

DOES DUST EVOLVE WITH REDSHIFT?



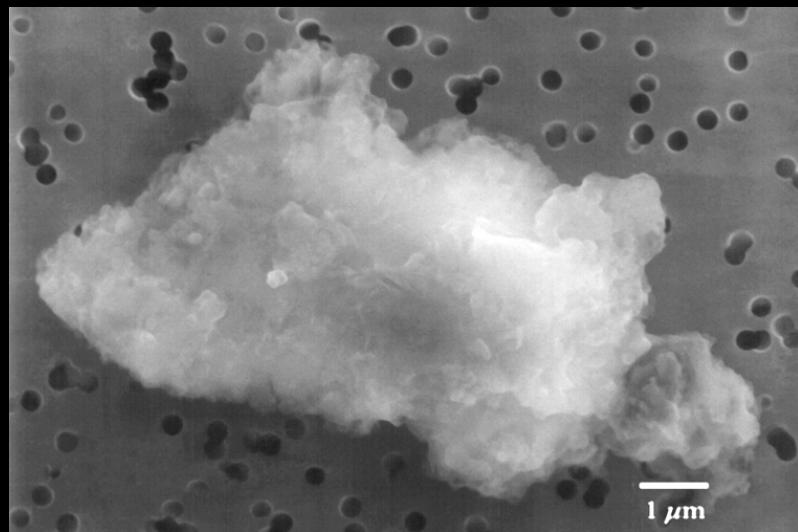
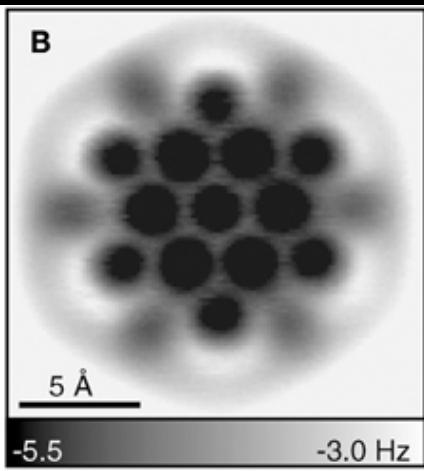
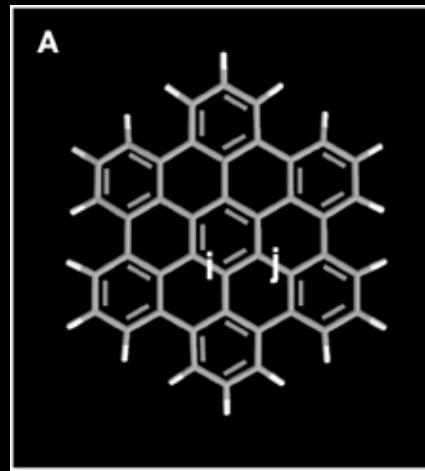
Dr. Jed McKinney

NASA Hubble Fellow - UT Austin

Email: jedmck@me.com

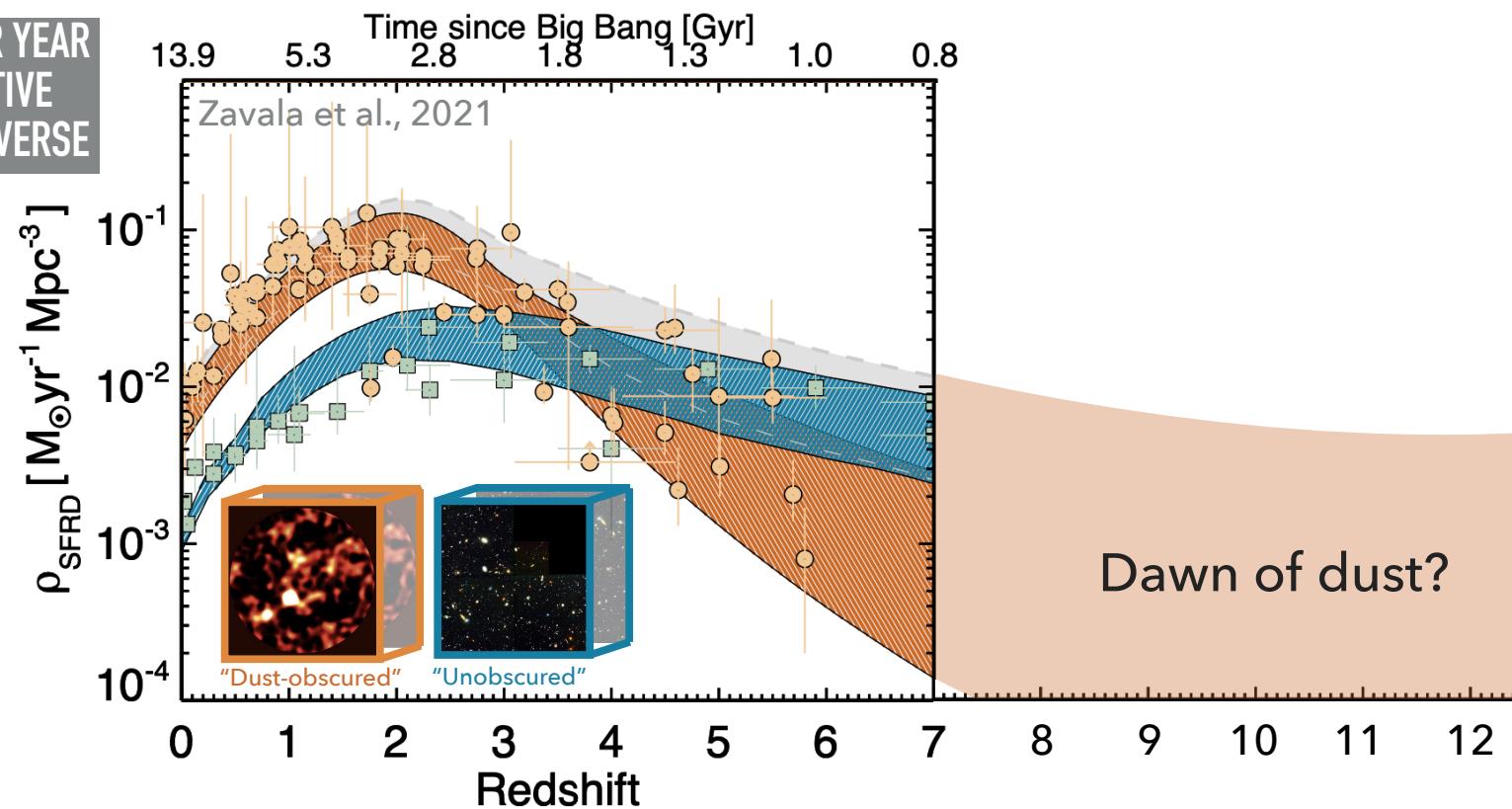
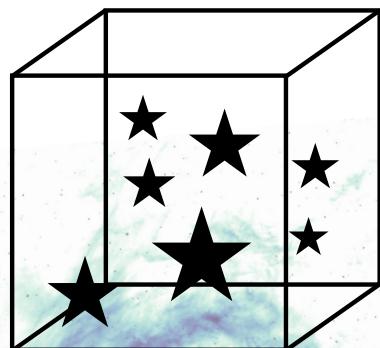
NHFP Symposium | September 17th, 2024

Astro-dust



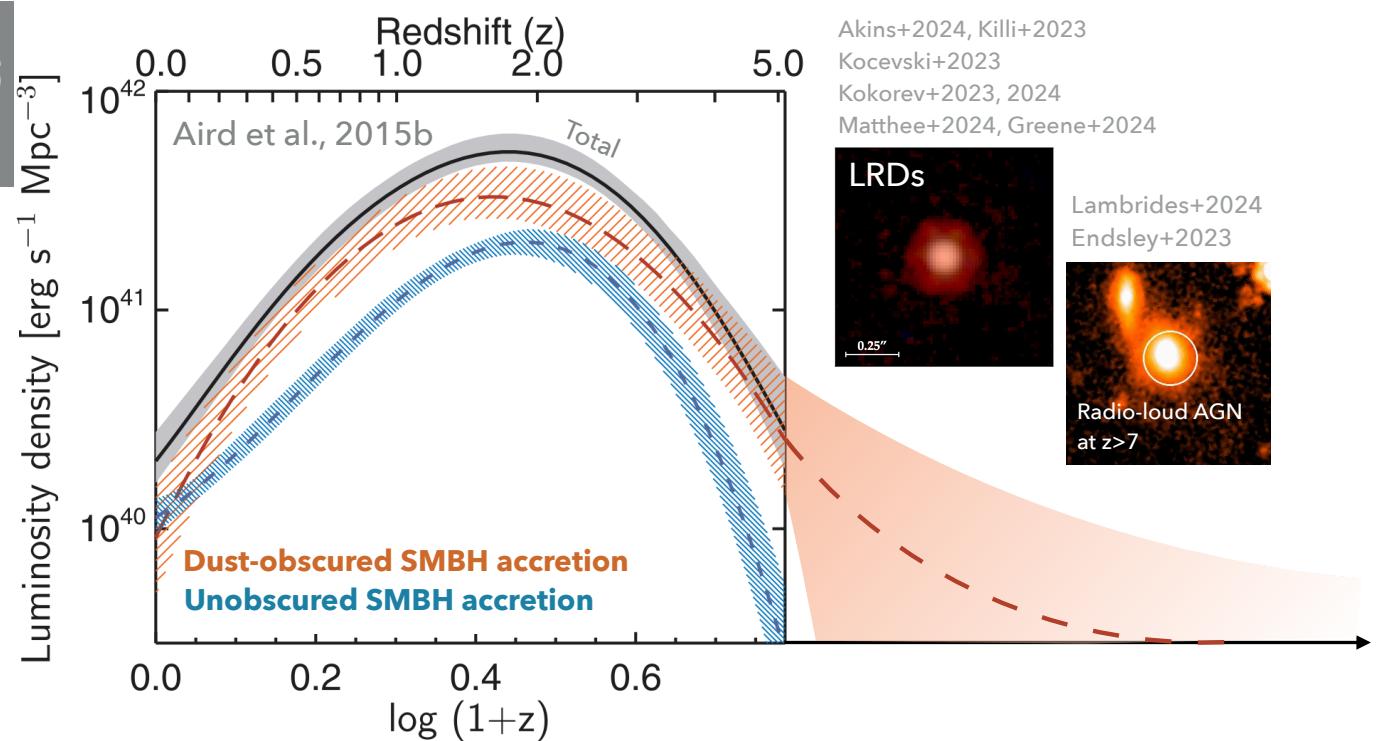
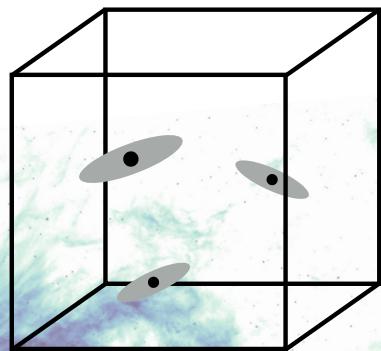
MOST STARS FORM DEEP IN DUST

STARS FORMING PER YEAR
IN A REPRESENTATIVE
VOLUME OF THE UNIVERSE



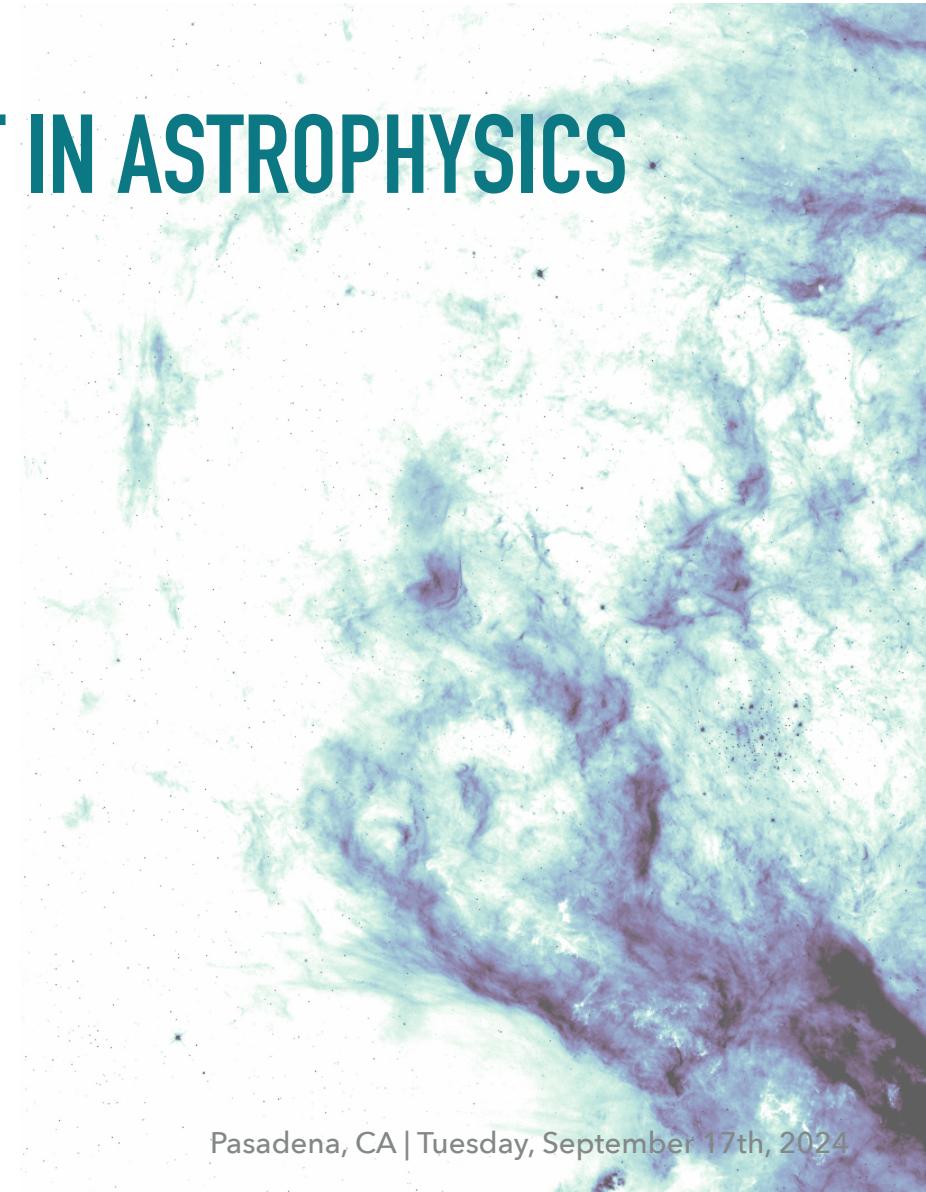
MOST BLACK HOLES GROW DEEP IN DUST

ACCRETION RATE OF
SUPERMASSIVE BLACK HOLES
IN A REPRESENTATIVE VOLUME OF THE
UNIVERSE



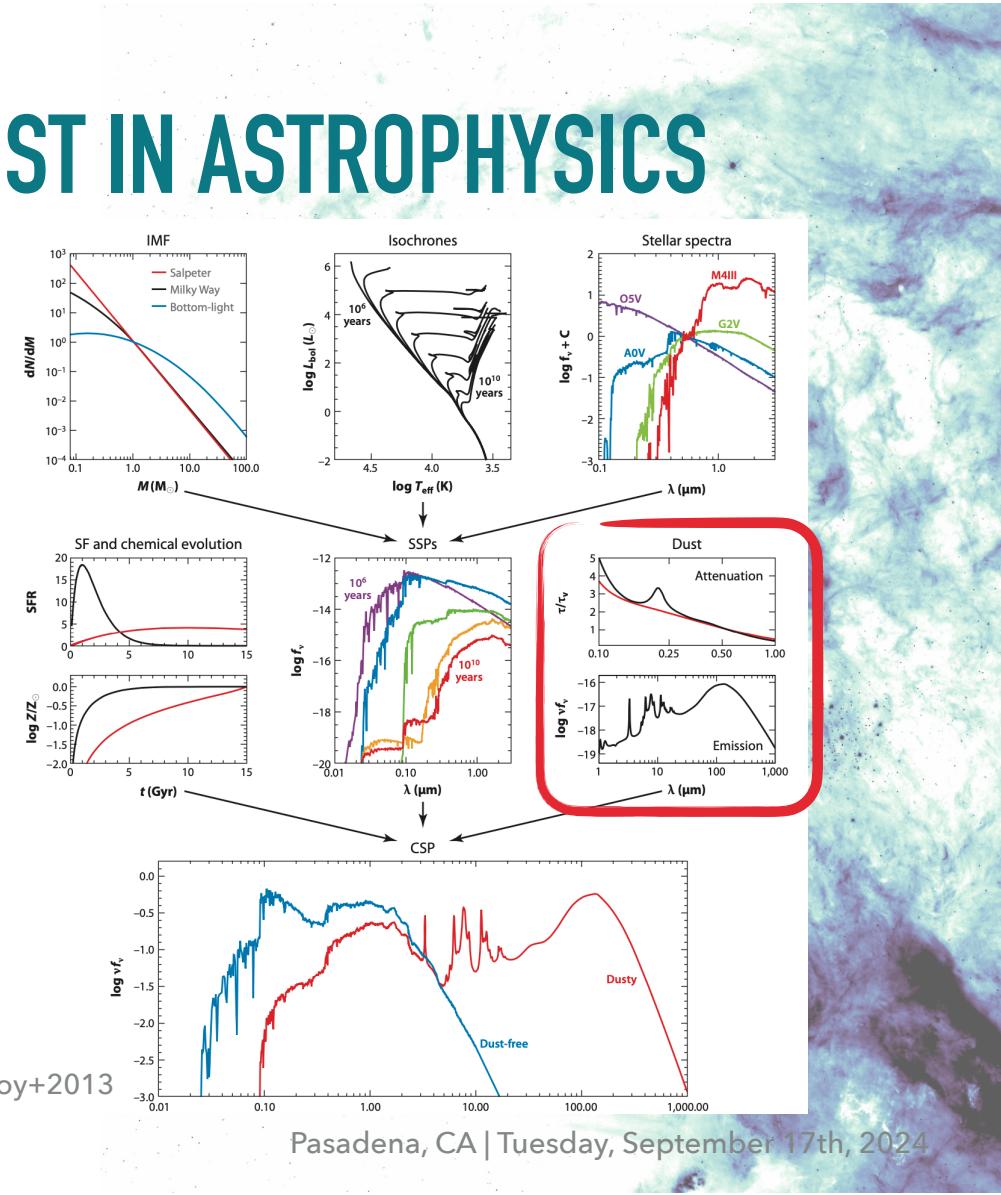
THE FUNDAMENTAL ROLE OF DUST IN ASTROPHYSICS

- ▶ **Dust** attenuates light and must be corrected for at short wavelengths
- ▶ **Dust** heats gas and sets the thermal structure of the interstellar medium
- ▶ **Dust** grains catalyze H₂ formation, the key ingredient in star-formation
- ▶ **Dust** grains seed planetesimals in proto-planetary disks



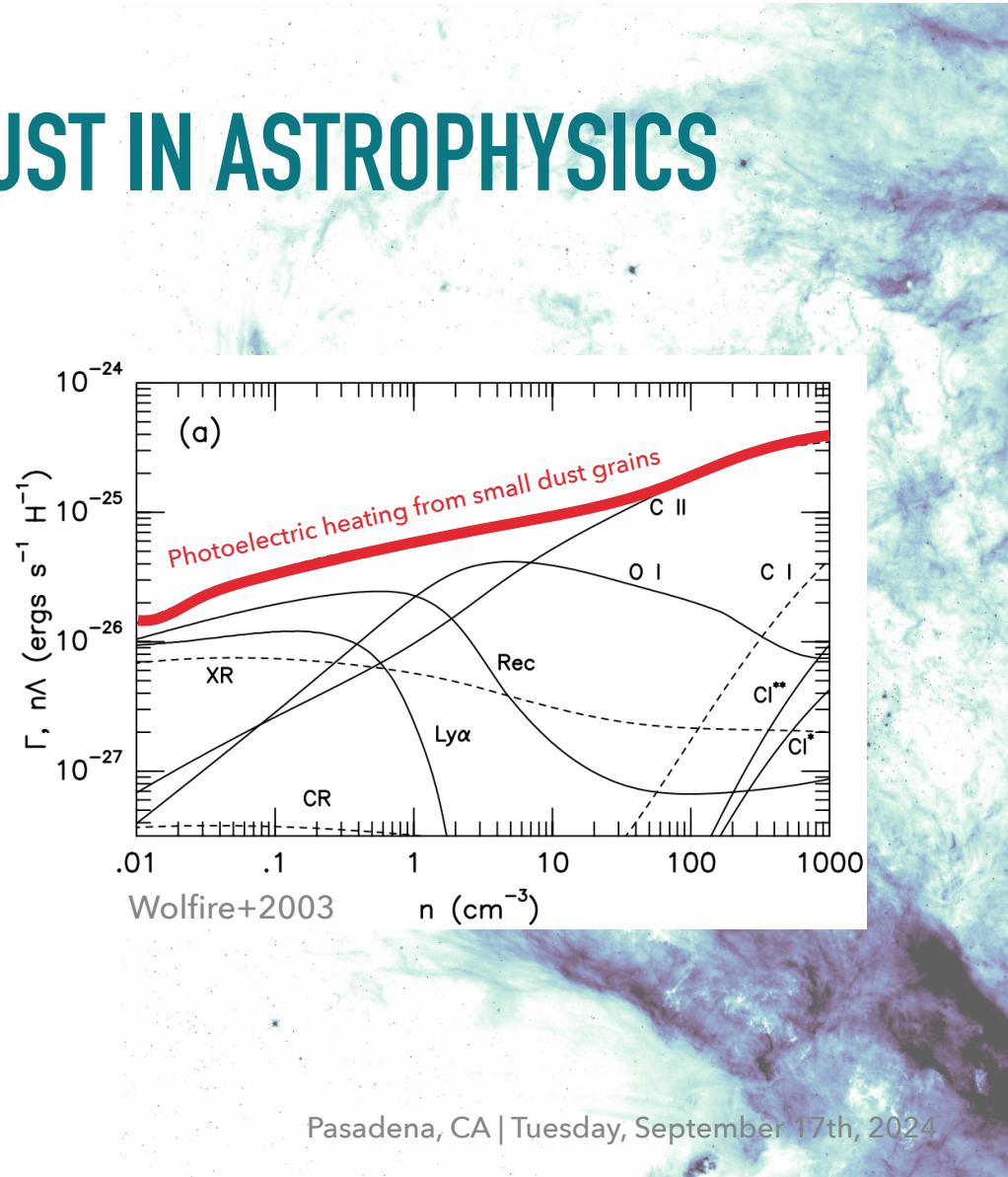
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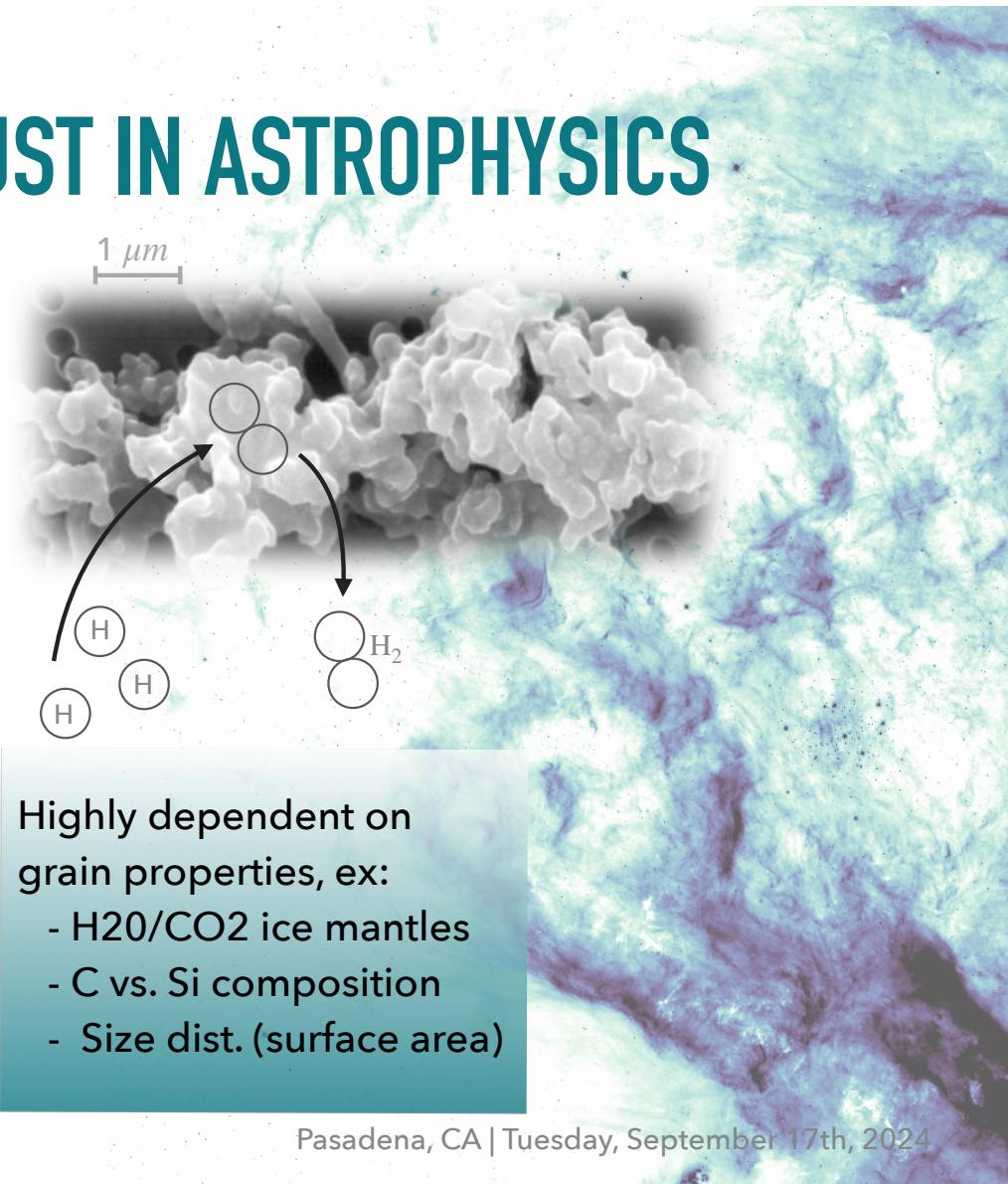
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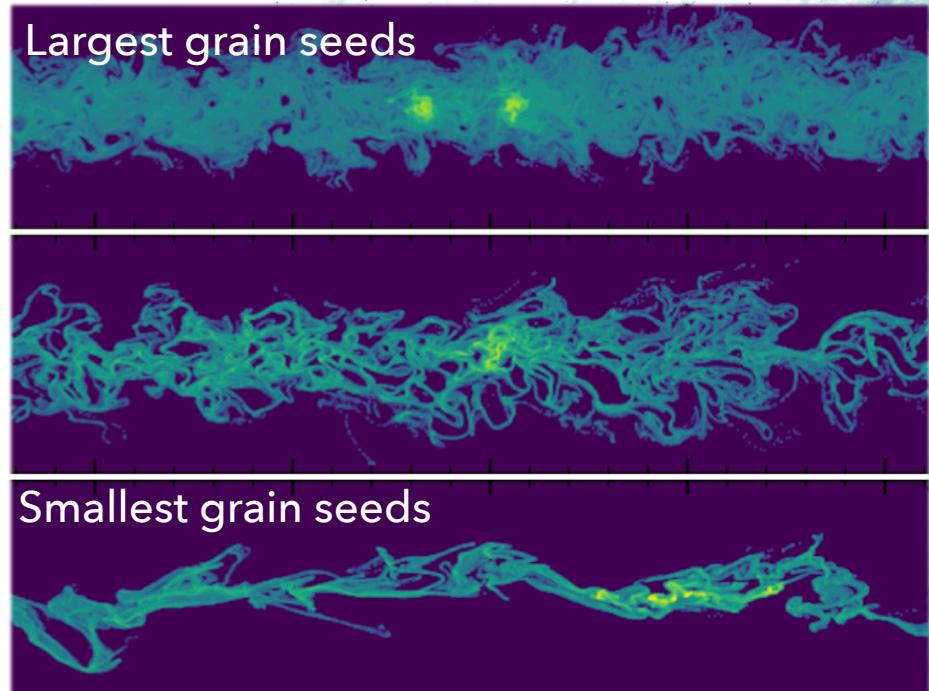
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THE FUNDAMENTAL ROLE OF DUST IN ASTROPHYSICS

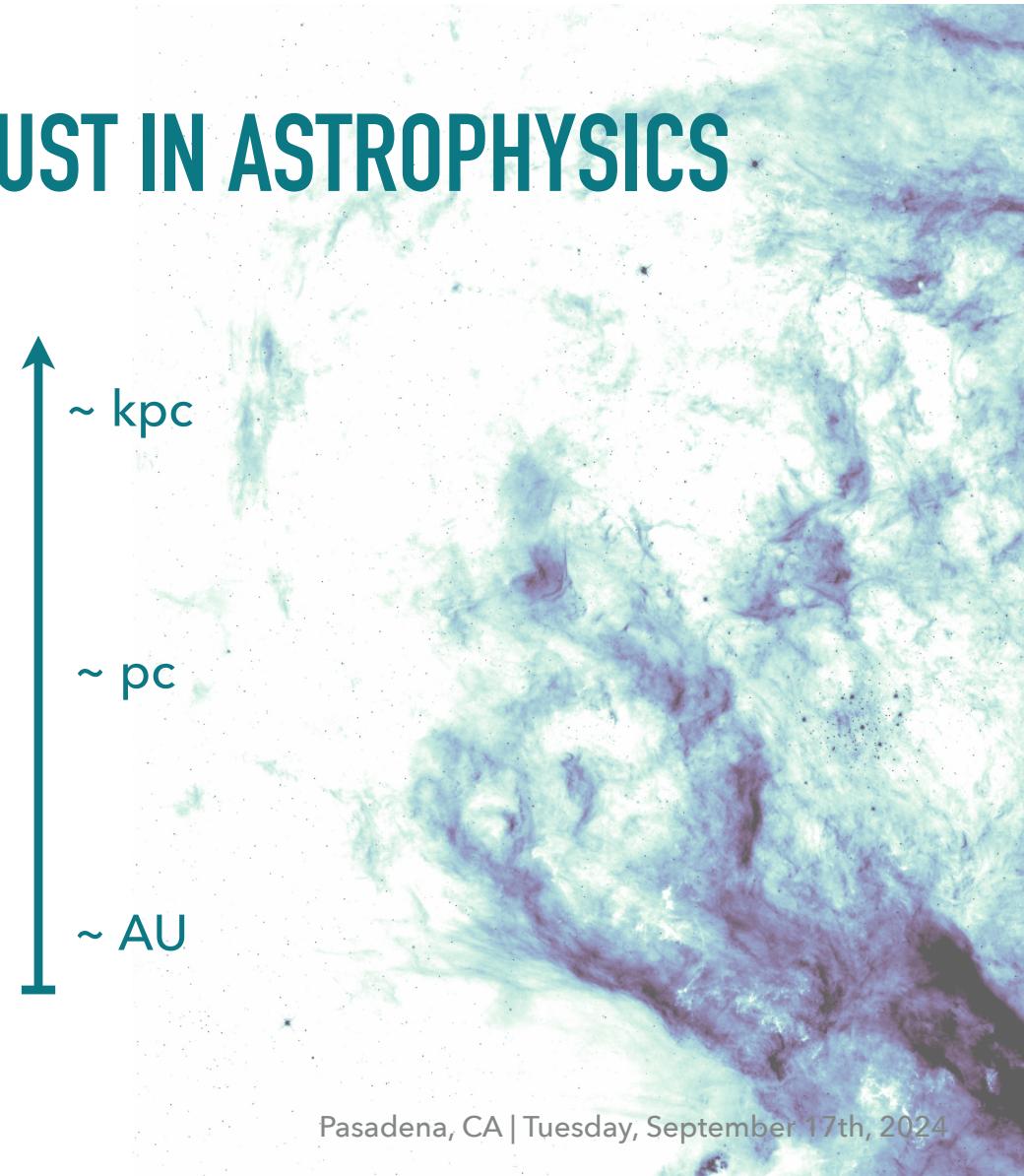
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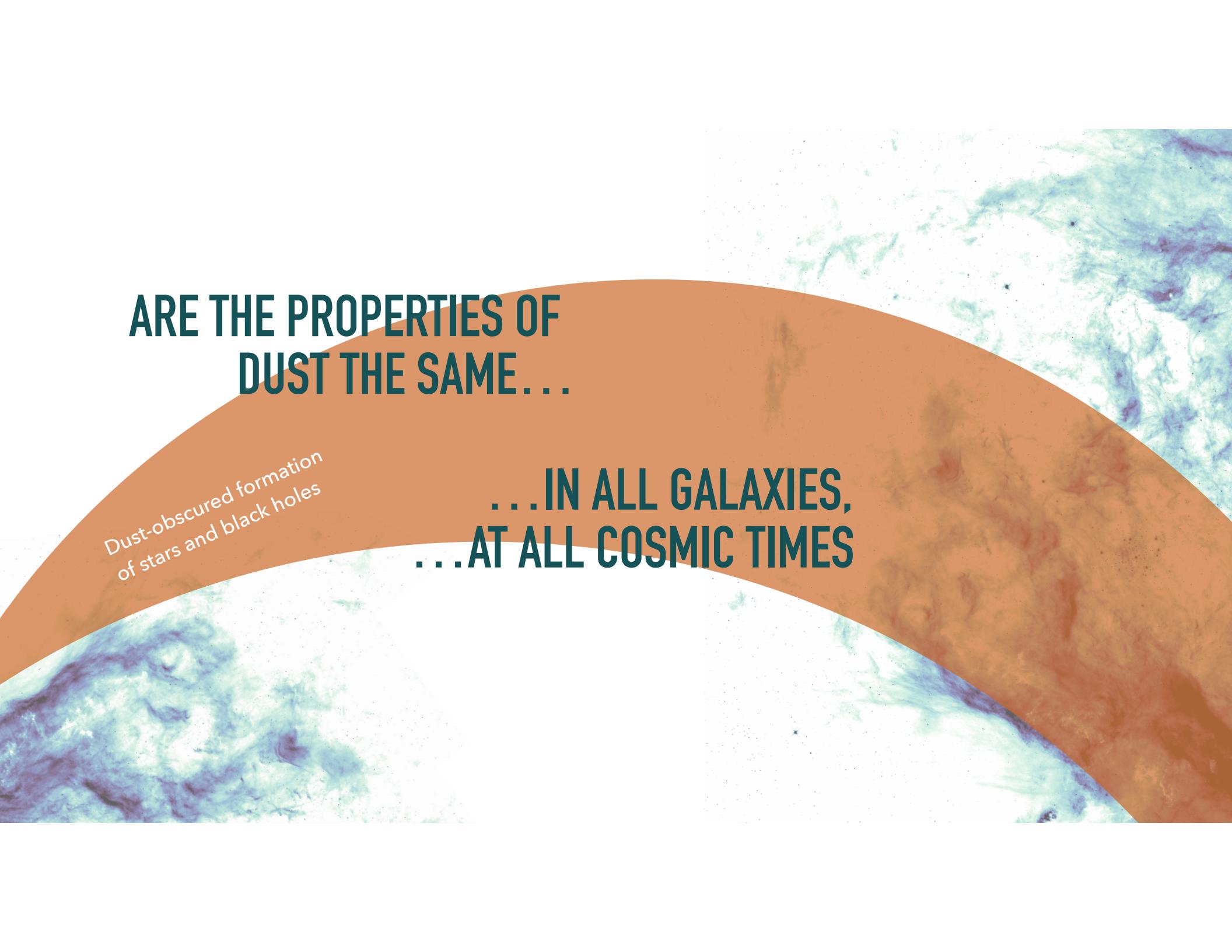


Rixin & Youdin + 2021,
see also: Paardekooper+2020,
Krapp+2019, Zhu & Yang 2021

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ARE THE PROPERTIES
OF
DUST THE SAME...

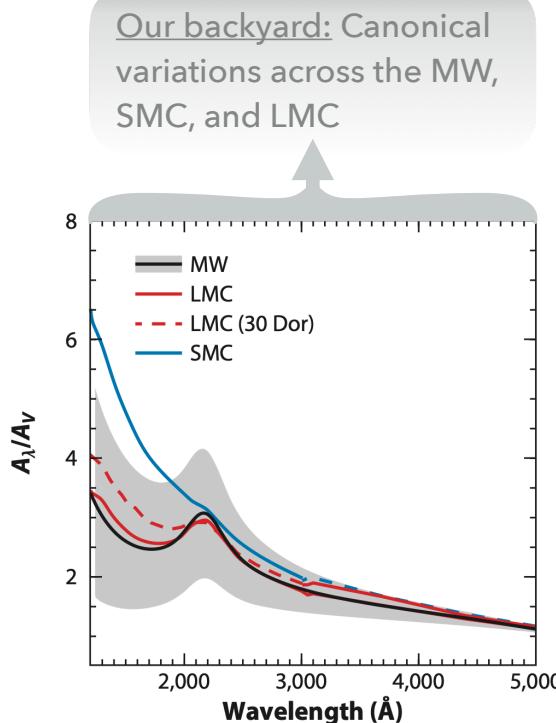
Dust-obscured formation
of stars and black holes

...IN ALL GALAXIES,
...AT ALL COSMIC TIMES

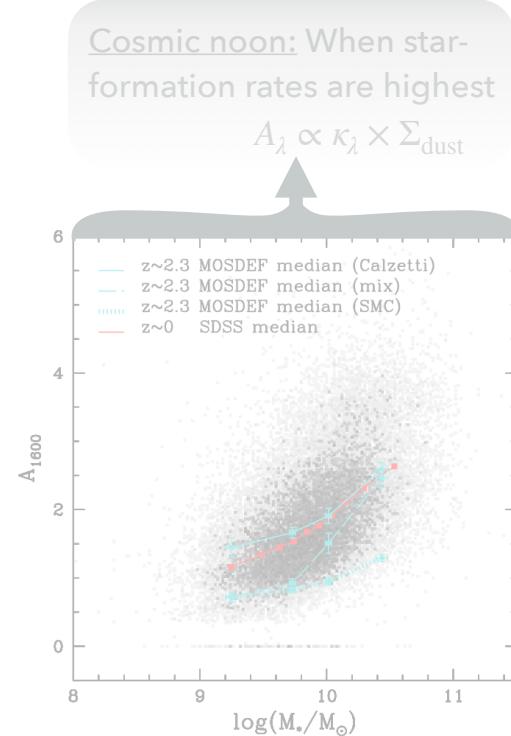
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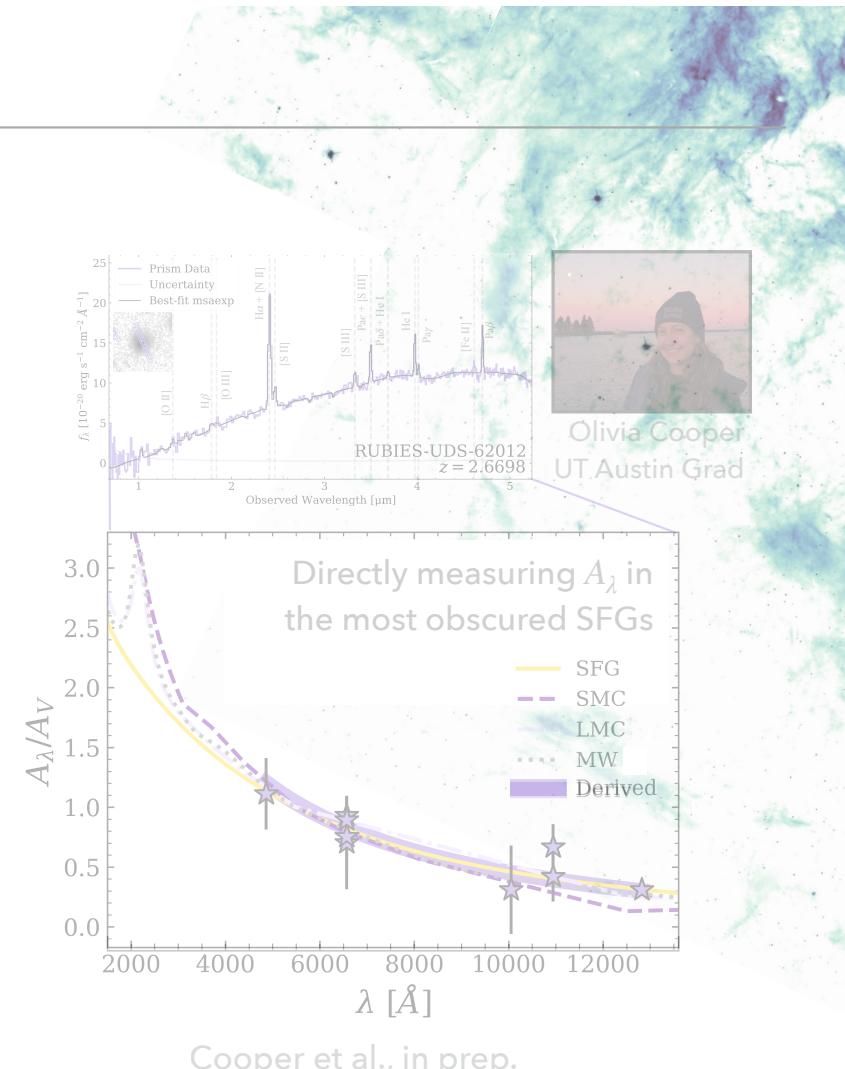
WHAT WE KNOW IN THE OPTICAL



Sarim & Narayanan 2020



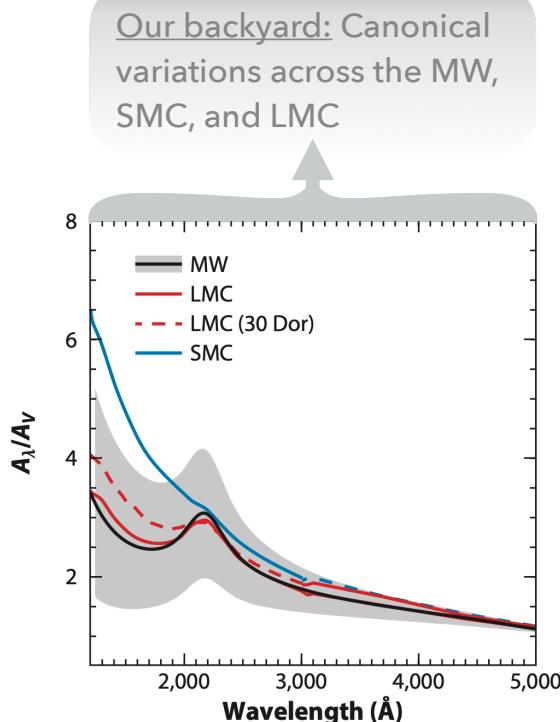
Shapley+2022



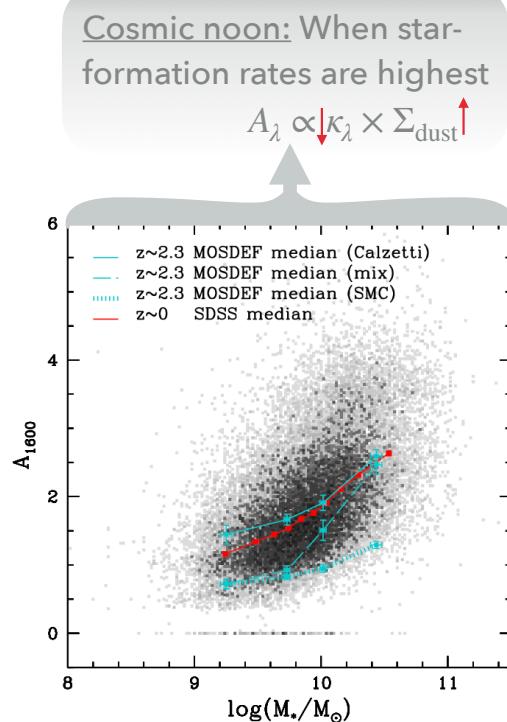
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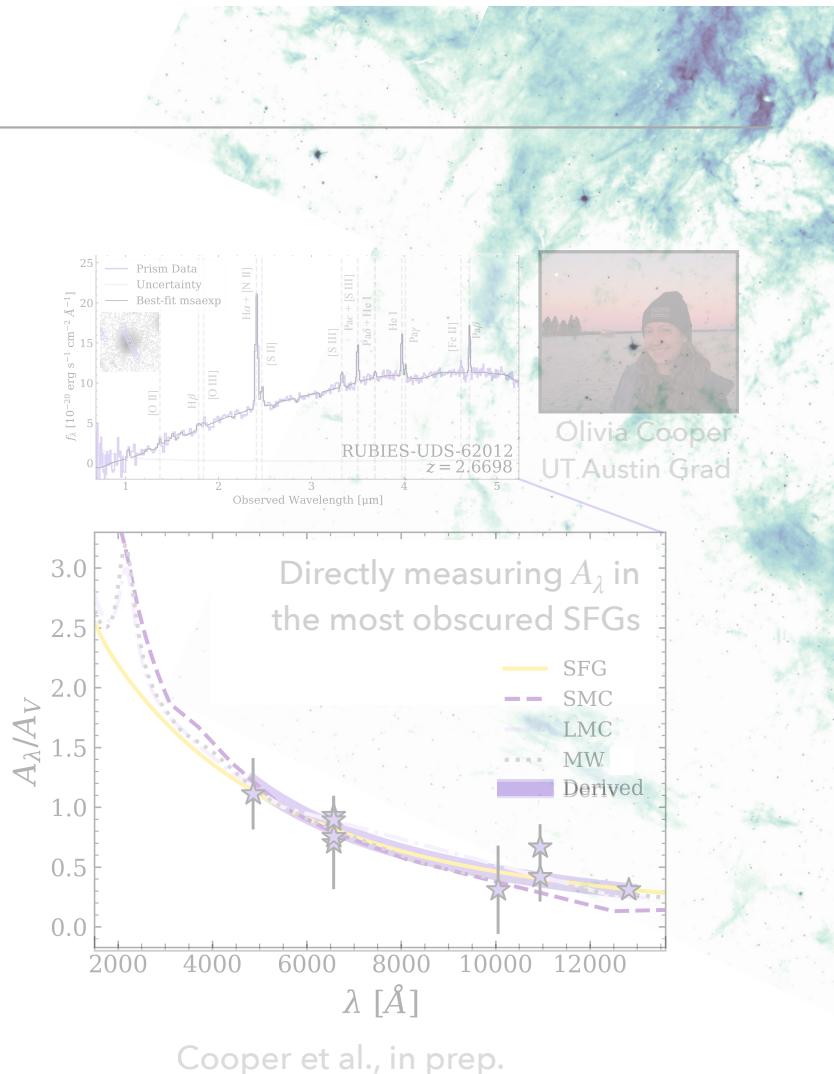
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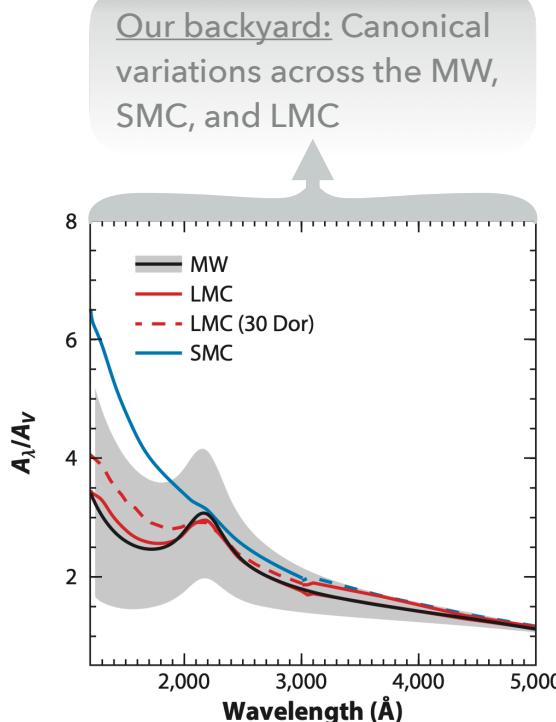


Cooper et al., in prep.

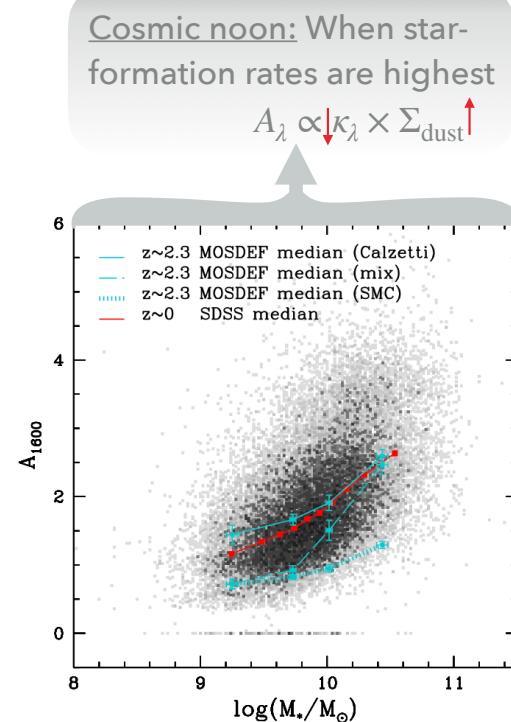
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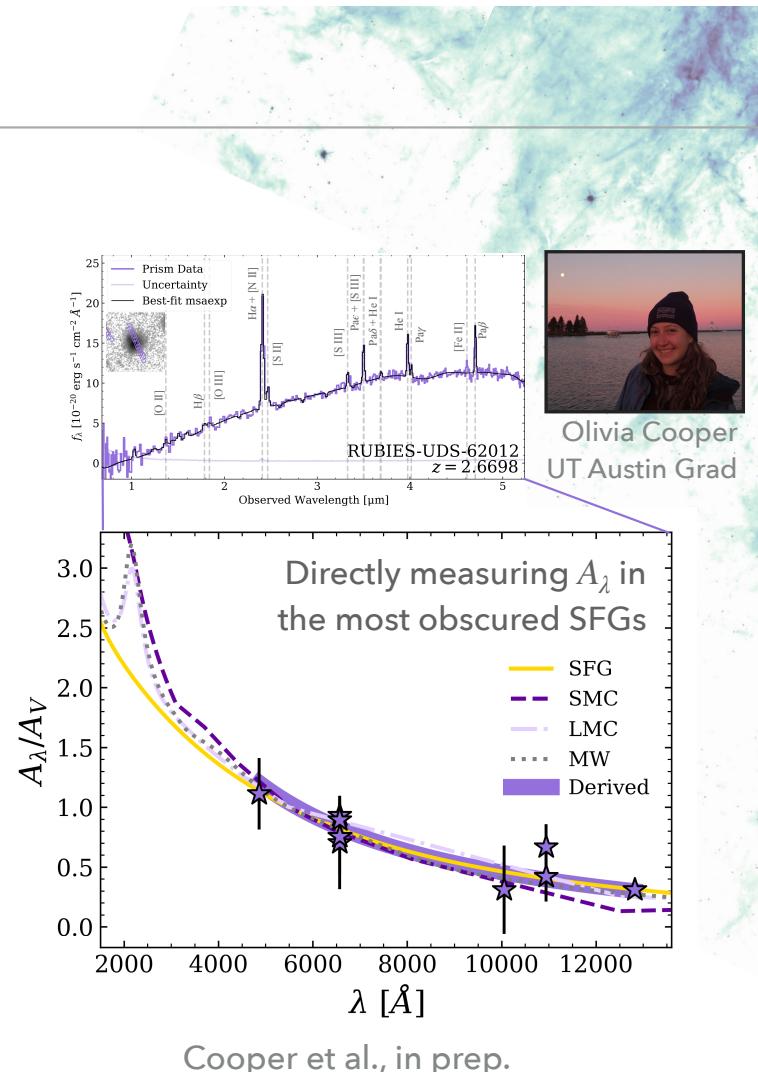
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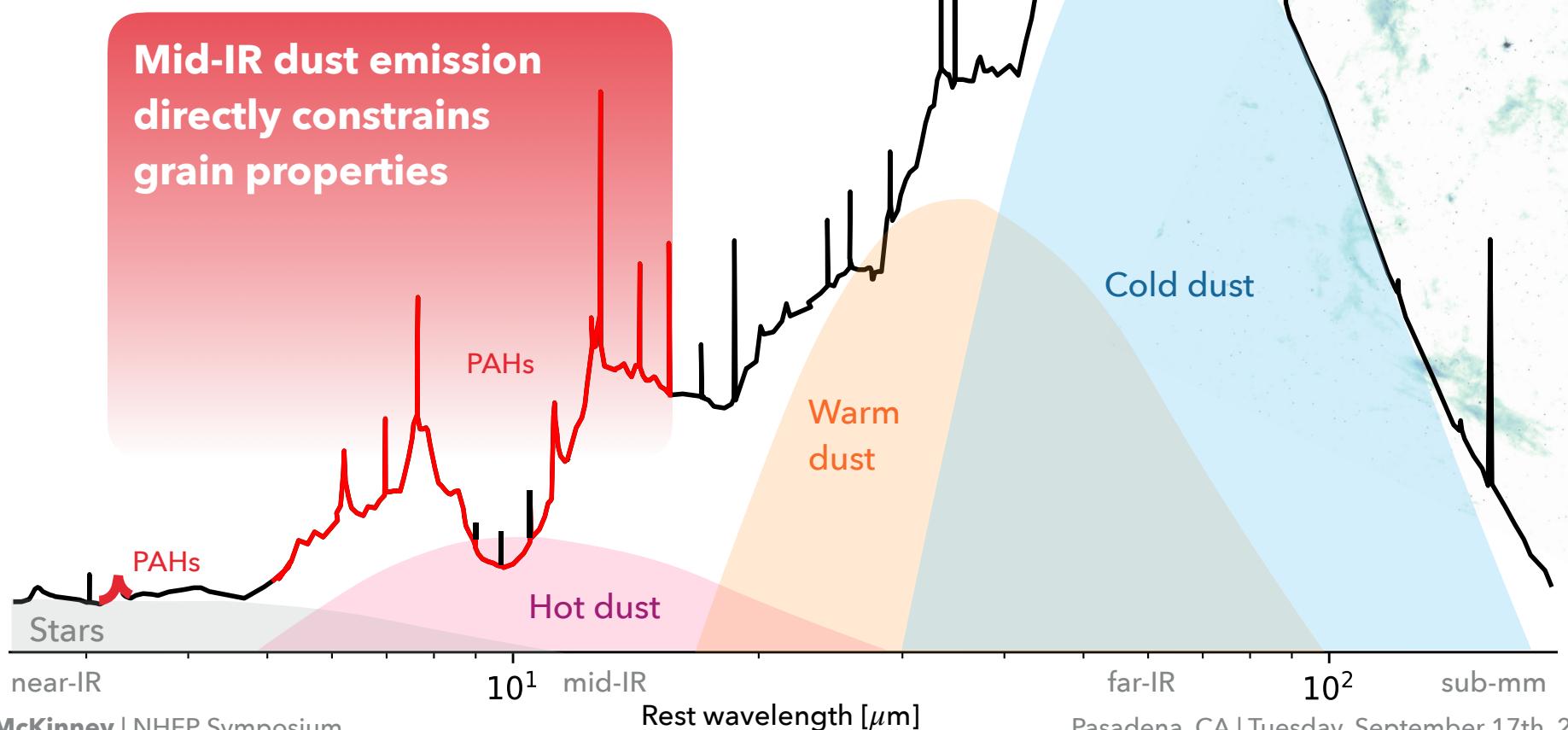


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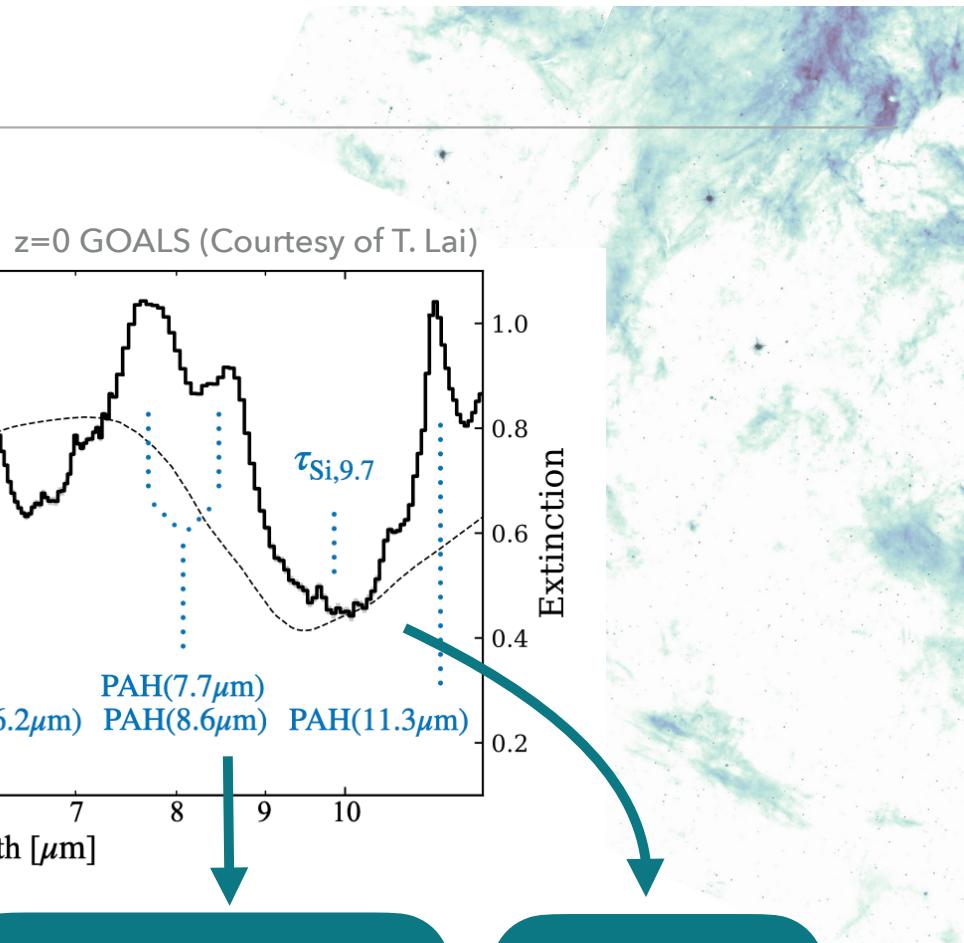
WHAT WE KNOW IN THE INFRARED



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ARE THE PROPERTIES OF DUST THE SAME?

WHAT WE KNOW IN THE INFRARED



Flux [mJy]

Rest-frame Wavelength [μm]

$\tau_{\text{H}_2\text{O}}$

Water ices, near-IR attenuation

$3.3\mu\text{m}$ PAH

Small grain size diagnostic

$> 6\mu\text{m}$ PAHs

Size and neutrality indicators

τ_{Si}

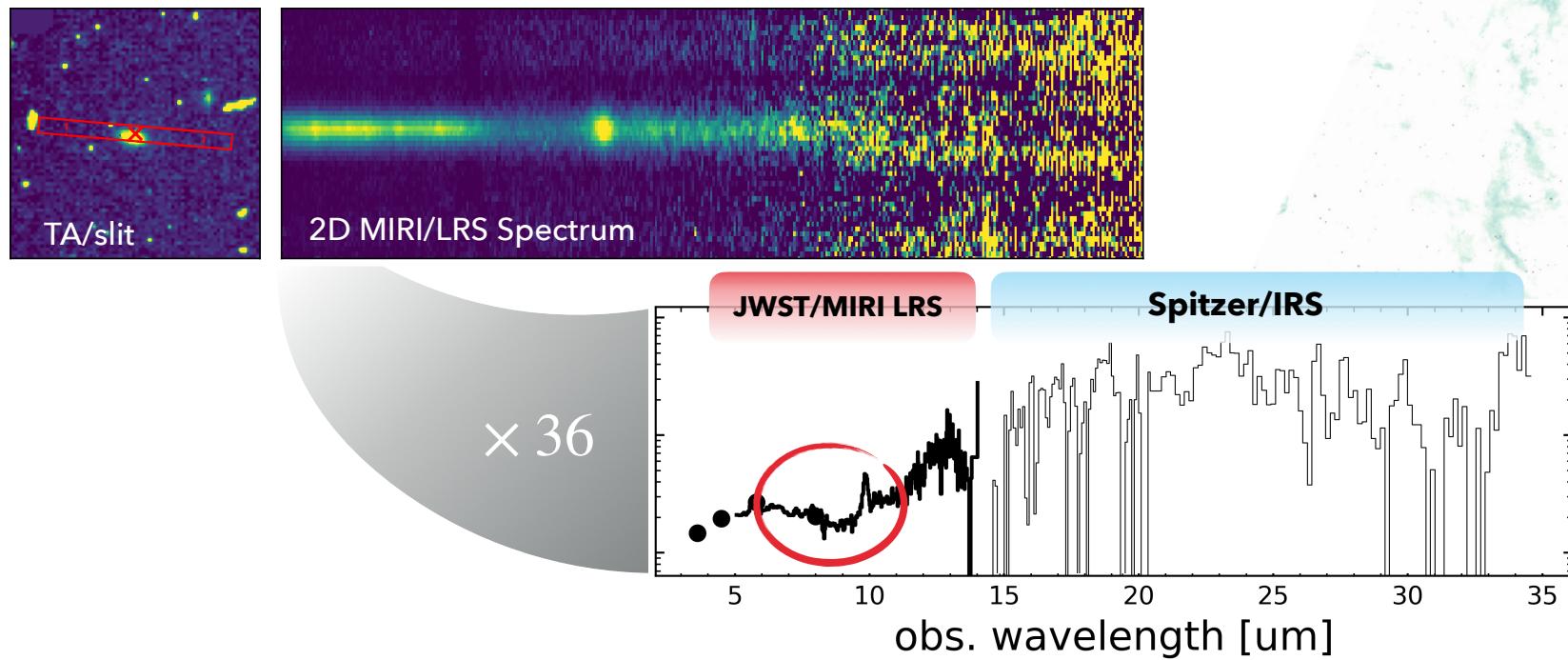
Silicates

DOES DUST EVOLVE WITH REDSHIFT?

ARE THE PROPERTIES OF DUST THE SAME? NO!

WHAT WE KNOW IN THE INFRARED

JWST Cy2 #3224 PI McKinney



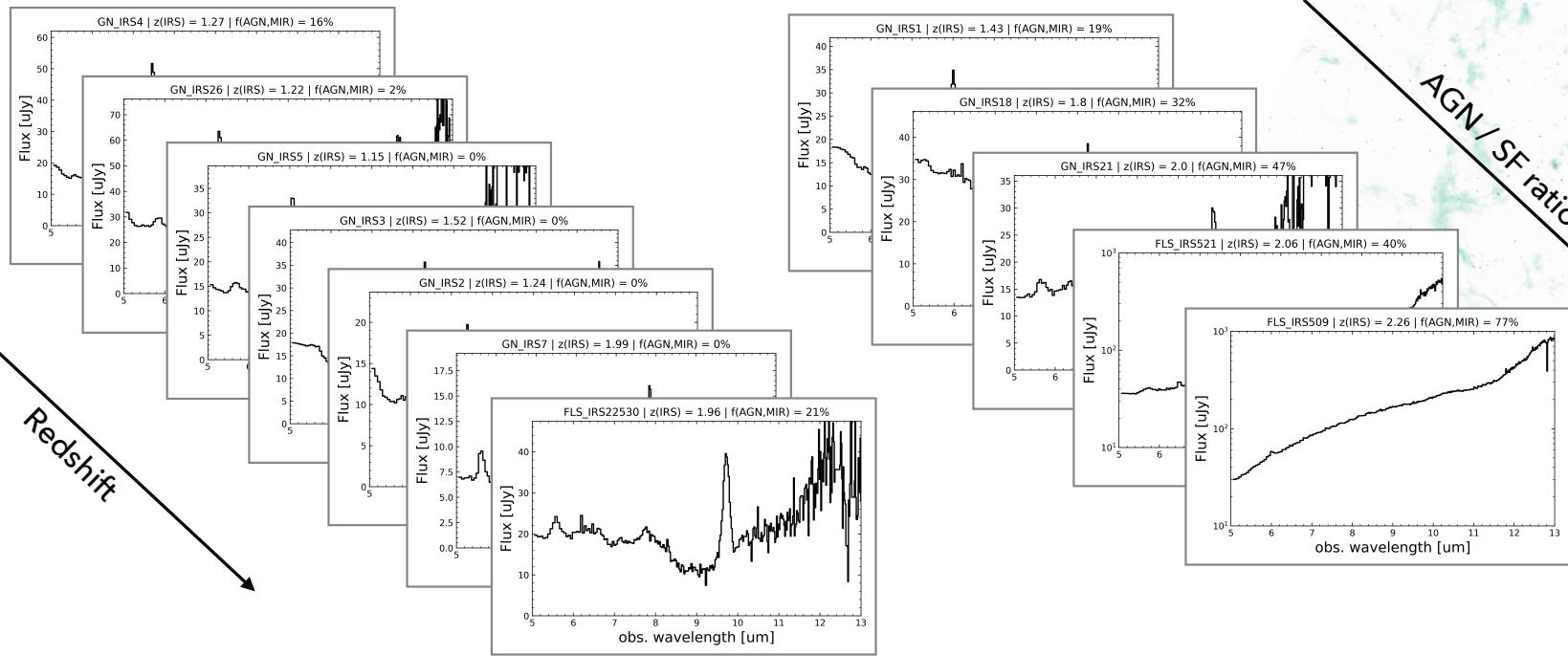
DOES DUST EVOLVE WITH REDSHIFT?

Showing 12/36 JWST PID#3224 spectra

ARE THE PROPERTIES OF DUST THE SAME? NO!

WHAT WE KNOW IN THE INFRARED

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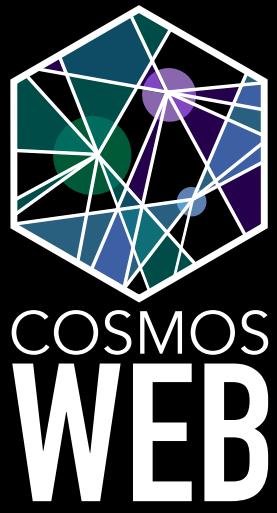




**DUST IS NOT
THE SAME...**

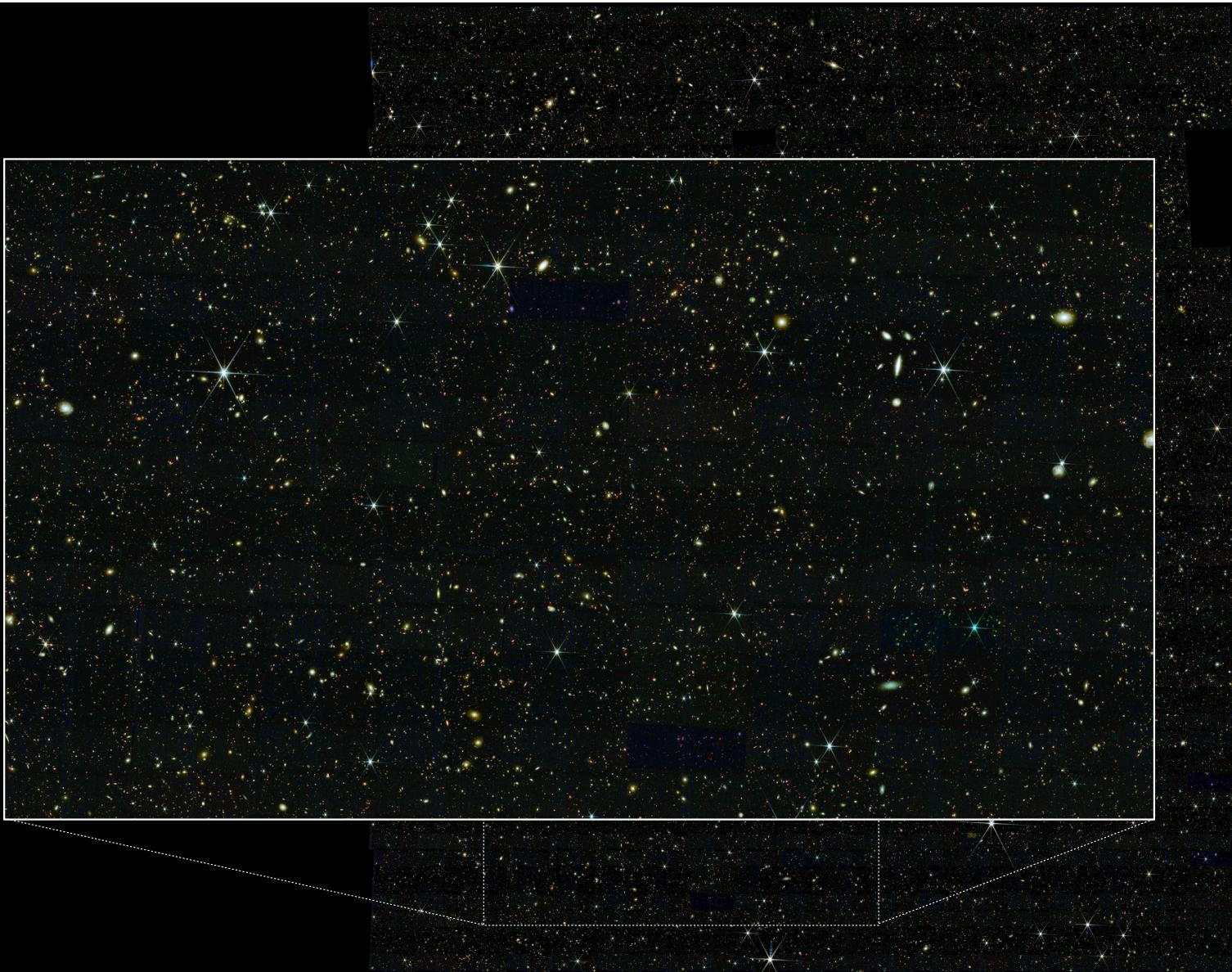
Dust-obscured formation
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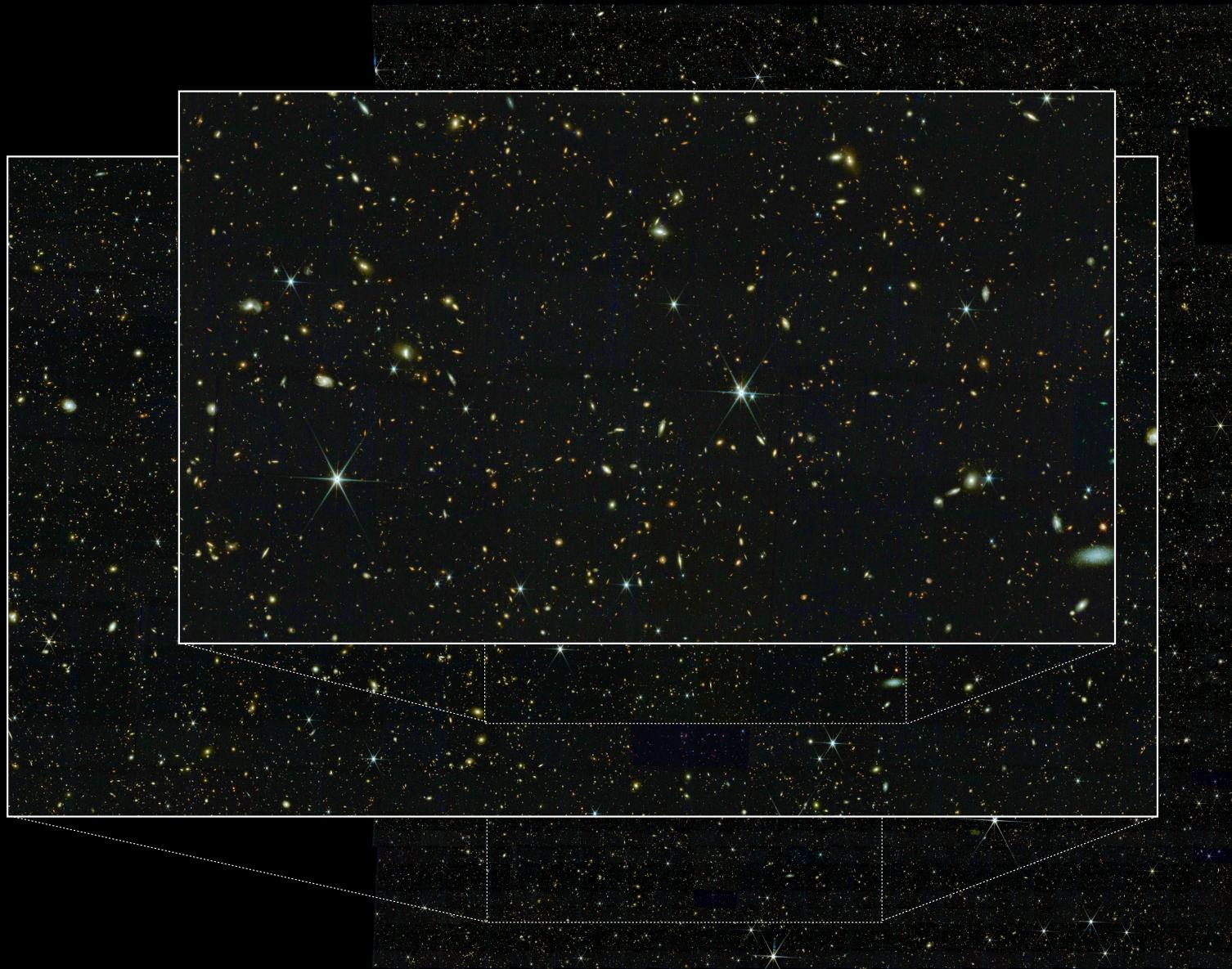
**...IN ALL GALAXIES,
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Courtesy of Caitlin Casey



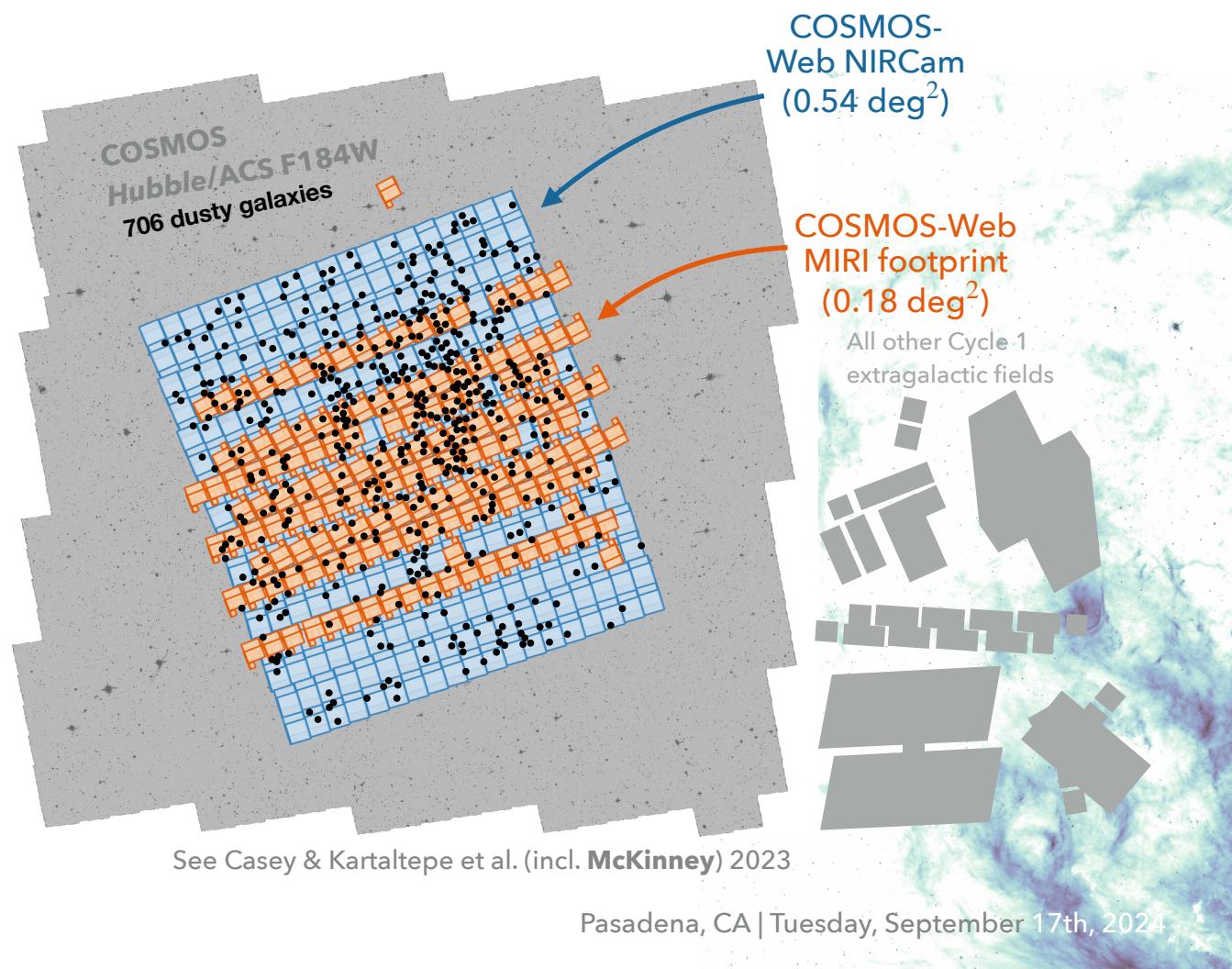




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SCUBADive

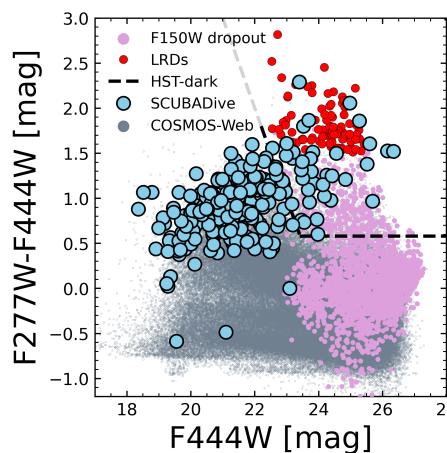
JWST Cy3 AR#5213 PI McKinney



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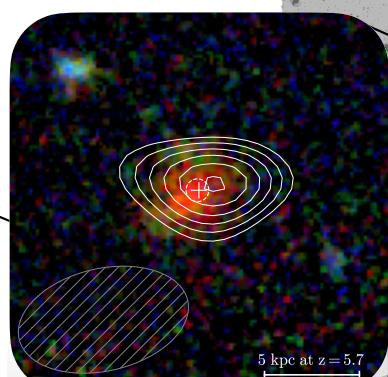
SCUBADive

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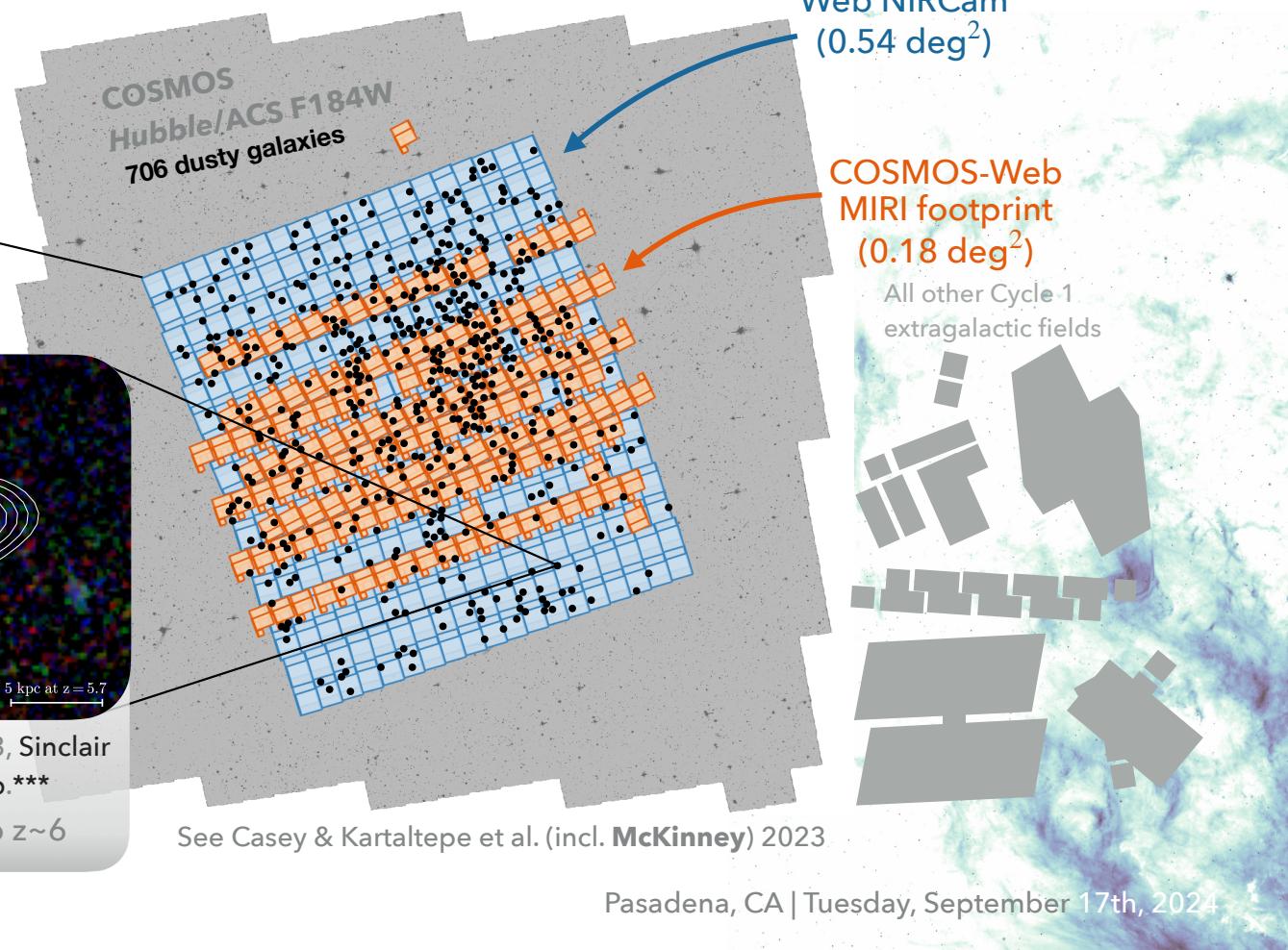
McKinney+2024

~300 SMGs matched
with ALMA and JWST



McKinney+2023, Sinclair
Manning in prep. ***

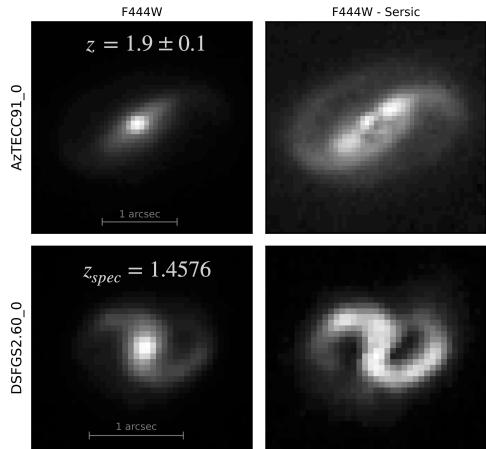
SMGs out to $z \sim 6$



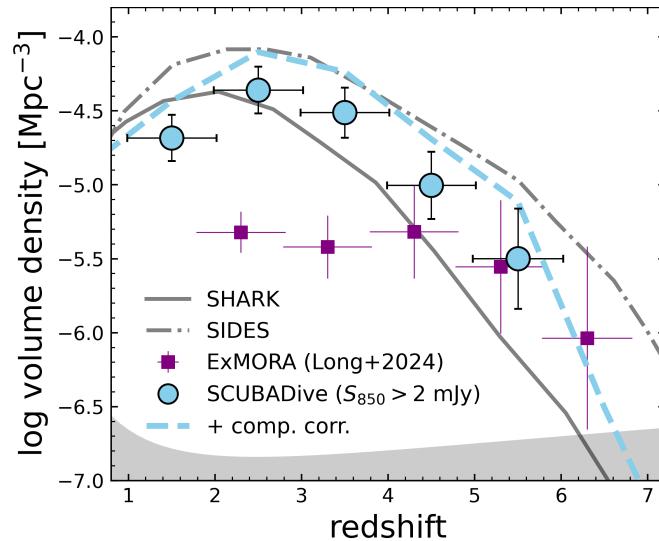
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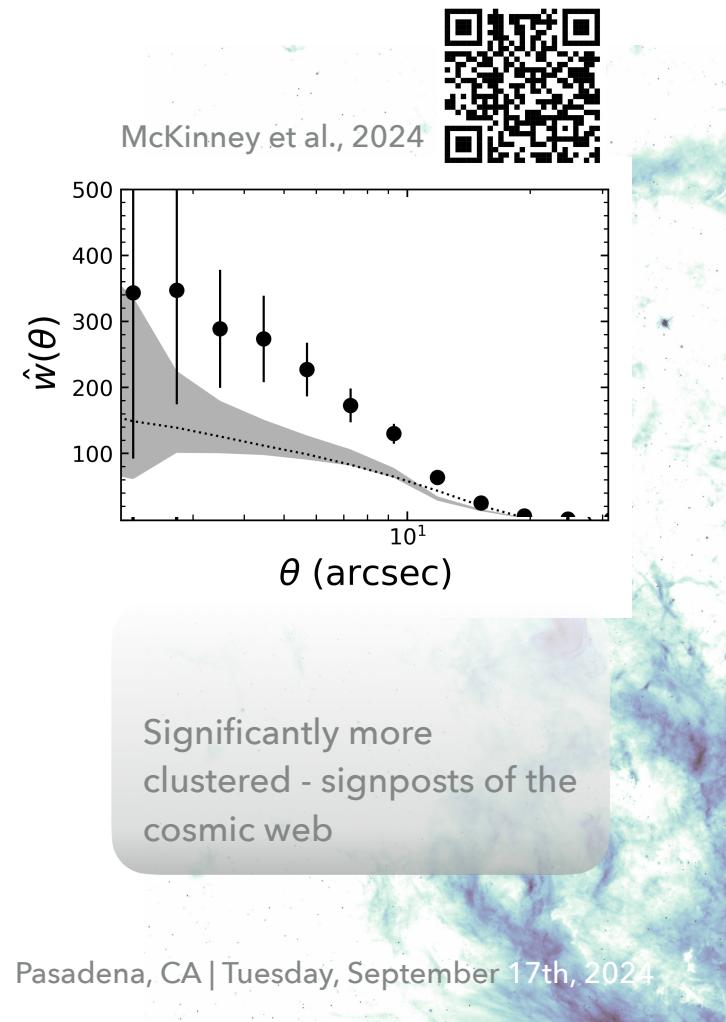
JWST Cy3 AR#5213 PI McKinney



Stellar bars growing in
highly dust-obscured
galaxies



Most precise estimate on the
abundance of dust-obscured
galaxies in the first 1.5 Gyr



Significantly more
clustered - signposts of the
cosmic web

DOES DUST EVOLVE WITH REDSHIFT?

SUMMARY

- ▶ Dust profoundly shapes observations and physics of the ISM of galaxies
- ▶ JWST/MIRI + ALMA opening new windows into to study dust out to early cosmic times
- ▶ New models needed as dust properties may be significantly different in the early Universe

Jed McKinney

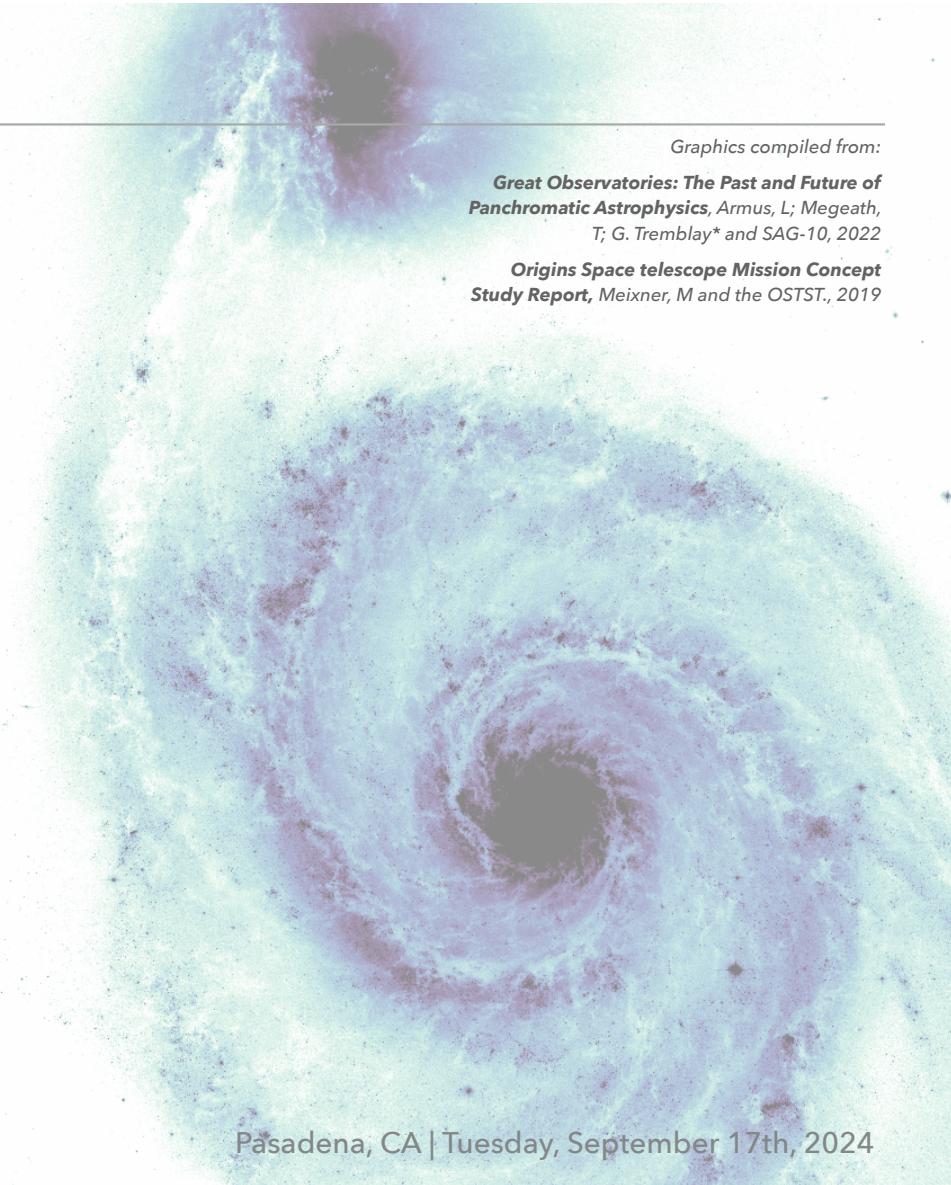
NHFP Hubble Fellow, UT Austin

jed.mckinney@austin.utexas.edu

Always happy to talk (science, or other) so please reach out!

Jed McKinney | NHFP Symposium

Pasadena, CA | Tuesday, September 17th, 2024



Graphics compiled from:

Great Observatories: The Past and Future of Panchromatic Astrophysics, Armus, L; Megeath, T; G. Tremblay* and SAG-10, 2022

Origins Space telescope Mission Concept Study Report, Meixner, M and the OSTST., 2019