

# Buildup of **Metals & Dust** from Deep Within the **Epoch of Reionization** to **Cosmic Noon**

**Danial Langeroodi**

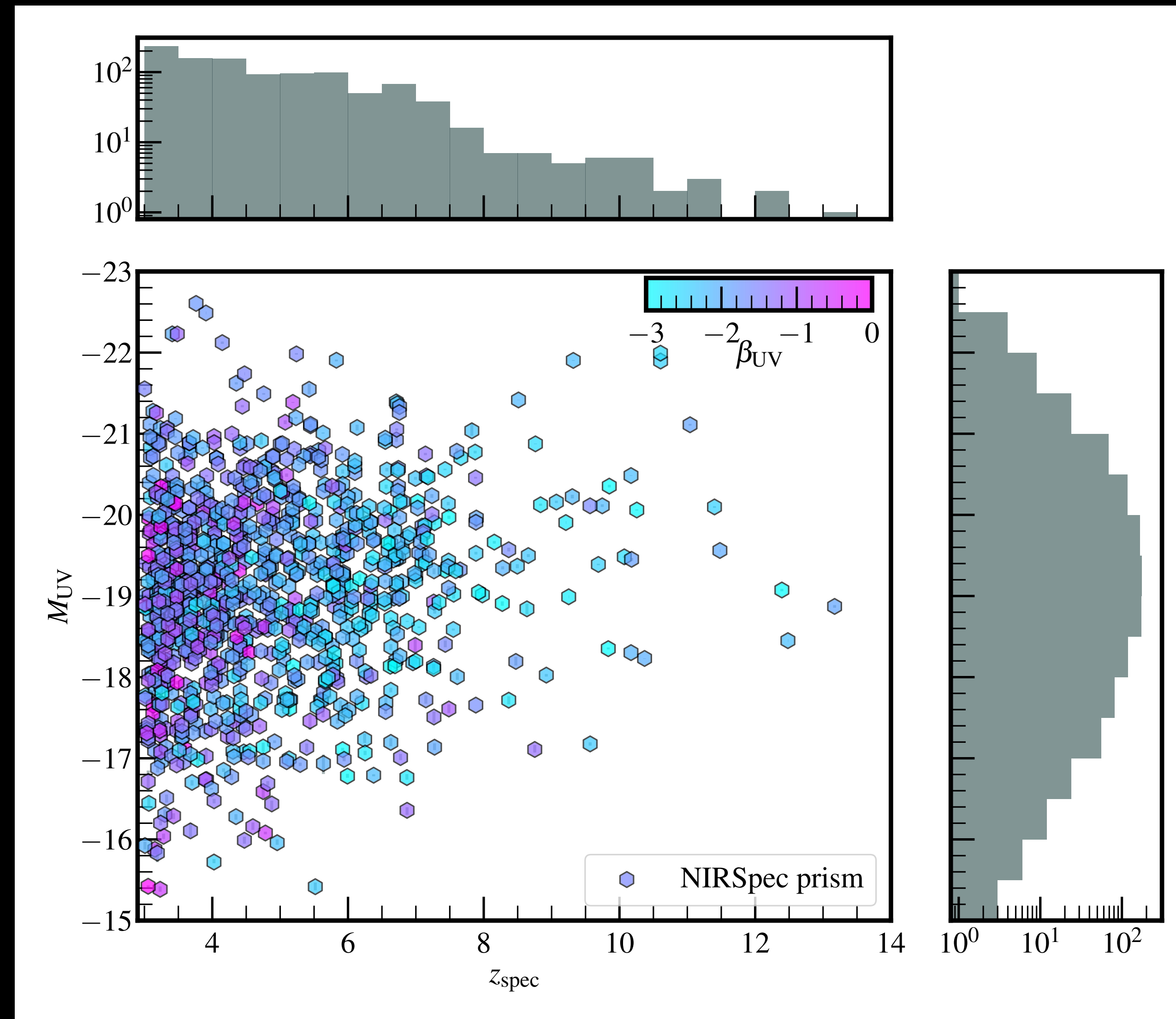
UNIVERSITY OF  
COPENHAGEN



**DARK**

# Uniformly Reduced Sample of NIRSpect MSA prism spectra

## > 2000 galaxies at $3 < z < 14$

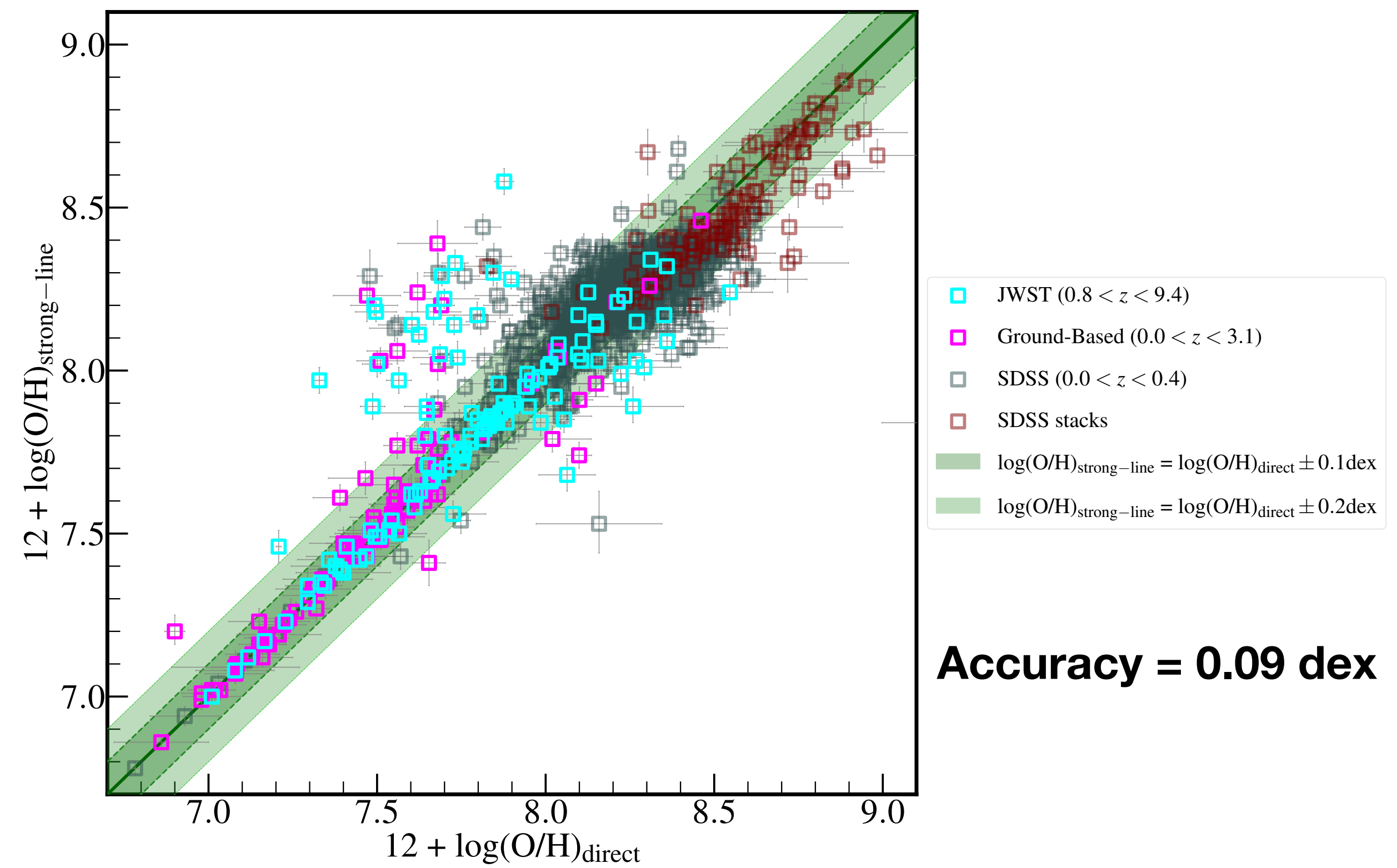
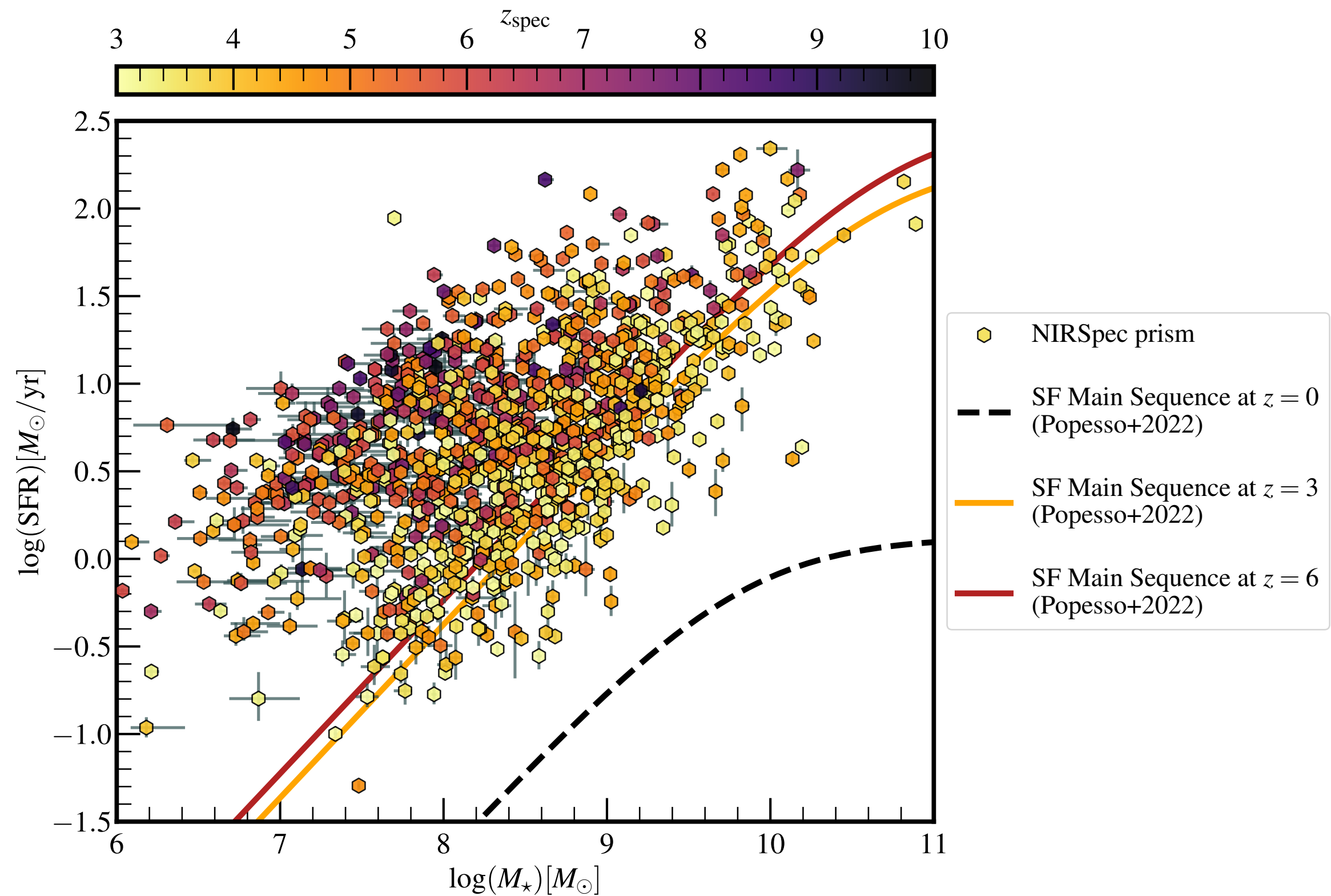


Langeroodi & Hjorth (2023)

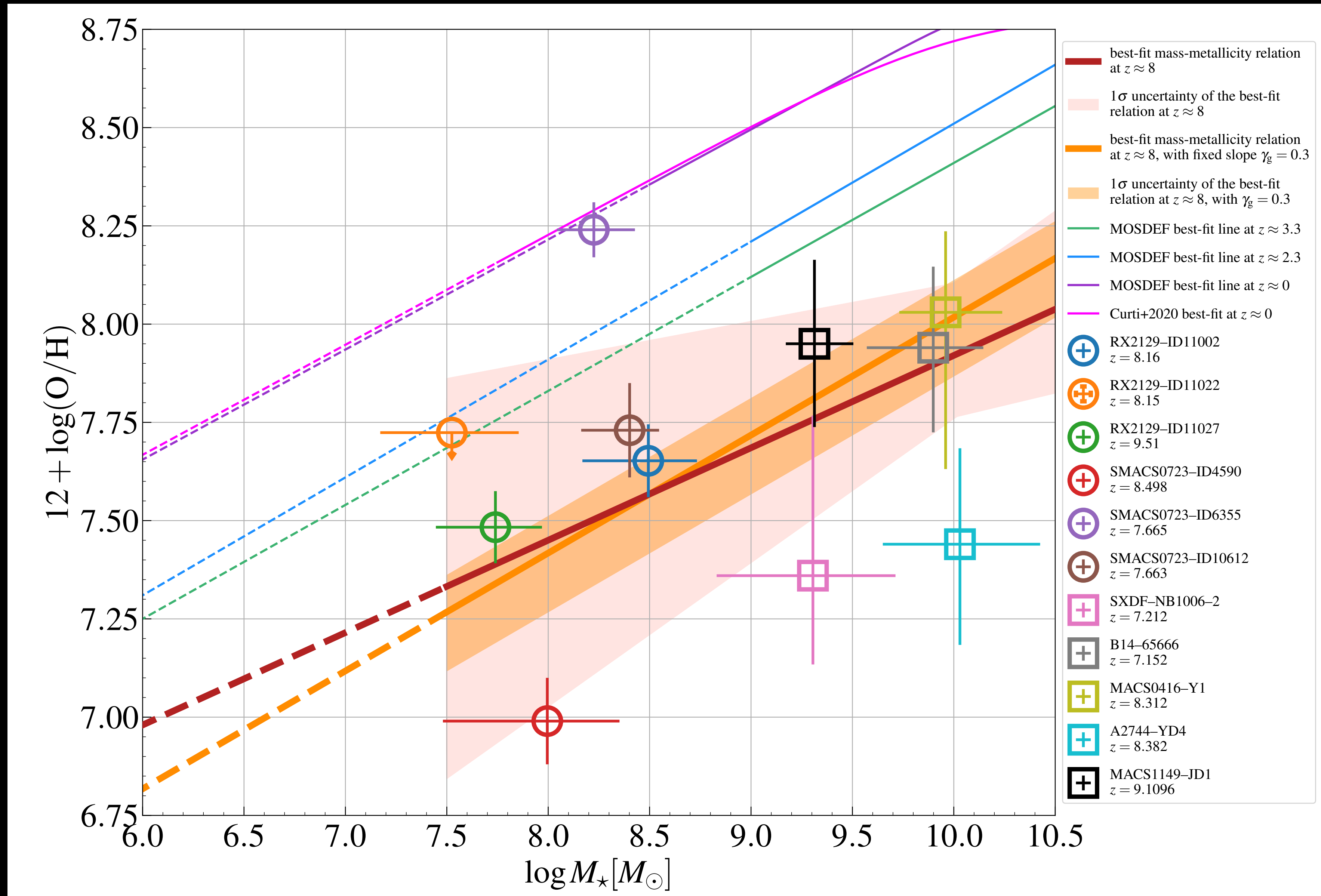
Langeroodi & Hjorth (2024a)

Langeroodi & Hjorth (in prep.)

# Genesis. Spectral Energy Distribution (SED) Fitting

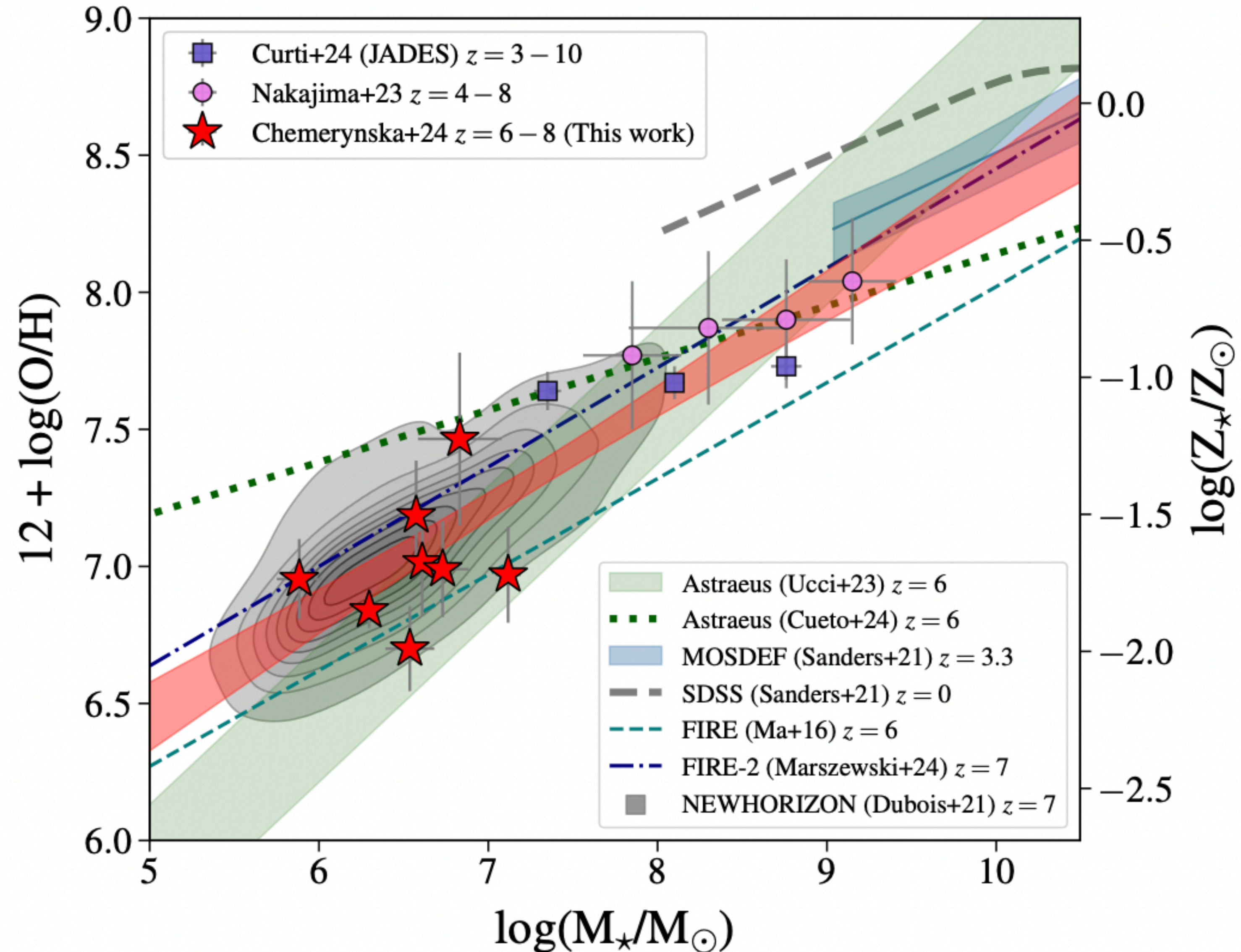


# Gas-Phase Metallicity at High Redshifts



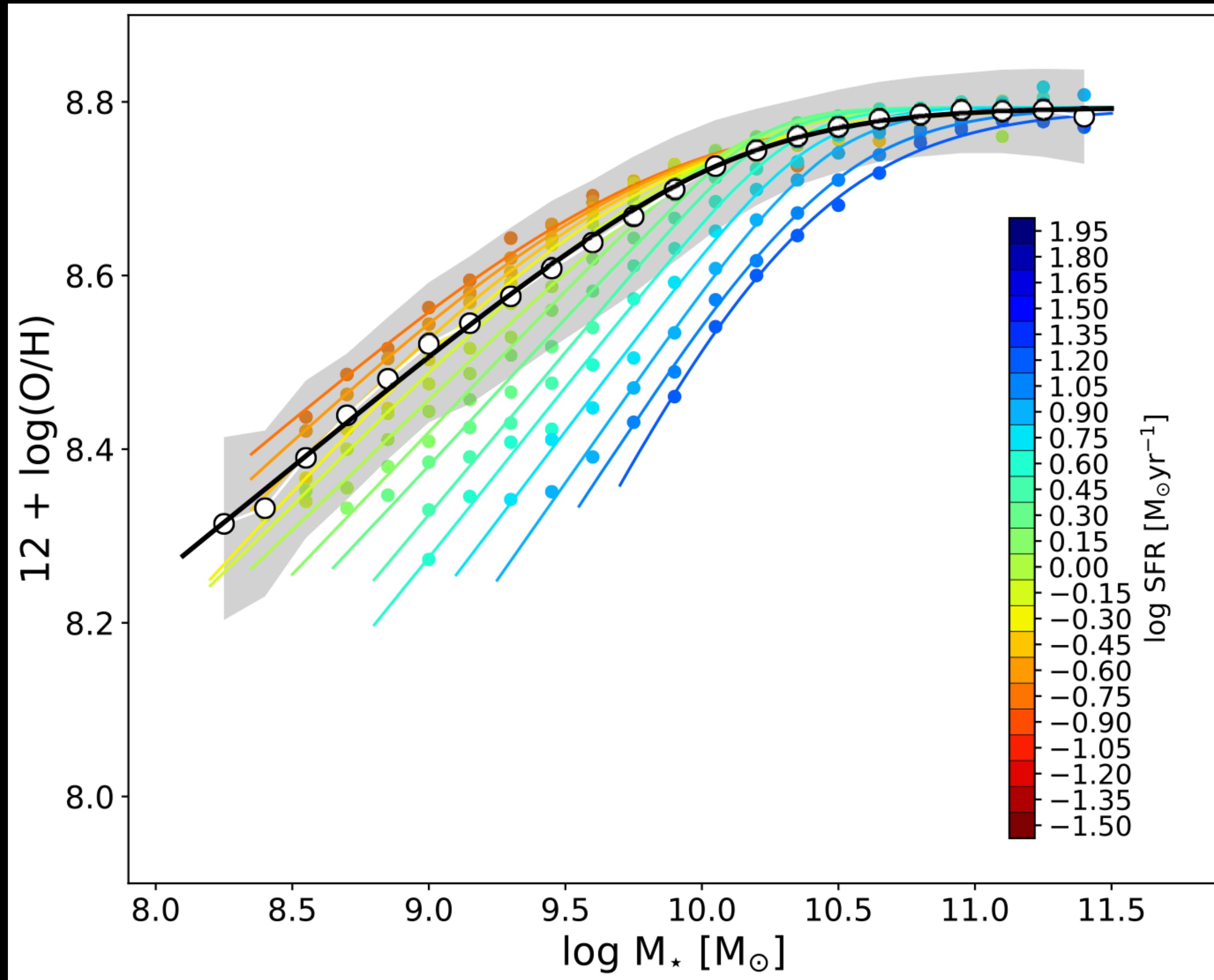


# Gas-Phase Metallicity at High Redshifts

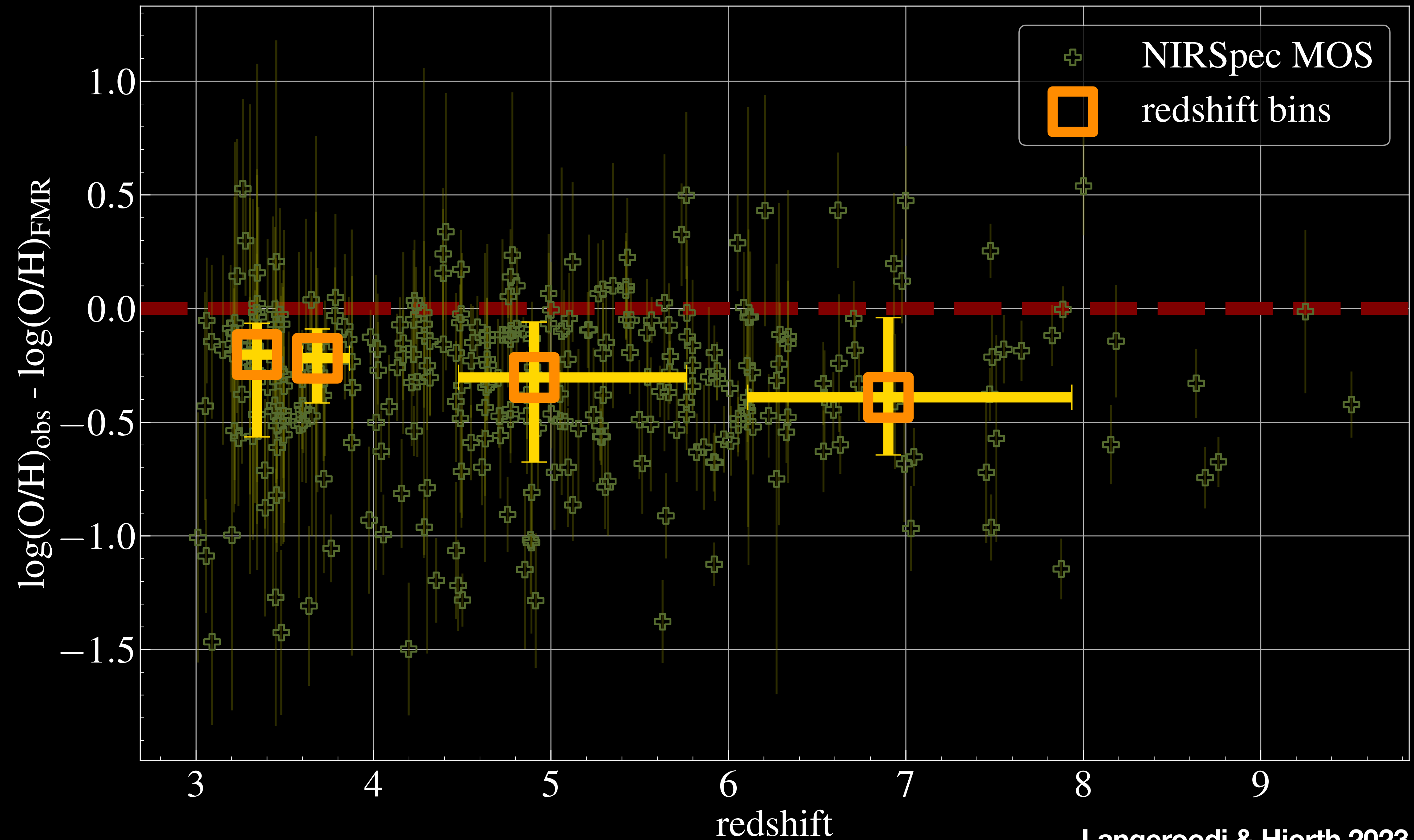




# Fundamental Metallicity Relation (FMR)

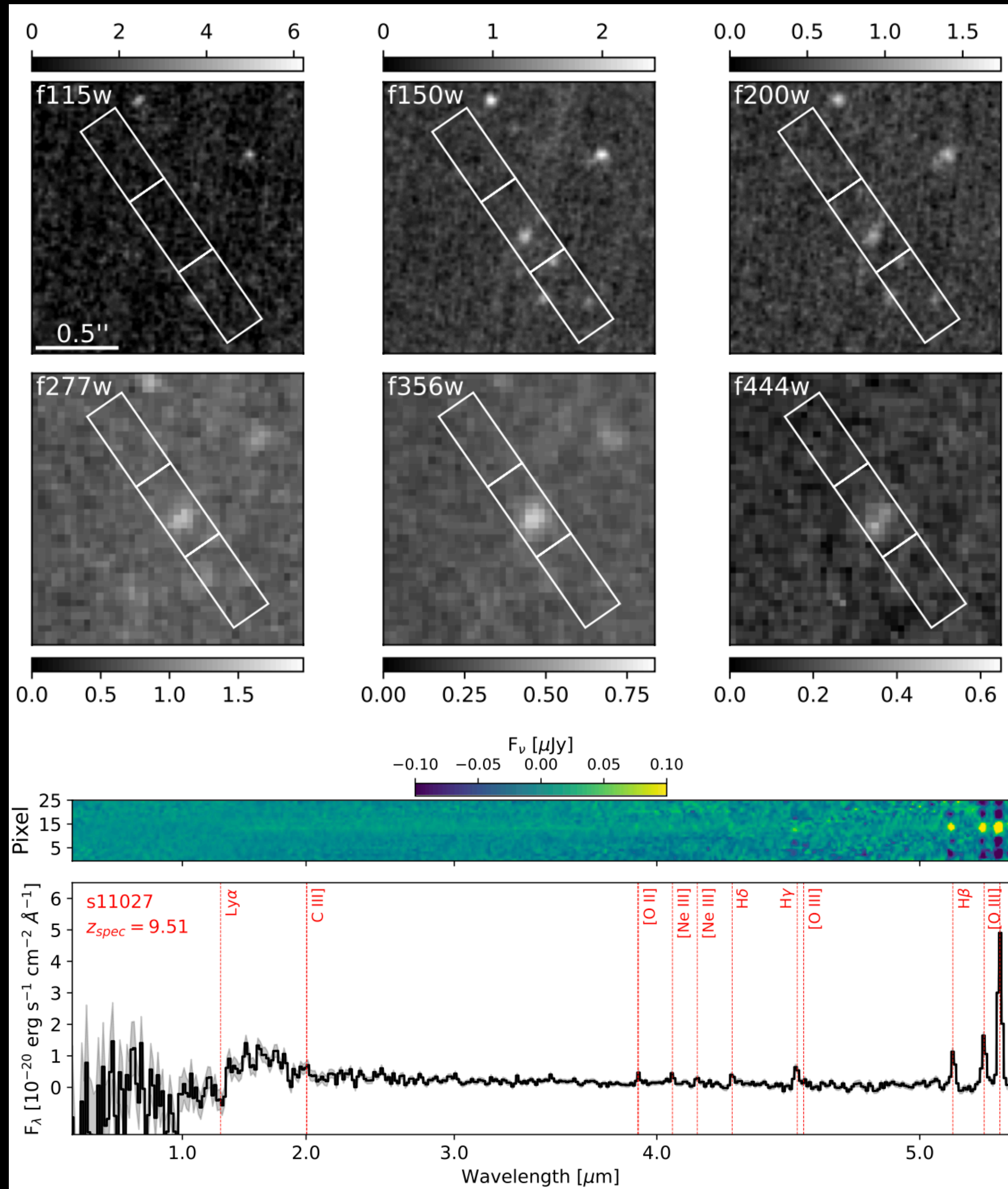


# High-Redshift Galaxies Appear Offset from the FMR



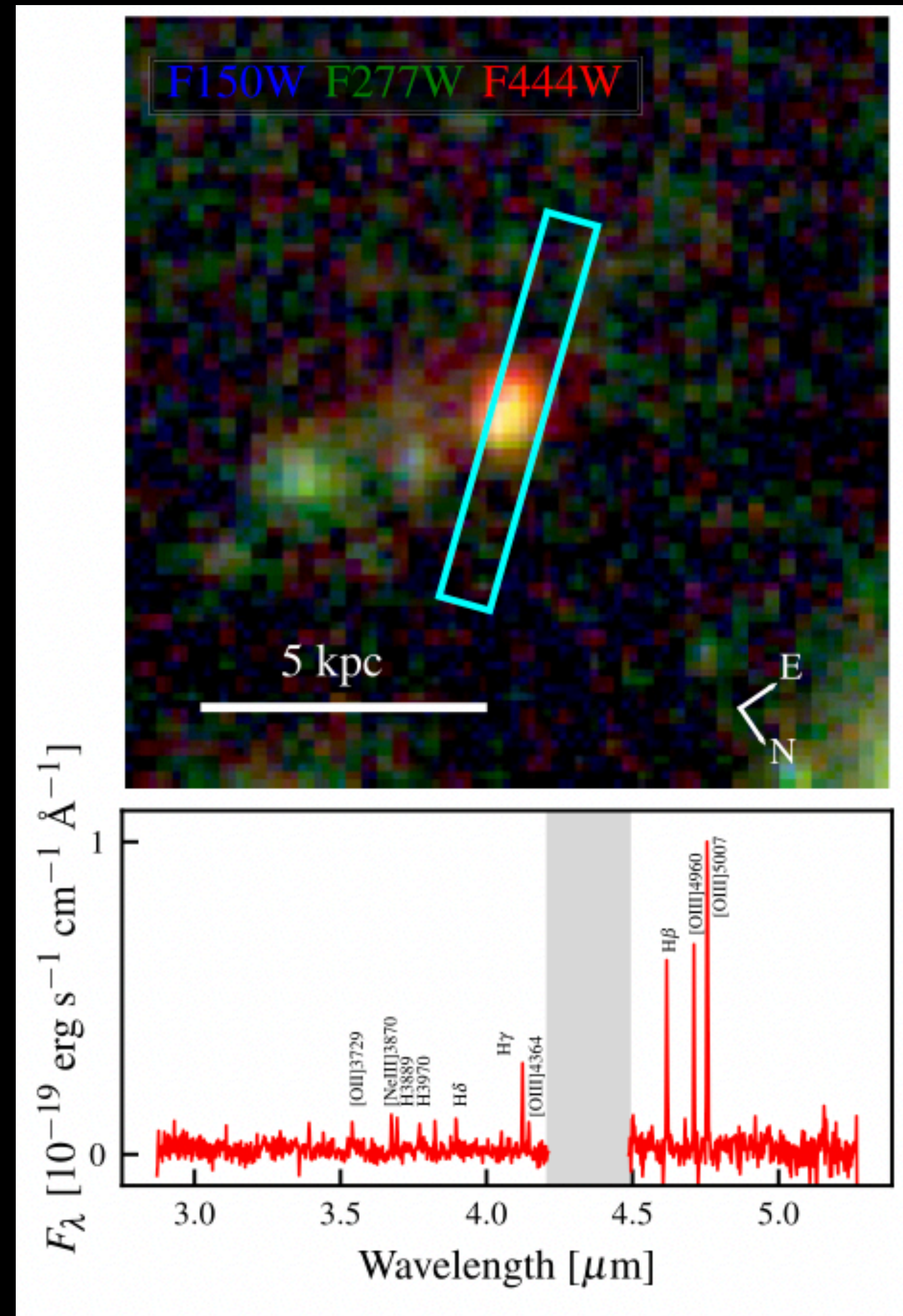


$R_e < 20$  pc ( $z=9.51$ )



H. Williams+2023

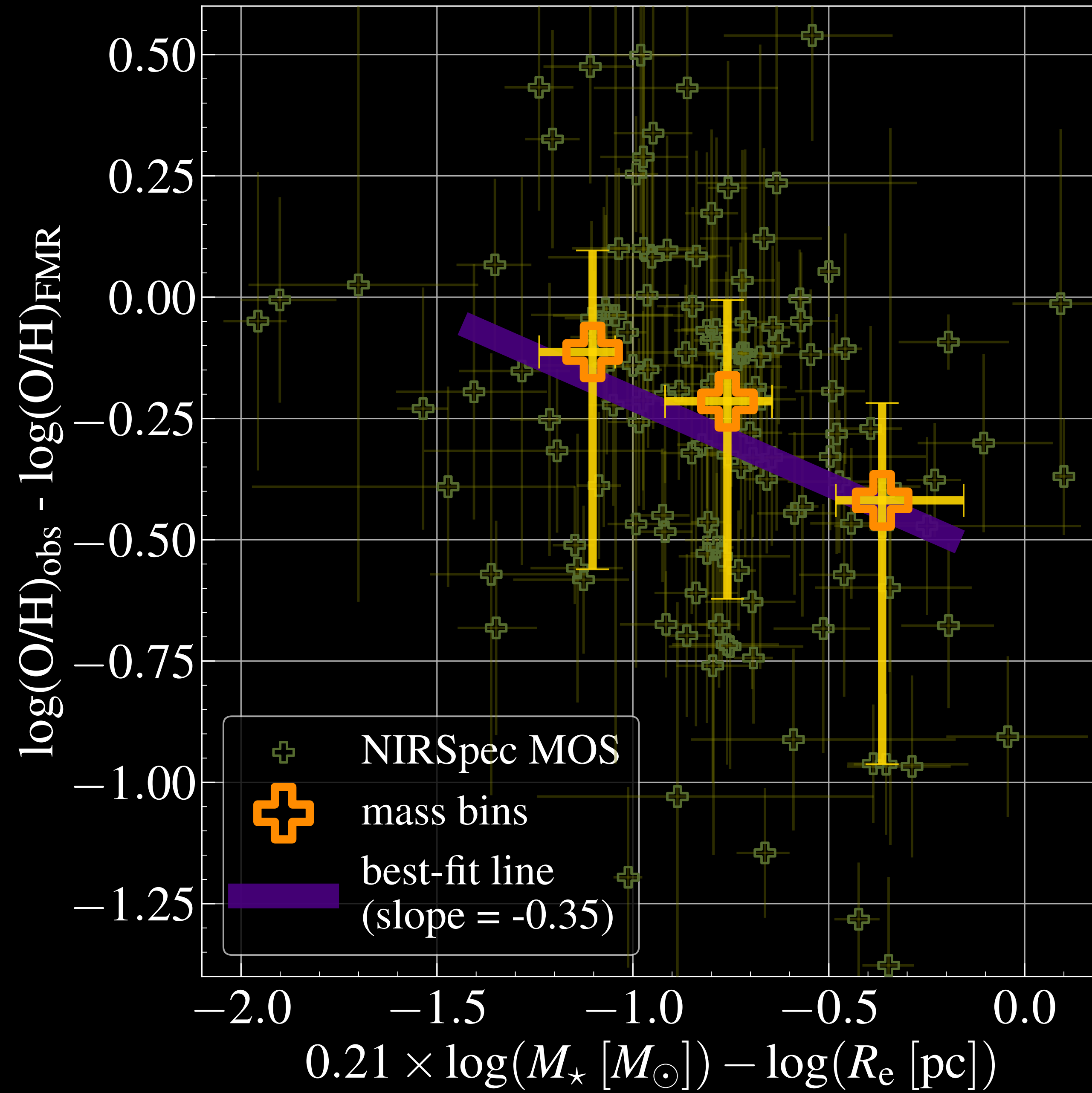
$R_e < 200$  pc ( $z=8.50$ )



Tacchella+2023



# Offset from the FMR Correlates with Compactness: The most compact galaxies are also the most metal-poor

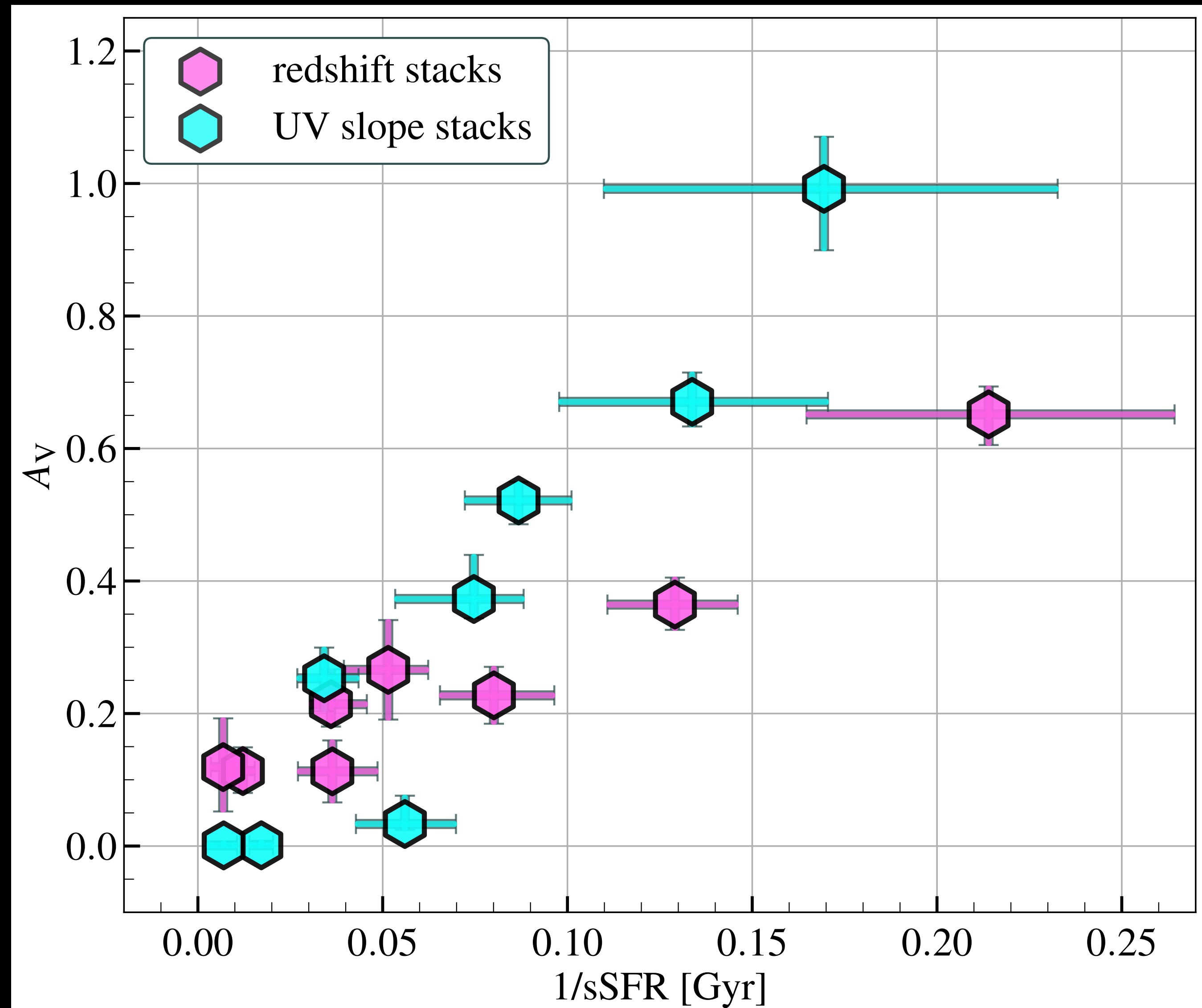


Langeroodi & Hjorth 2023

**The origin of interstellar dust and its formation timescale remain debated**



# Rapid Dust Buildup in the Early Universe

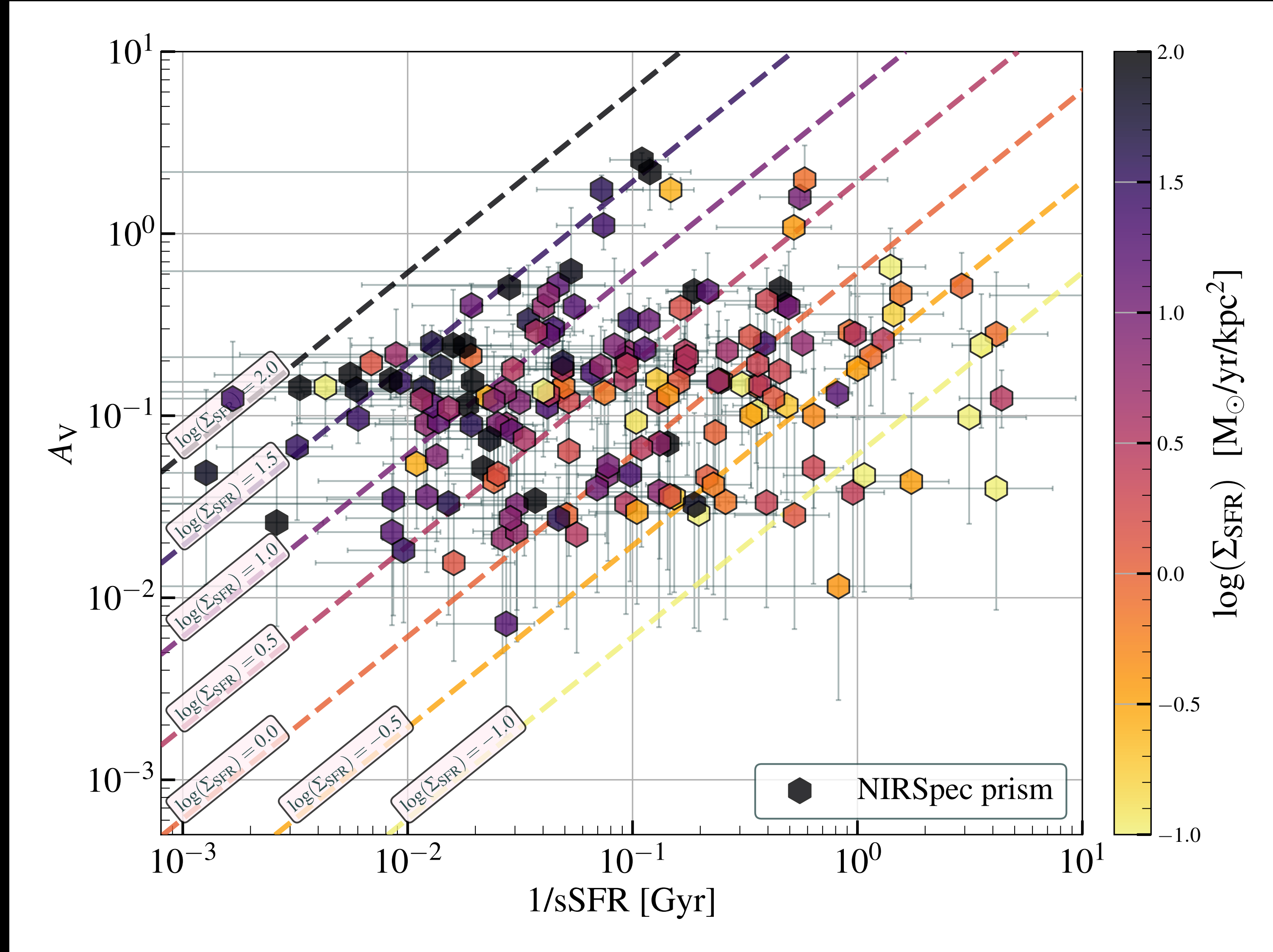


$$M_{\text{dust}} \propto M_{\star}$$

$$A_V = \Upsilon \Sigma_{\text{SFR}}/\text{sSFR}$$



# Early-universe galaxies appear much less attenuated than expected



Langeroodi, Hjorth, Ferrara, and Gall 2024

# Modifying the Dust Grains Properties

