Dust Evolution at Low Metallicity: A JWST study of NGC 6822

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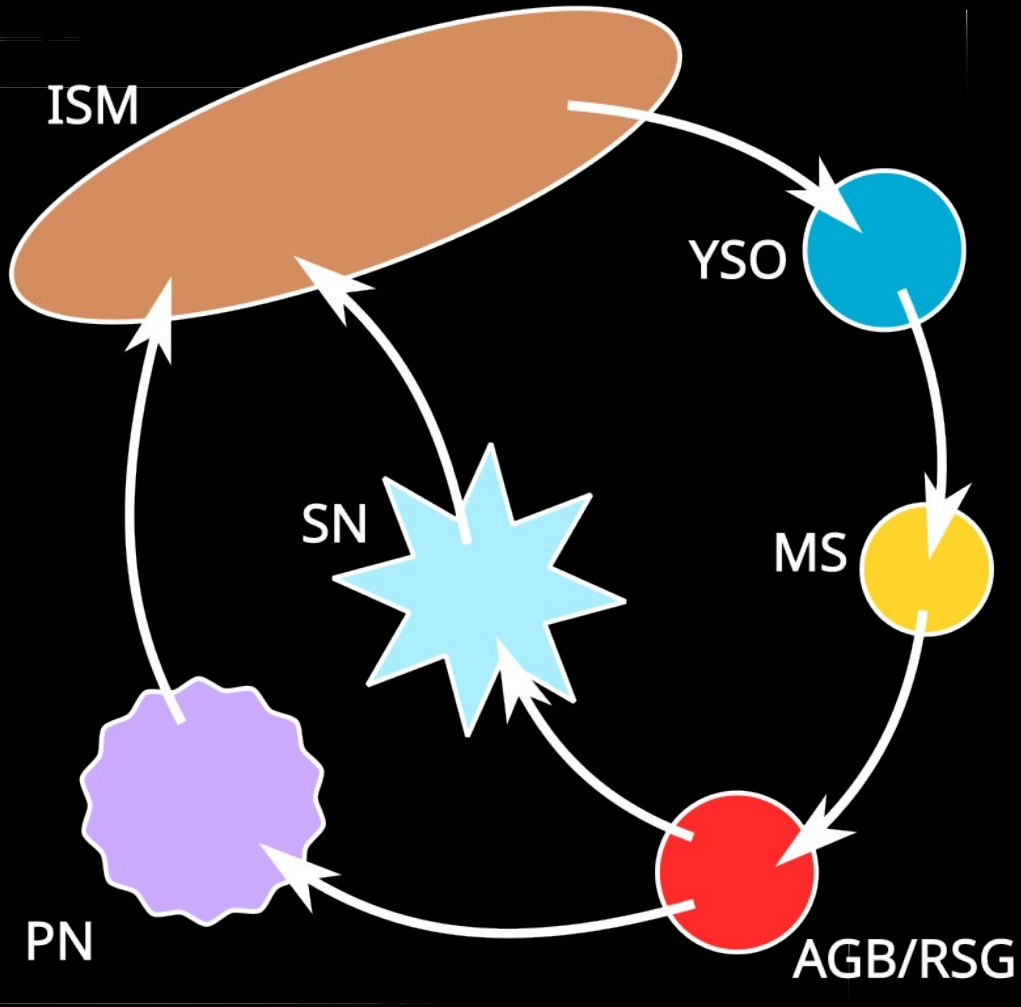
Dust Life Cycle

- Chemical evolution of a galaxy centres around the dust in the interstellar medium

- We need to understand all the dust creation and destruction mechanisms in the full range of metallicity scenarios.

- Resolved stellar studies are the tool used to build models on Local Group objects and applied to the early universe

- Understanding dust evolution is a key component to galactic evolution



Previous Work

- SAGE-LMC Meixner et al. (2006)

- SAGE-SMC Gordon et al. (2011)

- DUSTINGS Boyer et al. (2017)

- Spitzer sensitivity and resolution limited the study to within ~1Mpc

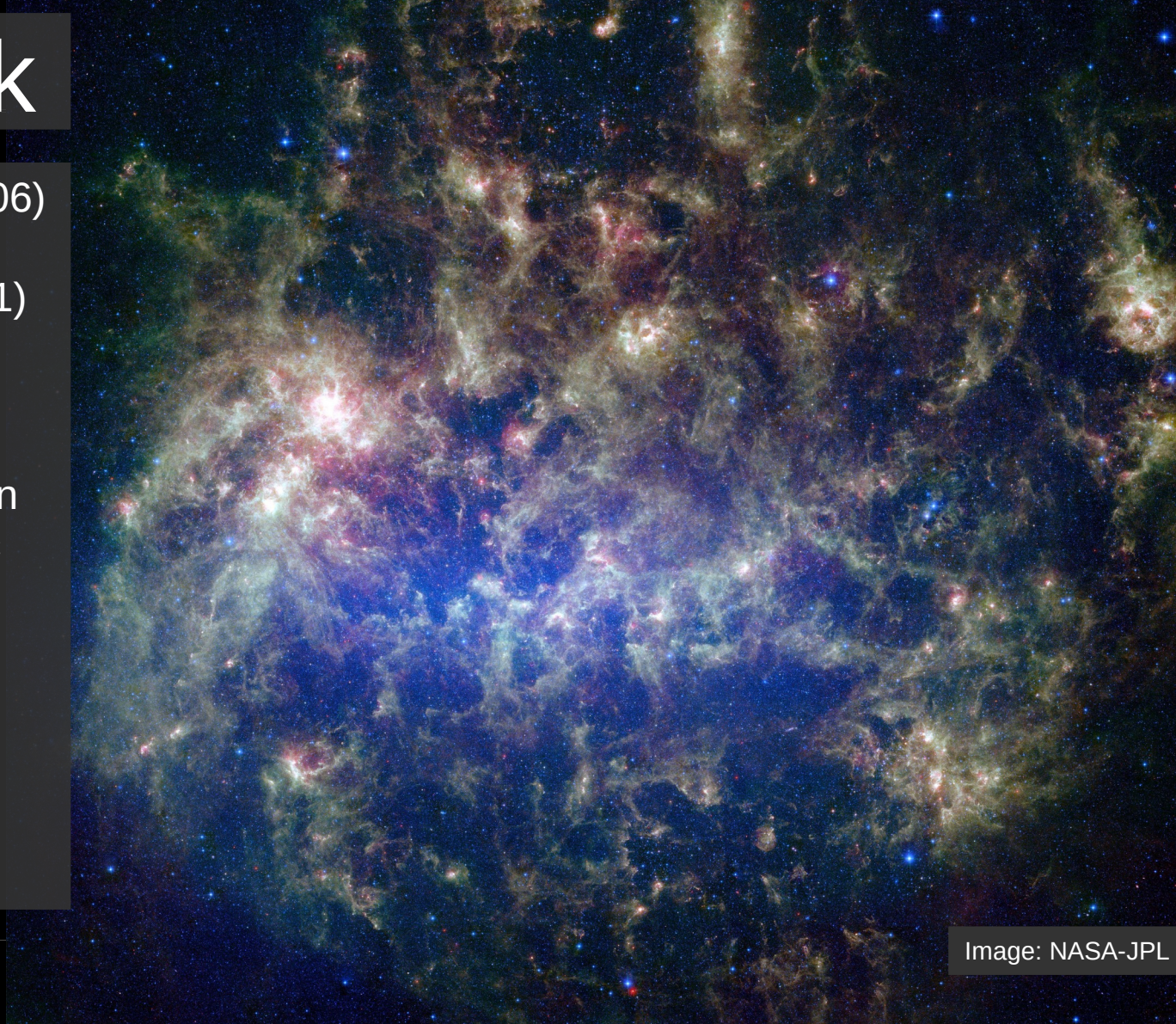


Image: NASA-JPL

NGC 6822

- Barred irregular galaxy in the Local Group

- Nearby: ~500kpc

- Metal Poor: $Z \sim 0.25 Z_{\odot}$

- Analogous star forming systems at epoch of peak star formation z=2

- Similar structure and composition as Small Magellanic Cloud

- Tidally isolated

- Unusual HI distribution and bright HII regions

Image: ESO

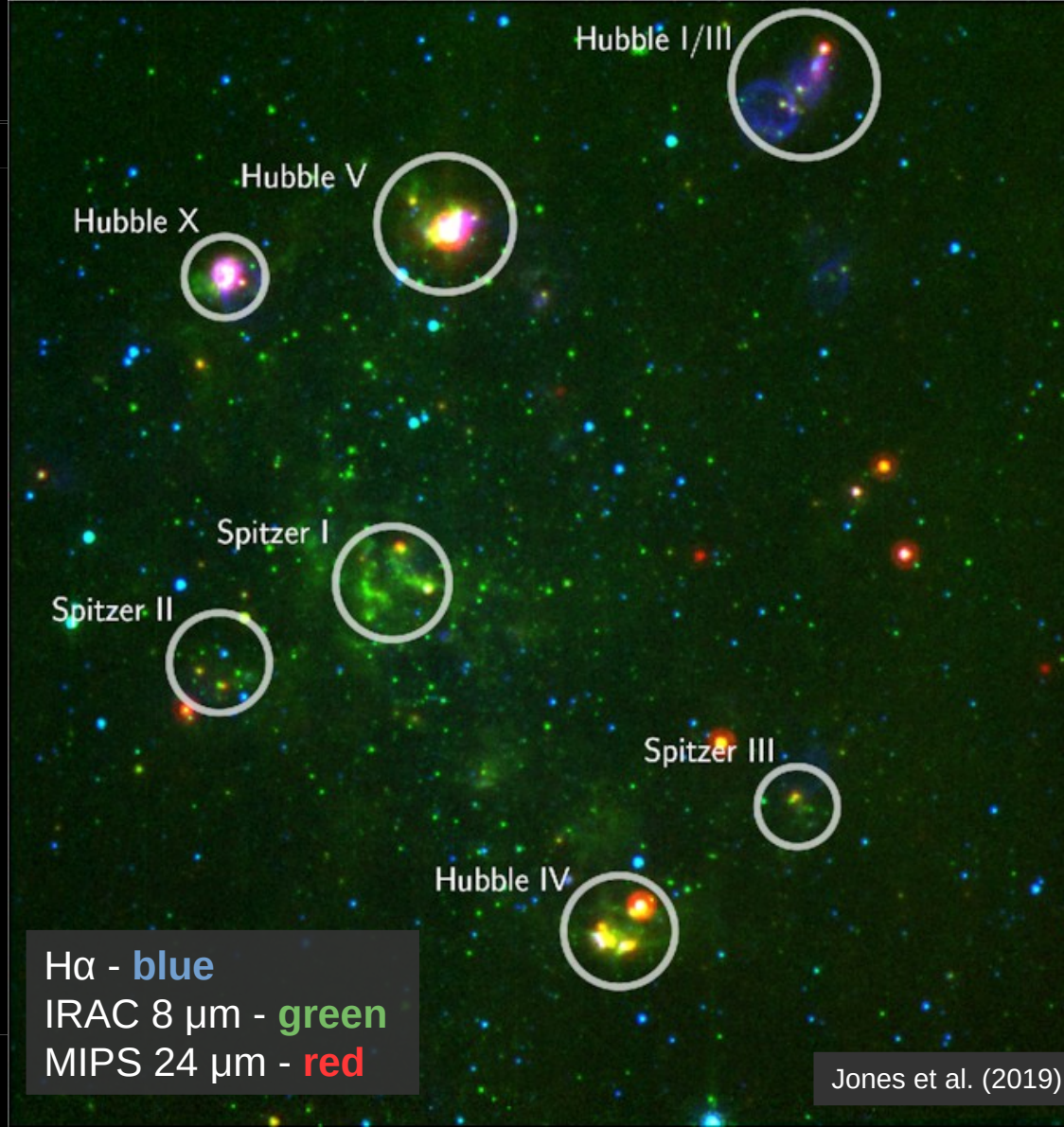
Young Population

- Home to several, bright, well know massive star-formation Hubble regions

- Spitzer archival data revealed three deeply embedded star forming regions

- Spitzer I has more young objects than any Hubble region

- Discovery changed the focus of this GTO program

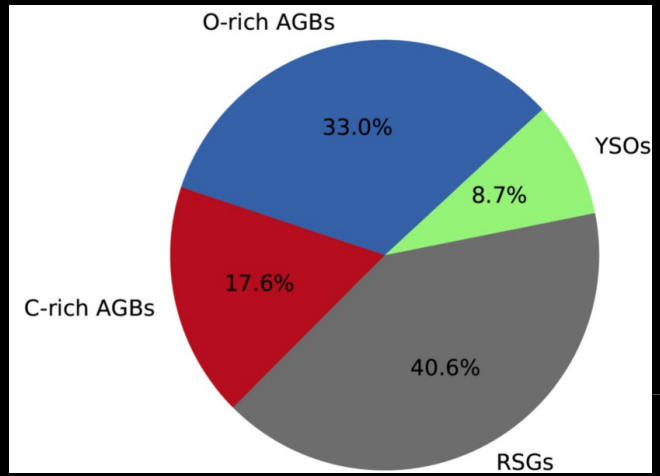


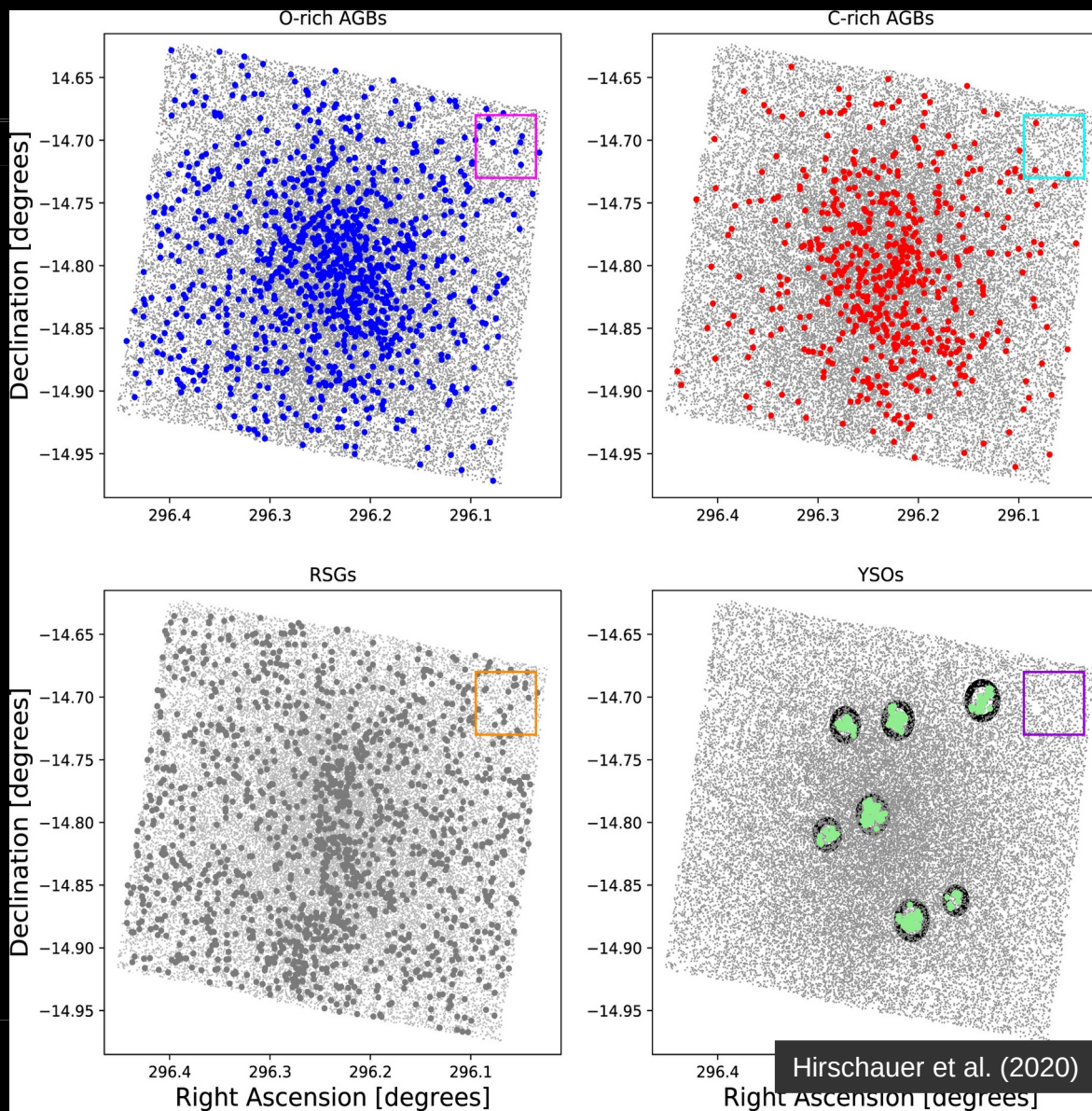
IR Population

- TRGB K=17.4; N>3500 AGBs

- Sibbons et al. 2012 (JKH) found even distribution of evolved stars

- Hirschauer et al. 2020 folded in Spitzer data and employed a statistical method to separate populations





Hirschauer et al. (2020)

JWST Study of NGC 6822

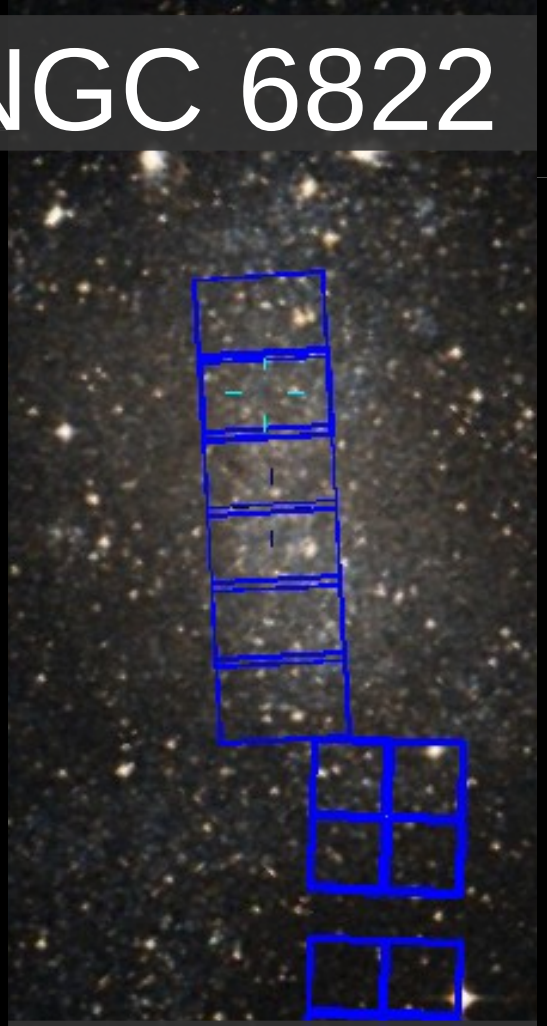
- 17 Hours total integration time in 4 NIRCam filters and 4 MIRI filters

- Filters selected based on stellar models and Spitzer Spectra in the Magellanic clouds (Jones et al 2017)

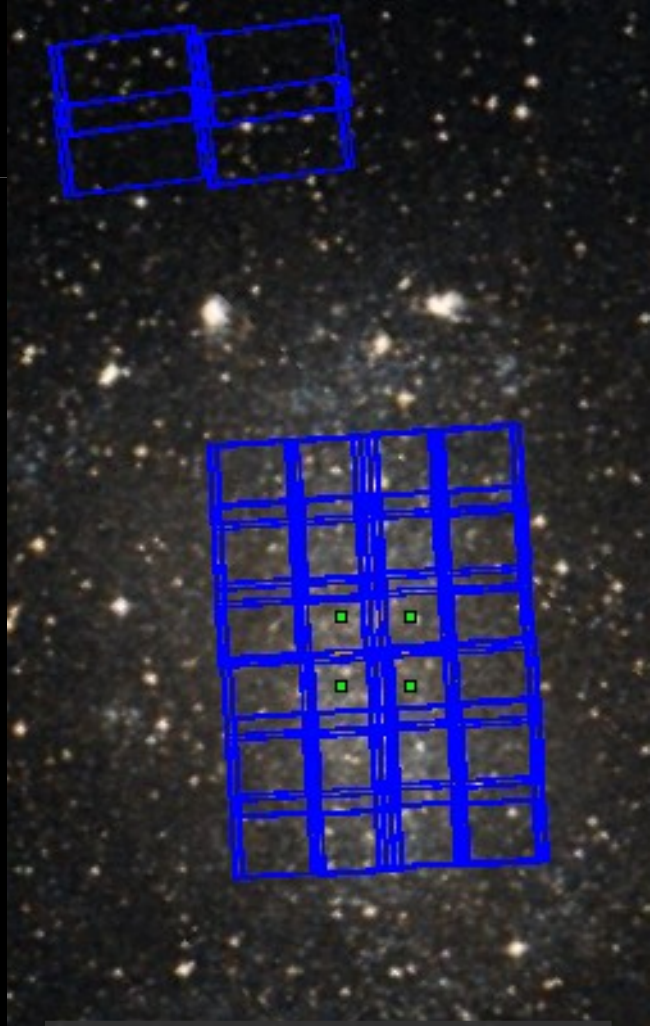
- Star formation down to 2 $M_{\odot}$

- Detecting several magnitudes below RC, entire IR population

- Embedded sources will be ideal spectroscopic follow up targets



MIRI: F770W F1000W F1500W F2100W



NIRCam: F115W F200W F356W F444W

Starbug II

- PSF fitting using python PHOTUTILS

- JWST Pipeline includes aperture photometry but for our purposes, PSF photometry is necessary

- Designed to accommodate large numbers of filters

- Ensemble of background subtractions to build a construct source list prior to fitting

- It will be able to recover saturated sources from earlier stages in JWST output pipeline

Starbug II

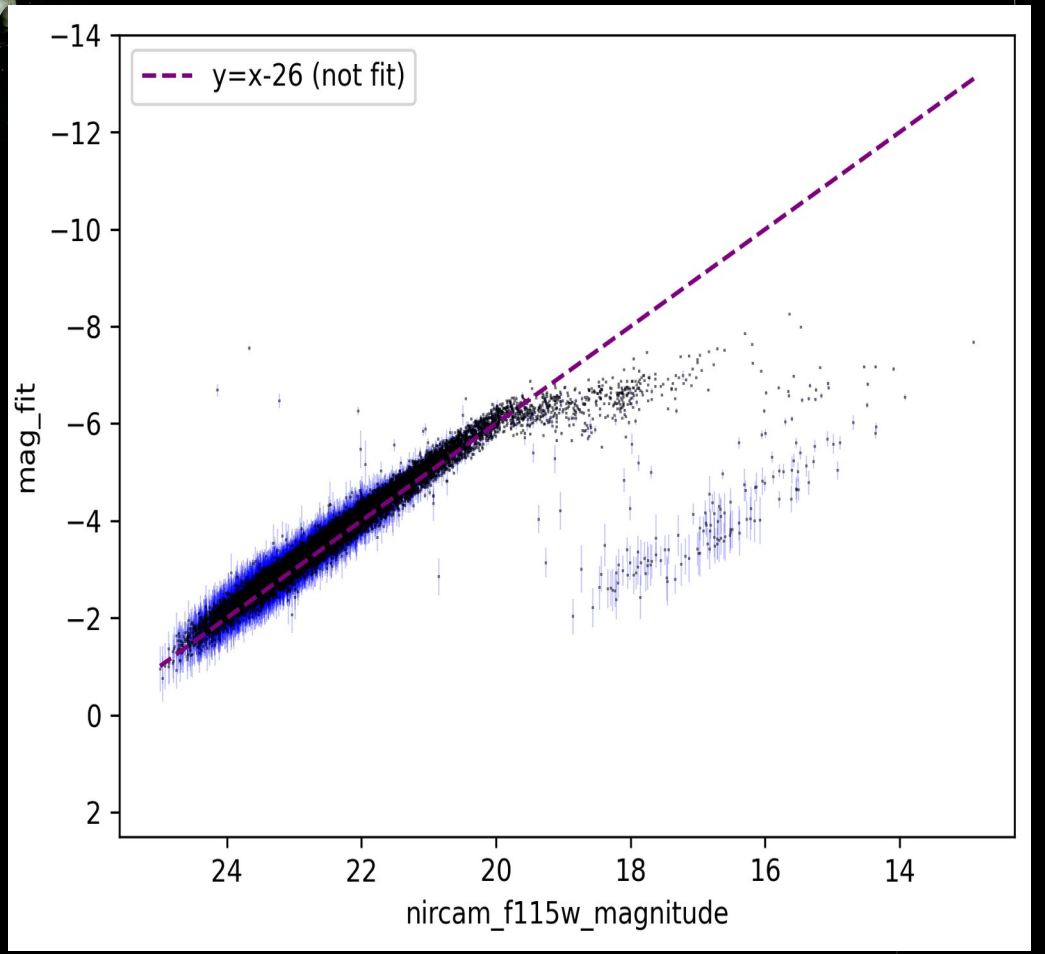
- Tested on MIRAGE NGC 346 simulation

- After cutting contaminants Starbug recovers simulated fluxes well

- Saturation effects demonstrate necessity to integrate with JWST pipeline

- Aim to have it publicly available after some real data testing following data release on the 12th

- https://github.com/conornally/starbug2



Summary

- Dust cycle is a core mechanism of galactic evolution

- NGC 6822 is an ideal target for studying galaxies during peak star forming epoch:
it has a significant population of evolved stars and several areas of very active star formation

- Our 17h JWST program using 8 NIRCam and MIRI filters
is expected to reach the below the red clump and will detect
embedded young stellar objects $M>2M_{\odot}$

- Starbug II (Nally et al. in prep.) is a python PSF fitting tool
that will be made public after robust testing is conducted
following the first light release:

https://github.com/conornally/starbug2