CAMILLA PACIFICI

THE ART OF MEASURING GALAXY STAR FORMATION HISTORIES

Credit: NASA, ESA, CSA

OUTLINE

- **Star formation histories in SED fitting**
  - Why do we care?
  - Parametric or non-parametric?
  - Importance of metallicity evolution
- **Understanding modeling uncertainties**
  - Different answers from different models
  - Use multiple codes!
- **Applications**
  - Star formation histories to measure dust laws
  - The Sparkler

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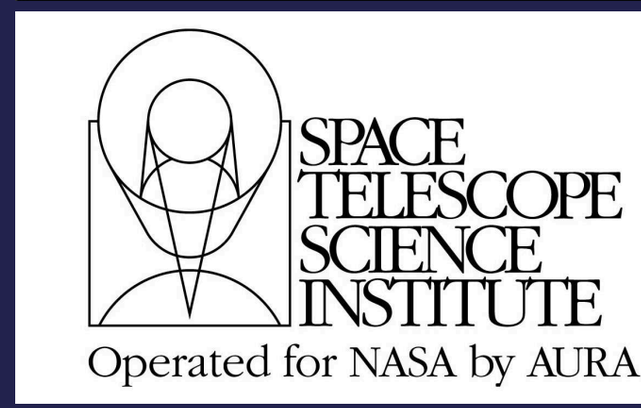

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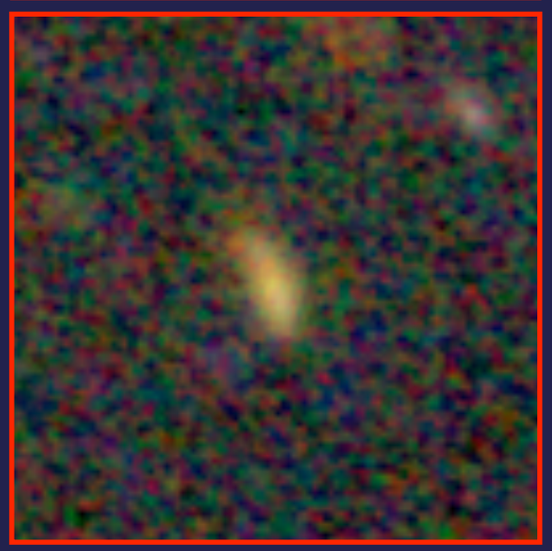
Time



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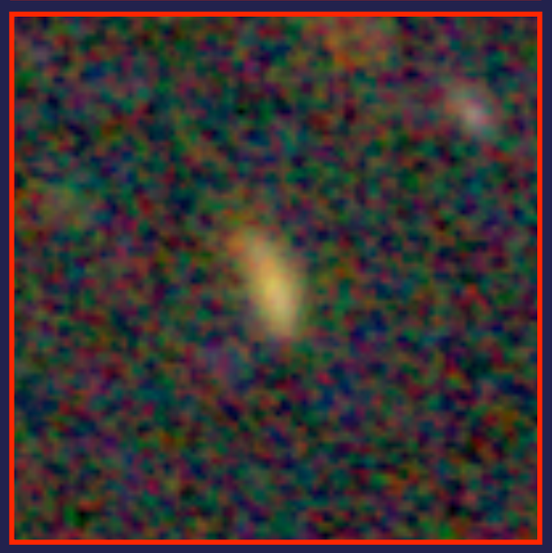

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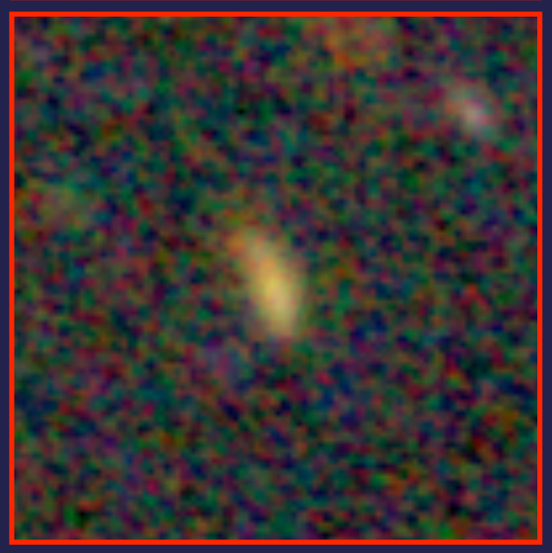

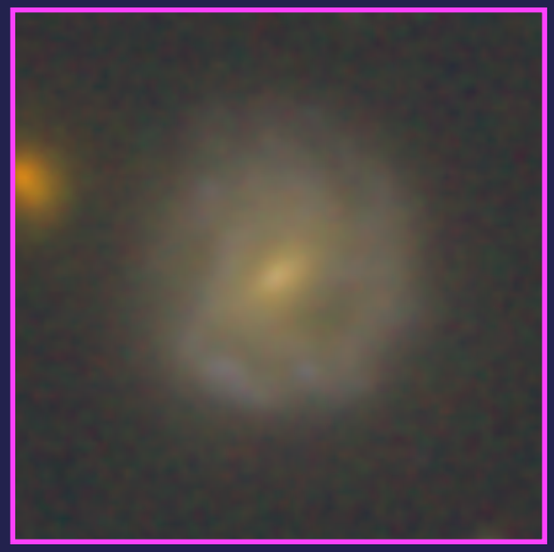

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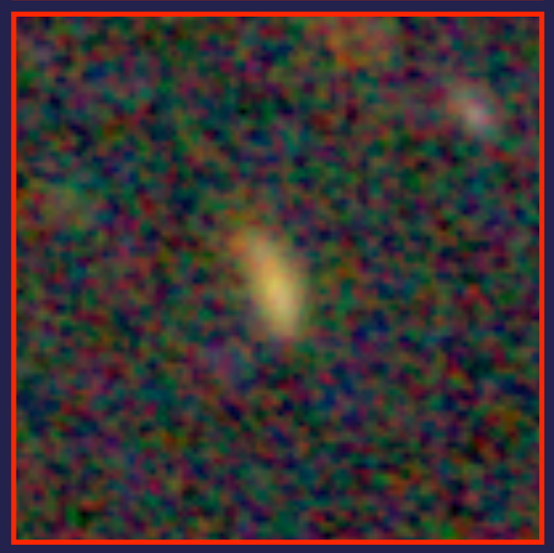

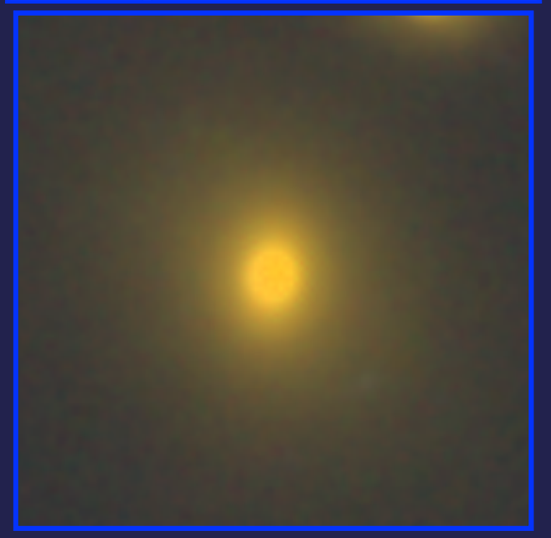

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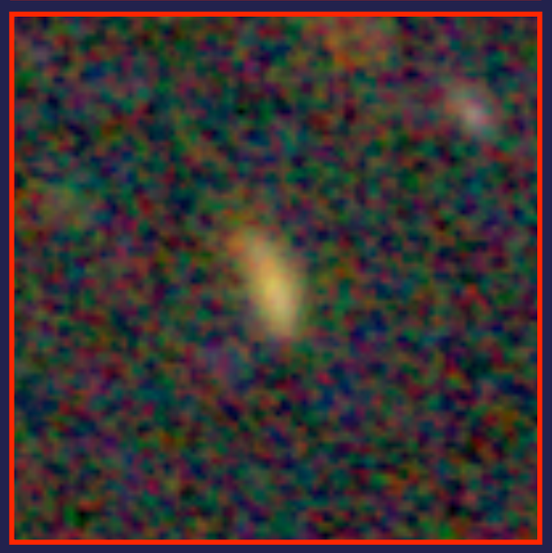

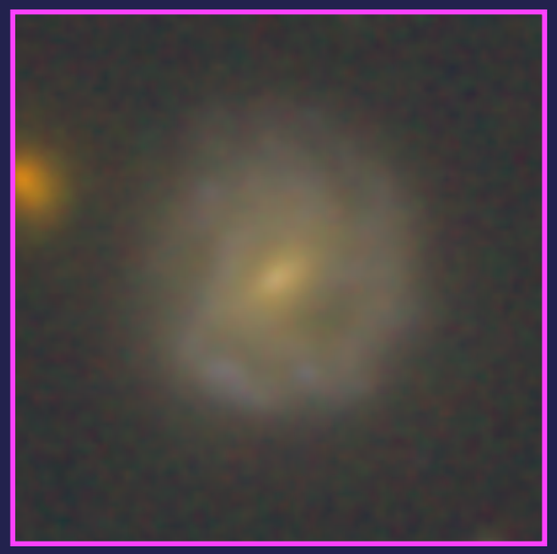

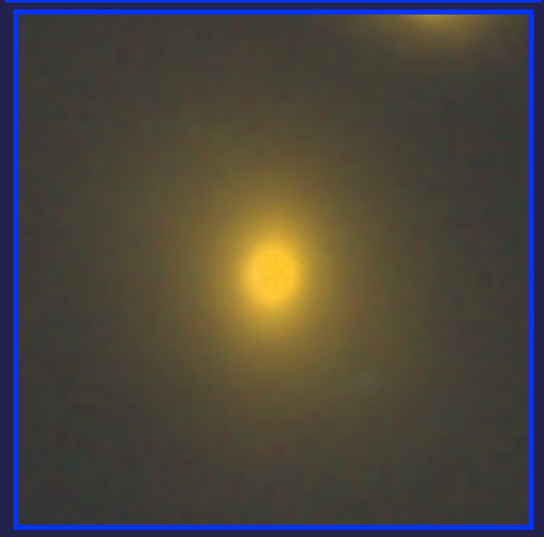

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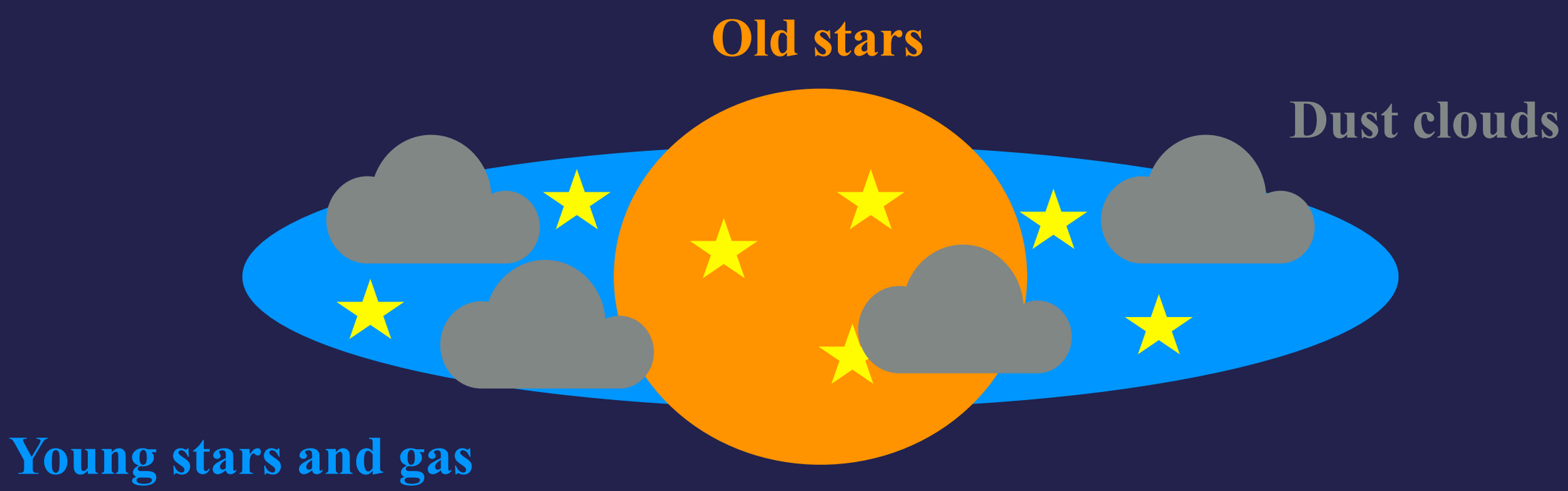
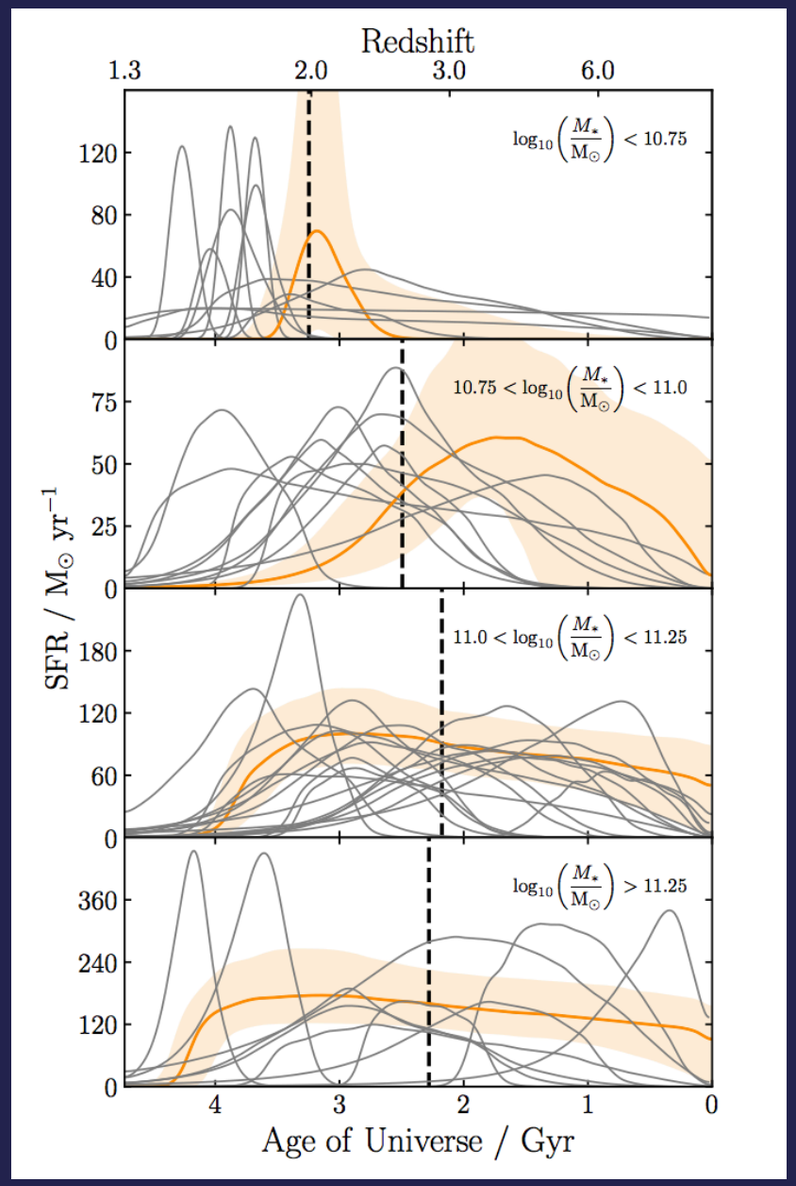
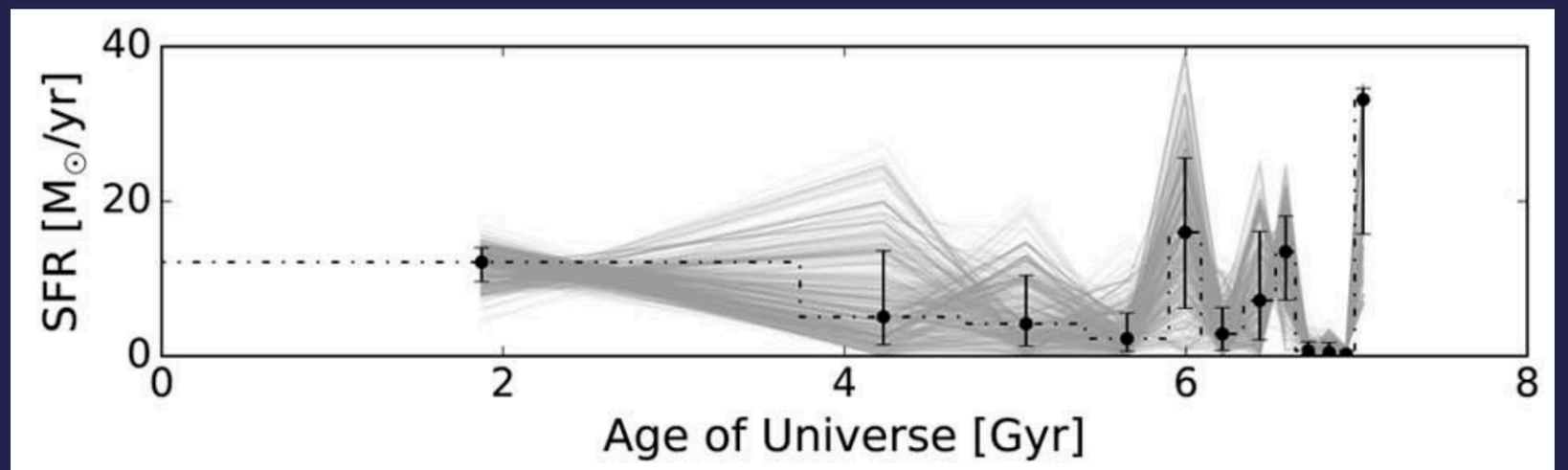


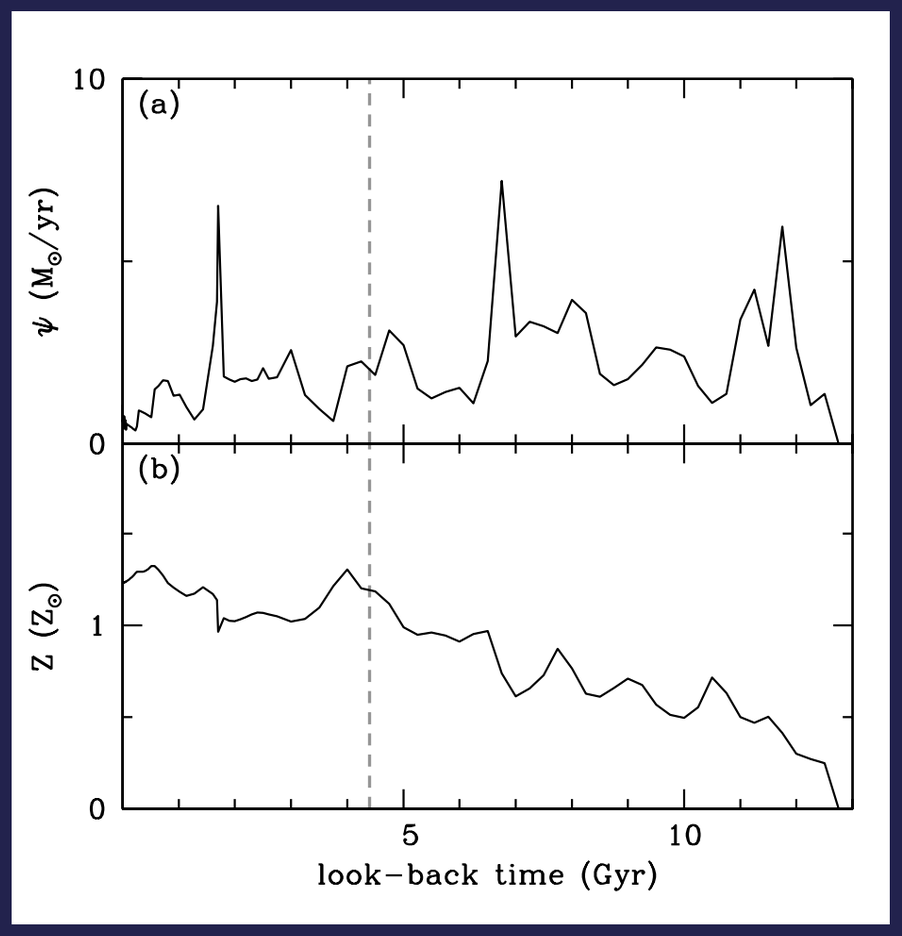
PARAMETRIC OR NON-PARAMETRIC?



Parametric
(Carnall et al. 2019)



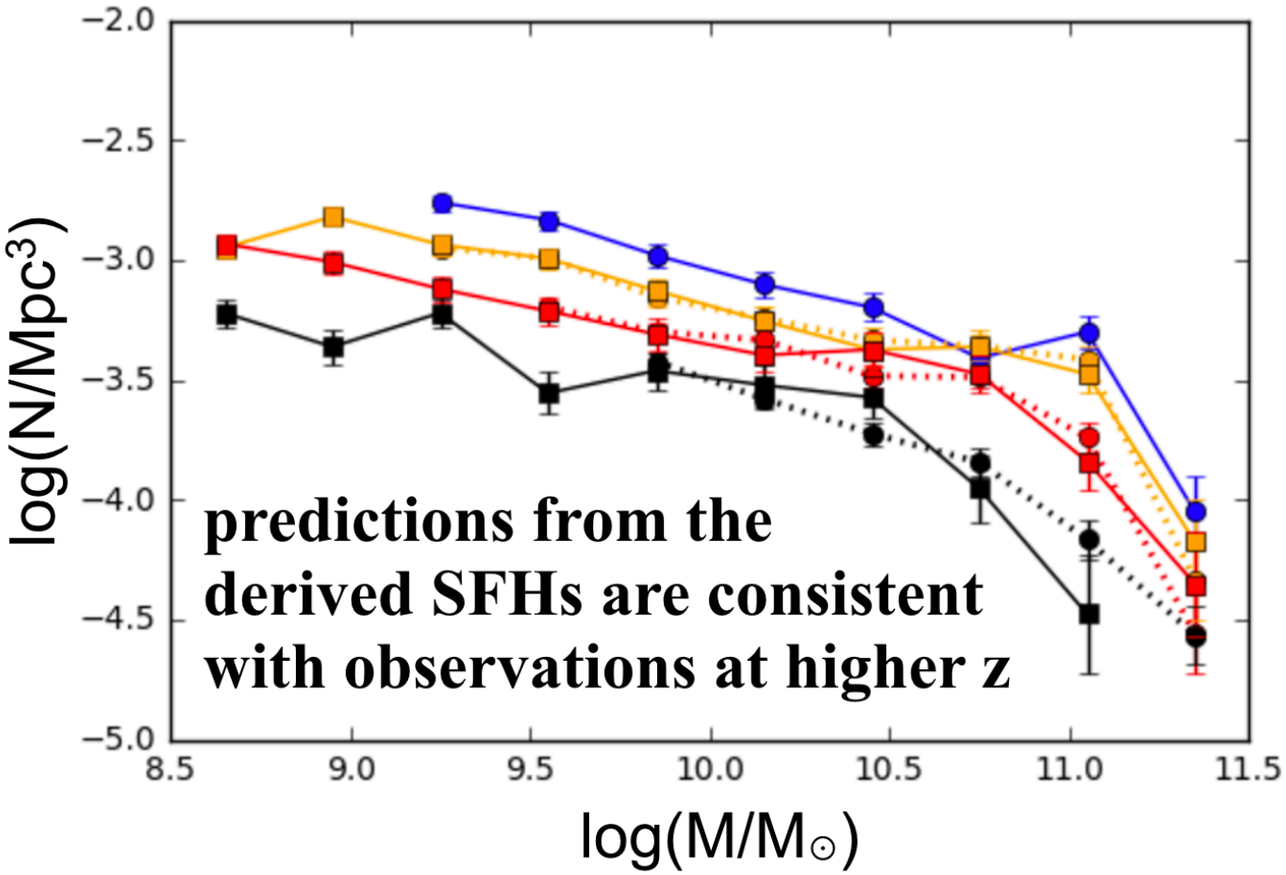
Non-parametric
(Chauke et al. 2018)



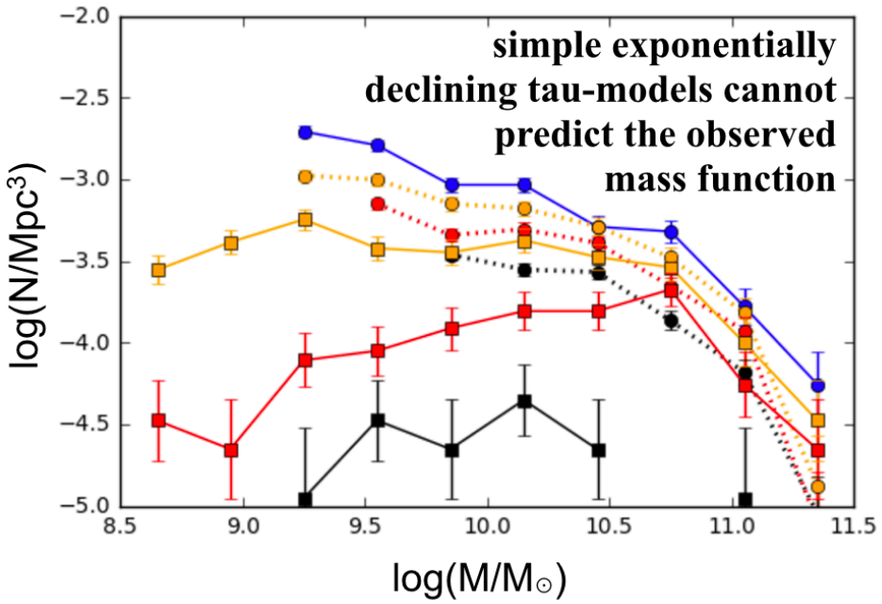
Based on simulations
(Pacifici et al. 2012)

PARAMETRIC OR NON-PARAMETRIC?

Mass function with realistic SFHs

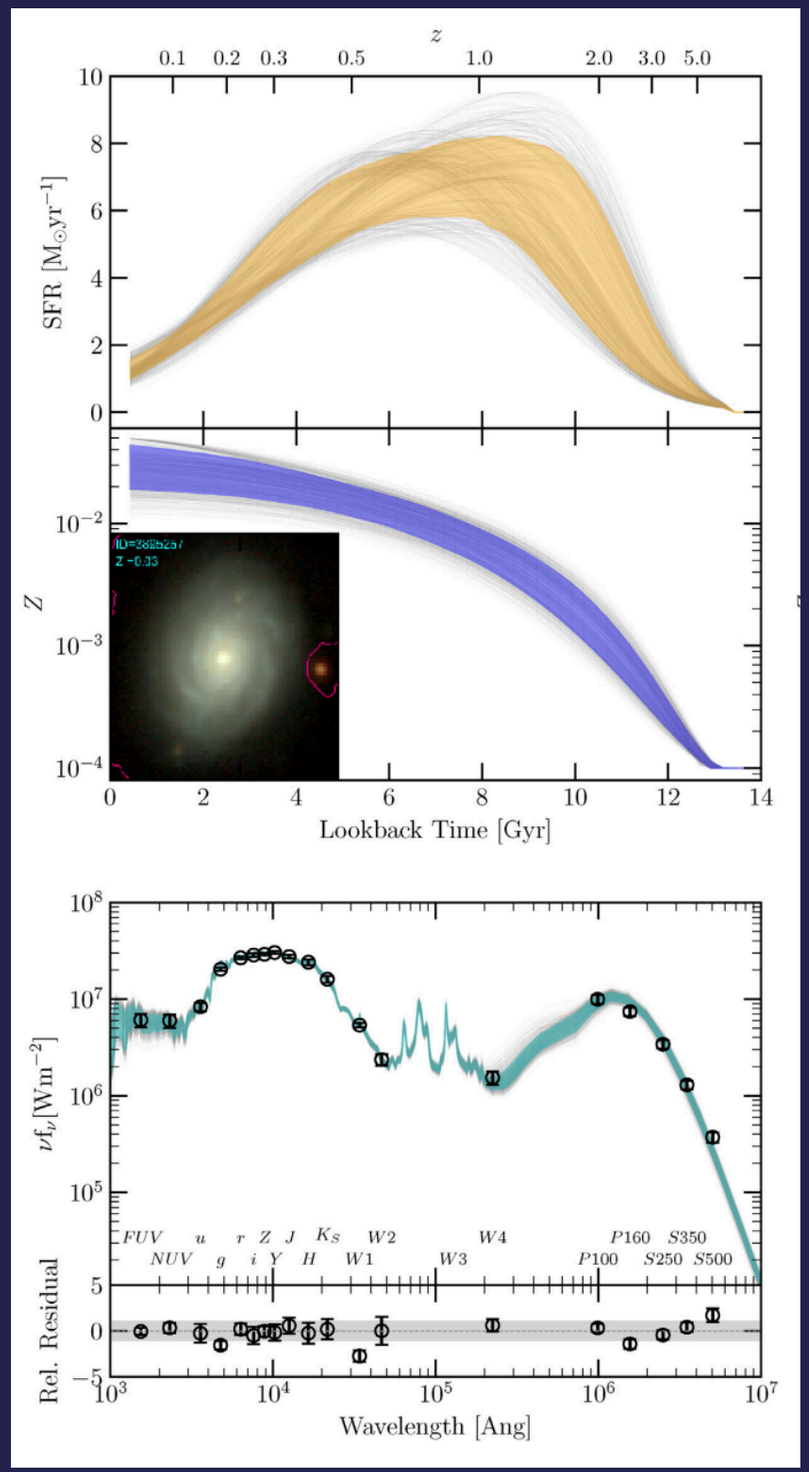


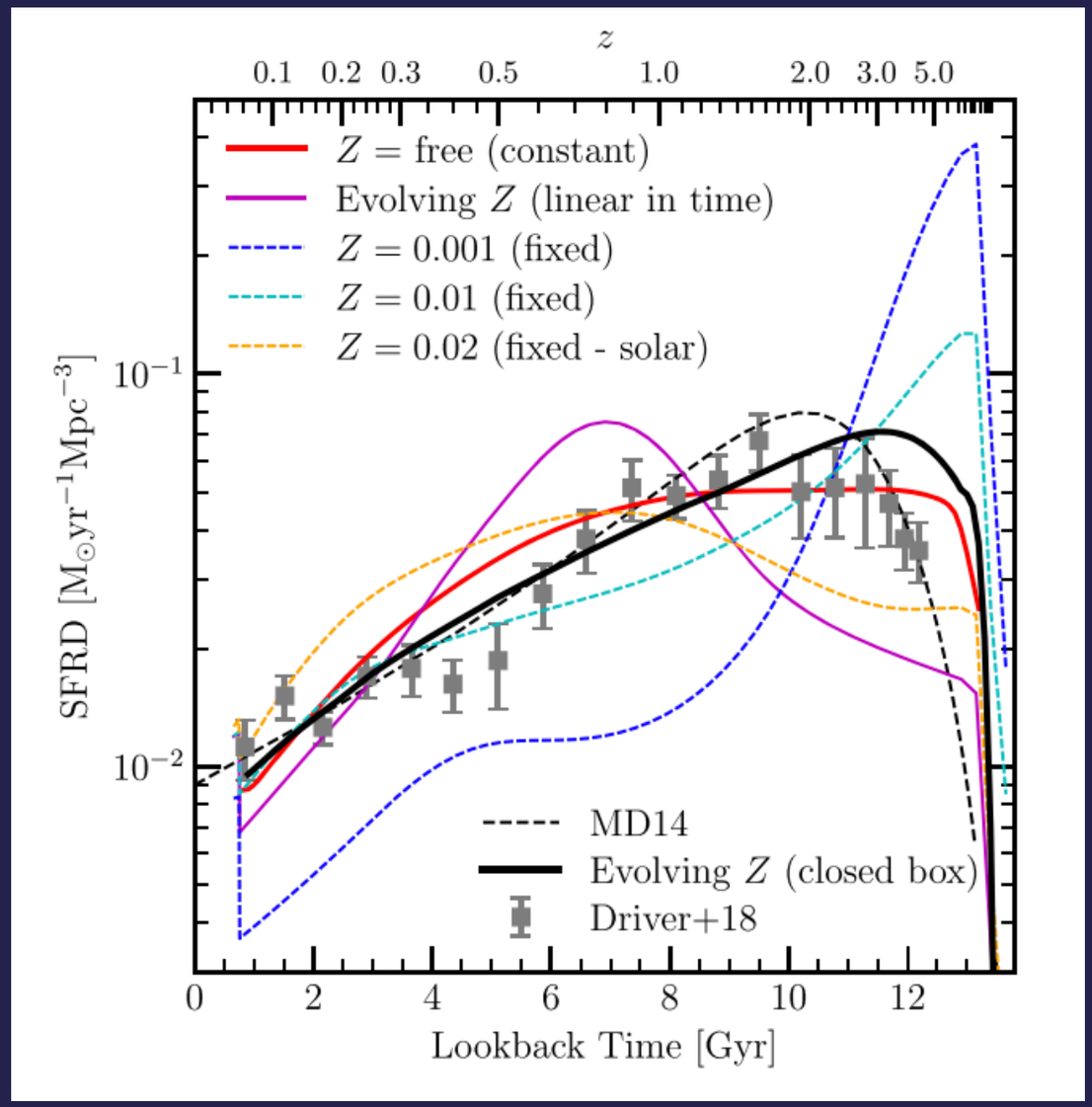
Mass function with tau-models



With oversimplified models,
stellar masses are ok(-ish), ages are completely wrong…

THE IMPORTANCE OF METALLICITY EVOLUTION





Bellstedt et al. 2020

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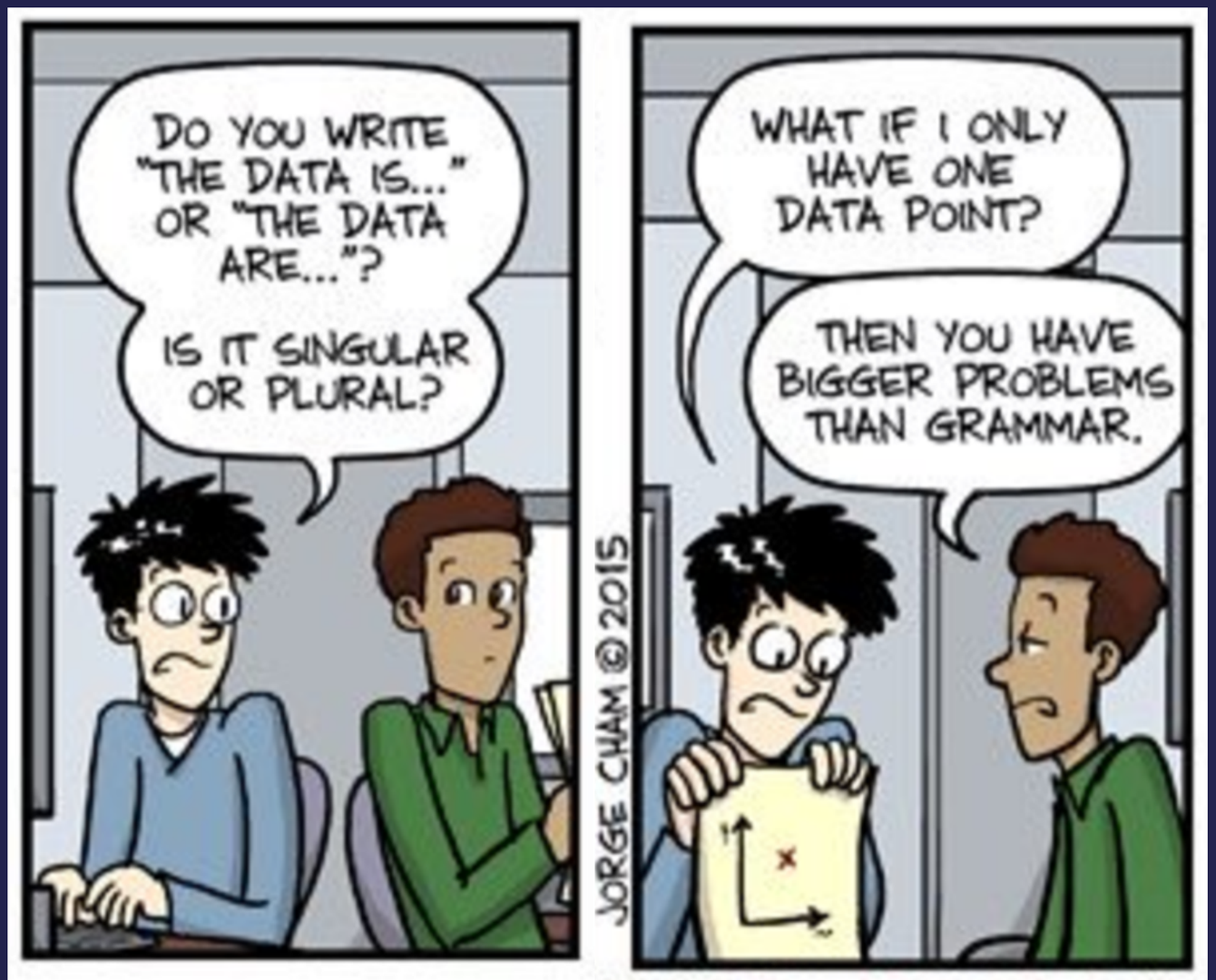
DIFFERENT ANSWERS FROM DIFFERENT MODELS

There is such thing as “too good data”…the more the details in the data, the more the details needed in the modeling.



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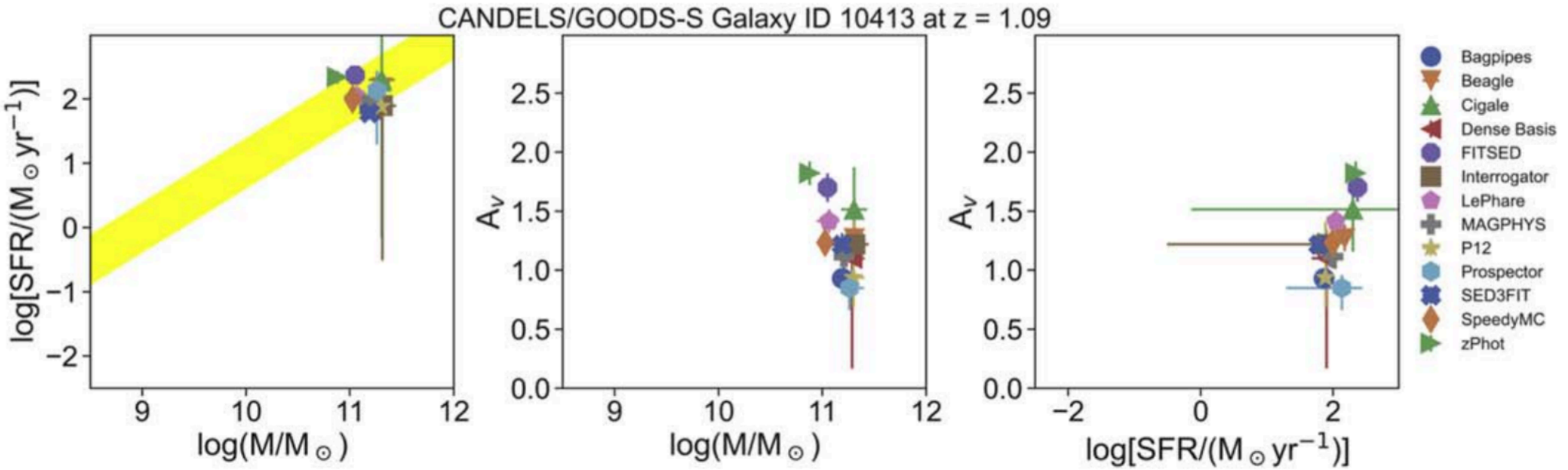
A bunch of state-of-the-art tools now:

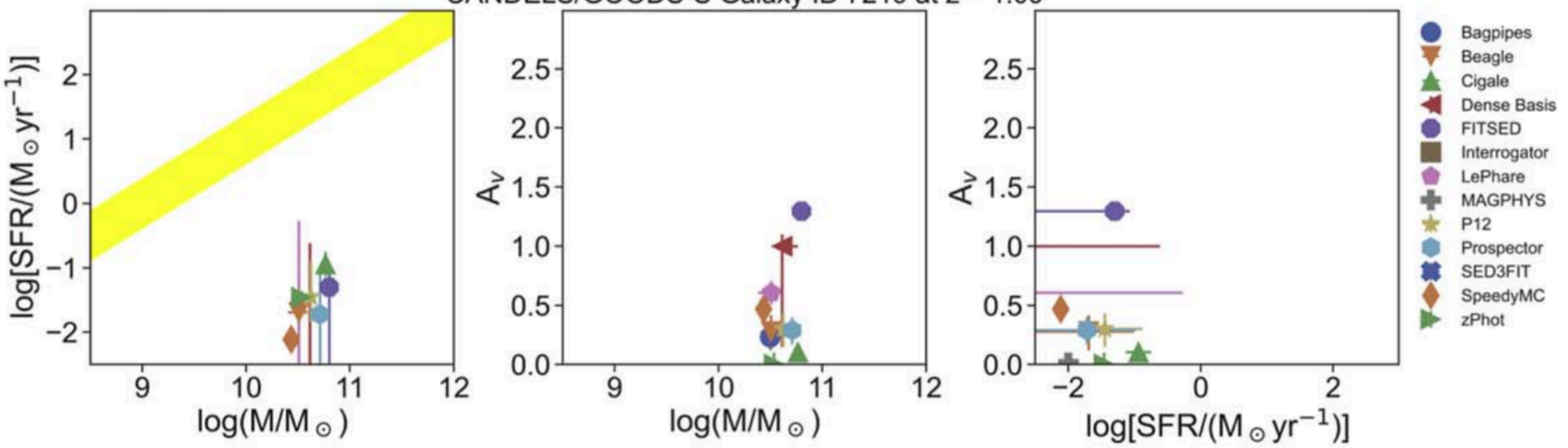
AGNFitter - Calistro Rivera et al. (2016)
BAGPIPES - Carnall et al. (2017)
BEAGLE - Chevallard & Charlot (2016)
CIGALE - Burgarella et al. (2005)
Dense Bases - Iyer & Gawiser 2017
Interrogator - Fairhurst, Wilkins, et al. (in preparation)
MAGPHYS - da Cunha et al. (2008, 2015)
Prospector - Leja et al. (2017)

Pacifici et al. 2023

UNDERSTANDING MODELING UNCERTAINTIES

12 SED fitters in the same room…almost a sociological experiment.





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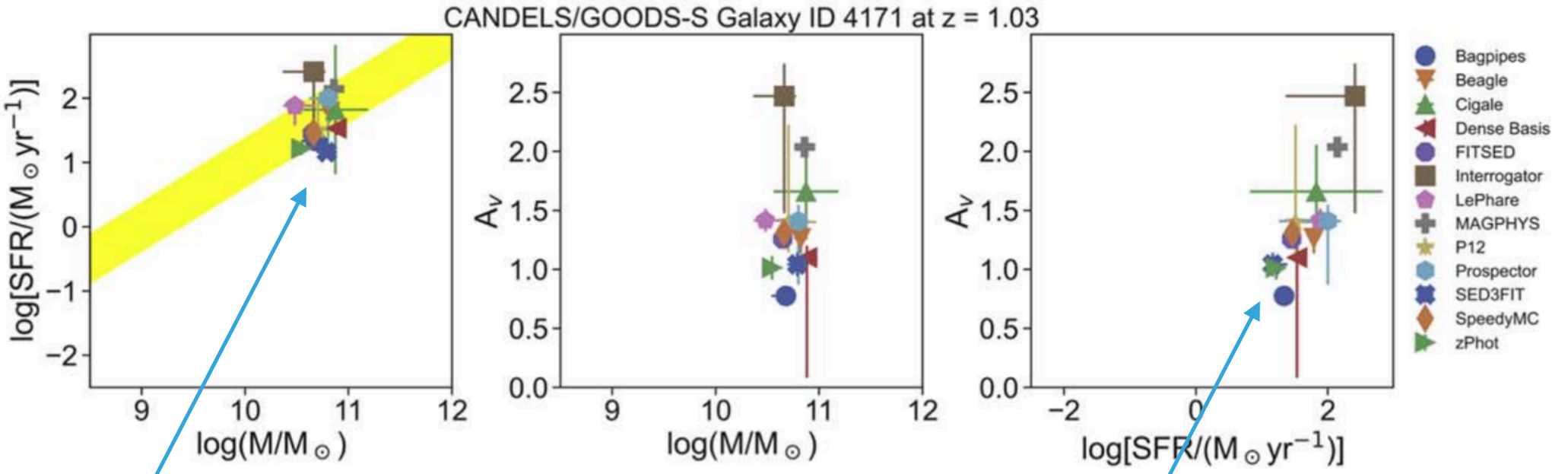

Large spread in SFR

Dust-SFR degeneracy

Pacifici et al. 2023

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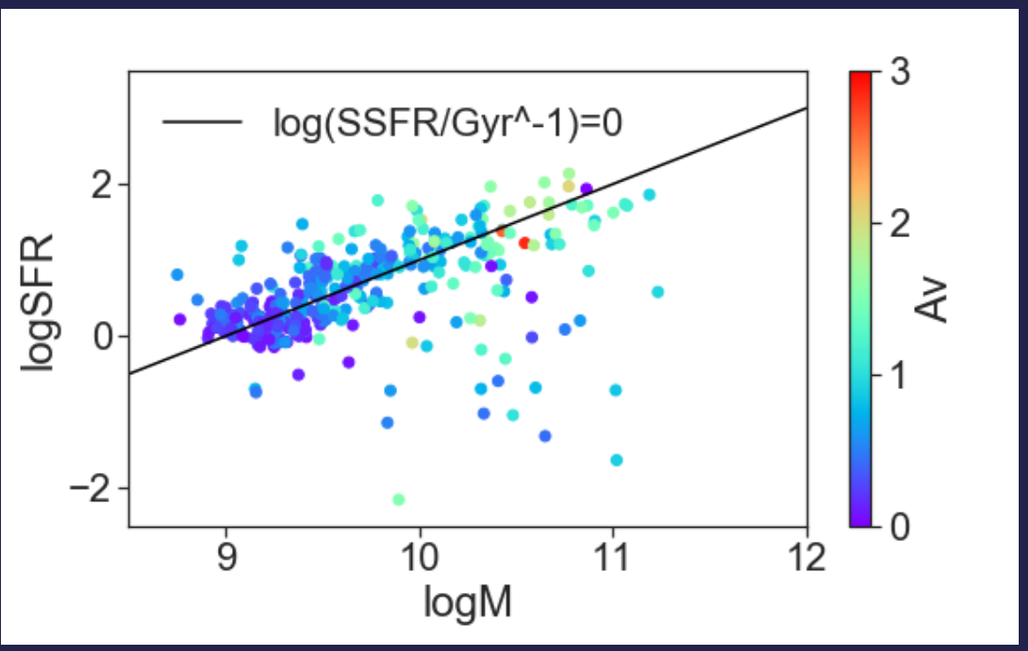
Now the scary part…



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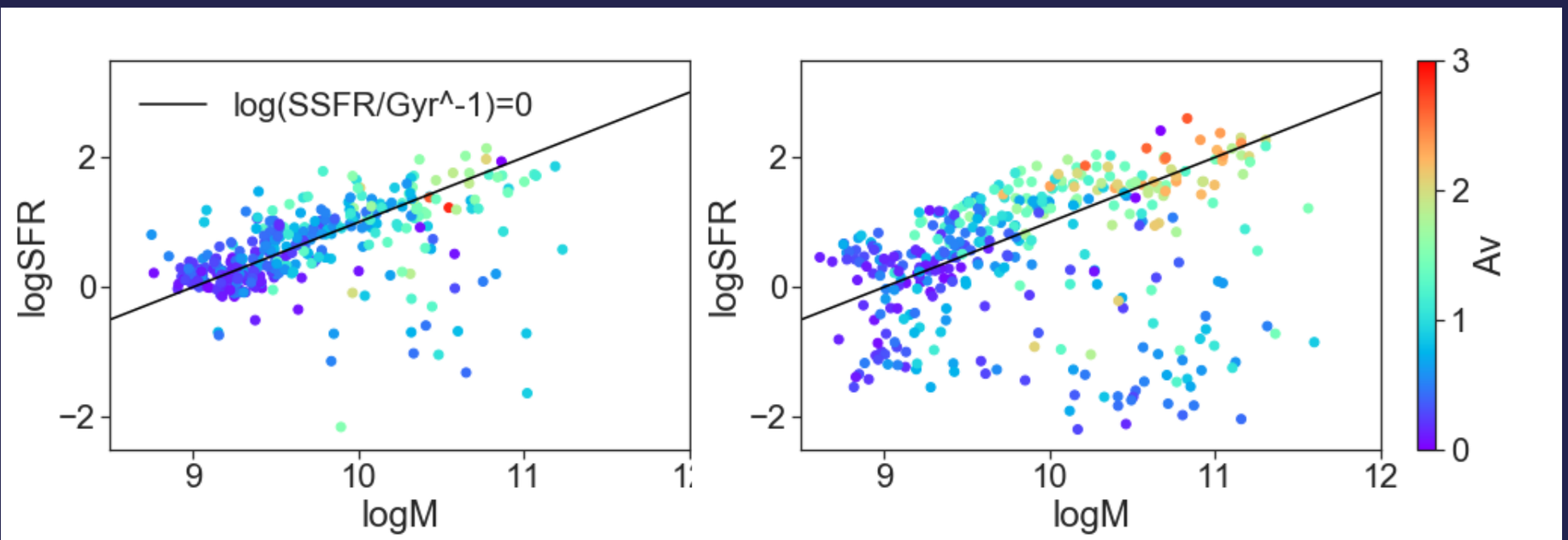

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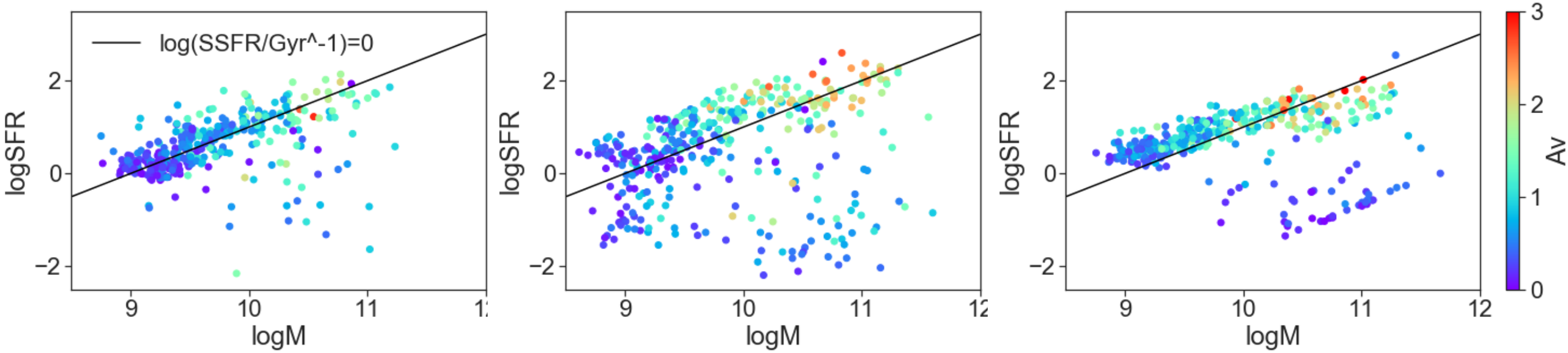

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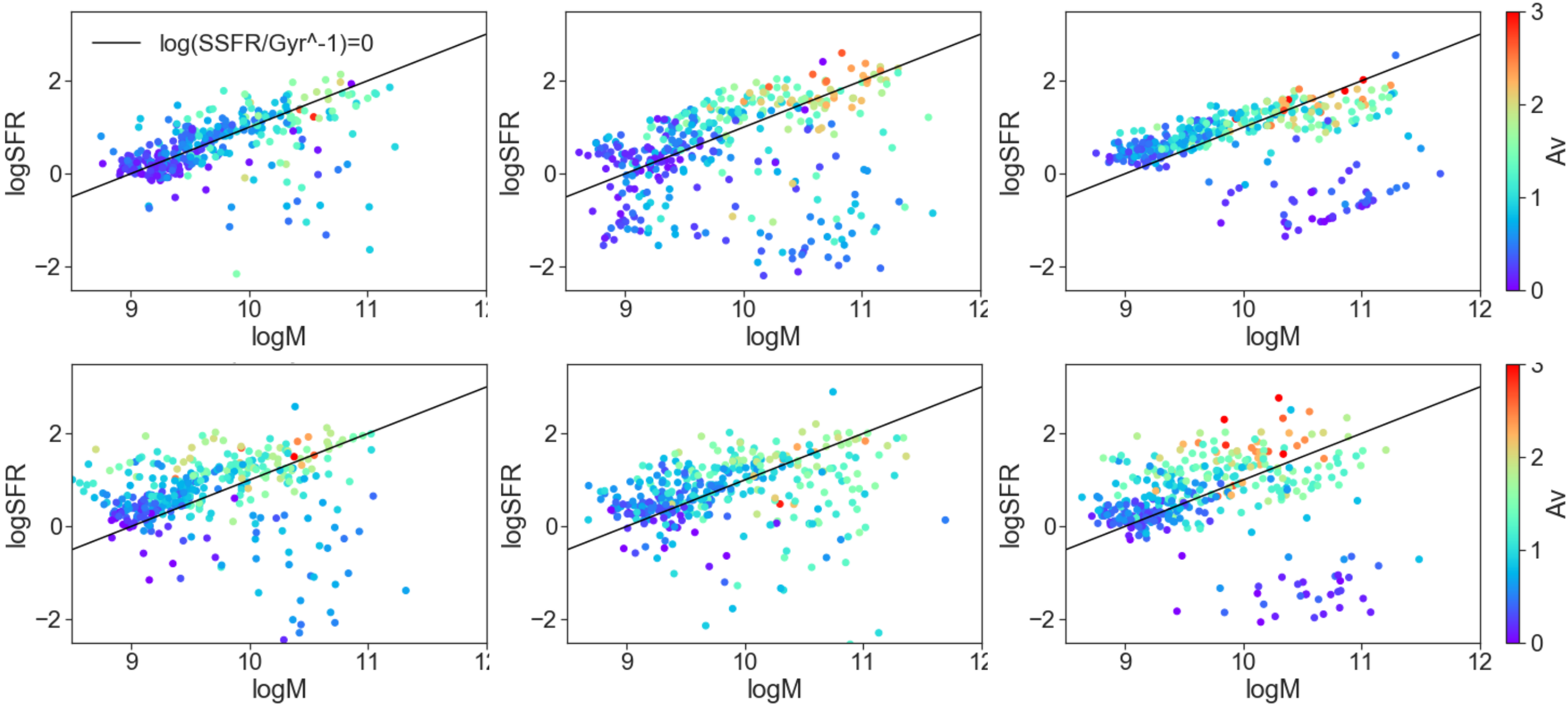

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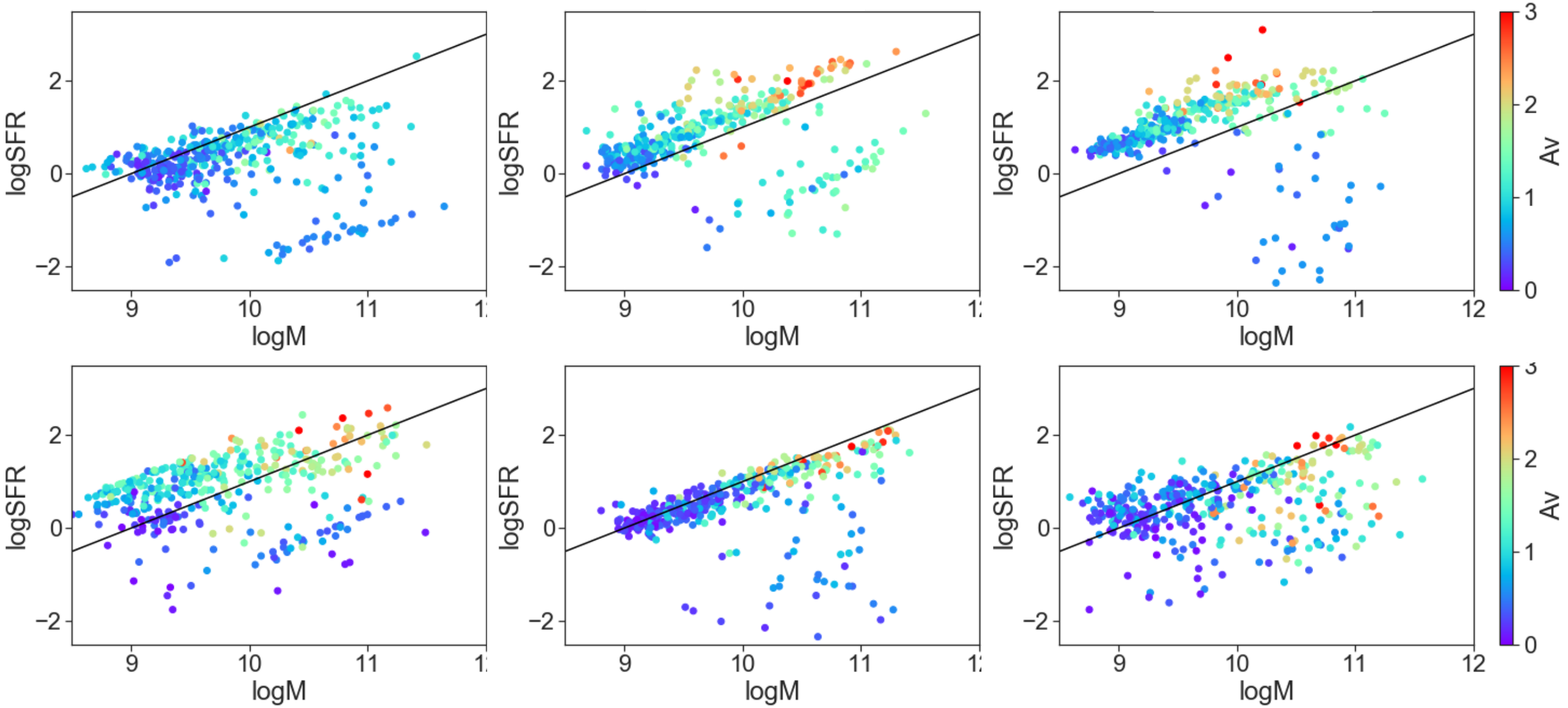
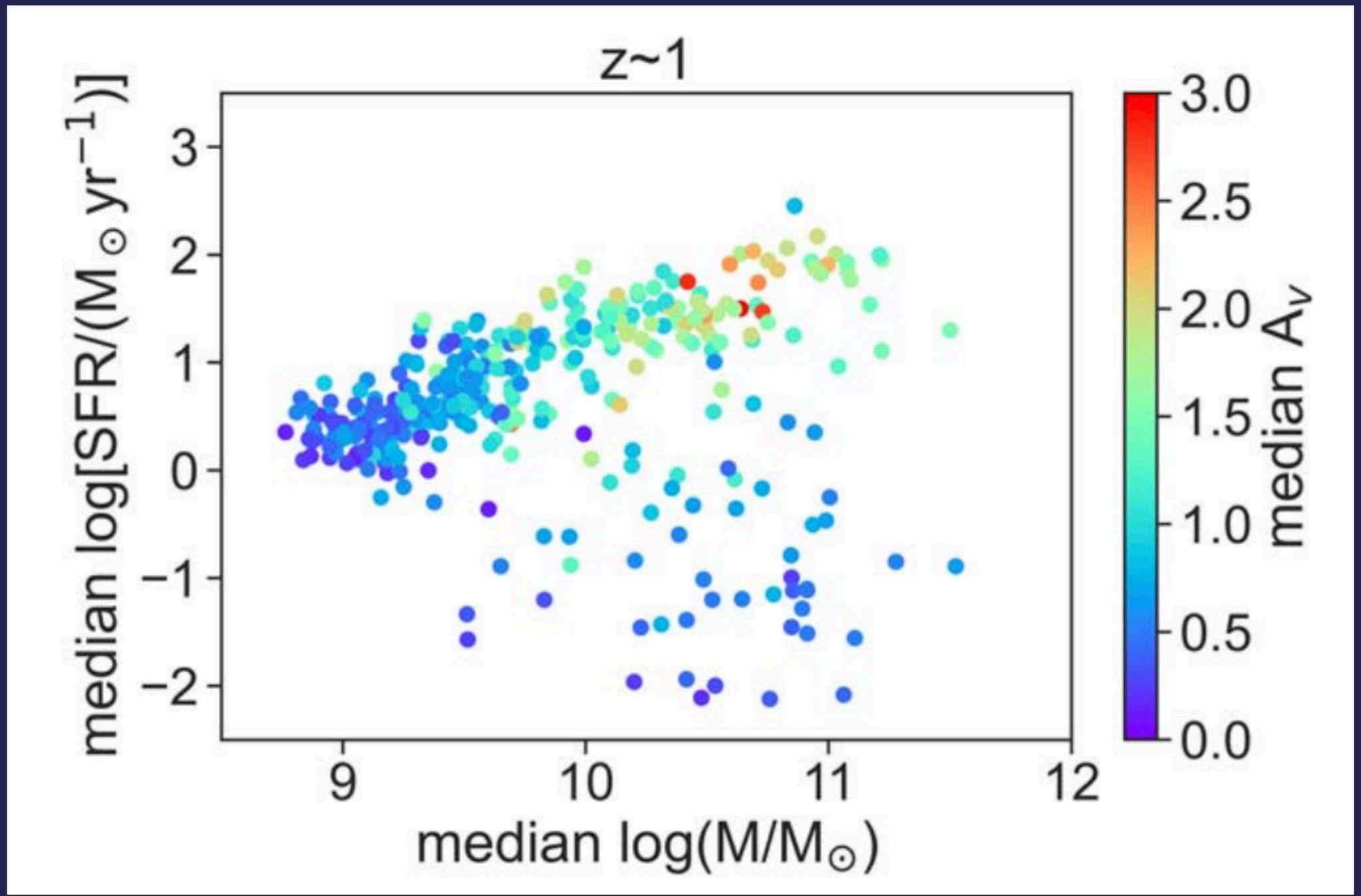


Pacifici et al. 2023

UNDERSTANDING MODELING UNCERTAINTIES

Not all is lost…



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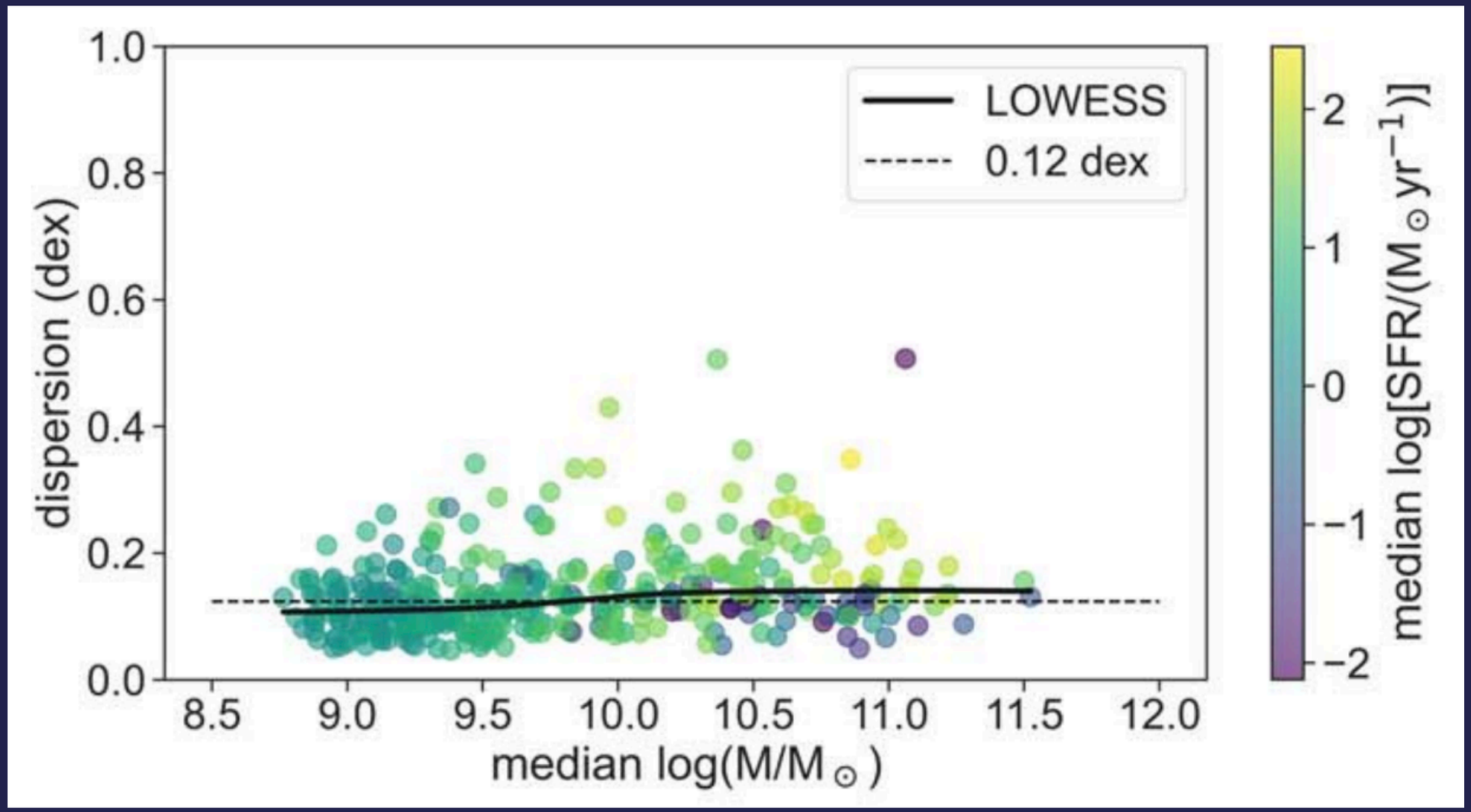

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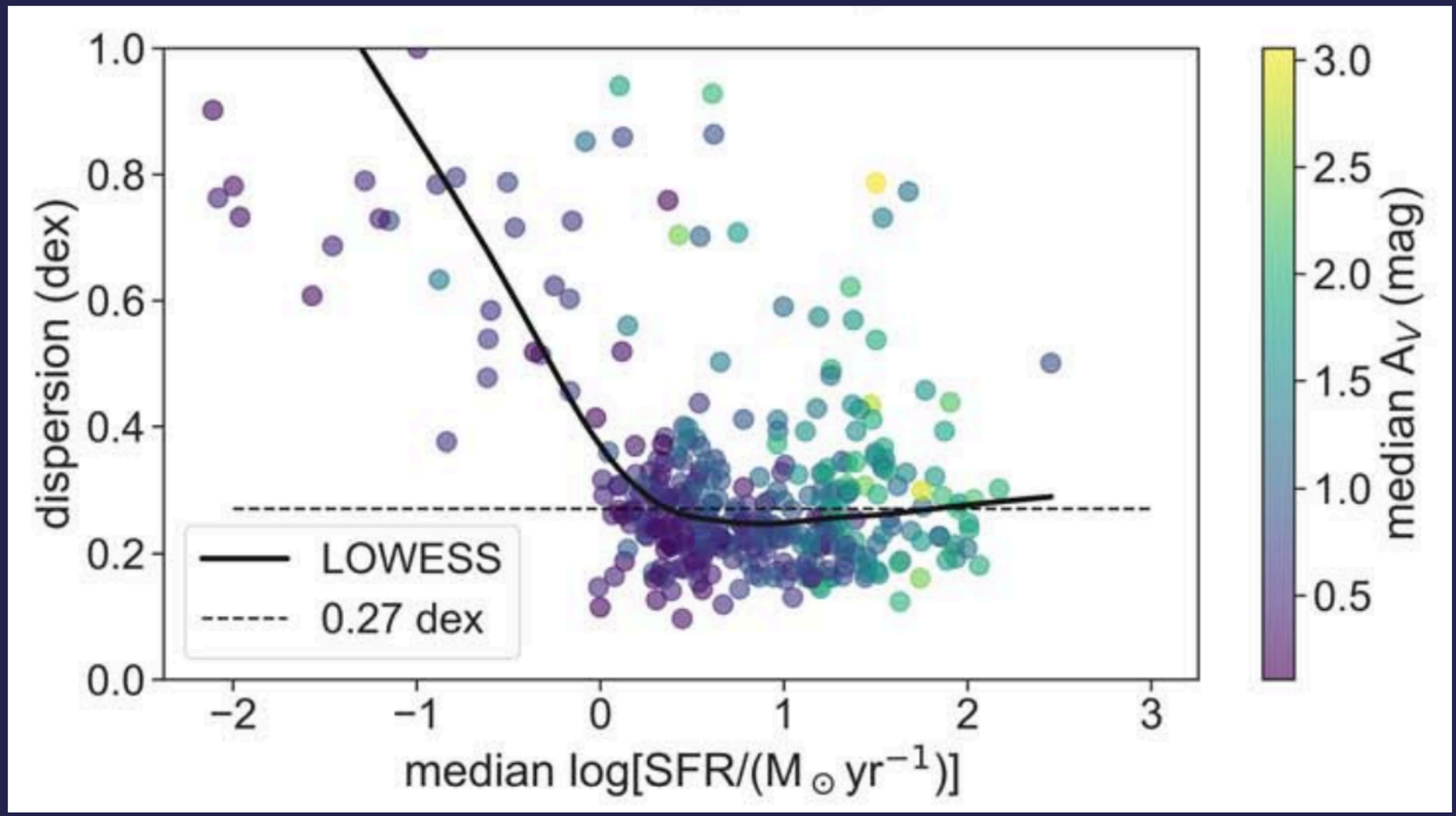

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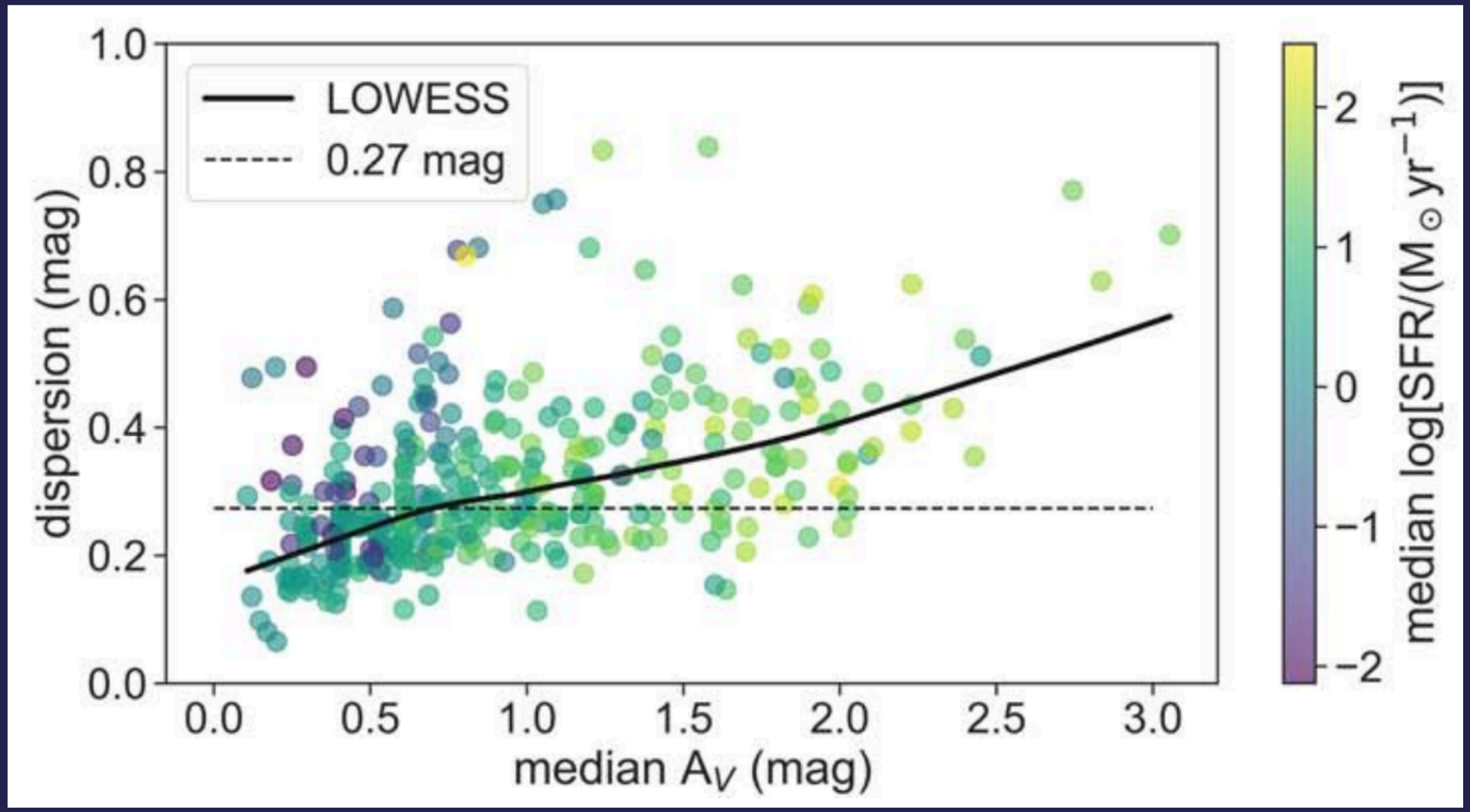
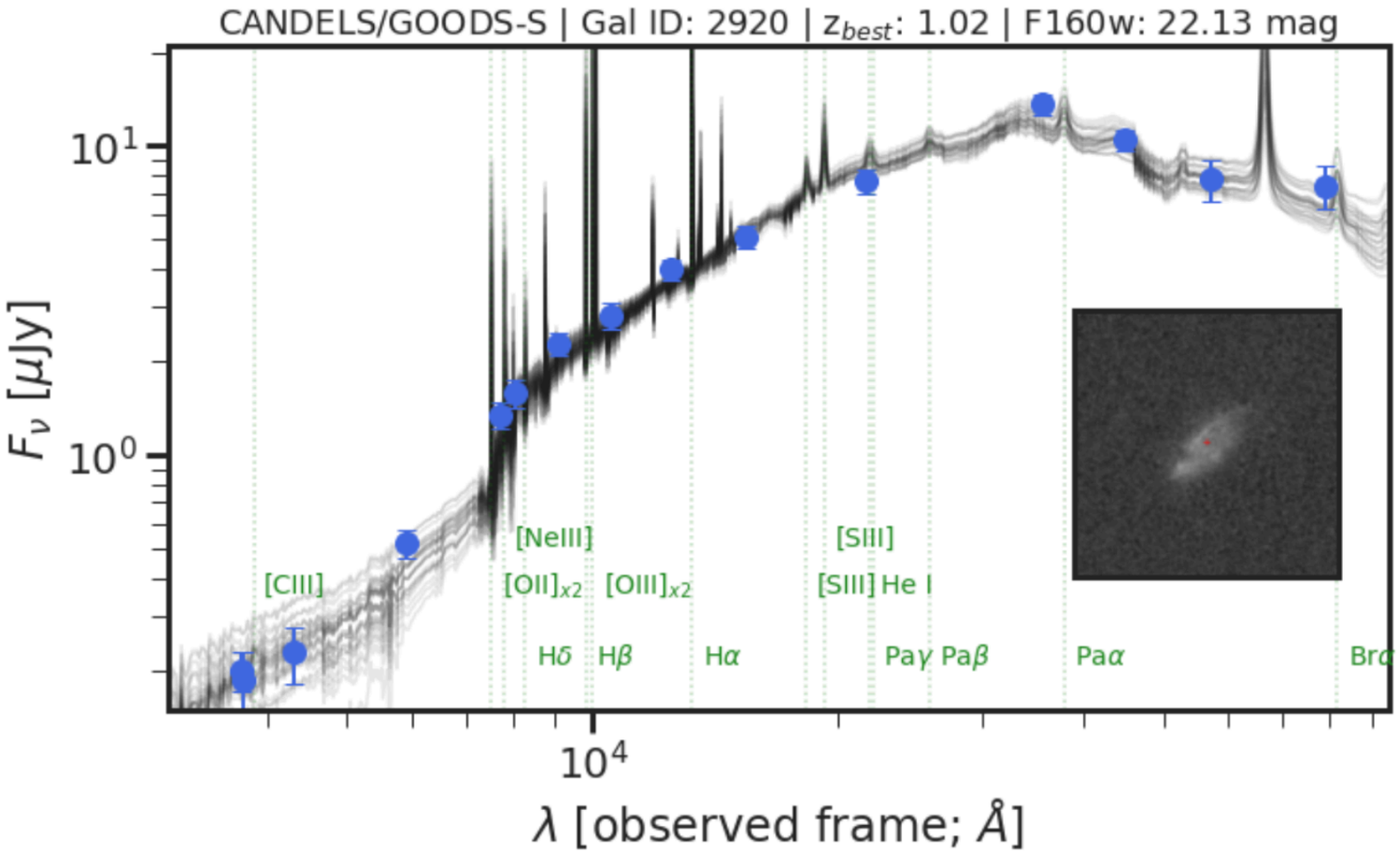
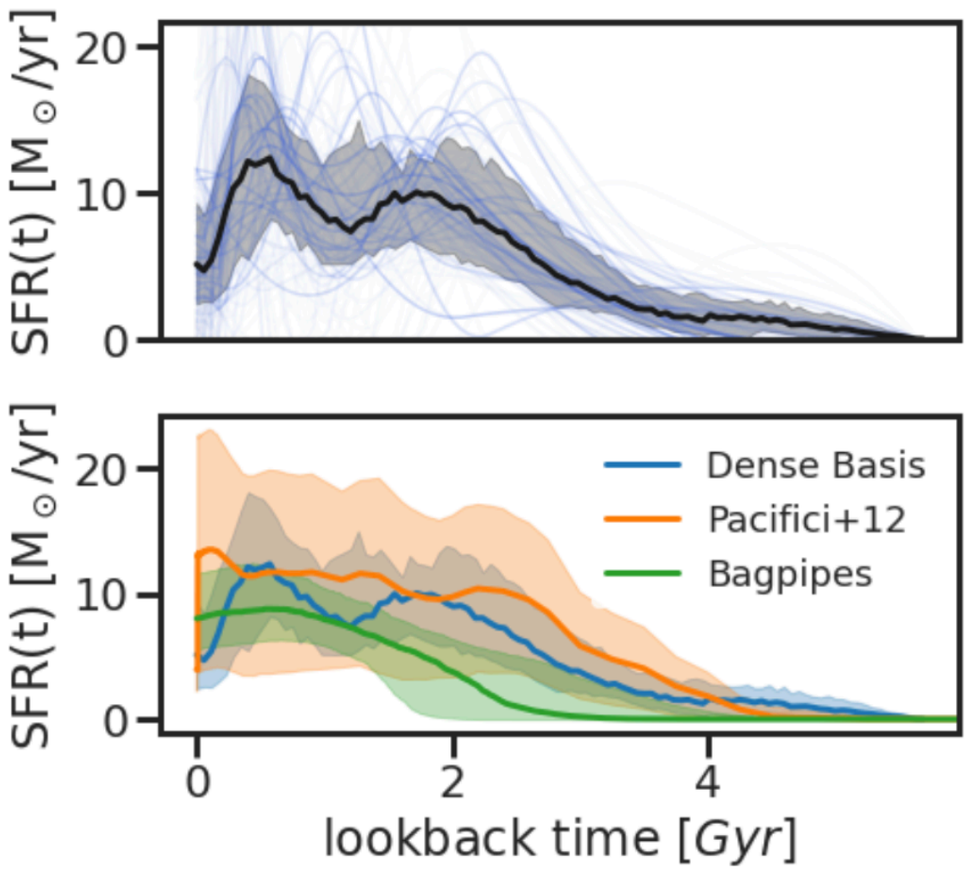


Pacifici et al. 2023

UNDERSTANDING MODELING UNCERTAINTIES

This is just for mass, SFR, and dust, but a similar approach can be applied to the measurement of star formation histories.





Iyer, Pacifici et al. in prep.

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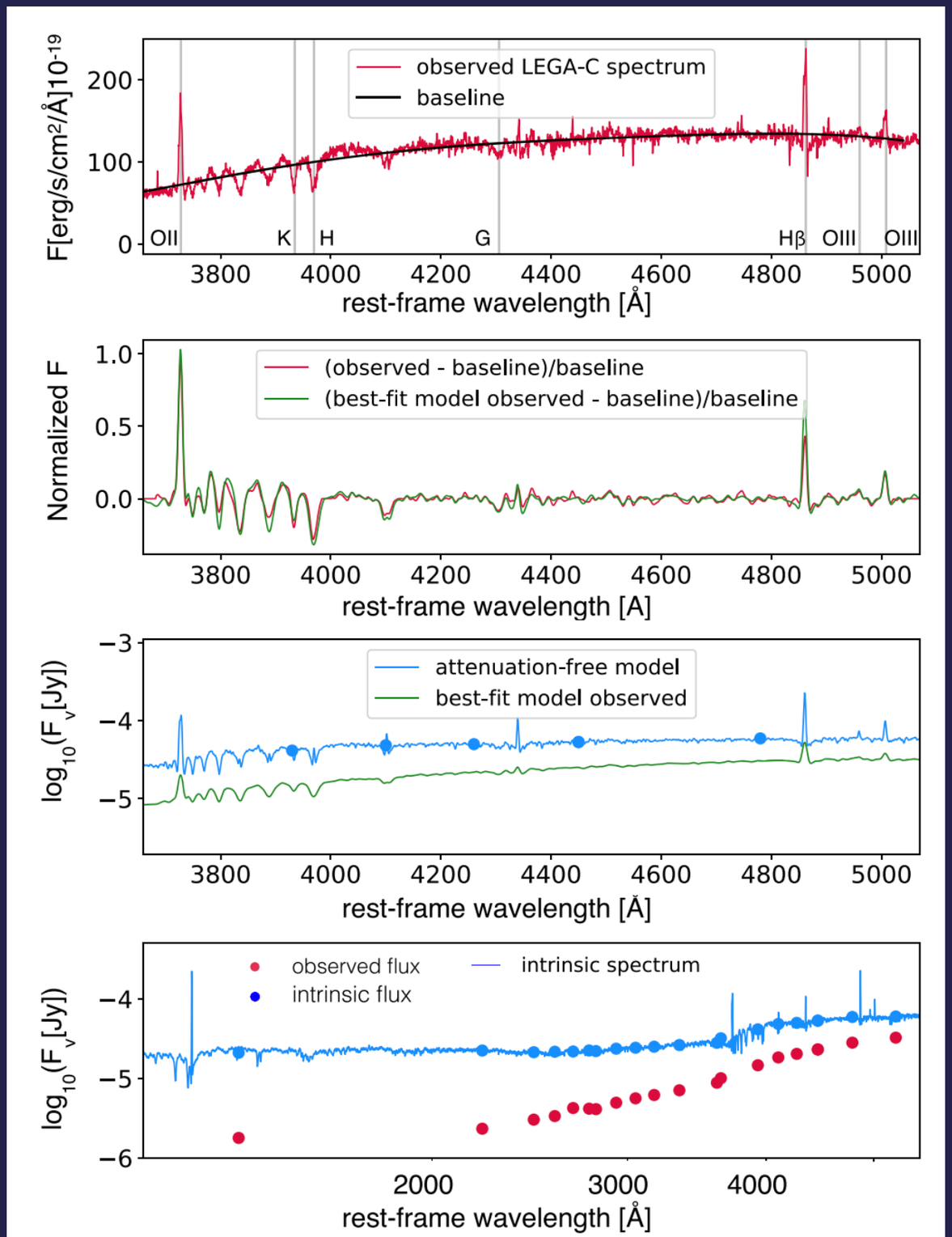
STAR FORMATION HISTORIES TO MEASURE DUST LAWS

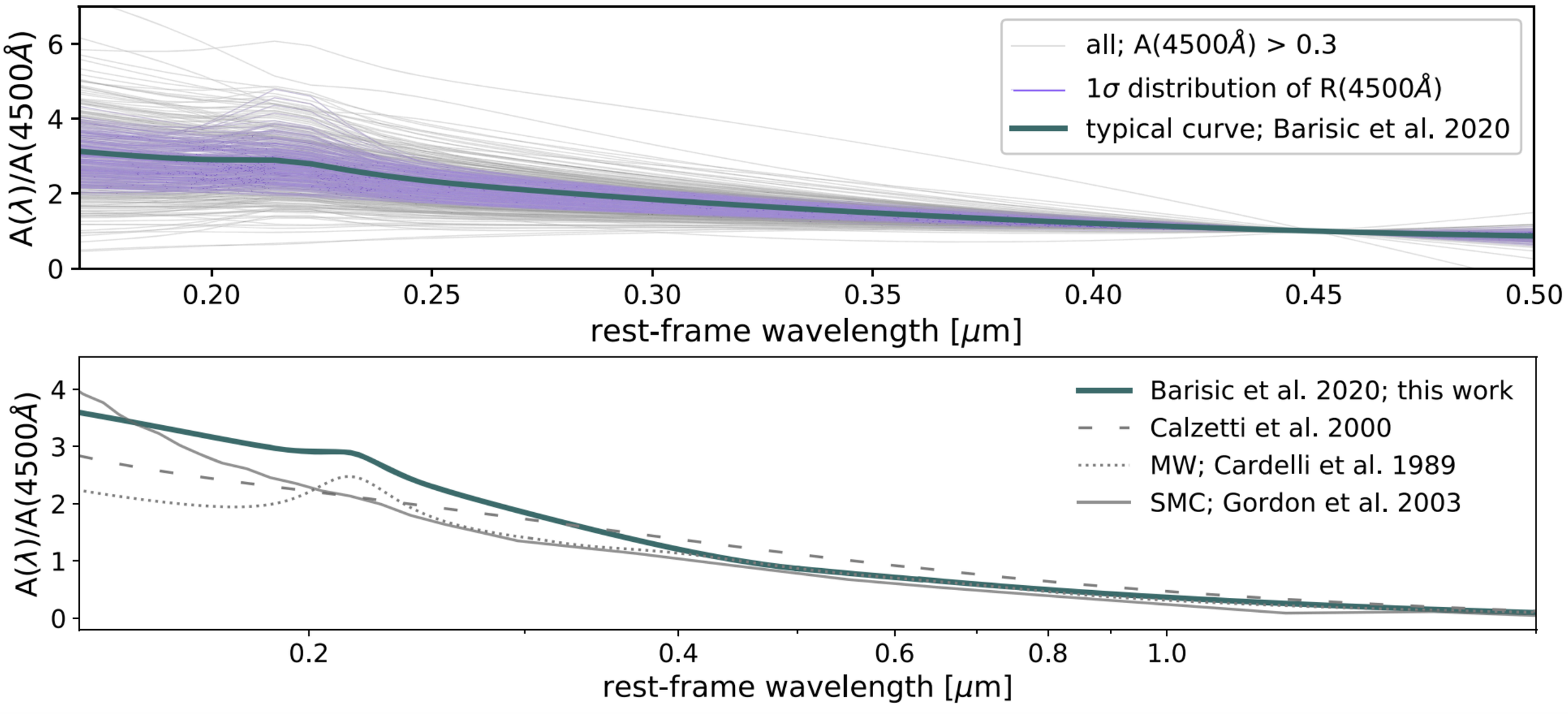


Fit to high-resolution rest-frame optical spectra from LEGA-C

Comparison of dust free model with observed photometry

Barisic, Pacifici, et al. (2020)

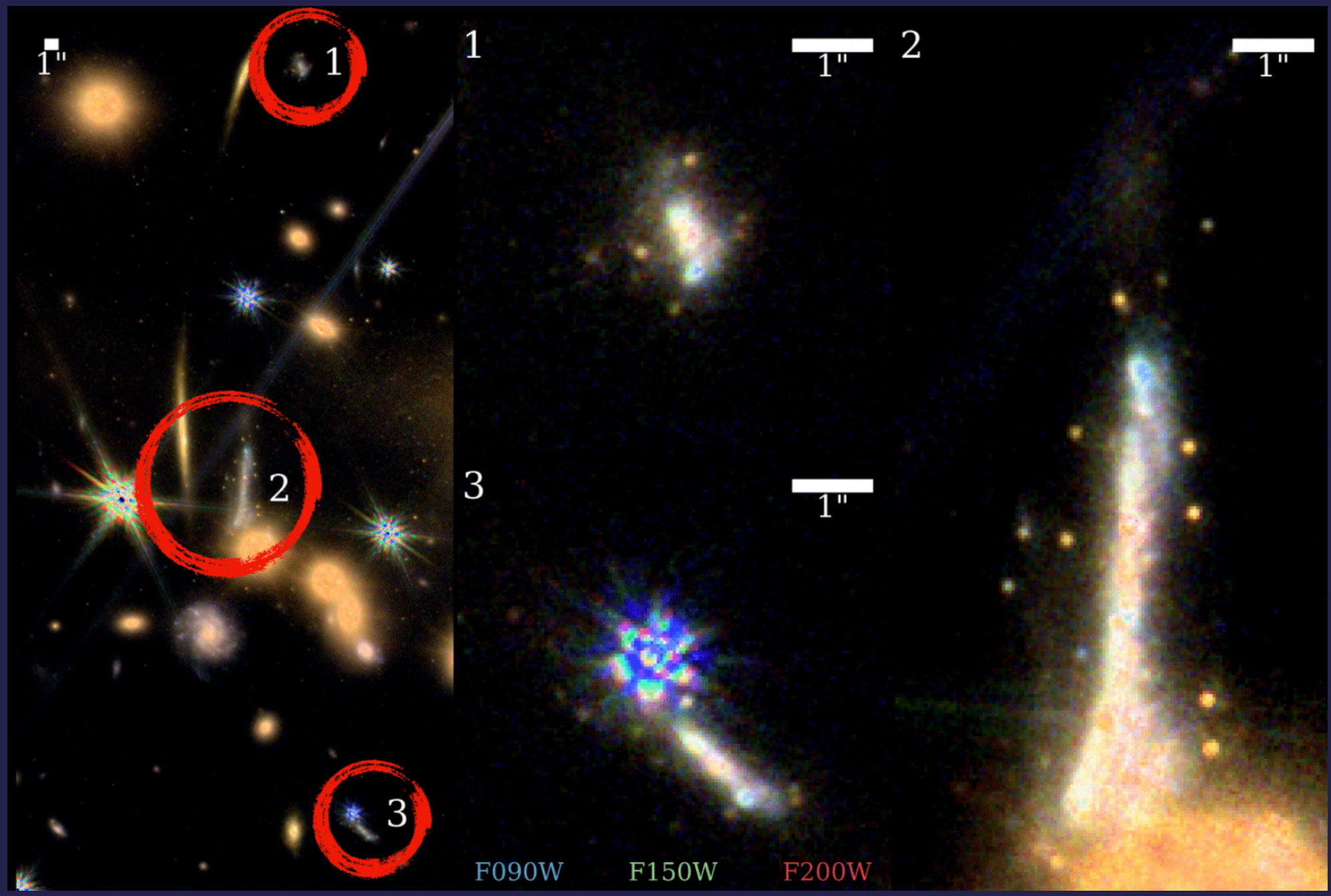
STAR FORMATION HISTORIES TO MEASURE DUST LAWS



Barisic, Pacifici, et al. (2020)

THE SPARKLER

In SMACS 0723



Mowla, Iyer, et al. (2022)

THE SPARKLER

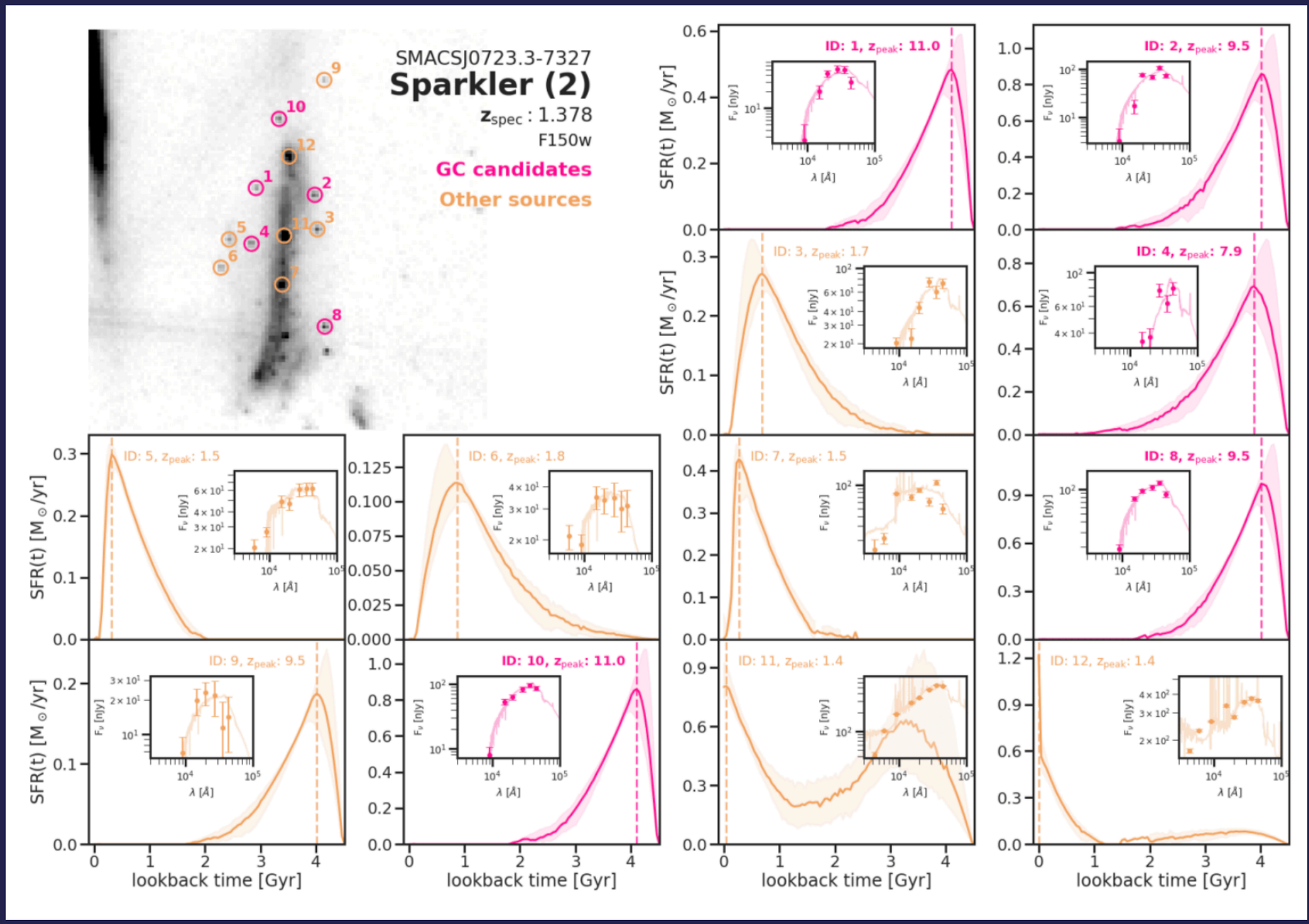
In SMACS 0723

Are the sparkles young or old?

Mowla, Iyer, et al. (2022)

THE SPARKLER

In SMACS 0723

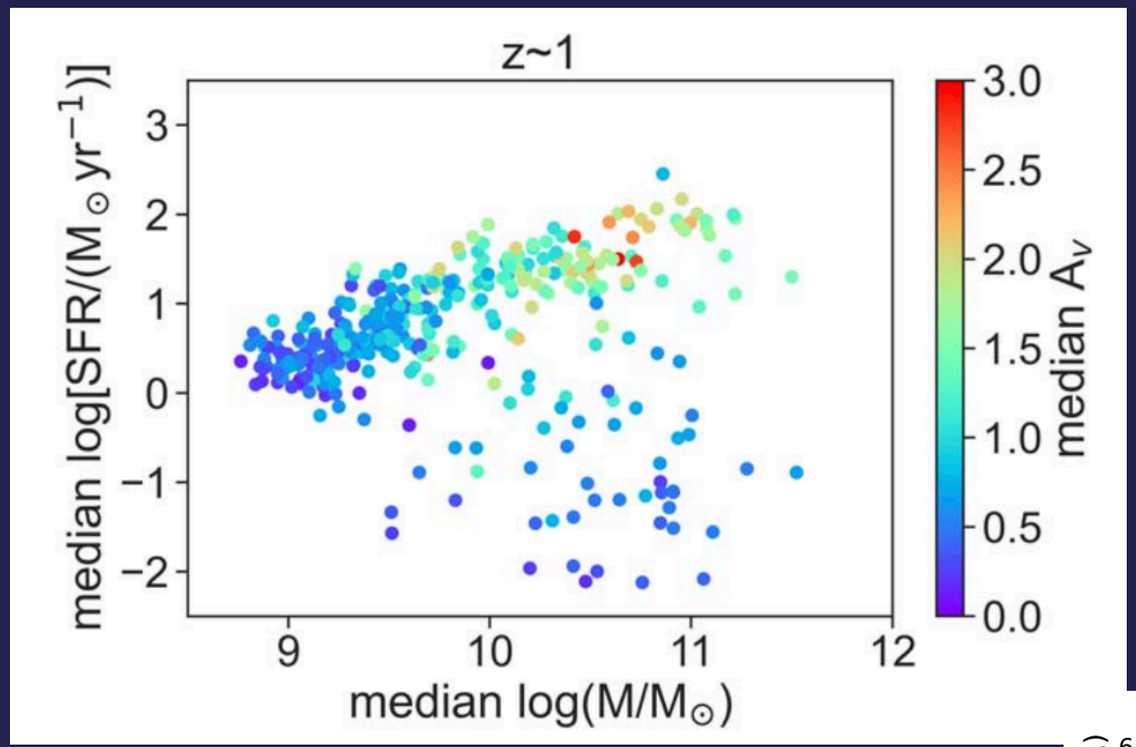


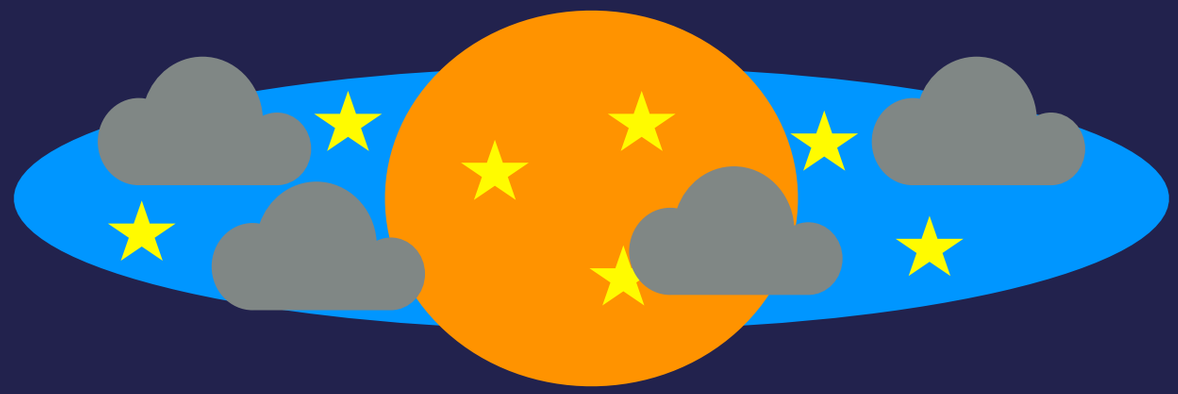
Mowla, Iyer, et al. (2022), see also Claeyssens et al. (2023) and Adamo et al. (2023)

CONCLUSIONS

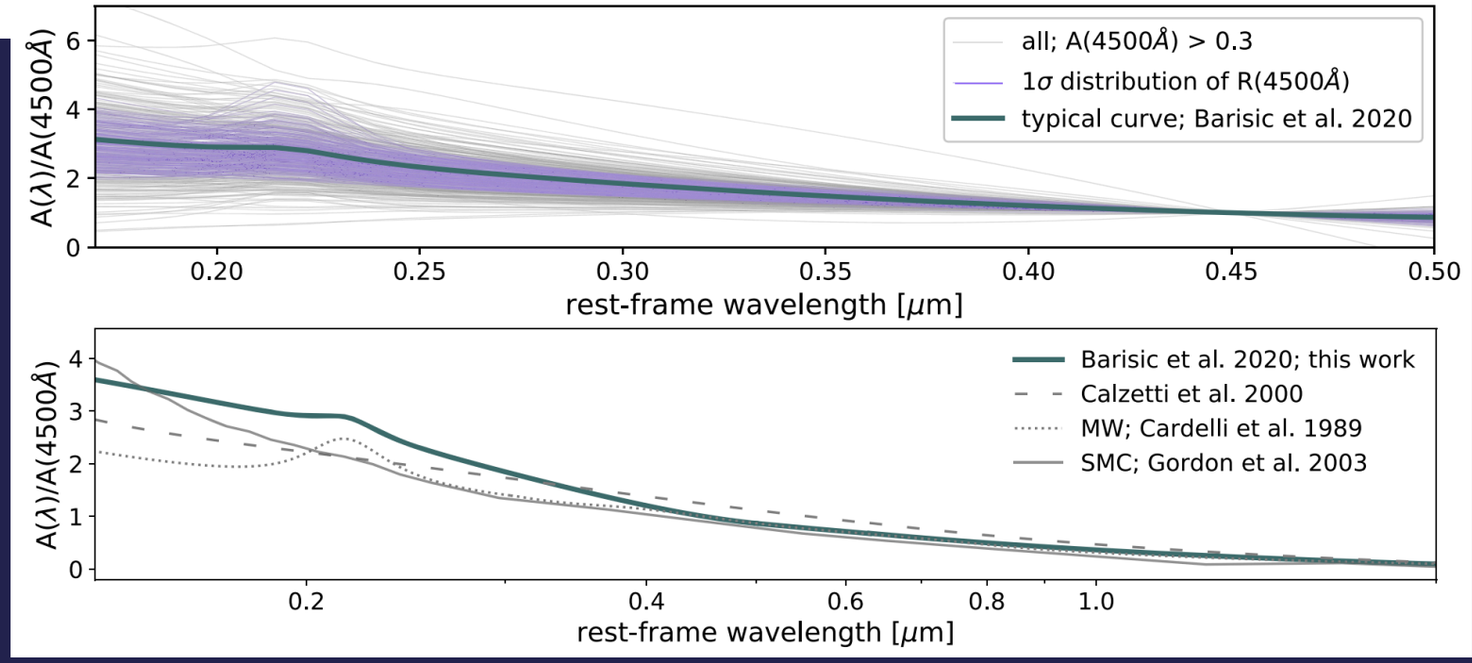
- We established that we care about star formation histories (both as assumptions and as outputs from SED fitting).
- The prior choice is important and does affect the output.
- It is important to account for different options and use multiple codes.
- Measuring star formation histories, we can measure the dust attenuation properties of samples of galaxies.
- Measuring star formation histories, we found globular clusters at high redshift with JWST.

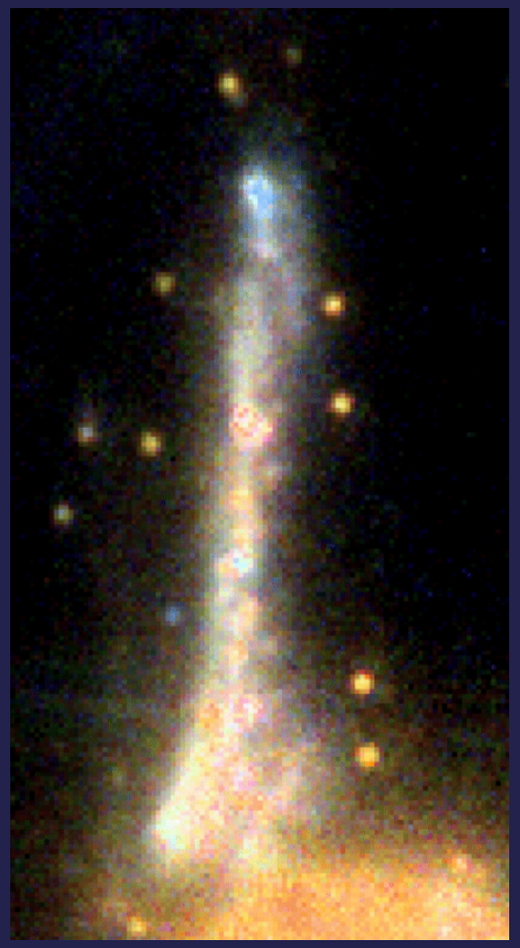
The sociological experiment...





Dust laws...





Sparkles everywhere...

Thank you!