Dust Production from Metal-Poor AGB Stars: JWST Results from Sextans A

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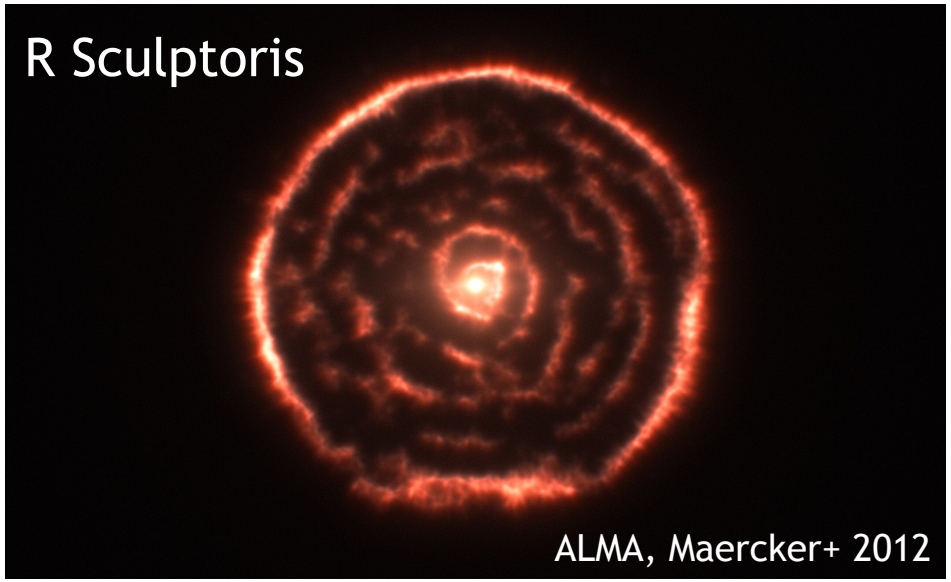
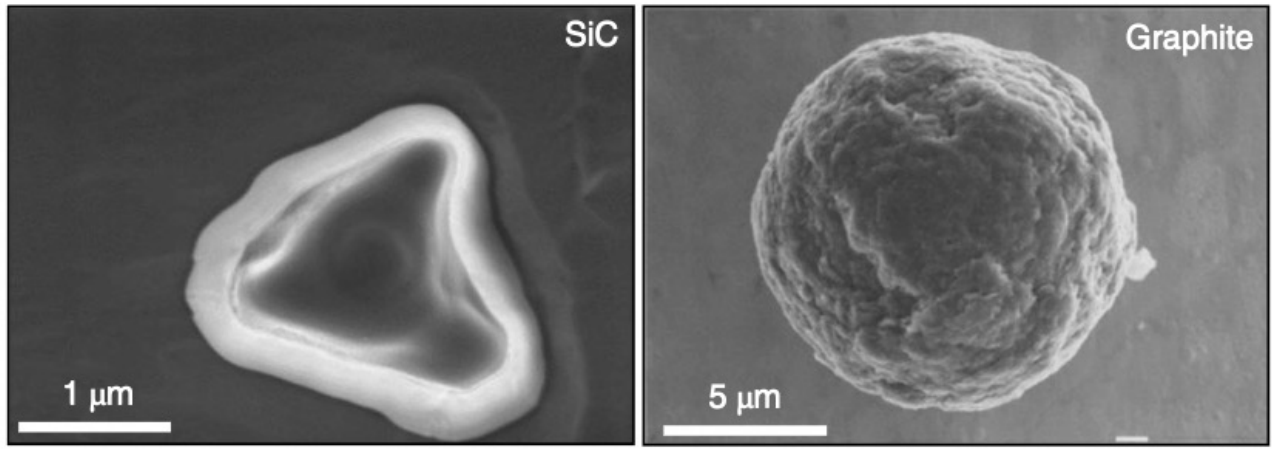
AGB Stars Produce Dust

Dust grains condense in the winds of thermally pulsating AGB stars and enrich the **interstellar medium**

AGB stars account for **~75%** of the **presolar** grains found in the Solar System (Hoppe+ 2022) and dominate the dust in the **Milky Way** (Tielens+ 2005)



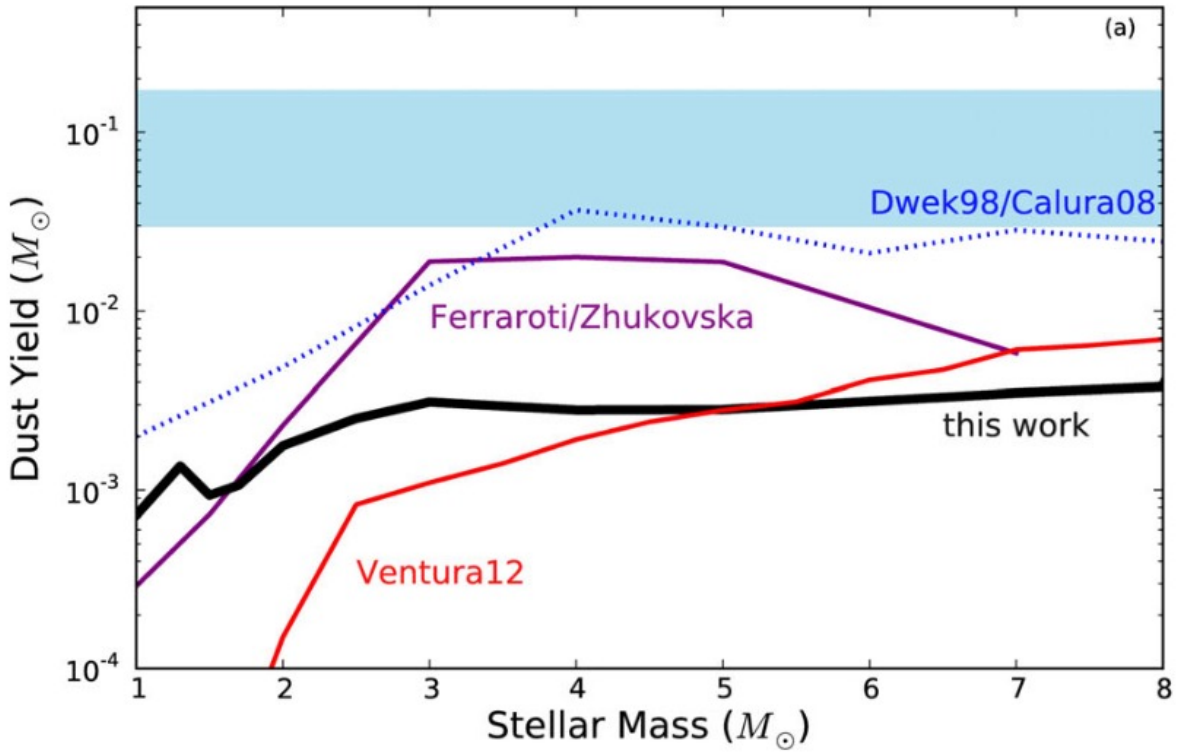


Hoppe+ 2022

The High Redshift Dust Budget "Crisis"

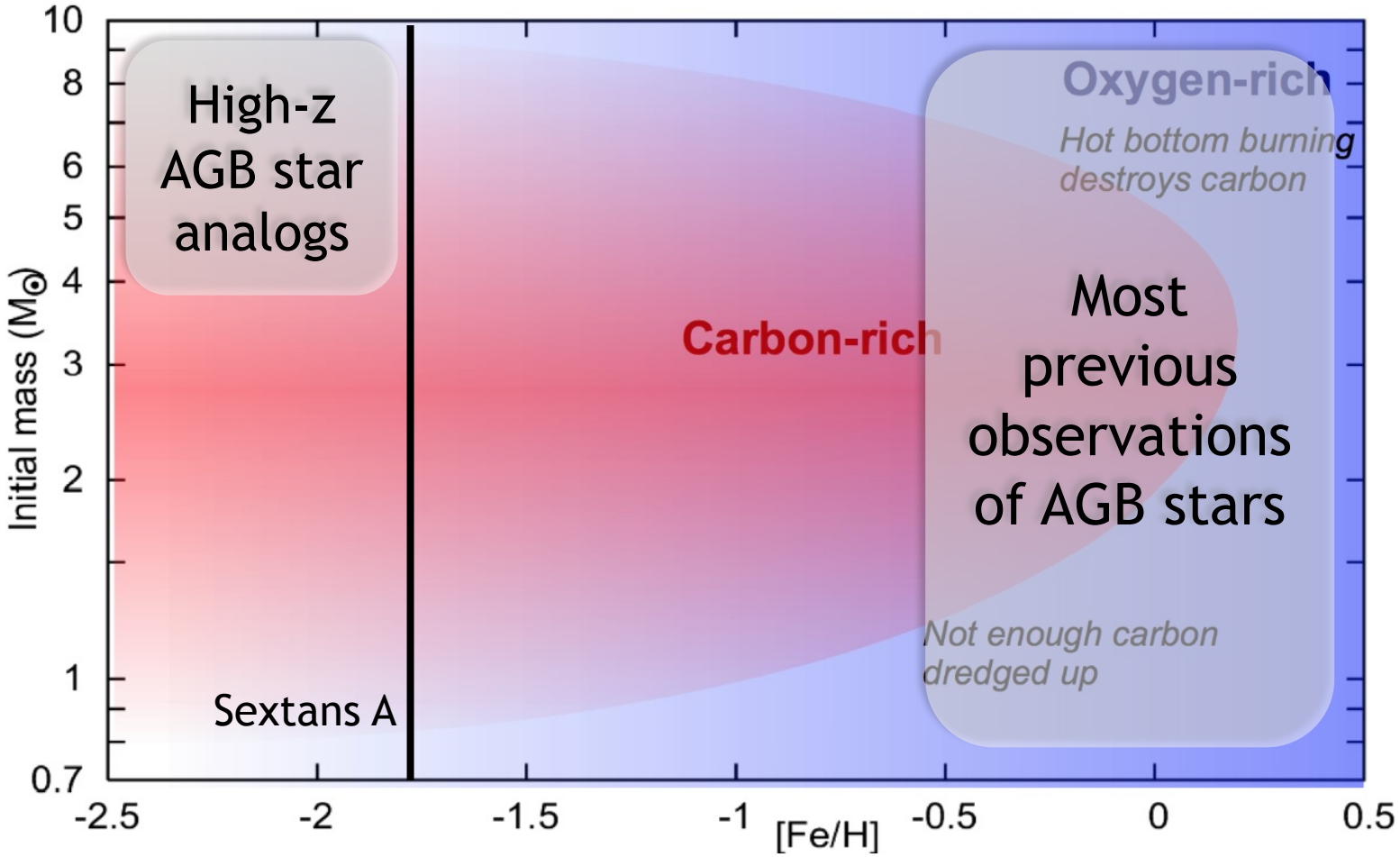
Are AGB dust production rates (DPRs) high enough to explain the dust masses in **high redshift (z>1) submillimeter galaxies**?

- Many models predict that metal-poor AGB stars don't produce enough dust *and* at **early enough times**
  - But this varies heavily by model!
- Possible solutions: **supernovae** and **ISM grain growth**
  - Supernovae can **destroy** their dust reservoirs
  - ISM grain growth models need seed particles



Rowlands+ 2014

AGB Star Chemistry Depends on Metallicity



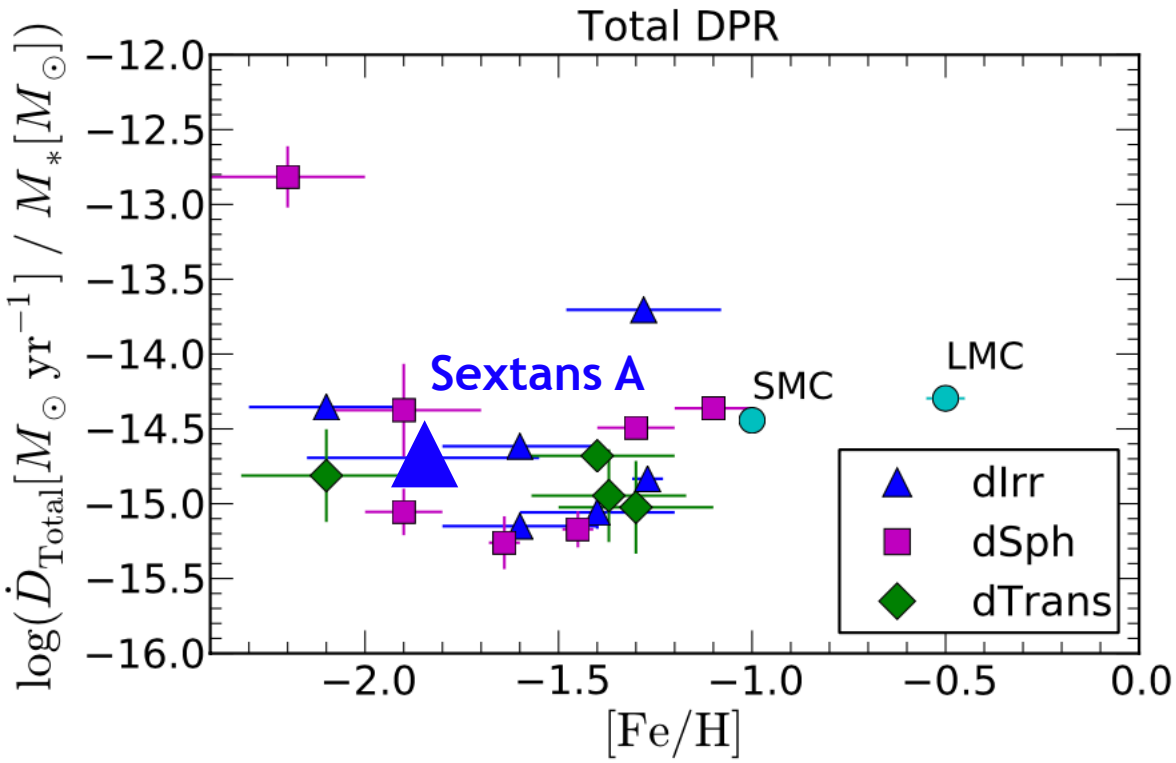
Massive M stars can produce dust **30 Myr** after they form

Models: Karakas & Lattanzio (2007)
Underlying graphic: Iain McDonald

Groundwork with Spitzer

Spitzer observations of dwarf galaxies show that dust production rate **does not depend on metallicity**

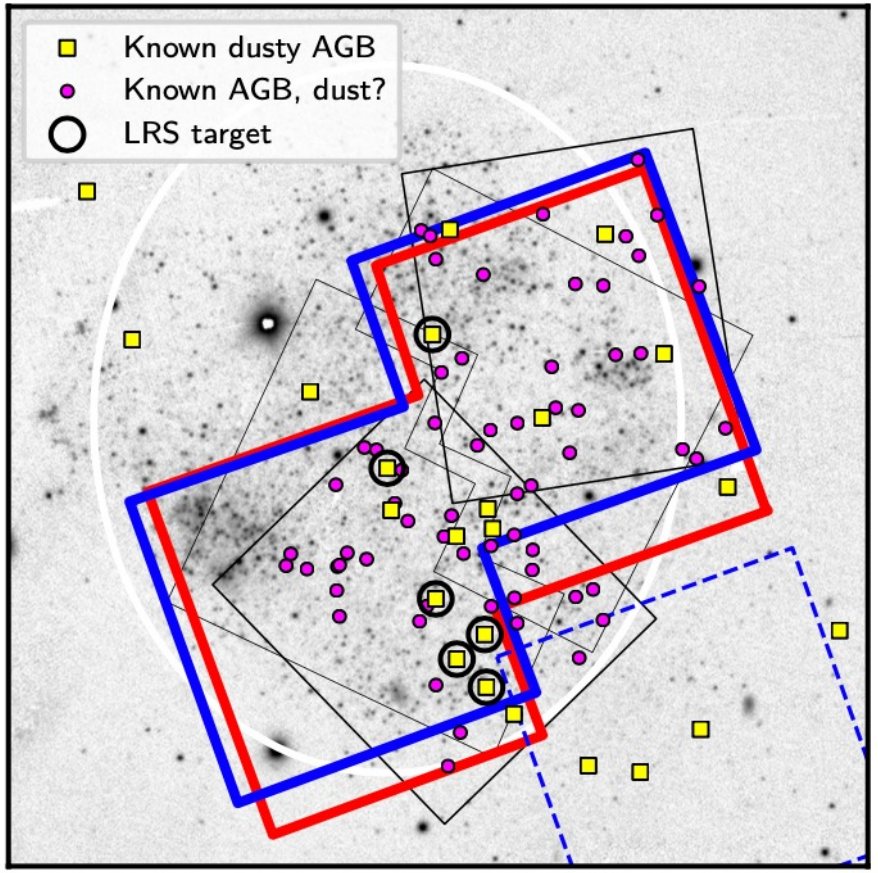
- On average, these metal poor galaxies have dust producing AGB stars
- **Limitations of Spitzer photometry:**
  - Unreliable Spitzer [3.6] − [4.5] colors to calculate the DPR
  - Little information on the dust features and subsequent mineralogy
  - Relied on variability to identify AGB stars



DUSTiNGS, Boyer+ 2015 (see also Jones+ 2018 and Dell'Agli+ 2019)

JWST PID 1619: The AGB Population in Sextans A

- Sextans A:
  - is very metal-poor
    - Gas phase: 12 + log(O/H) = 7.54 (~7% $Z_\odot$, Kniazev+ 2005)
    - RGB: [Fe/H] = −1.85 (~1-3% $Z_\odot$, Sakai+ 1996)
  - harbors a large stellar population (Dolphin+ 2003)
  - contains detected ISM dust (Shi+ 2014)
  - is nearby (D~1.4 Mpc, McQuinn+ 2017)
  - **has known dusty stars from Spitzer** (Boyer+ 2015)
- JWST PID 1619 (PI: M. Boyer)
  - NIRCam & MIRI imaging most of the stellar disk, covering 13 wide and medium band filters (8 NIRCam, 5 MIRI)
  - MIRI LRS spectroscopy (5—14 μm) of six interesting AGB stars found by Spitzer



NIRCam MIRI

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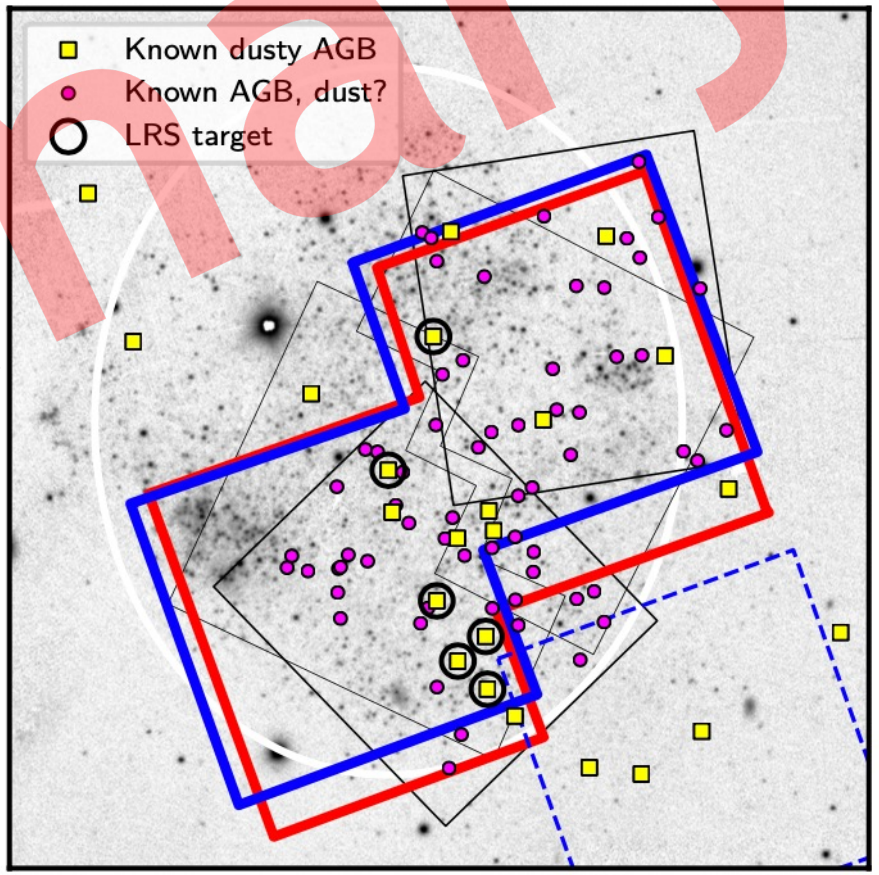
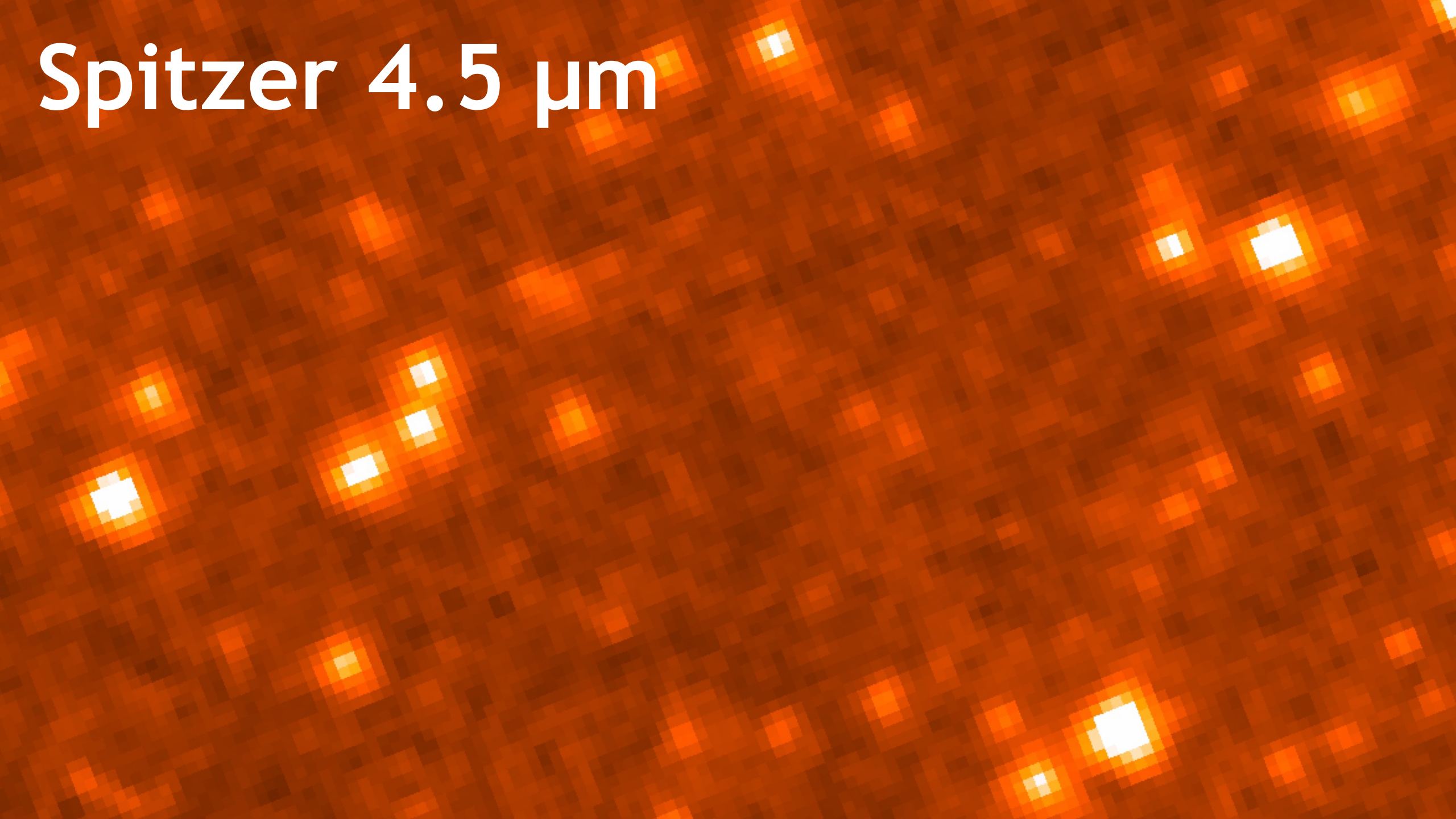
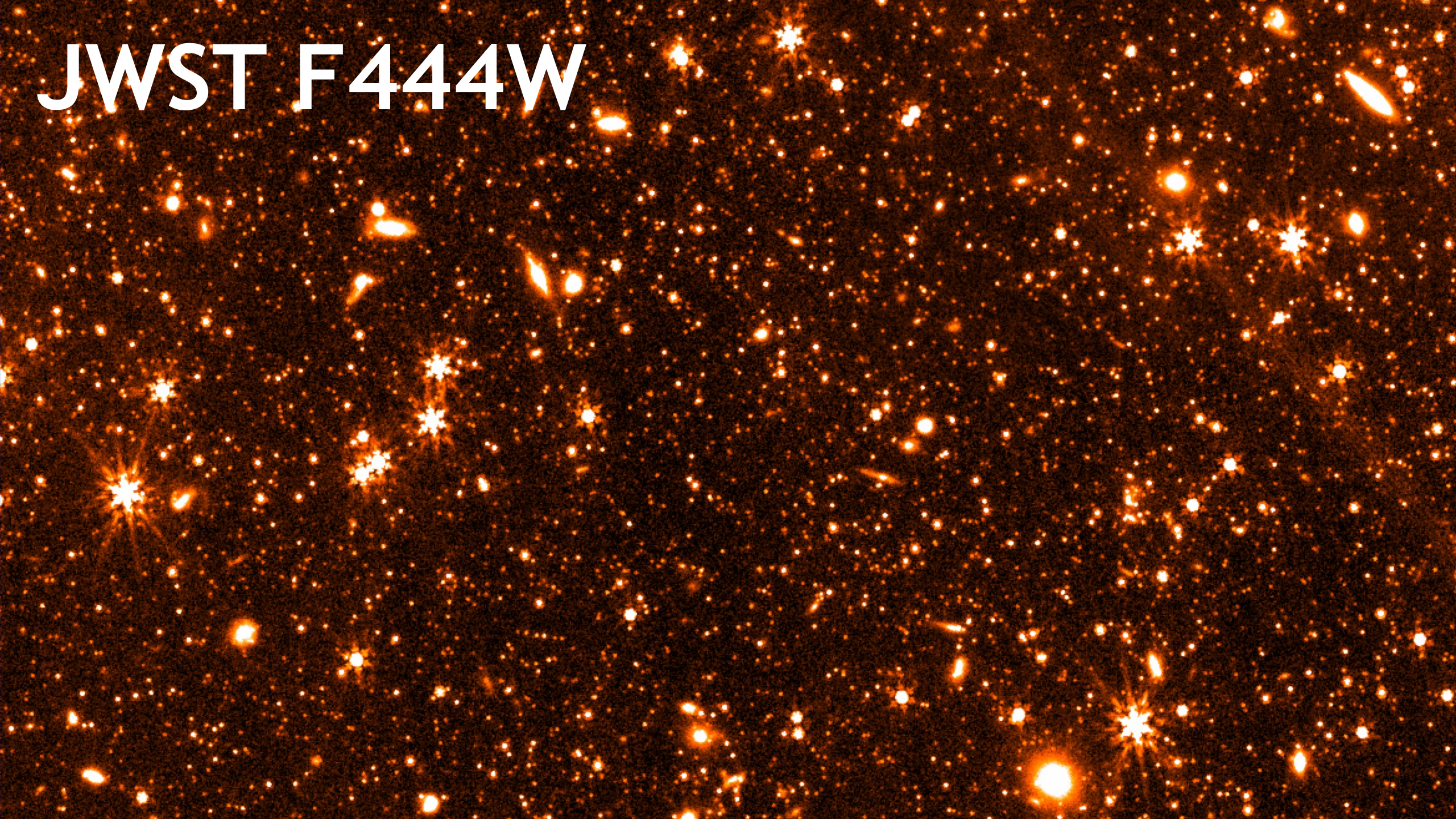


NIRCam MIRI


Spitzer 4.5 μm


JWST F444W

Summary and Ongoing Work

- JWST observations of metal-poor nearby galaxies like Sextans A provide insight on the nature of dust production at high redshift
- Preliminary JWST results:
  - We identify ~250 AGB stars in Sextans A and use JWST filters to classify the stars into C and M types
  - JWST reveals dust production in <7% $Z_{\odot}$ metal-poor AGB stars
  - C stars: Spectroscopy and photometry reveal SiC and C_2H_2 features at similar levels seen in the SMC and LMC
  - M stars: Photometric observations of the oxygen-rich stars show possible silicate dust features → suggesting early input of dust in high-z galaxies
- **Ongoing work:** radiative transfer fitting of the SEDs will reveal the DPRs which we will compare to:
  - the dust in the ISM of Sextans A to determine the dominant dust producers
  - high redshift dust yields needed to reproduce the dust masses of submillimeter galaxies