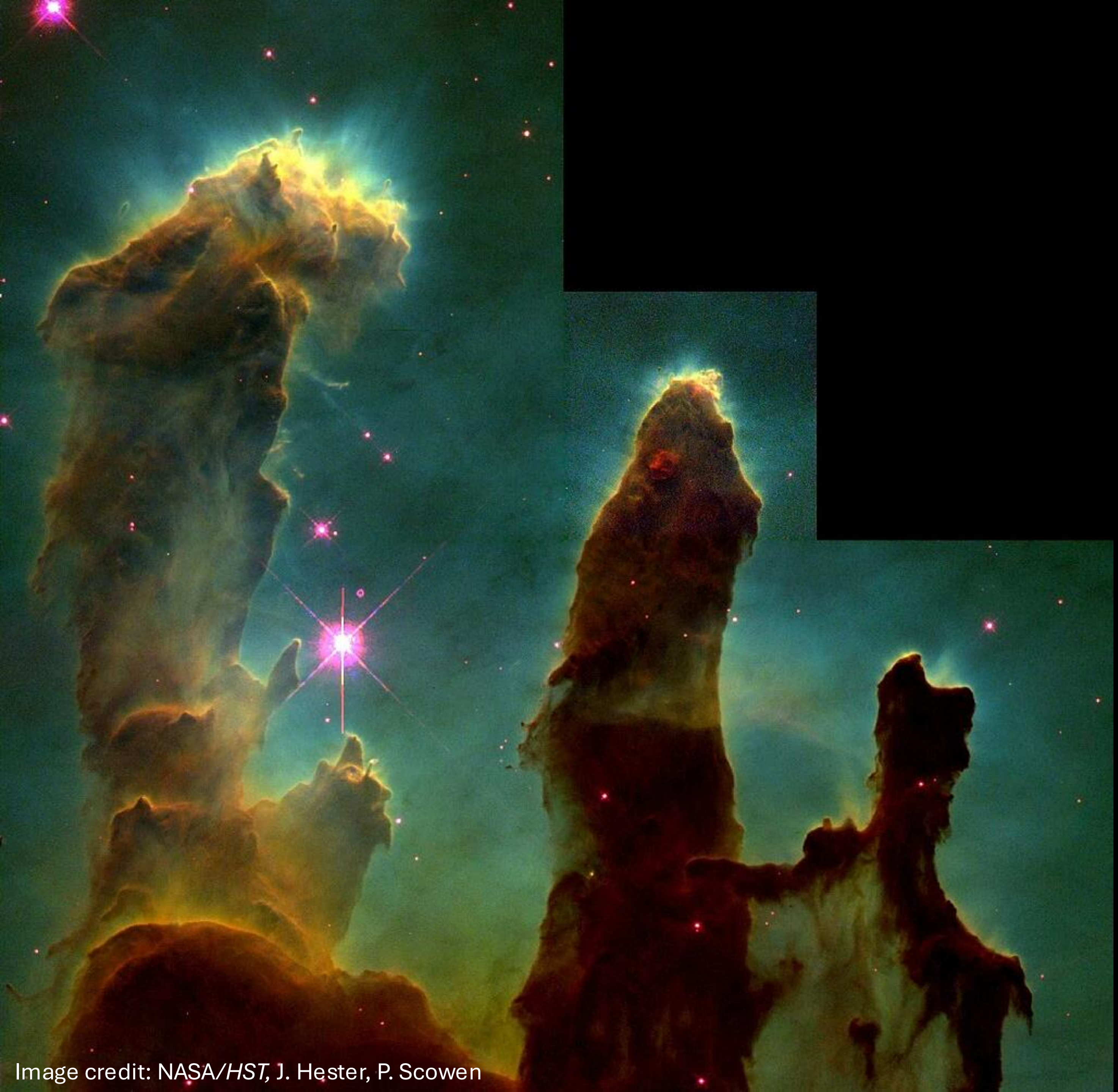


Image credit: NASA/*HST*, J. Hester, P. Scowen

Searching for sources of carbonaceous dust grains with JWST spectroscopy

Dusty Universe 2025

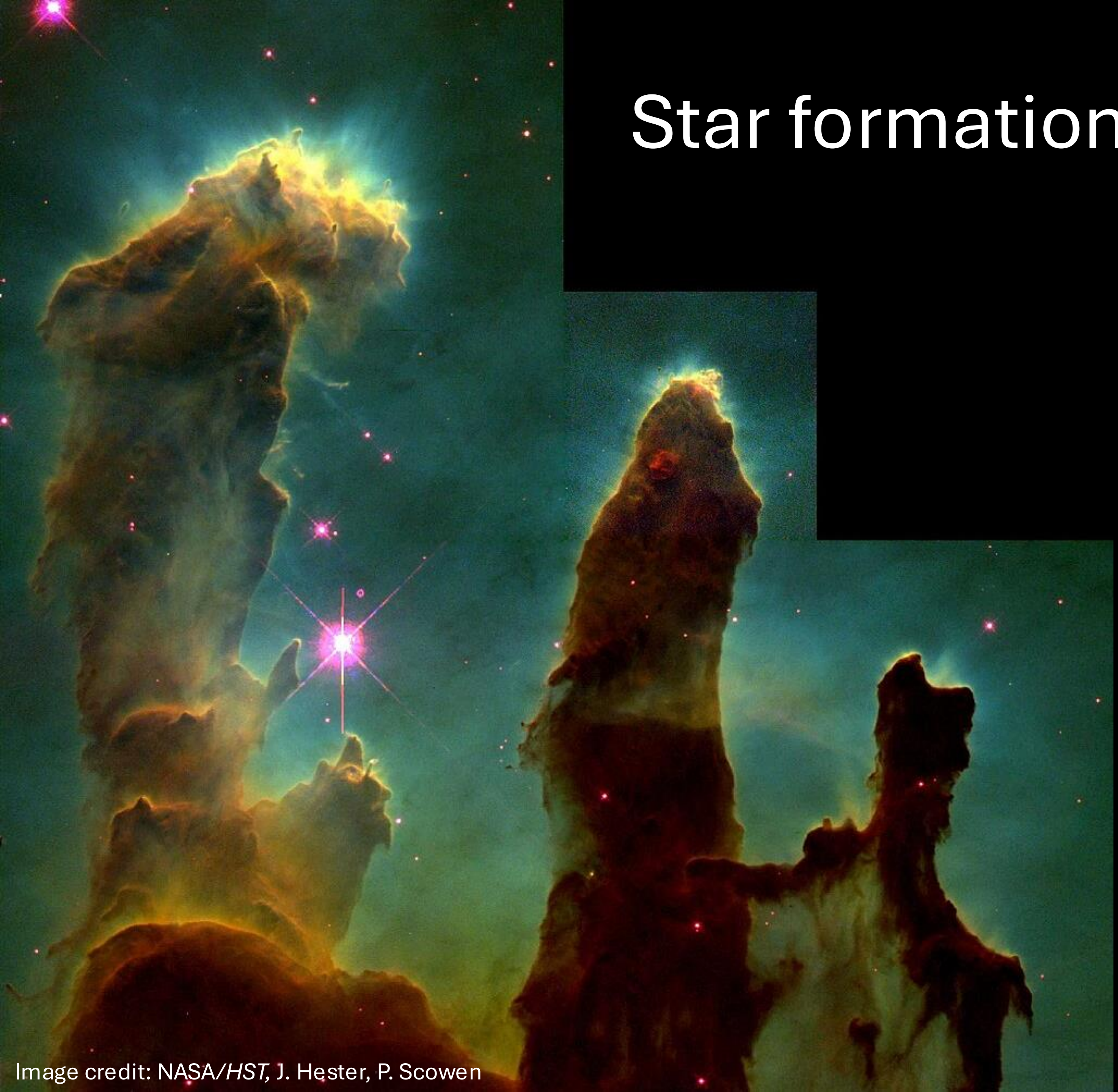
University of Arizona November 11th, 2025

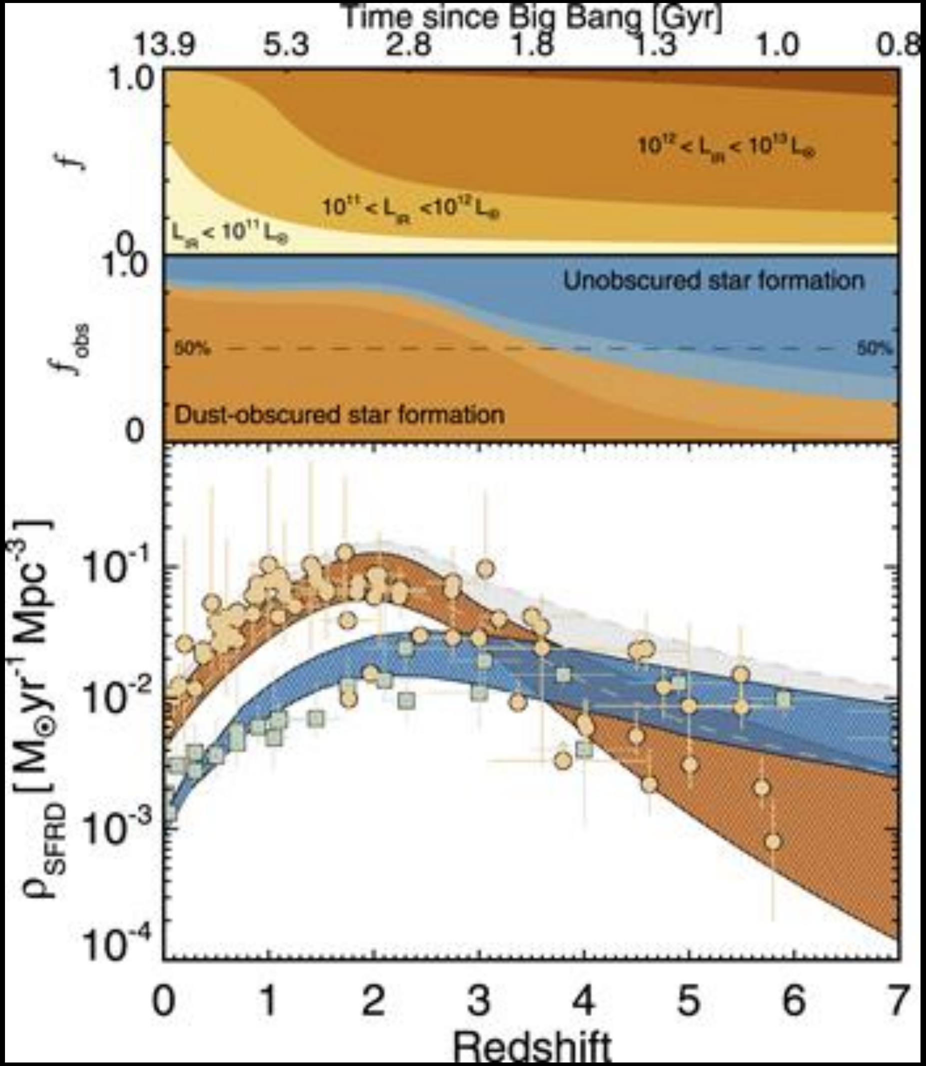
Sam Rose (Caltech)

With Mansi Kasliwal (Caltech), Ryan Lau (IPAC), Jacob Jencson(IPAC), Viraj Karambelkar (Columbia), Howard Bond (STScI/Penn State), and the WR-Dust-ERS team

Why study astronomical dust formation?

Star formation is dust obscured!





Zavala+ 2021

Image credit: NASA/*HST*, J. Hester, P. Scowen

Dust rocks!

Image credit: NASA

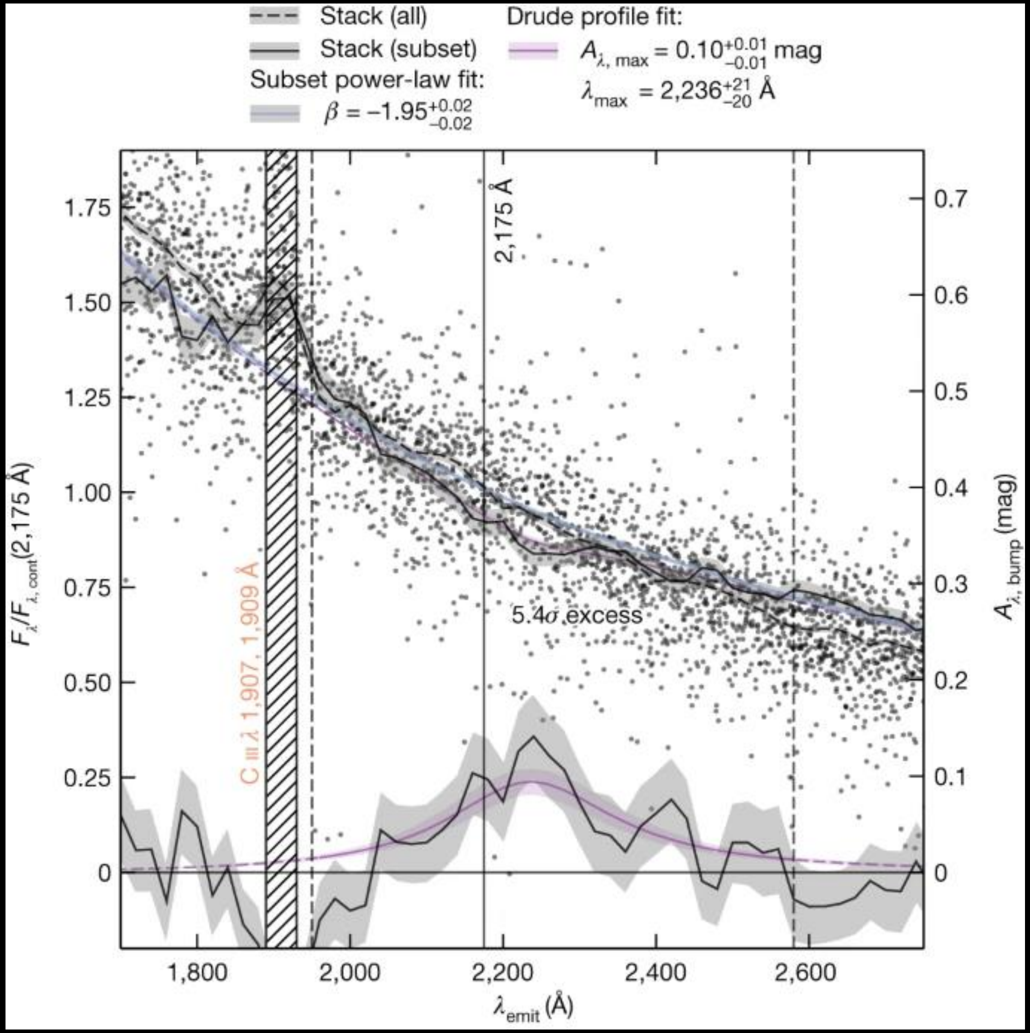
Image credit: NASA/Apollo 17

Image credit: S. Rose

Dust chemistry (silicate versus carbonaceous) impacts planet formation!

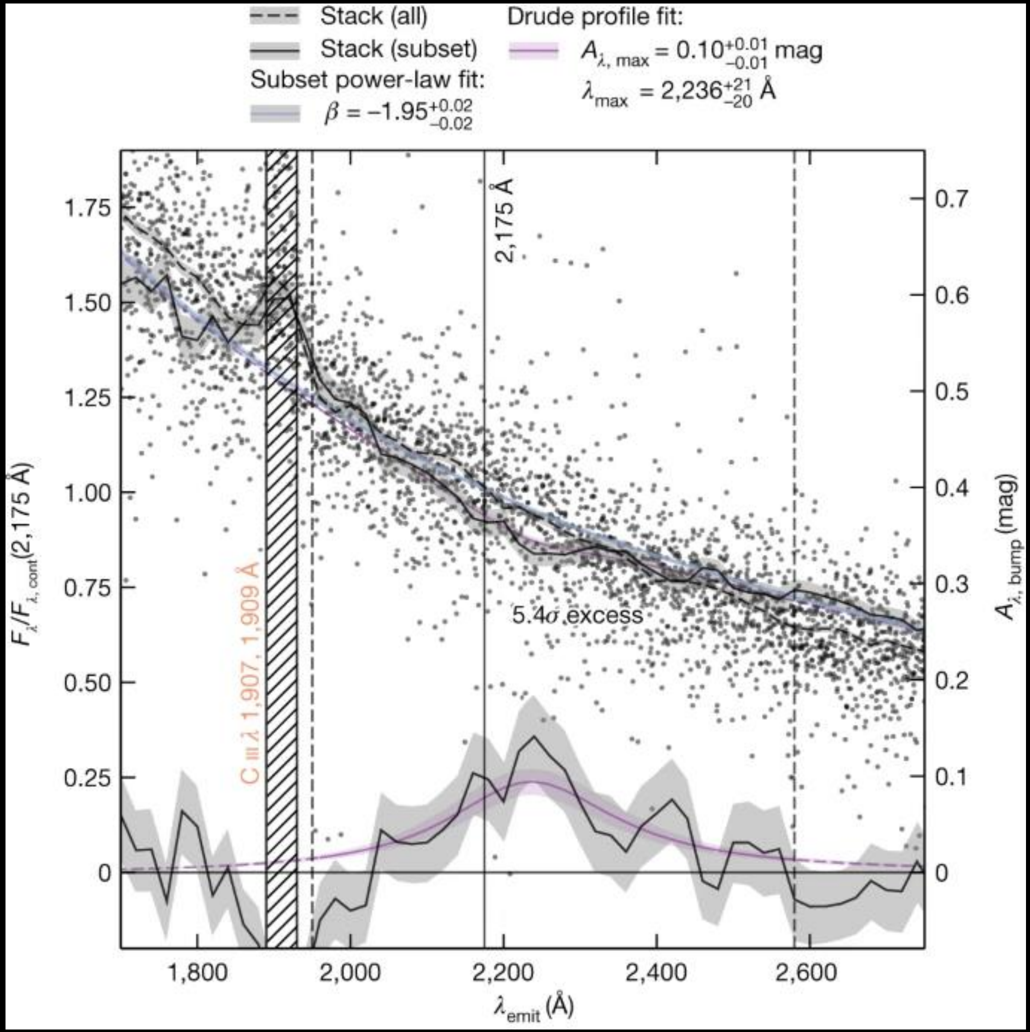
Image credit: NASA

Dust forms early in the Universe – including carbonaceous dust grains!

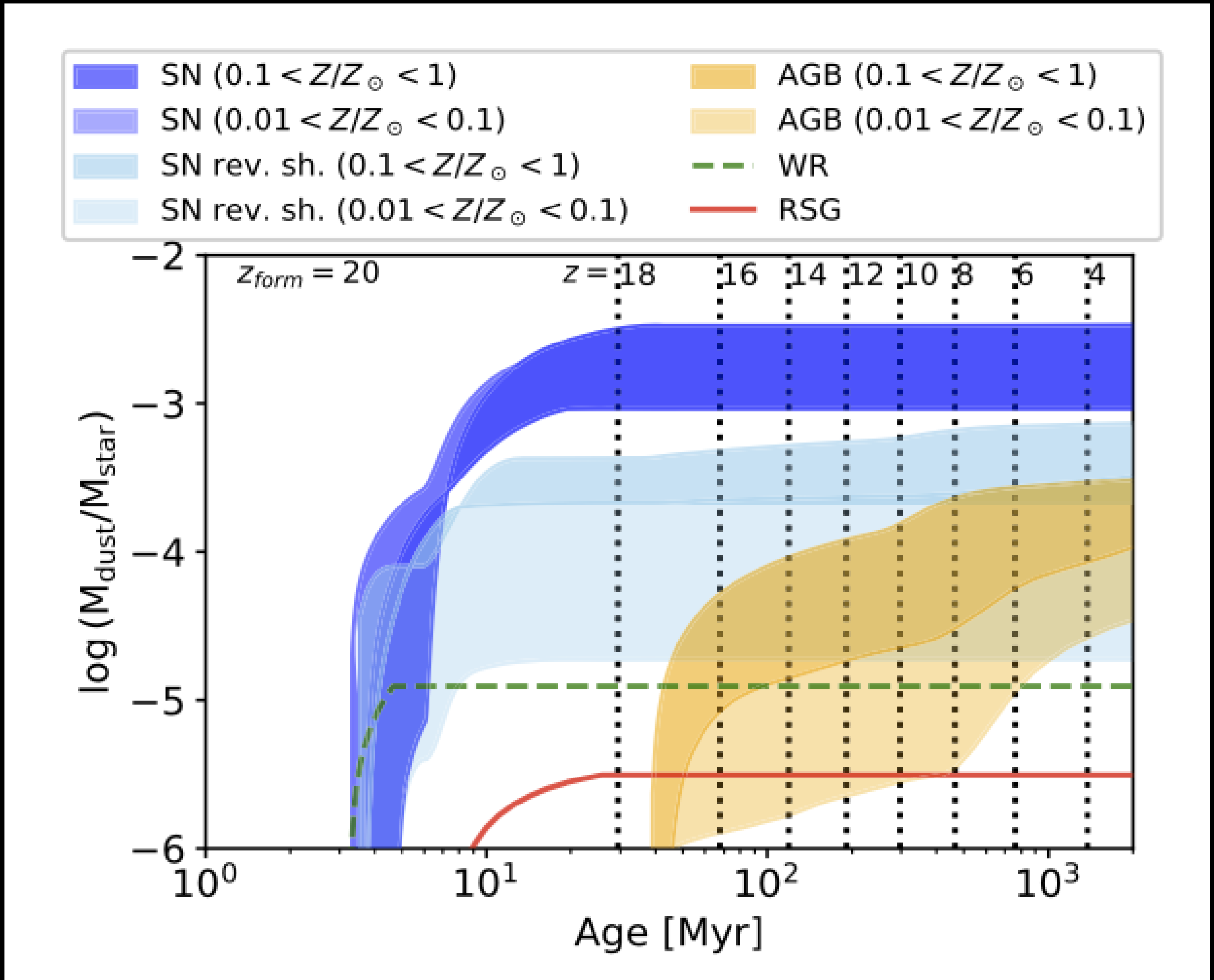


Witstok+ 2023

Supernovae form dust early

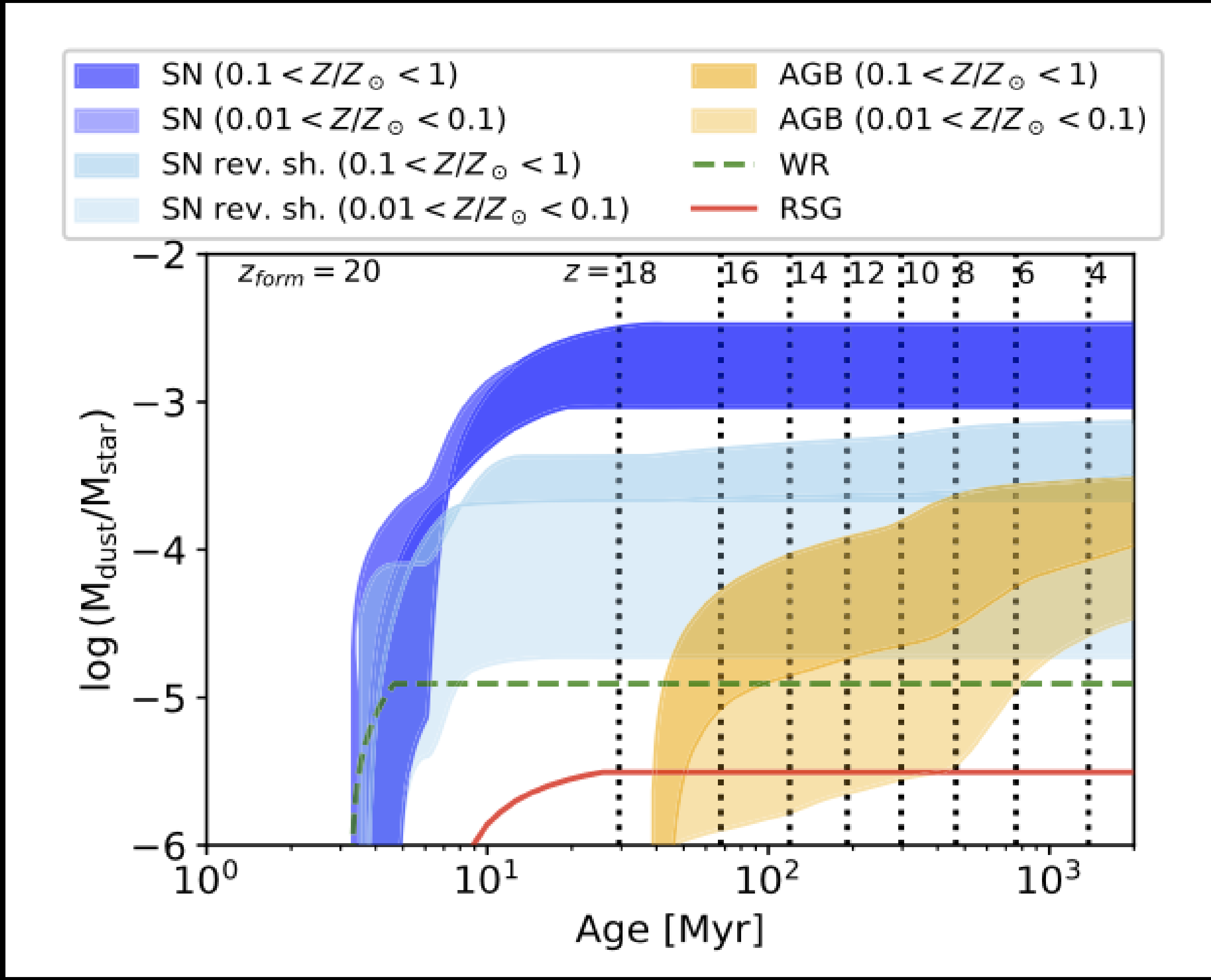


Witstok+ 2023

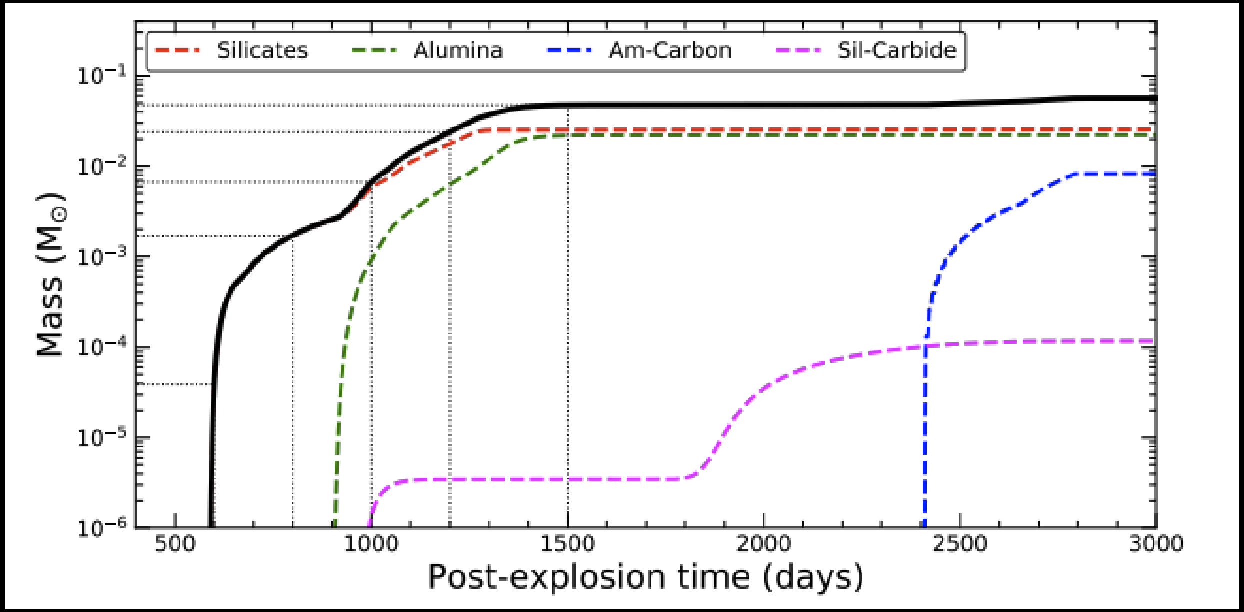


Schneider and Maiolino 2024

… but primarily form O-rich silicate dust



Schneider and Maiolino 2024

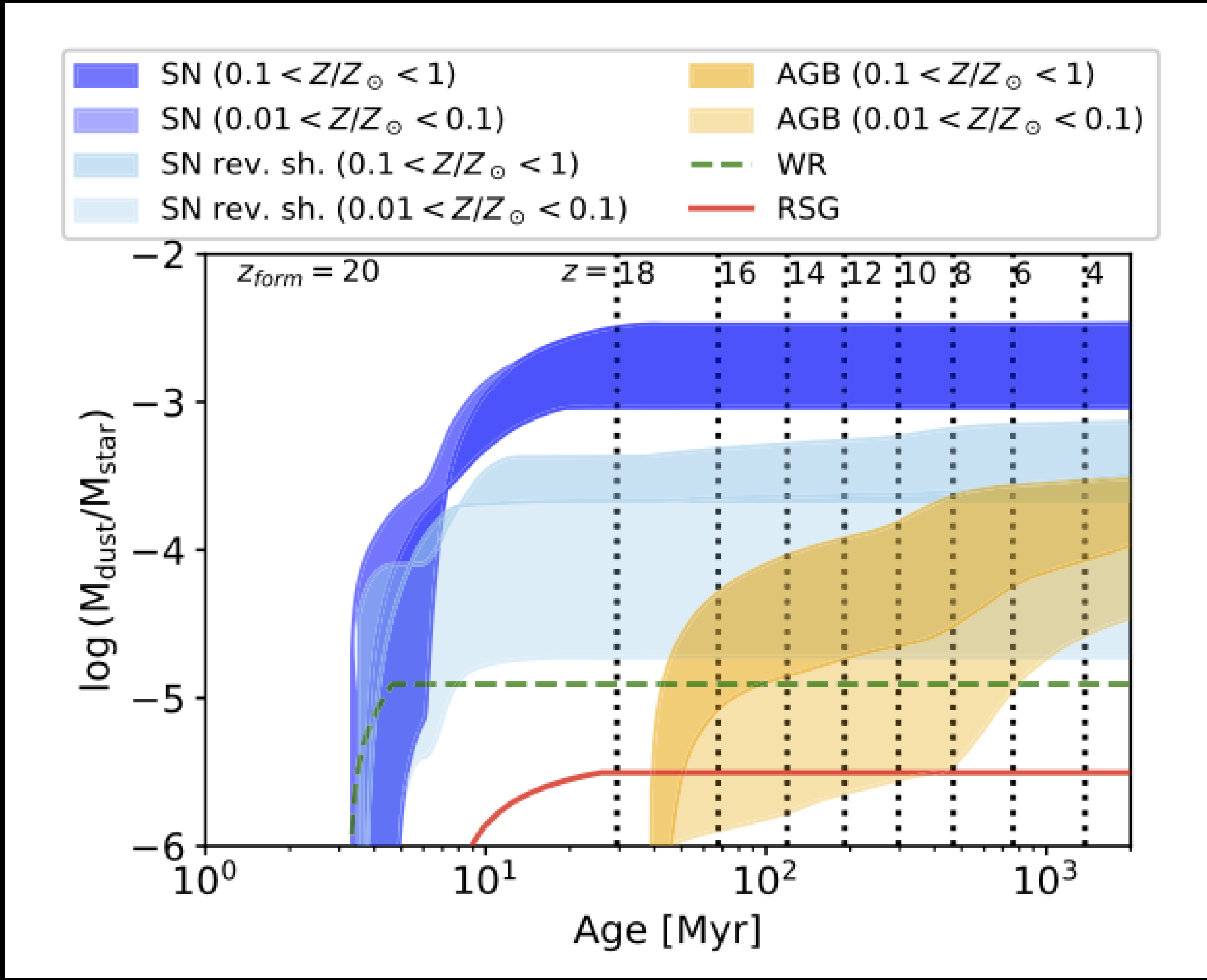


Sarangi 2022

See also: Gall+ 2014, Shahbandeh+2023,2025, Tinyanont +2025

Also, what about dust destruction by the reverse shock? E.g., (Micelotta+2018)

AGB stars form C-rich dust ... but not early enough



Schneider and Maiolino 2024

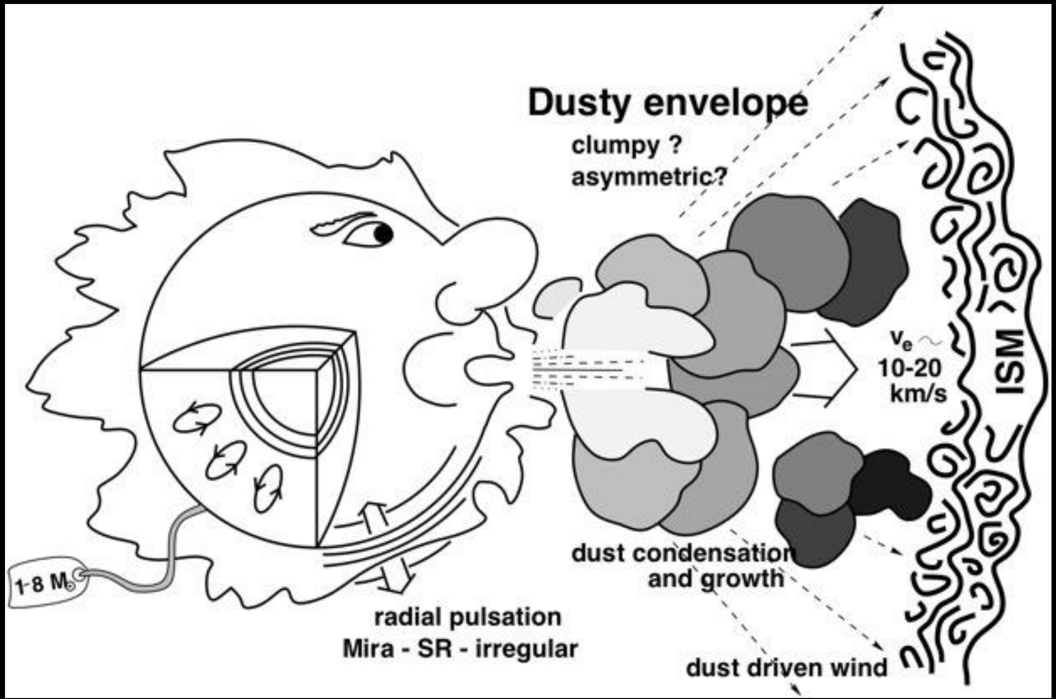
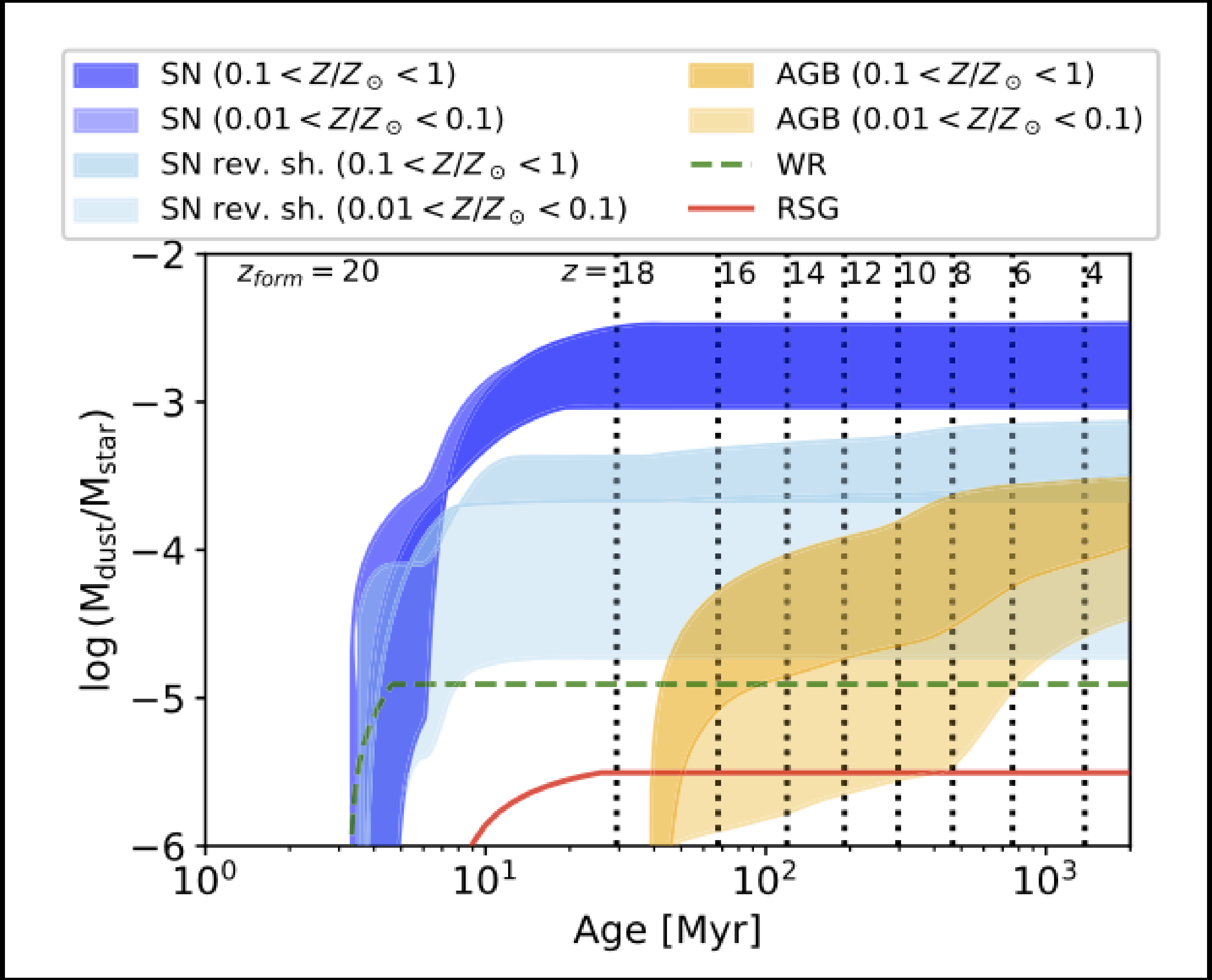


Image credit: M. Marengo CfA

Are there other important sources of dust?



Schneider and Maiolino 2024

WR 140: *JWST*/NASA/ESA Lau +2022

Riko Senoo's earlier talk on WR 140!

Can you get carbon-rich dust producing WR stars at low metallicity?

How do you get a dust producing WR system?

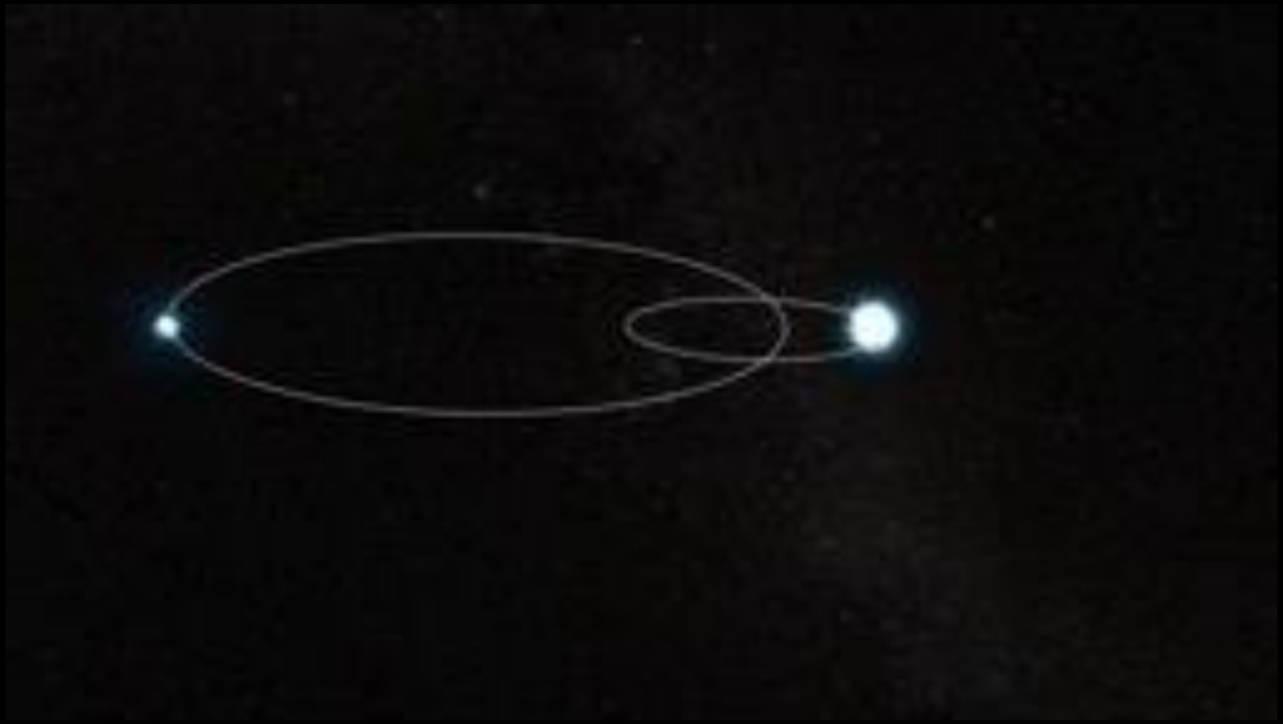
- WR stars form from massive evolved stars
- Hot (20,000-200,000 K) exposed C/O (N) core
- Characterized by broad features
- High wind velocities + mass loss rates

A little surprising that we get dust formation in such an inhospitable environment!

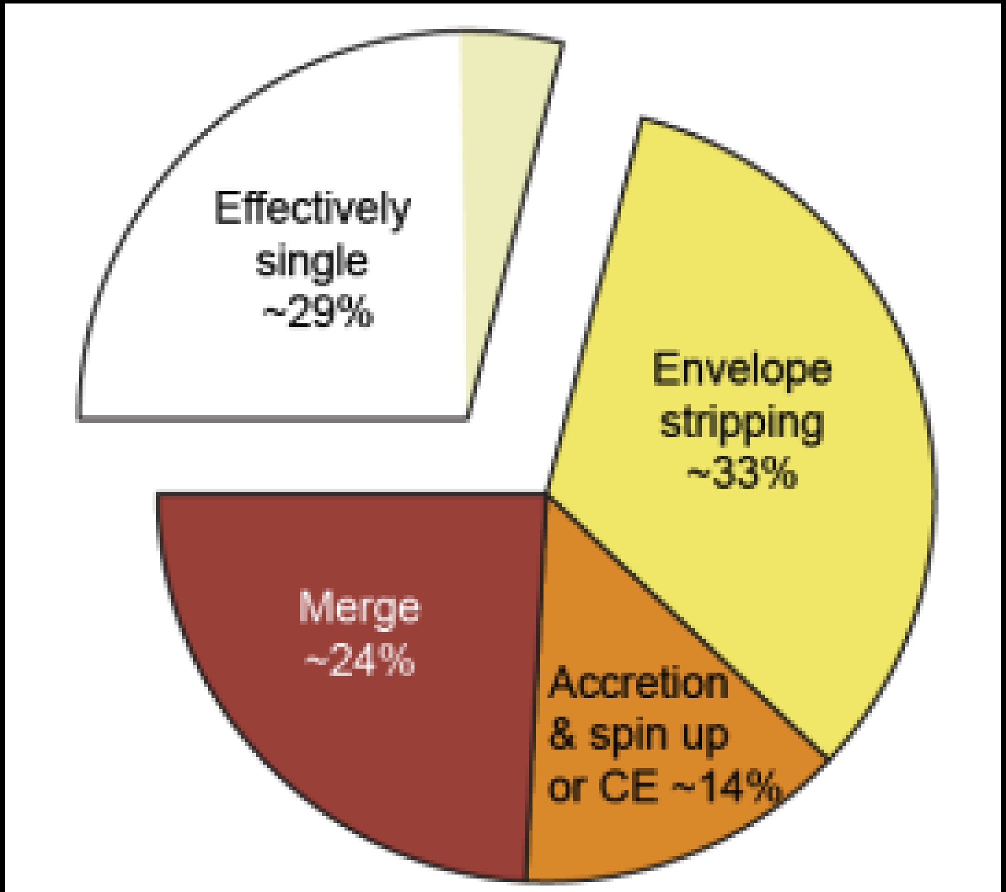
See, e.g., Allen+1972, Williams+1987,2001,2009, Usov+1991,Lau+2020a

Video credit: NASA, ESA, and J. Olmsted (STScI)

How do you get a dust producing WR system?



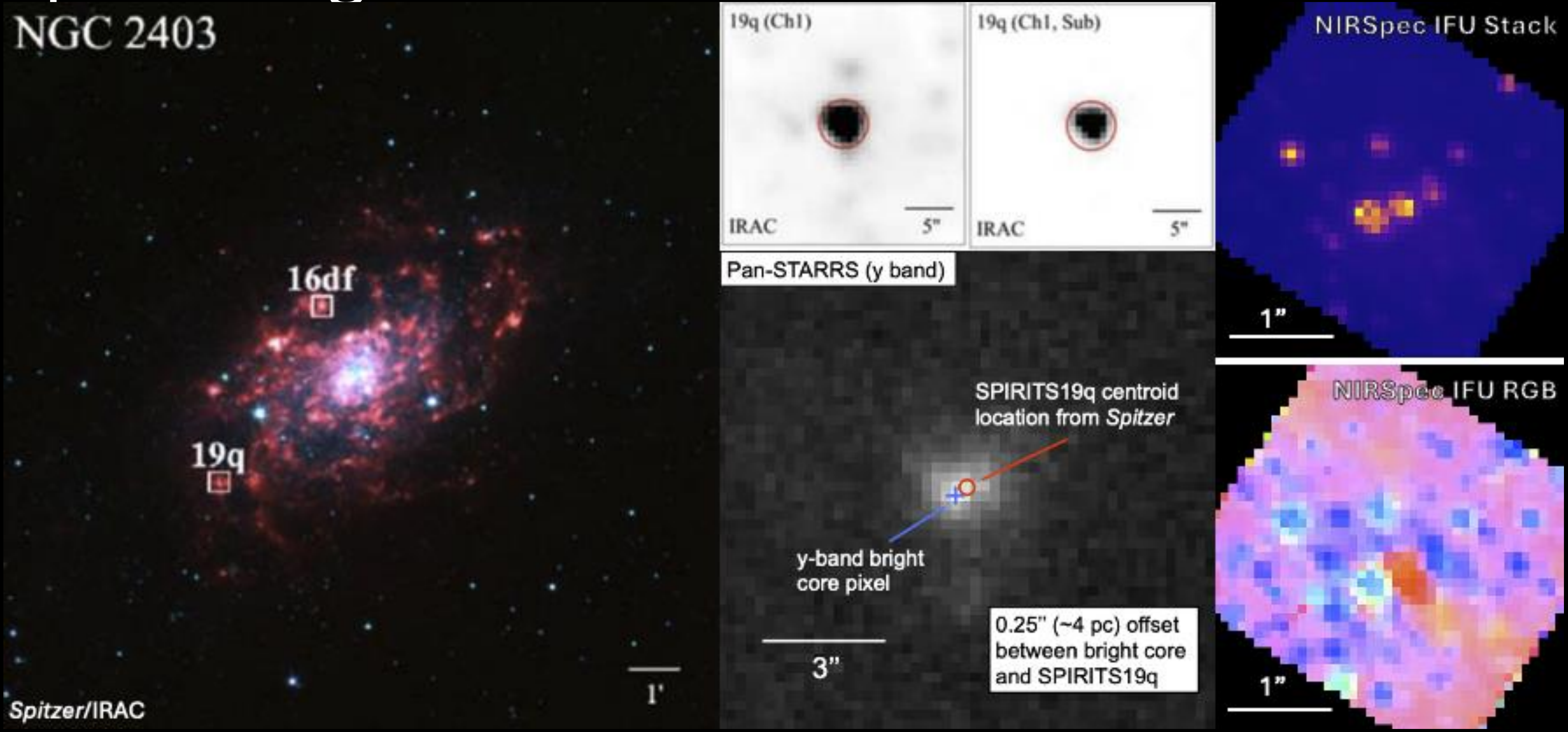
See e.g., Allen+1972, Williams+1987, Usov+1991,Lau+2020a



Sana+ 2012, see also Dsilva+2020

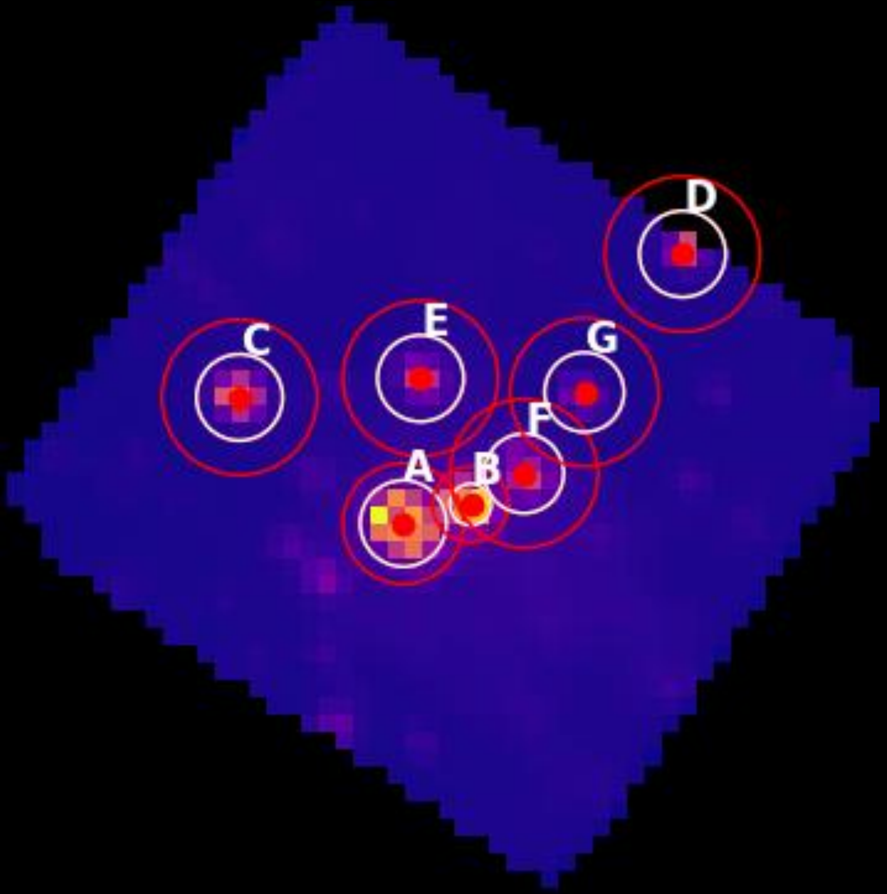
Video credit: NASA, ESA, and J. Olmsted (STScI)

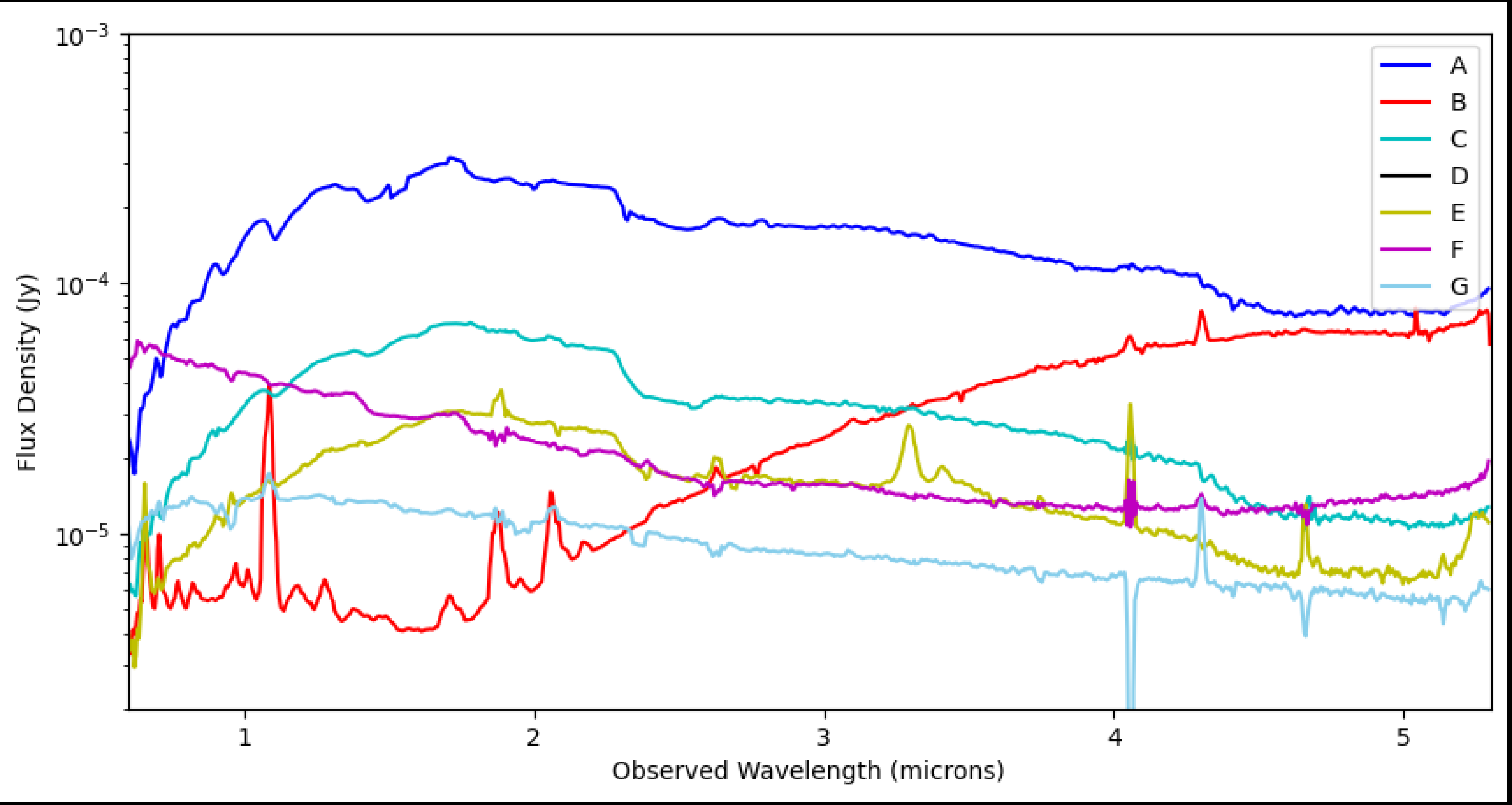
SPIRITS 19q: a low metallicity highly dust producing WC candidate



SPIRITS 19q is a WC star!

- SPIRITS 19q is red: $F_{4.5\,\mu m} > F_{3.6\,\mu m}$



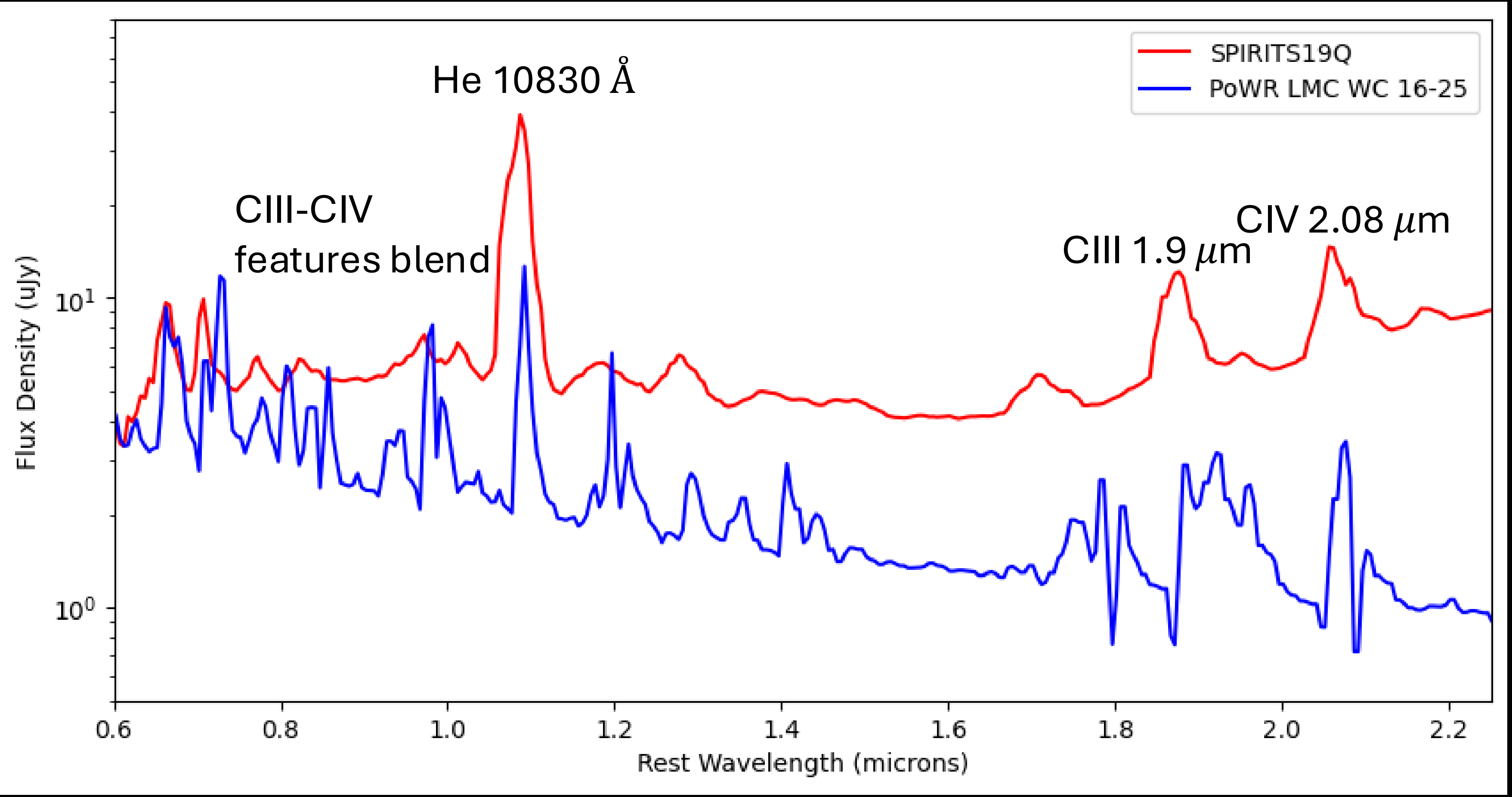


Rose+ in prep

SPIRITS 19q is a highly dust producing WC star!

Up to 4 x 10^{-6} $M_\odot$/yr of dust forming (Lau+2021)!
All AGB stars in the LMC: 1.4 x 10^{-5} $M_\odot$/yr (Riebel+2012)

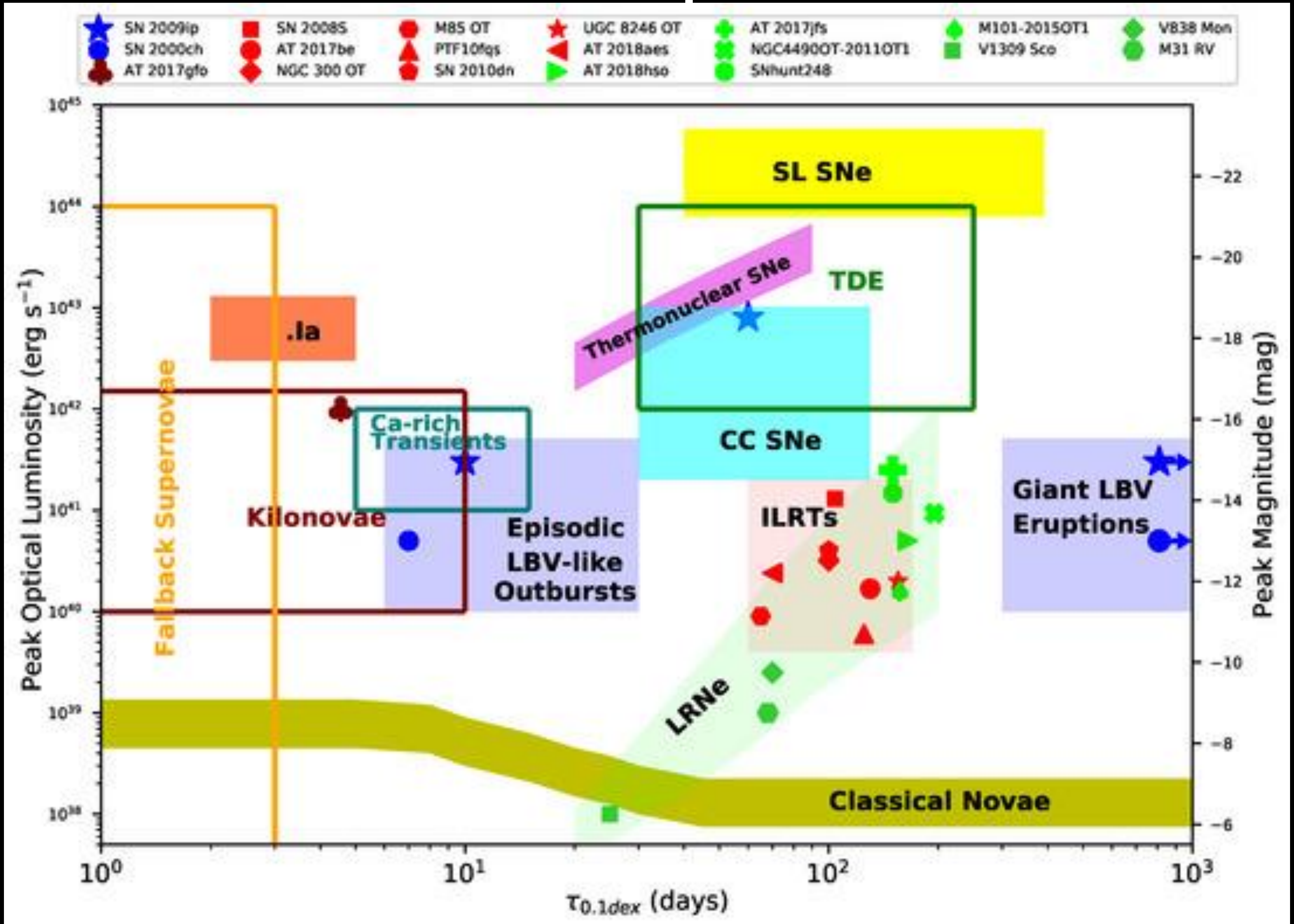
$\log(T_{eff}/K)$	5.15
$\log(L/L_\odot)$	5.3
R_*	0.75 $R_\odot$
$\log(\dot{M}/\frac{M_\odot}{yr})$	-4.2
V_f	2000 km/s
M_*	11.64 $M_\odot$



Rose+ in prep, Sander+2012/PoWR team

There is at least one highly dust producing WC star system at LMC metallicity! We should look for more…

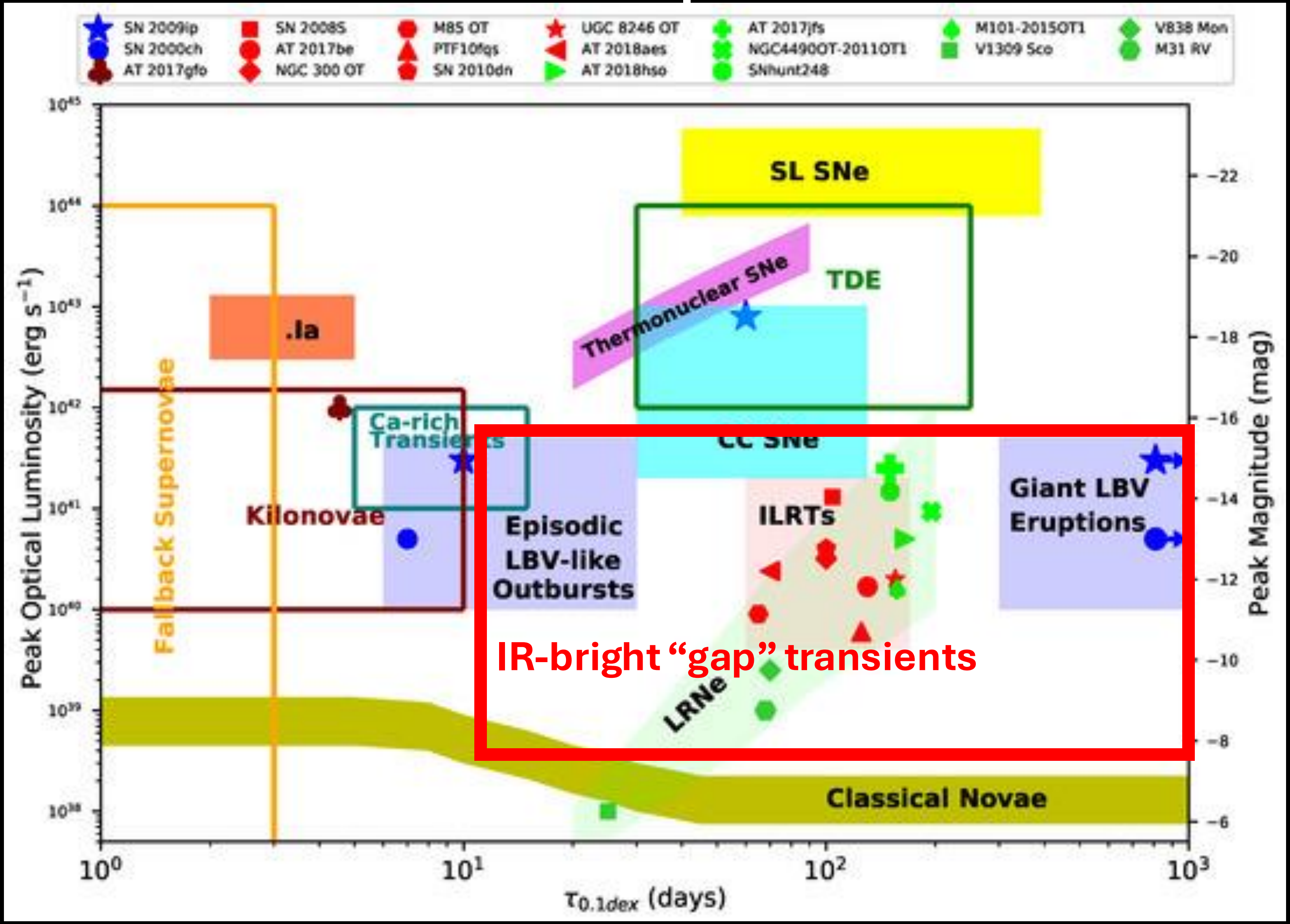
Are there other important sources of dust?



A whole landscape of astronomical transients with lots of mass ejected!

Cai+ 2022

Are there other important sources of dust?



A whole landscape of astronomical transients with lots of mass ejected!

Cai+ 2022

Are there dust producing transients in the luminosity gap and do they make carbonaceous dust?

Sam Rose (Caltech) srose@caltech.edu

JWST Cycle 4 7040: A MIR *Survey* of "gap" transients

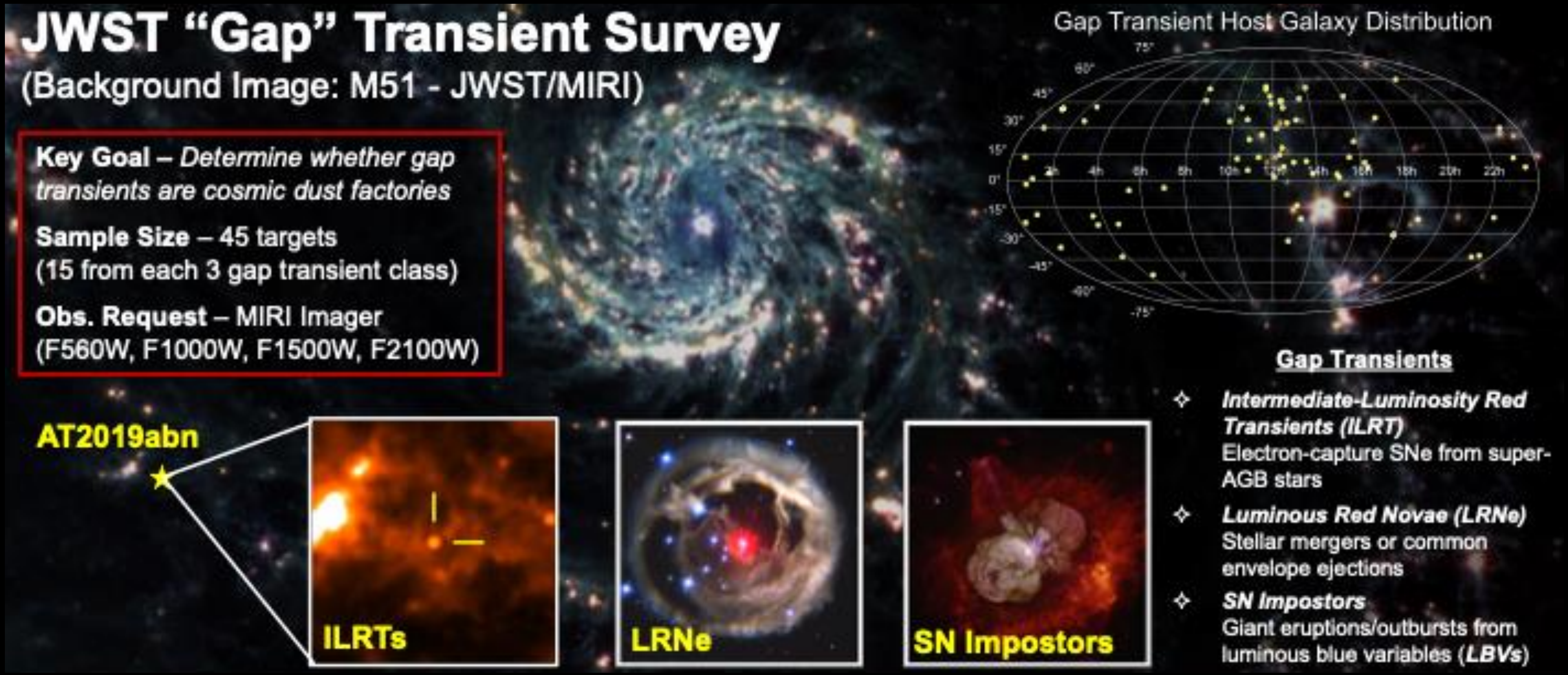
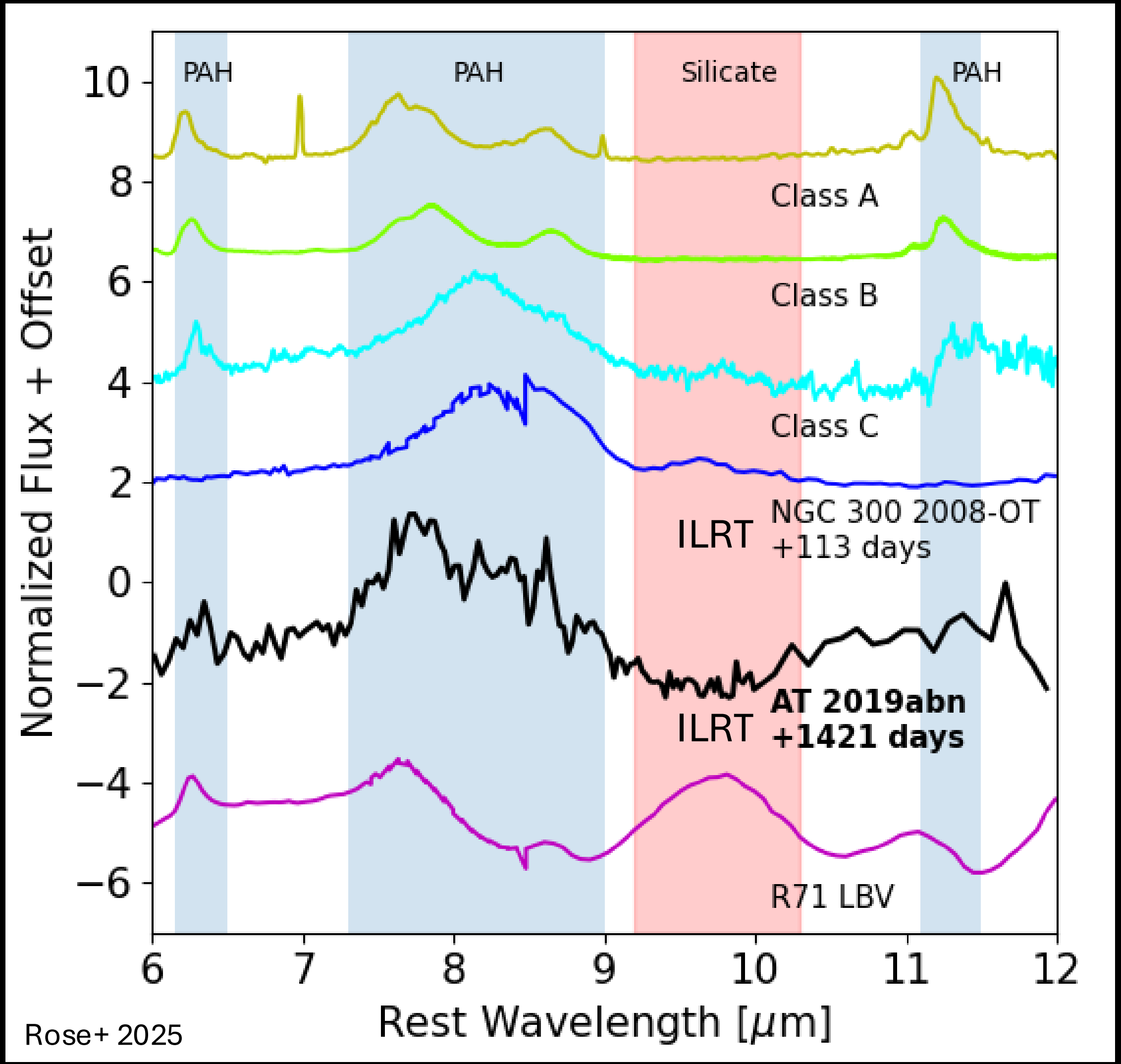
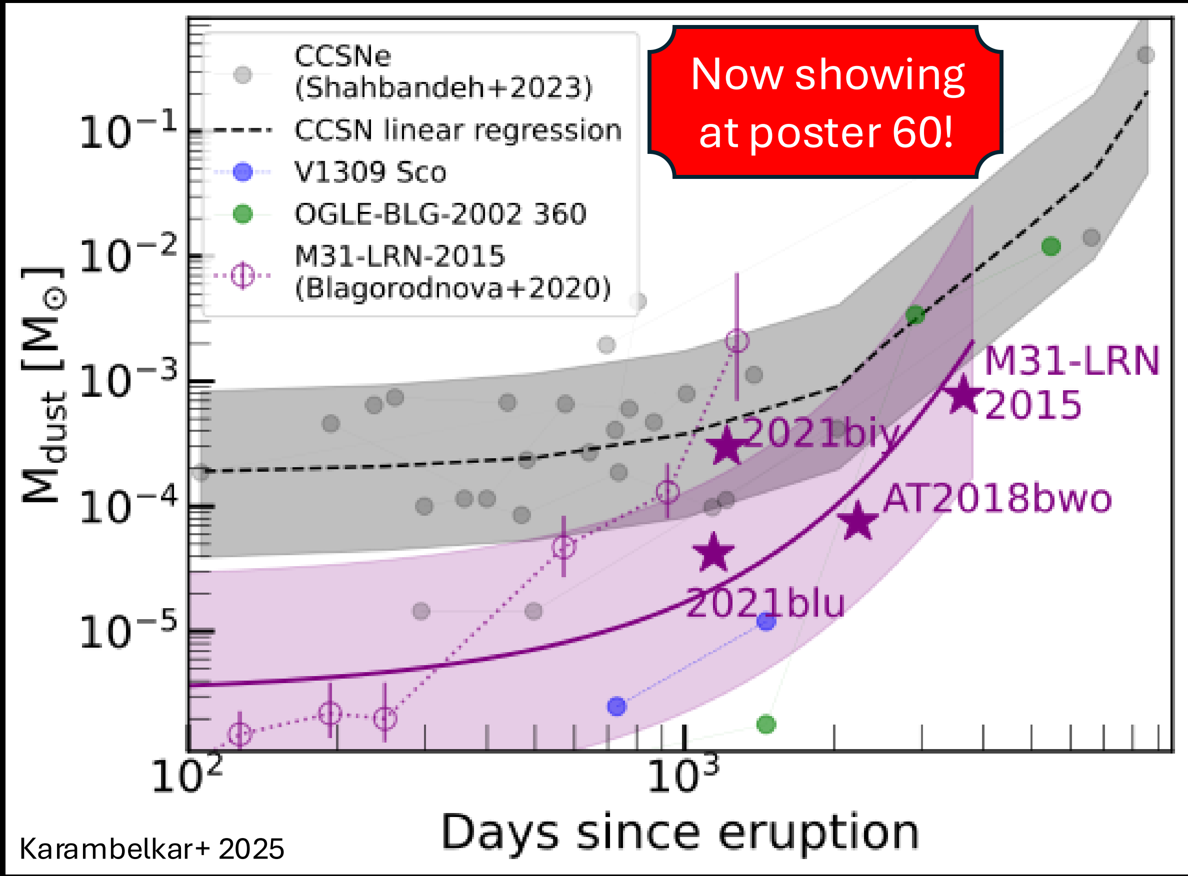


Image credit: R. Lau

Already evidence to suggest substantial dust contribution, including carbonaceous grains!





Dust produced by LRNe is ~25% dust produced by CCSNe!

Conclusions

- There are likely important contributors to the cosmic dust budget (especially at early times!) beyond AGB stars and core-collapse supernovae
- WR stars can produce significant amounts of carbonaceous dust at LMC-like metallicities
- The contributions to the cosmic dust budget of IR-bright “gap” transients remain underexplored
- Need IR missions for discovery and follow-up!

The future is IR-bright!

SPHEREx

ROMAN
SPACE TELESCOPE

WINTER
Wide-field INfrared Transient ExploreR

Cryoscope