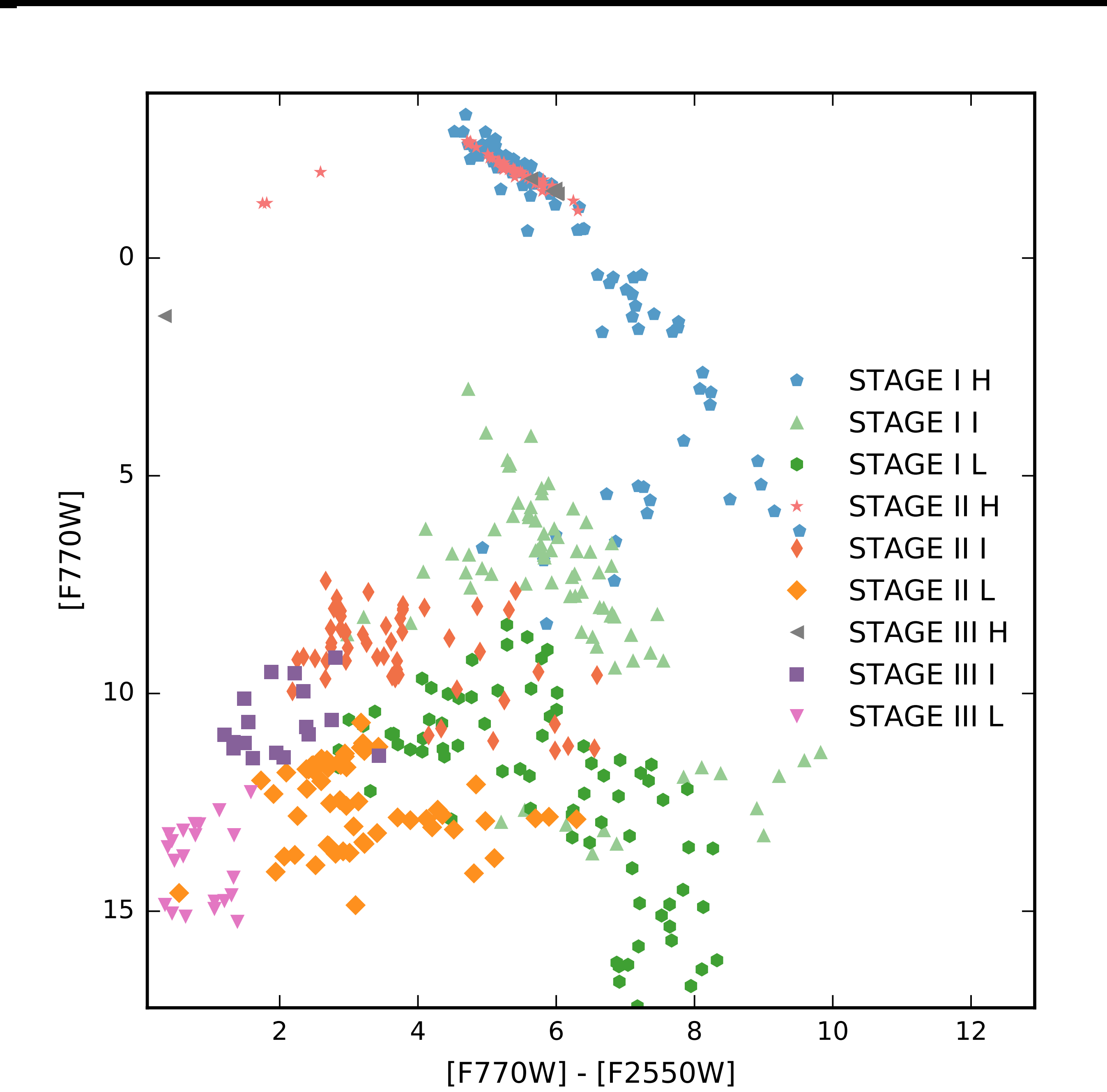



Model data: Sargent et al. 2011; Srinivasan et al. 2011

Jones et al. (2017a)

# Choice of MIRI filters for stellar populations: YSO models

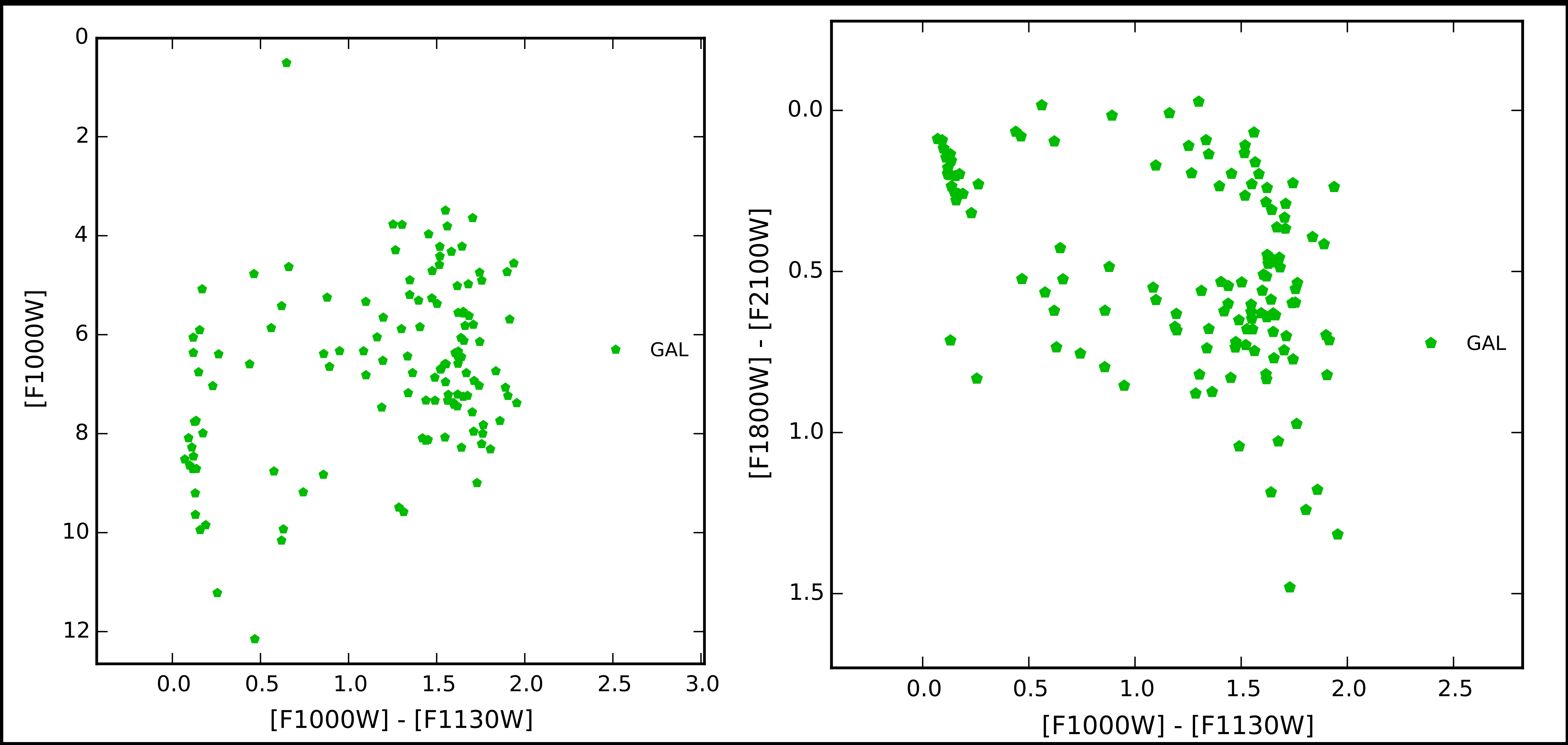


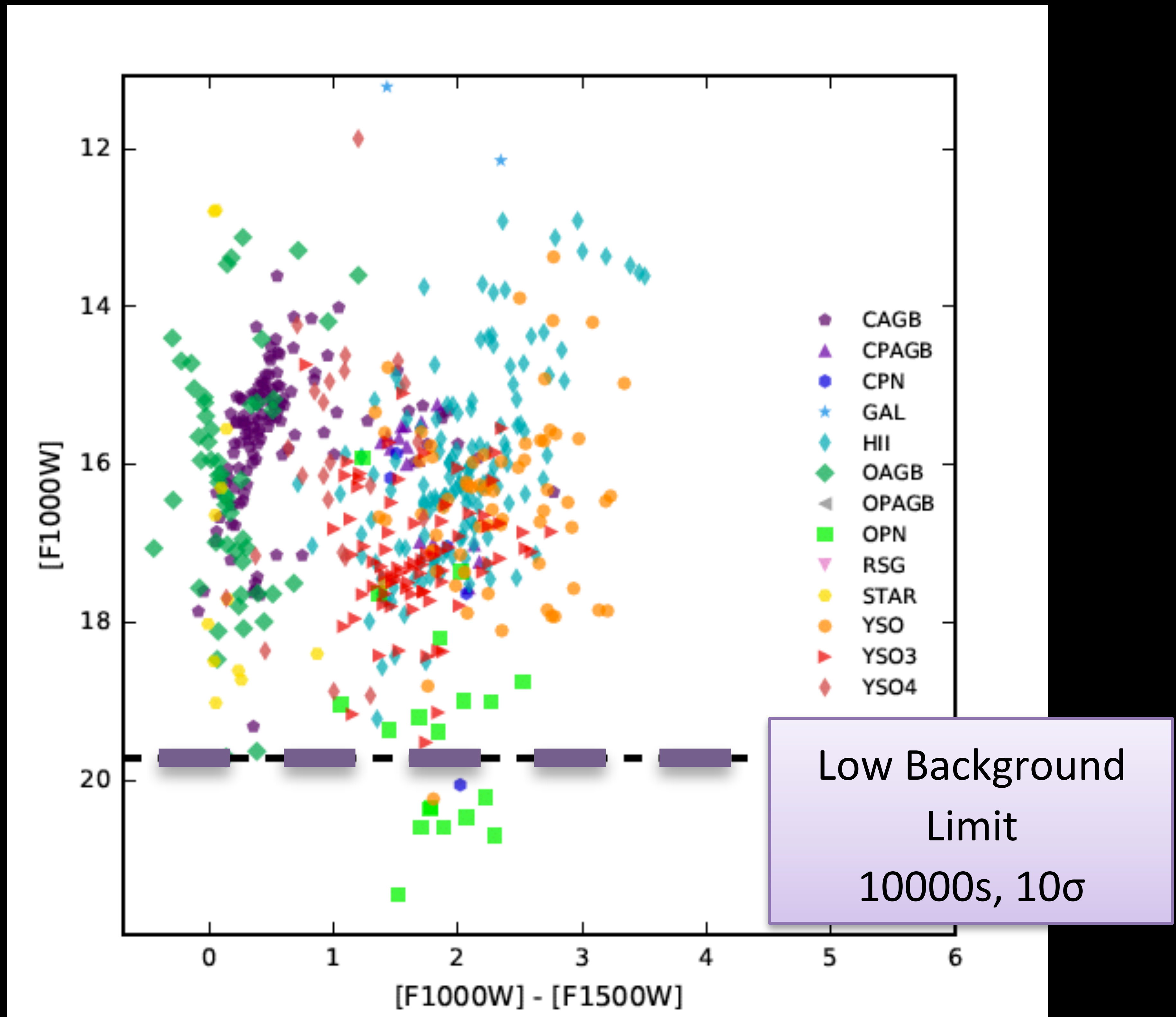

Jones et al. (2017a)

Model data: Robitaille et al. (2006)

# External galaxies are a major source of contamination in resolved stellar populations studies of local group galaxies - careful choice of MIRI filters can eliminate this contamination.



# MIRI predictions for the LMC placed at 2 Mpc




Jones et al. (2017a)

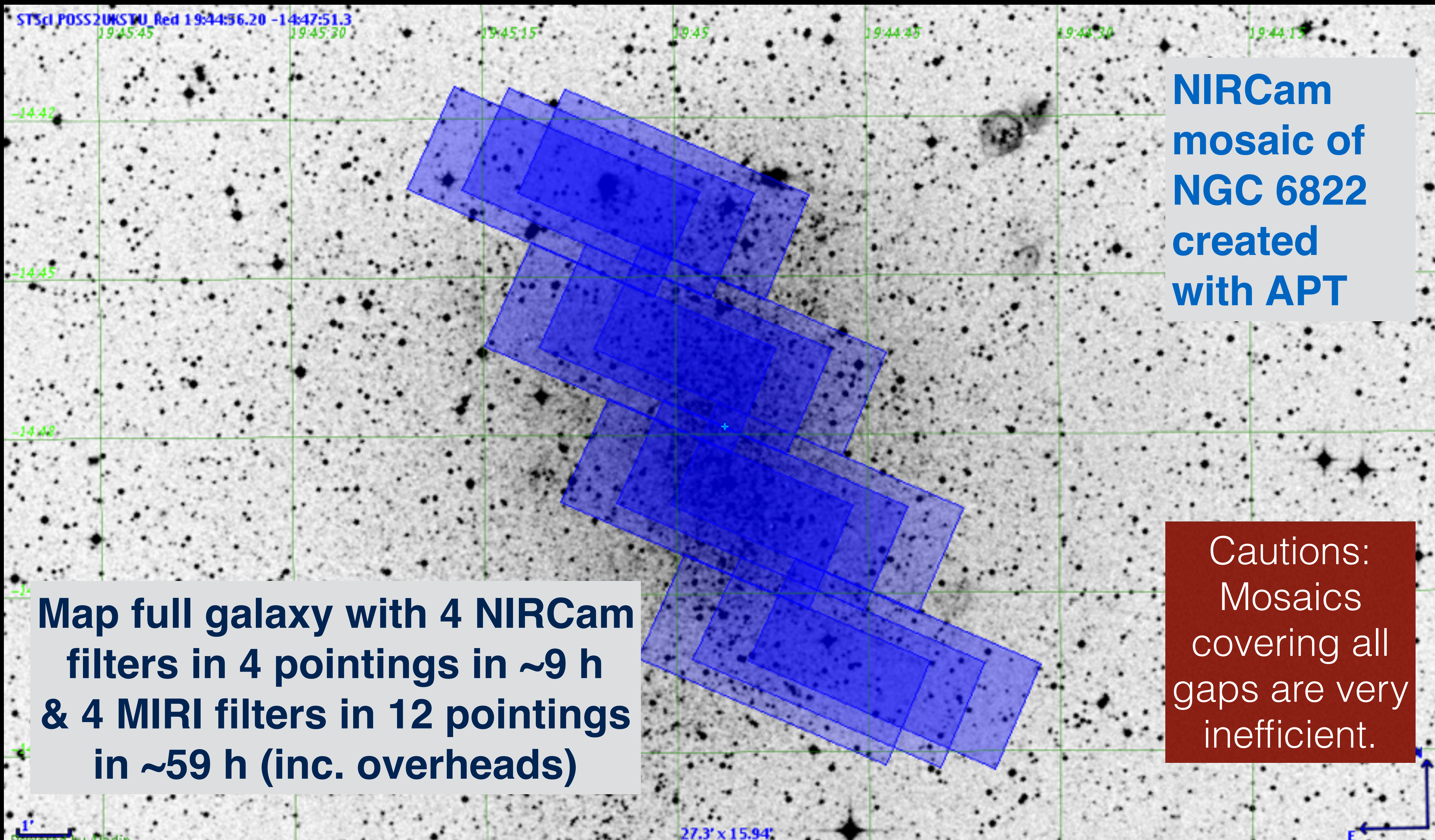
# Potential Galaxy Targets

| Galaxy | D (Mpc) | Size (') | [Fe/H] | Depth MIRI |
|---|---|---|---|---|
| NGC 6822 | 0.49 | 15.5 x 13.5 | -0.49 | Several Mag <TRGB |
| IC 10 | 0.67 | 6.8 x 5.9 | -1.08 | |
| M31 | 0.79 | 190 x 60 | > -0.1 | ~ 2 Mag < TRGB |
| M33 | 0.81 | 70.8 x 41.7 | -0.5 | |
| Sextans A | 1.32 | 5.9 x 4.9 | -1.9 | ~ TRGB |
| M81 Group | 3.6 | | | Few mag > TRGB |
| Sculptor Group | 3.9 | | | |
| I Zw 18 | 18.2 | 0.3 x 0.2 | -1.76 | Only the Brigtest sources |


NGC 6822:  Dust Life Cycle Study
of a Nearby Low Metallicity Galaxy


D = 490 Kpc
[Fe/H] = - 0.49
Unusual H I distribution
Bright HII regions
TRGB K0= 12.4 mag
>3500 AGB star candidates

# Galaxy wide Observations - A case study

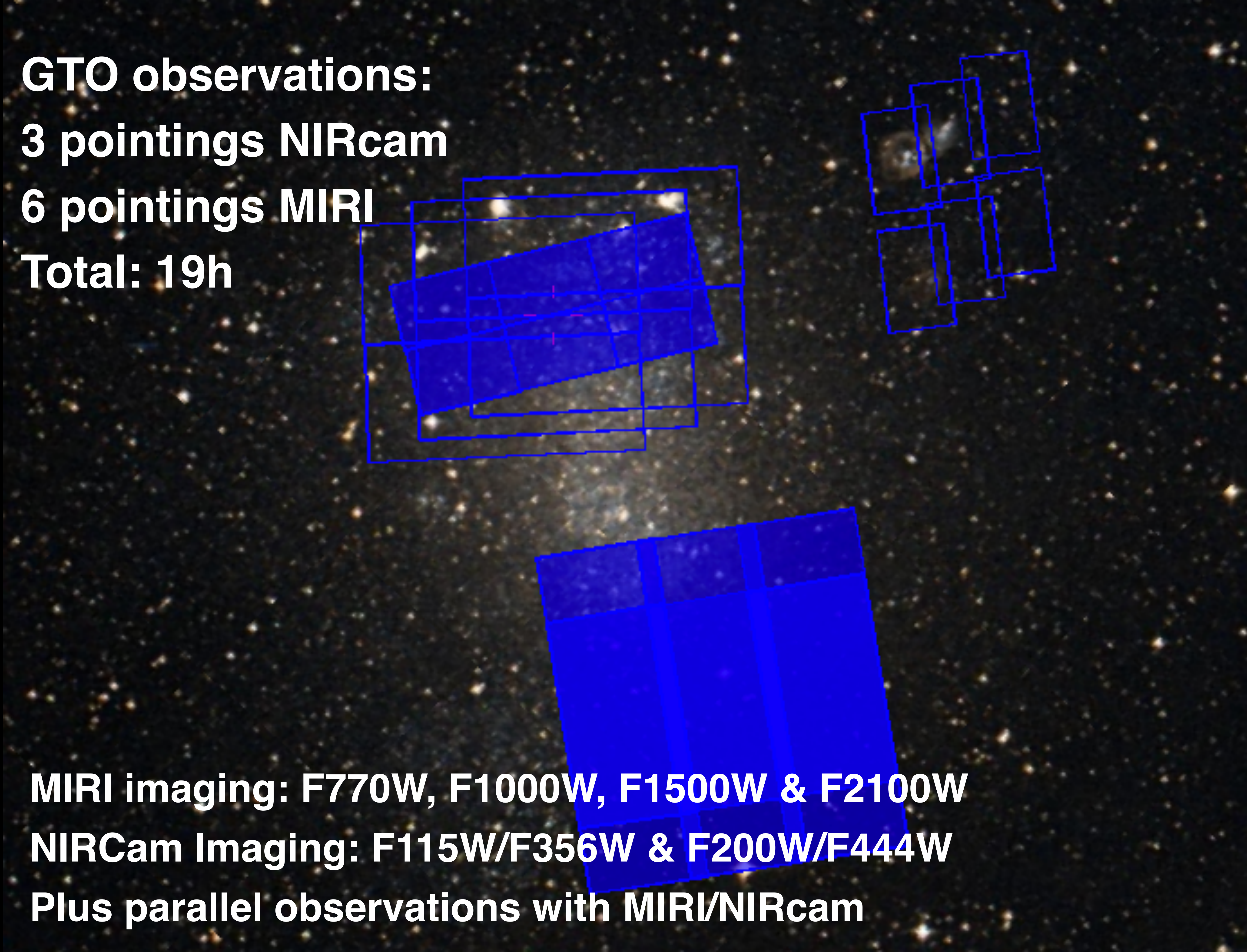



**NIRCam mosaic of NGC 6822 created with APT**

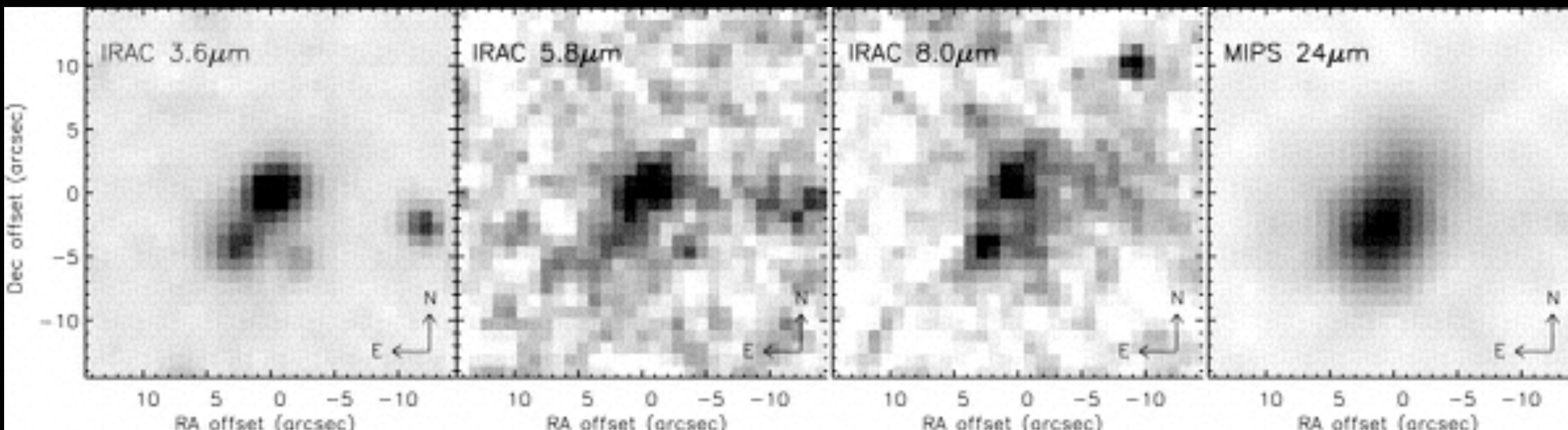
**Map full galaxy with 4 NIRCam filters in 4 pointings in ~9 h & 4 MIRI filters in 12 pointings in ~59 h (inc. overheads)**

Cautions: Mosaics covering all gaps are very inefficient.

ALMA observations have targeted the brightest star-formation regions.


GTO observations:
3 pointings NIRcam
6 pointings MIRI
Total: 19h
• MIRI imaging: F770W, F1000W, F1500W & F2100W
• NIRCam Imaging: F115W/F356W & F200W/F444W
• Plus parallel observations with MIRI/NIRcam

# I Zw18: Dust Life Cycle at Very Low Metallicity



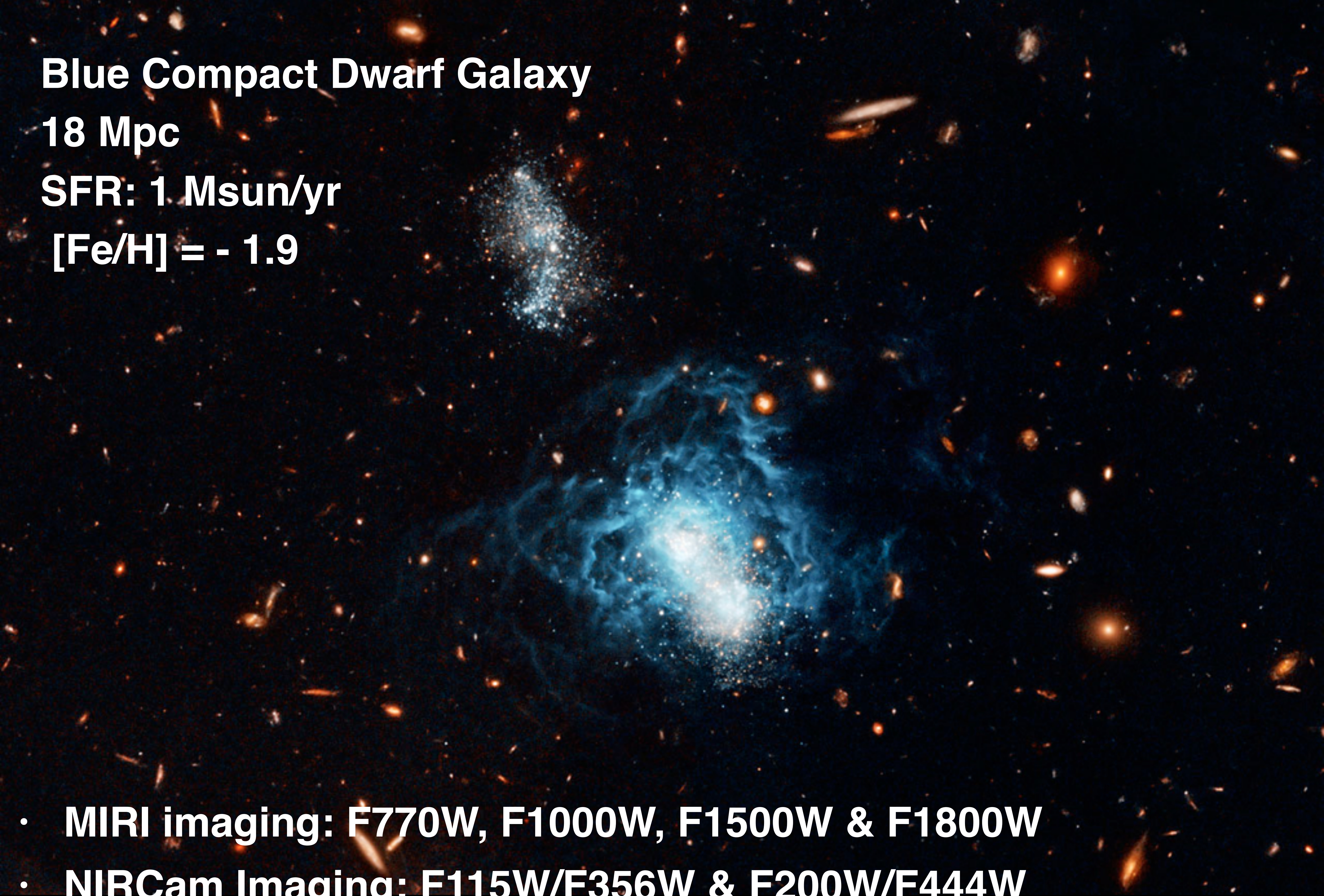

**At the distance of 18.2 Mpc, 1′′ corresponds to ~88pc**

Blue Compact Dwarf Galaxy

18 Mpc

SFR: 1 Msun/yr

[Fe/H] = - 1.9



- MIRI imaging: F770W, F1000W, F1500W & F1800W
- NIRCam Imaging: F115W/F356W & F200W/F444W
- Total observing time (inc. overheads): 6 *hours*

# Star formation in MCs



**Imaging and spectroscopic study with:**

**NIRCam, MIRI Imager, MIRI MRS spectroscopy & NIRSpec MSA spectroscopy.**

# What *will* JWST do for us?

- MIRI imaging: F770W, F1000W, F1130W, F1500W & F2500W
- NIRCam Imaging: F115W/F300M, F150W/F346W & F200W/F444W
- NIRSpec MSA spectroscopy - Many sources
- MIRI MRS - 5-10 embedded sources selected to be within <1’
- Plus parallel observations with MIRI/NIRcam -> F070W/F335M: Background field to correct for galaxy & foreground contamination; measure PAHs off field.

# Summary

The superior angular resolution of JWST will enable us to replicate Spitzer LMC/SMC SAGE-like studies over a wide parameter space.

MIRI can resolve stars below the tip of the RGB in galaxies at 2 Mpc

Characterise dust produced by evolved stars at high-z by looking at dwarf irregulars.

Observe low mass star-formation in the MCs.

[F1000W]-[F1500W] is excellent at separating composite IR stellar populations.

To target specific populations other bands may be optimal!

Fluxes & magnitudes for >1250 stellar sources & galaxies are publicly available - Jones et al. 2017a