
On the Model Dependence of the ionizing photon production efficiency

What are we really measuring

The Ionizing Photon Production Efficiency

The background of the slide is a dark grey-blue gradient. It is filled with numerous small, out-of-focus particles in shades of red, orange, yellow, and teal. These particles are arranged in several distinct, diagonal streaks or tracks that run from the bottom-left towards the top-right, suggesting a path of particle movement or ionization. The overall effect is a dynamic, scientific, and somewhat ethereal visual.

The Ionizing Photon Production Efficiency

Feeds into
timescale for
reionization

$$\dot{n}_{ion} = f_{esc} \times \xi_{ion} \times \rho_{UV}$$

Escape
Fraction of LyC
light

Ionizing photon
production
efficiency

Number density of
emitting sources

The Ionizing Photon Production Efficiency

$$\dot{n}_{ion} = f_{esc} \times \xi_{ion} \times \rho_{UV}$$

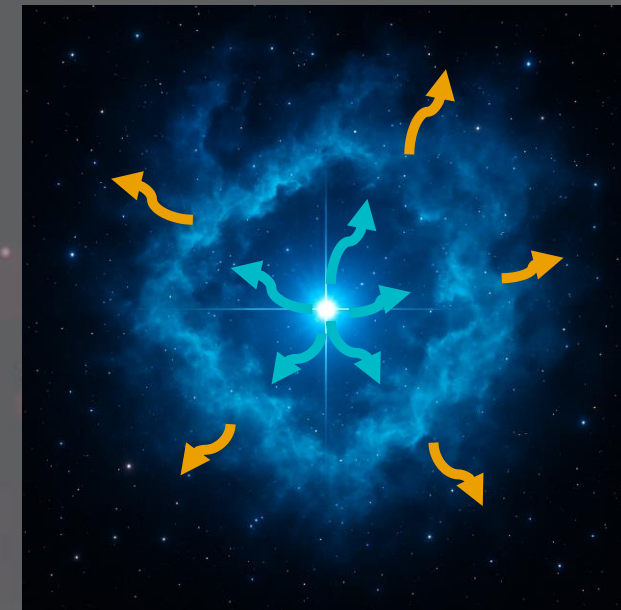
$$\xi_{ion} = \frac{N(H^0)}{L_{UV}}$$

Ionizing
radiation

The Ionizing Photon Production Efficiency

$$N(H^0) = 7.28 \times 10^{11} L(H\alpha)$$

$$\xi_{ion} = \frac{N(H^0)}{L_{UV}}$$



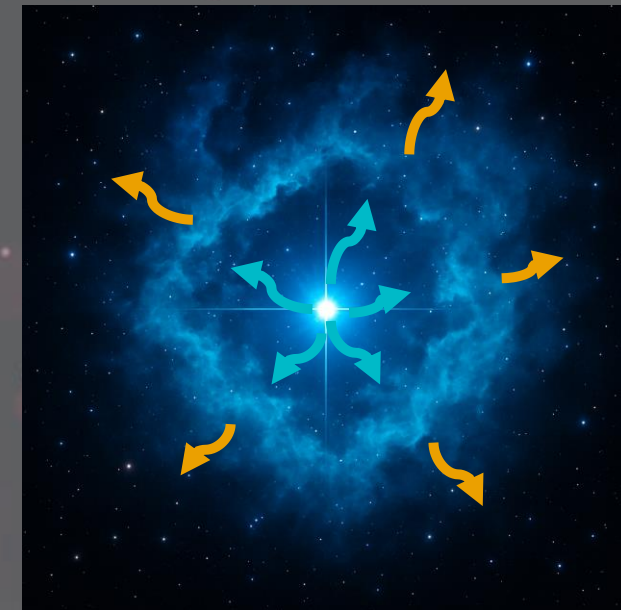
LyC
Hα

The Ionizing Photon Production Efficiency

$$N(H^0) = 7.28 \times 10^{11} L(H\alpha)$$

$$\xi_{ion} = \frac{N(H^0)}{L_{UV}}$$

Luminosity
density of non-
ionizing UV
component



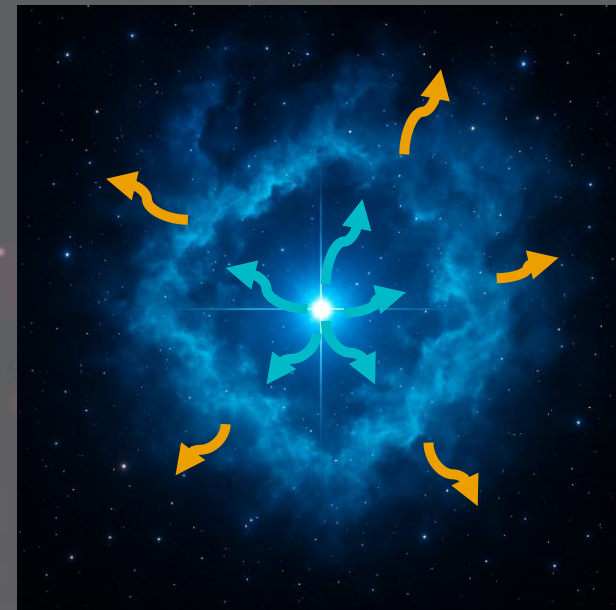
LyC
H α

The Ionizing Photon Production Efficiency

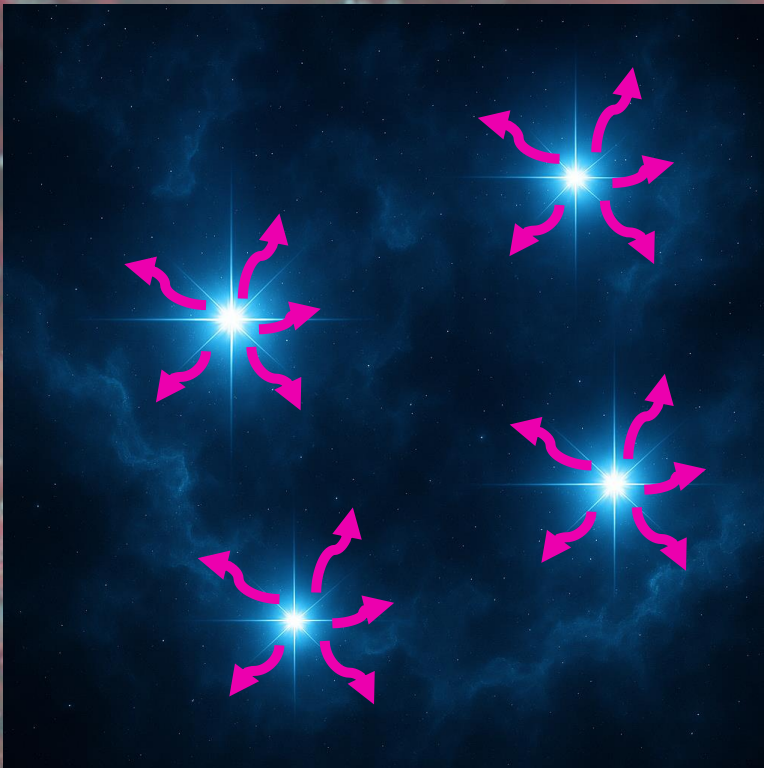
$$N(H^0) = 7.28 \times 10^{11} L(H\alpha)$$

$$\xi_{ion} = \frac{N(H^0)}{L_{UV}}$$

Non-ionizing UV

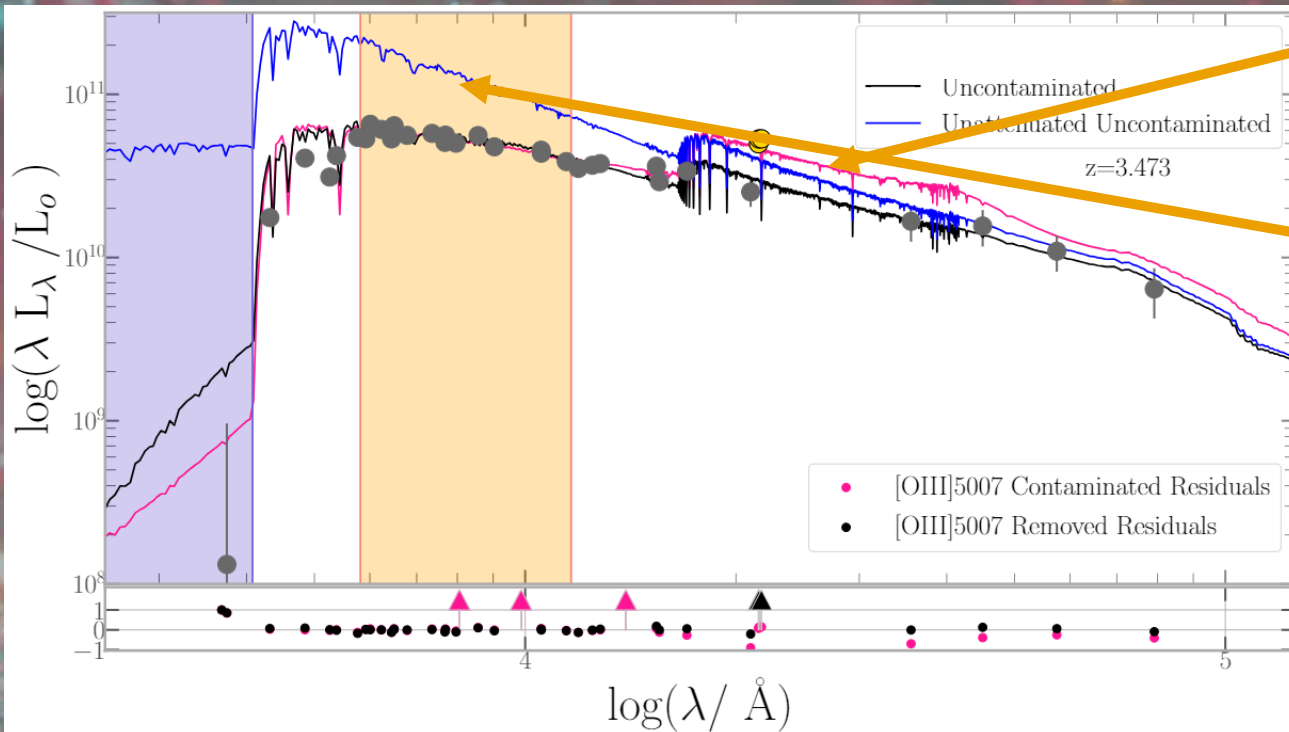


LyC
Hα



The Ionizing Photon Production Efficiency

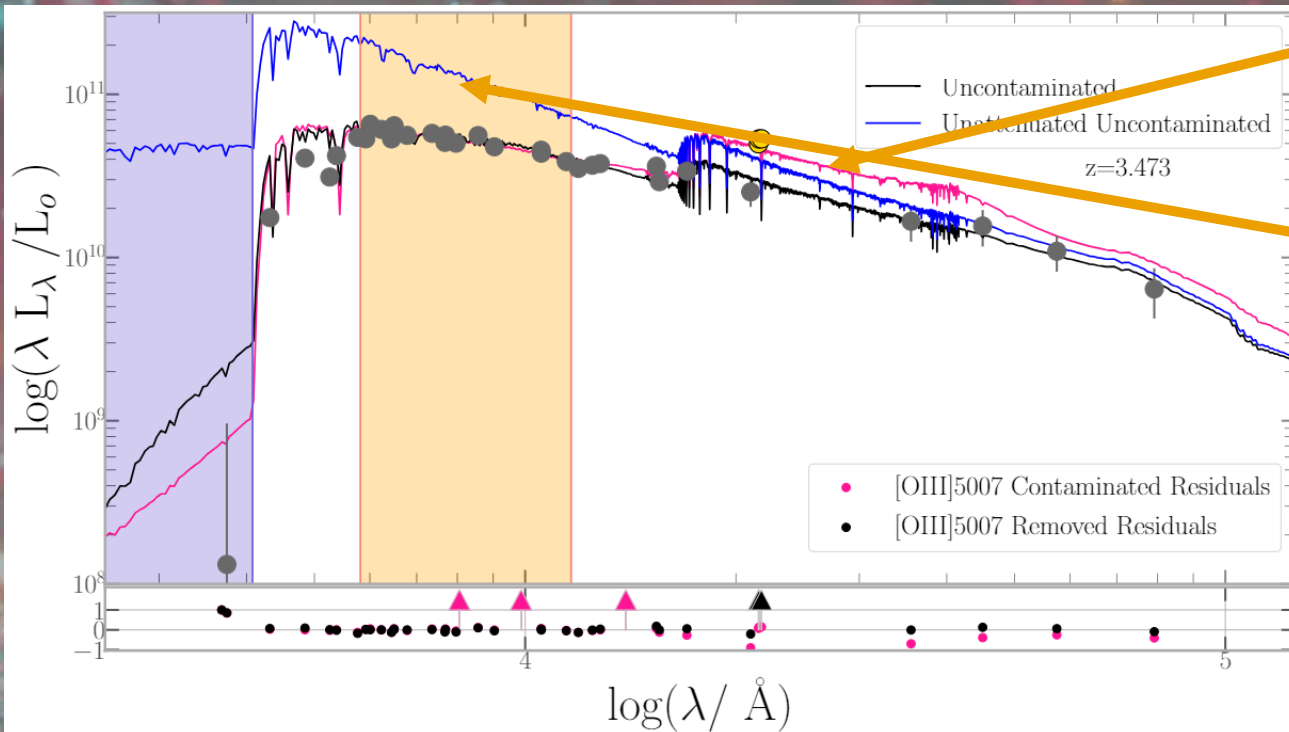
$$N(H^0) = 7.28 \times 10^{11} L(H\alpha)$$



$$\xi_{ion} = \frac{N(H^0)}{L_{UV}}$$

The Ionizing Photon Production Efficiency

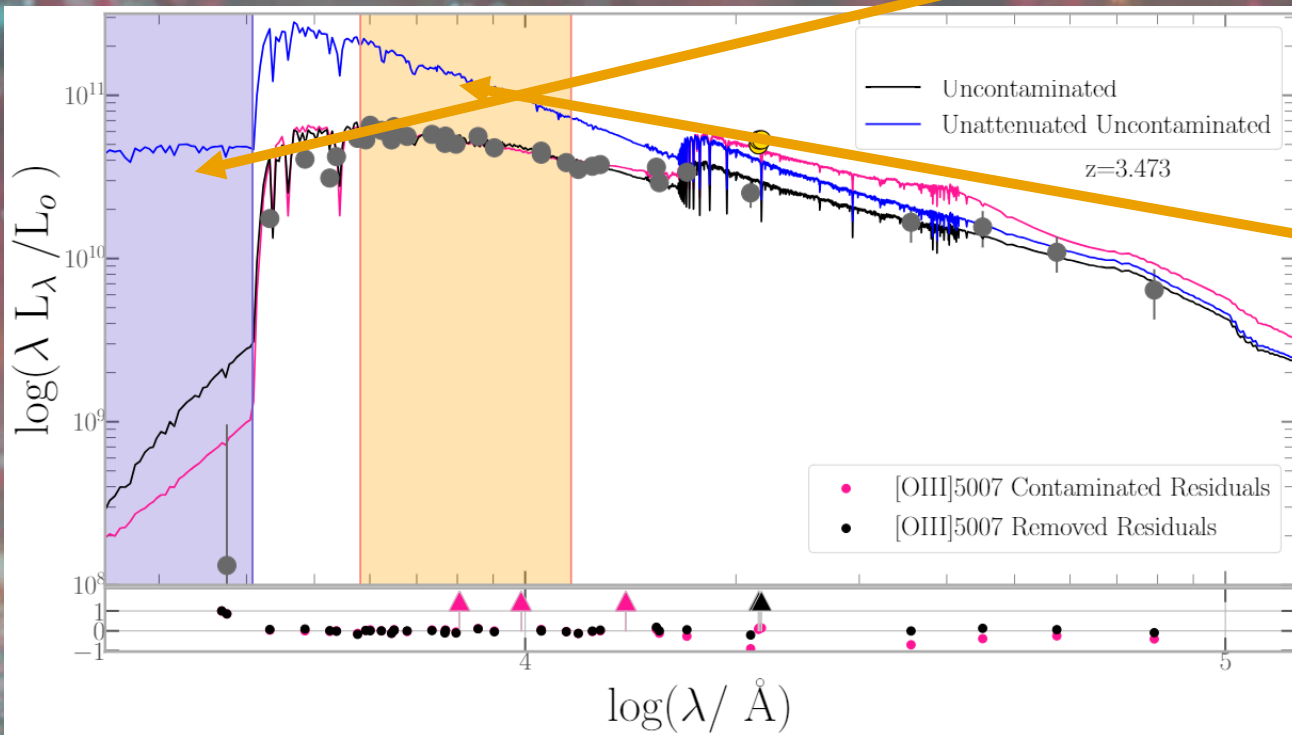
$$N(H^0) = 7.28 \times 10^{11} L(H\alpha)$$



$$\xi_{ion} = \frac{N(H^0)}{L_{UV}}$$

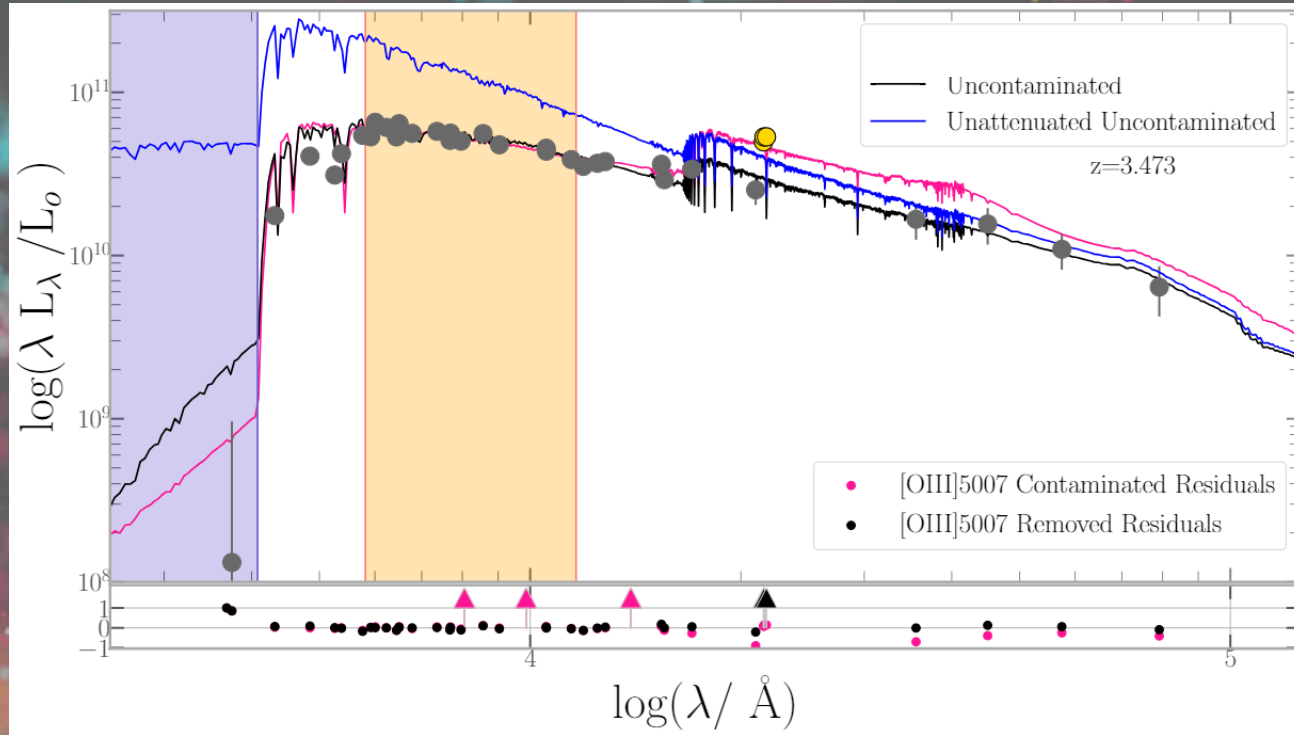
The Ionizing Photon Production Efficiency

$$\int_{c/\infty}^{c/912\text{\AA}} L_{\nu} (h\nu)^{-1}$$



$$\xi_{\text{ion}} = \frac{N(H^0)}{L_{\text{UV}}}$$

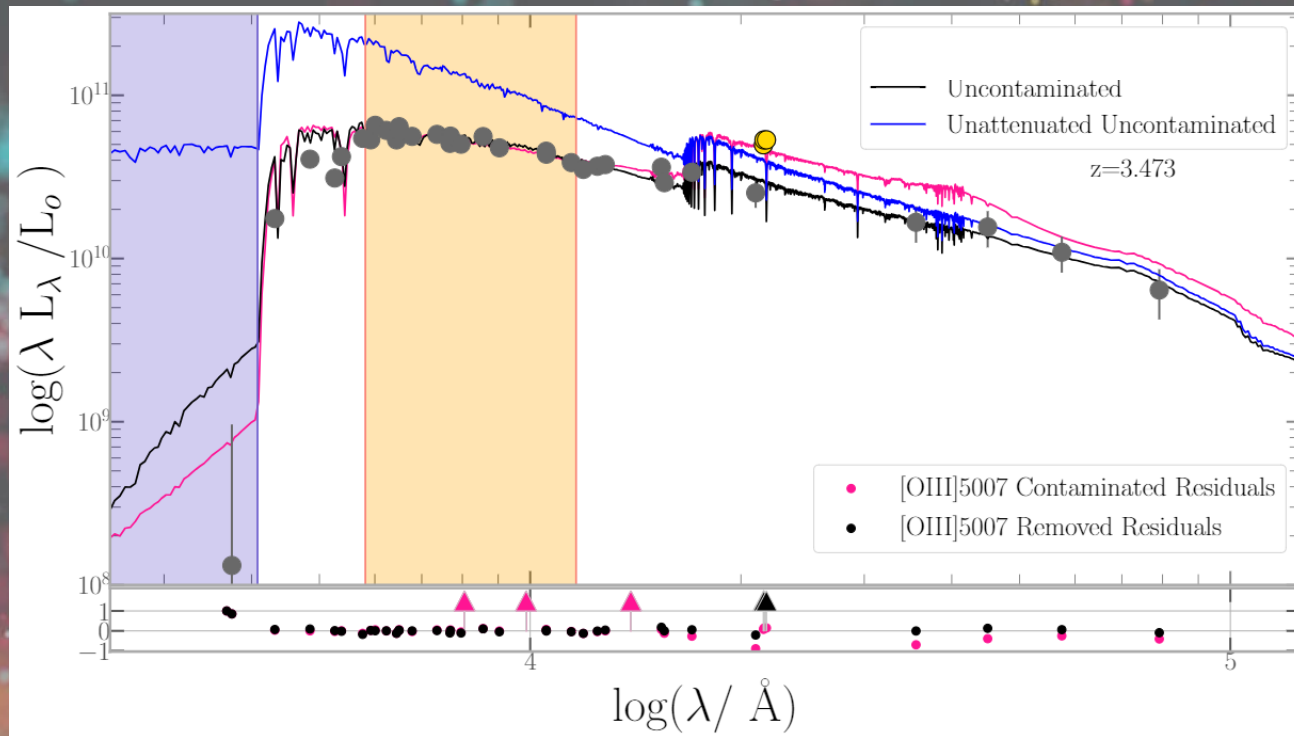
SED Modelling



$$\xi_{ion} = \frac{N(H^0)}{L_{UV} \times c_{rec}}$$

$$\int_{c/-\infty}^{c/912\text{\AA}} L_\nu (h\nu)^{-1}$$

SED Modelling



Stuff that emits	Stuff that absorbs
Star Formation History	Dust attenuation (and re-emission)
AGN	Photoionization
Stellar Population Synthesis	IGM absorption

$$\xi_{ion} = \frac{N(H^0)}{L_{UV} \times c_{rec}}$$

$$\int_{c/-\infty}^{c/912\text{\AA}} L_\nu (h\nu)^{-1}$$

SED Modelling

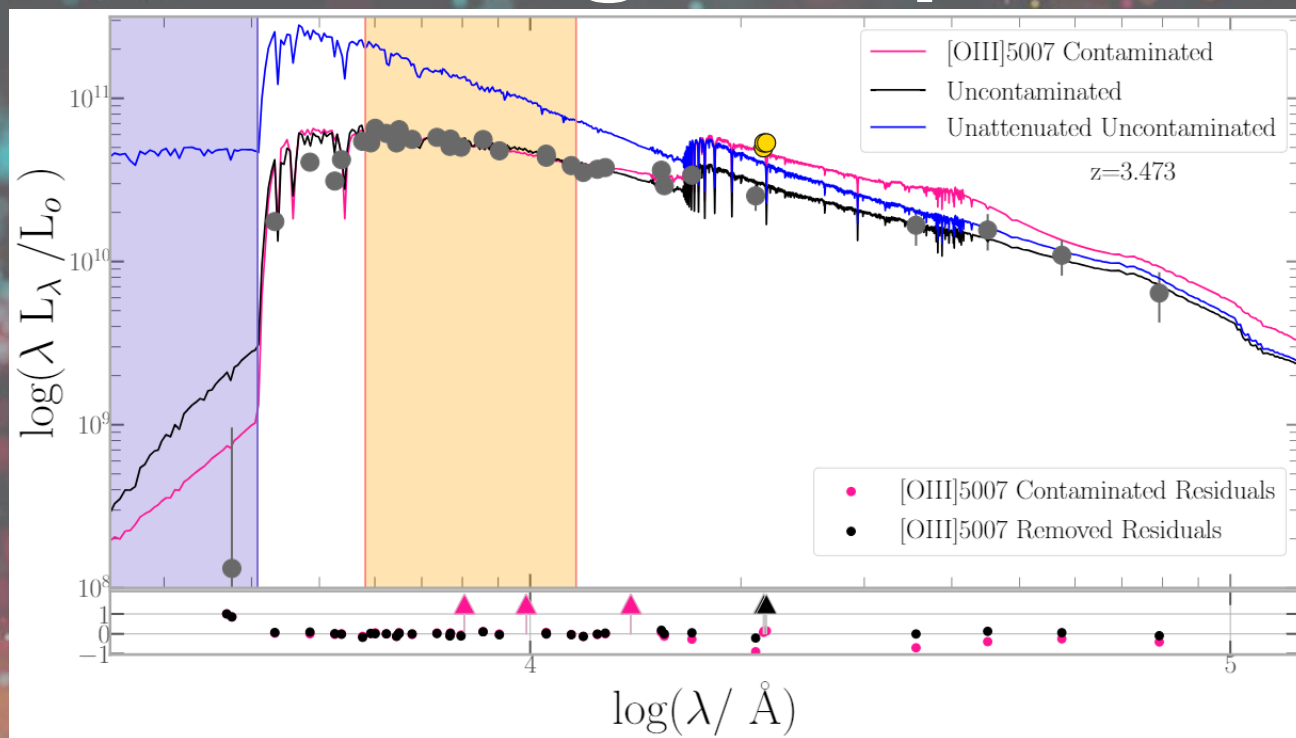
Burst Implementation

Stuff that emits	Stuff that absorbs
Star Formation History	Dust attenuation (and re-emission)
AGN ✗	Photoionization
Stellar Population Synthesis	IGM absorption ✗

$$\xi_{ion} = \frac{N(H^0)}{L_{UV} \times c_{rec}}$$

$$\int_{c/-\infty}^{c/912\text{\AA}} L_{\nu} (h\nu)^{-1}$$

EoR Analog Sample

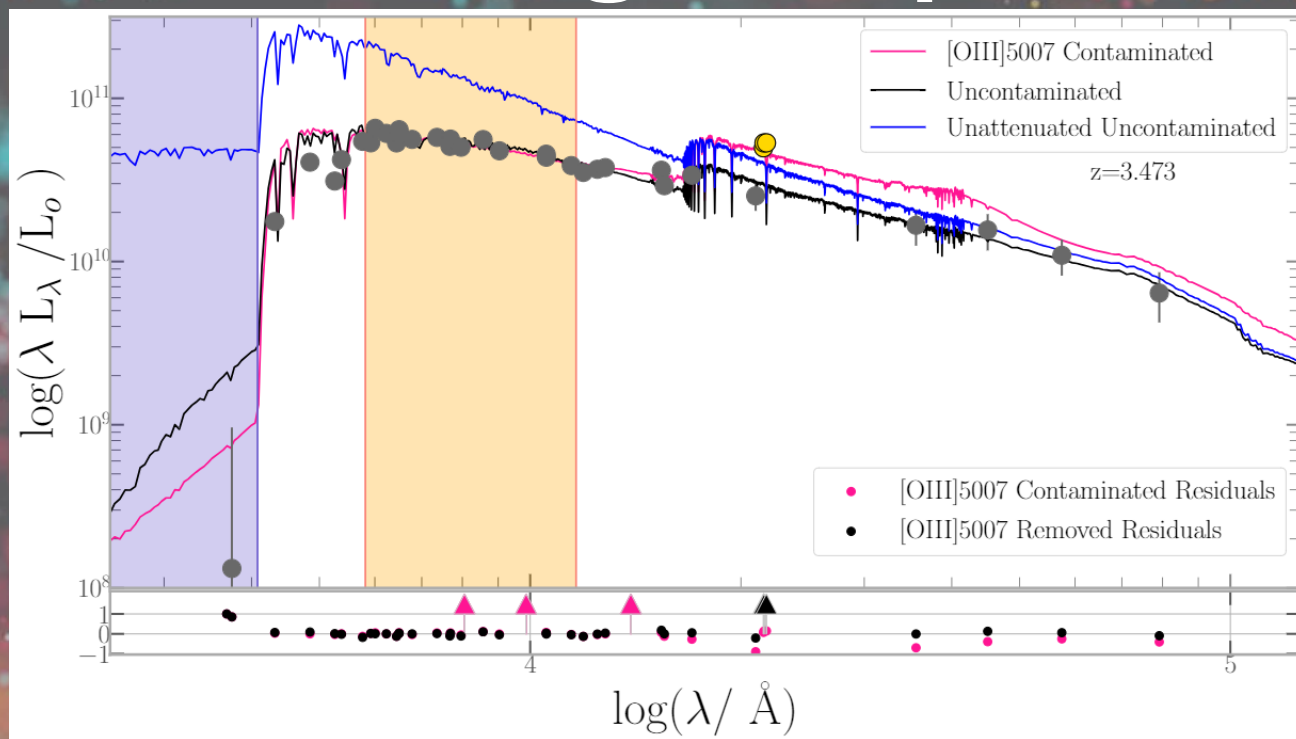


These galaxies are morphologically more similar than low redshift galaxies

Decent photometric coverage across a wide/useful range

Directly accessible LyC

EoR Analog Sample



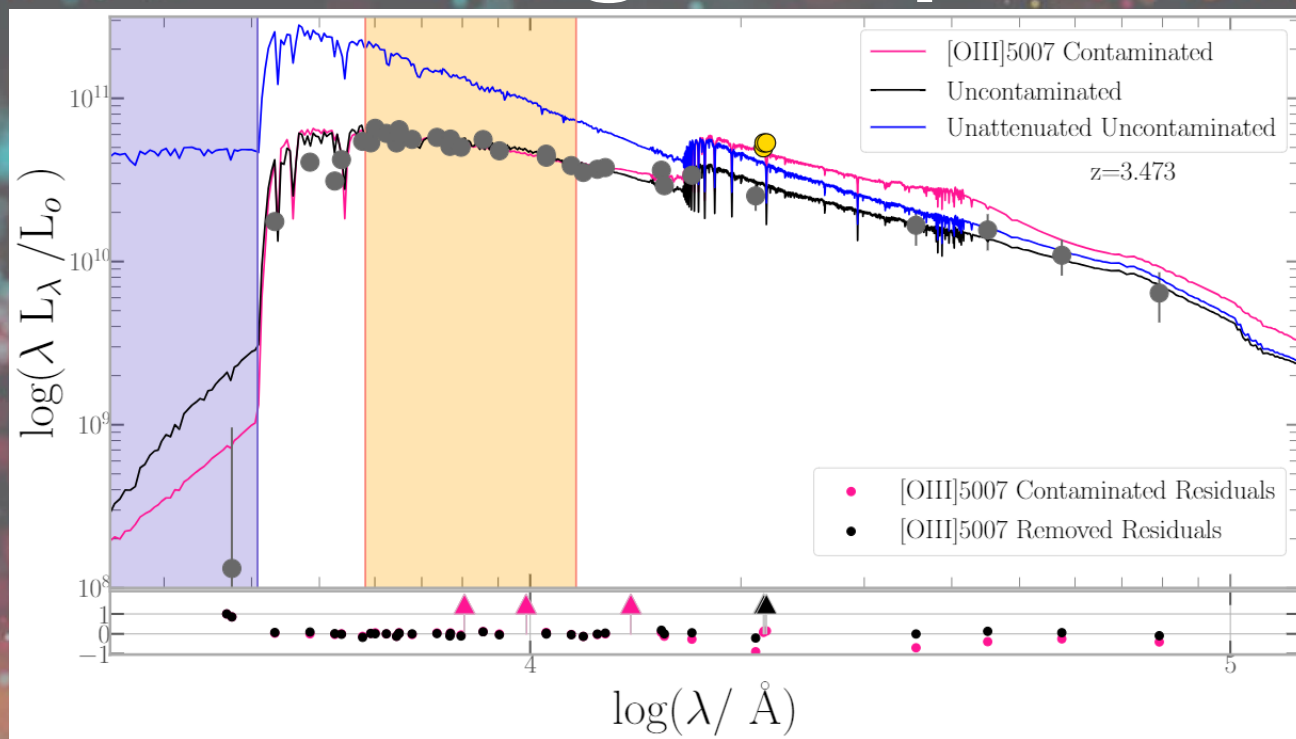
These galaxies are morphologically more similar than low redshift galaxies

Decent photometric coverage across a wide/useful range

Directly accessible LyC



EoR Analog Sample



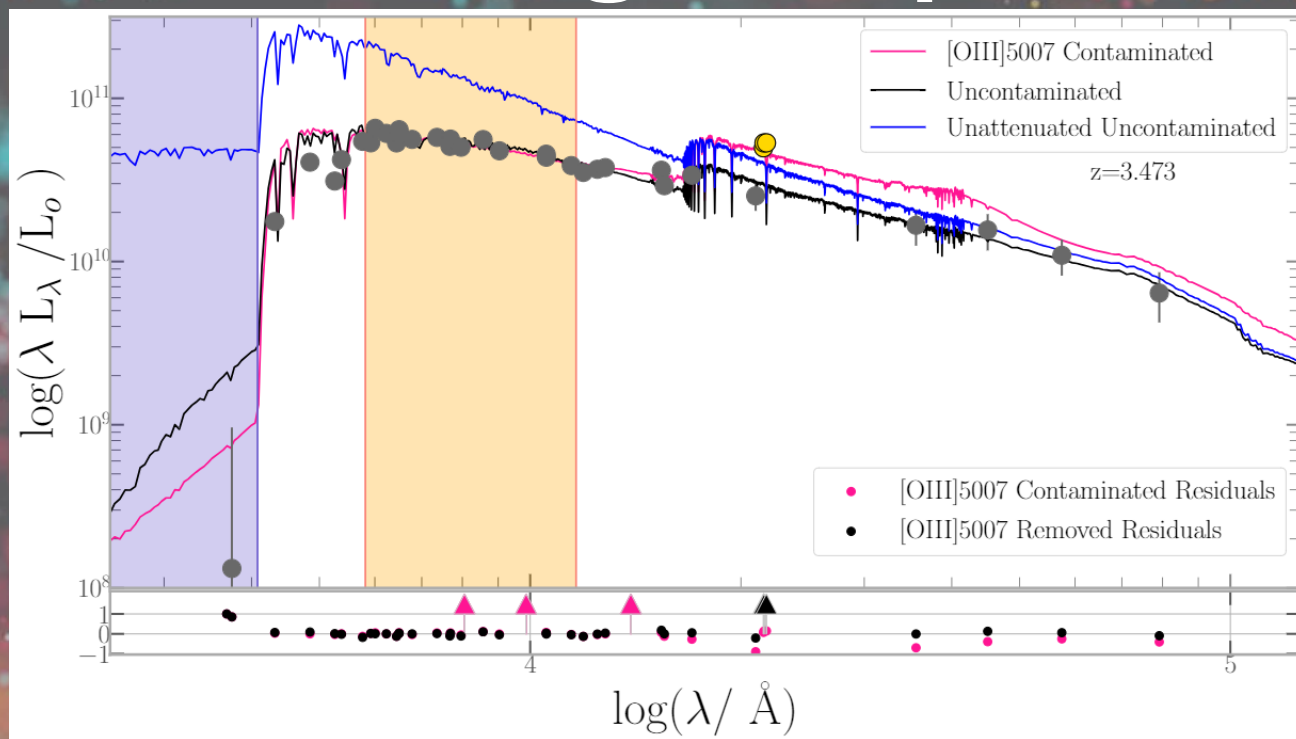
These galaxies are morphologically more similar than low redshift galaxies

Decent photometric coverage across a wide/useful range

Directly accessible LyC



EoR Analog Sample



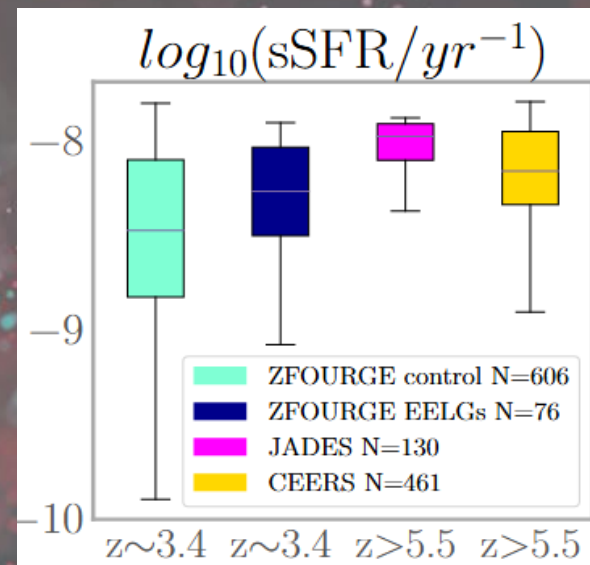
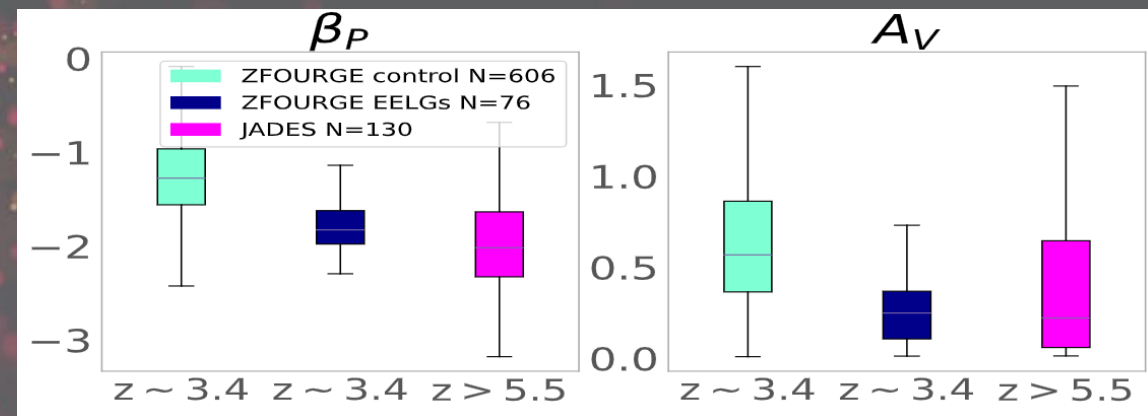
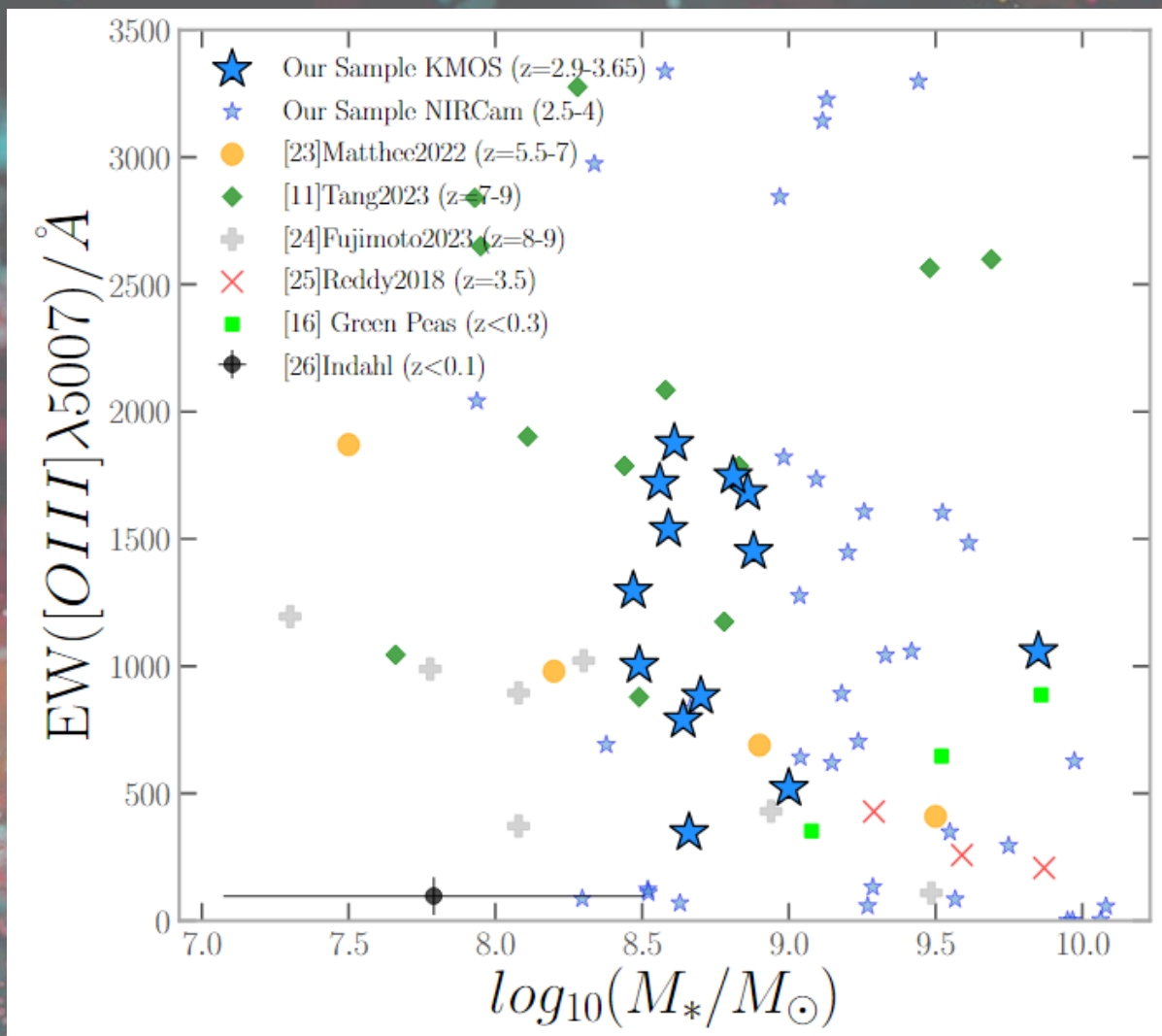
These galaxies are morphologically more similar than low redshift galaxies

Decent photometric coverage across a wide/useful range

Directly accessible LyC

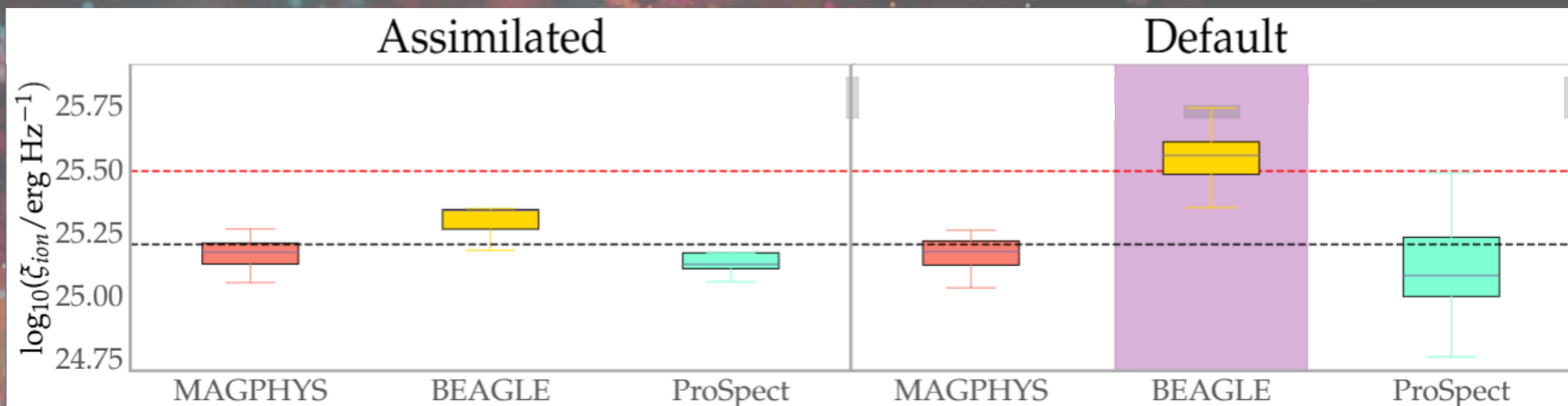


EoR Analog Sample

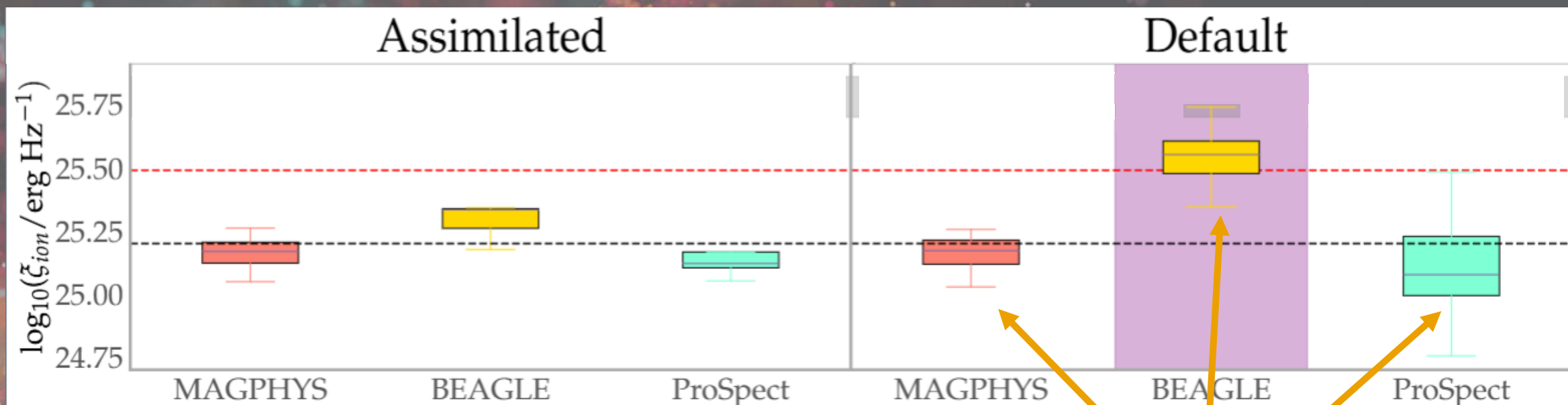


Jaiswar 2024

Proof of concept

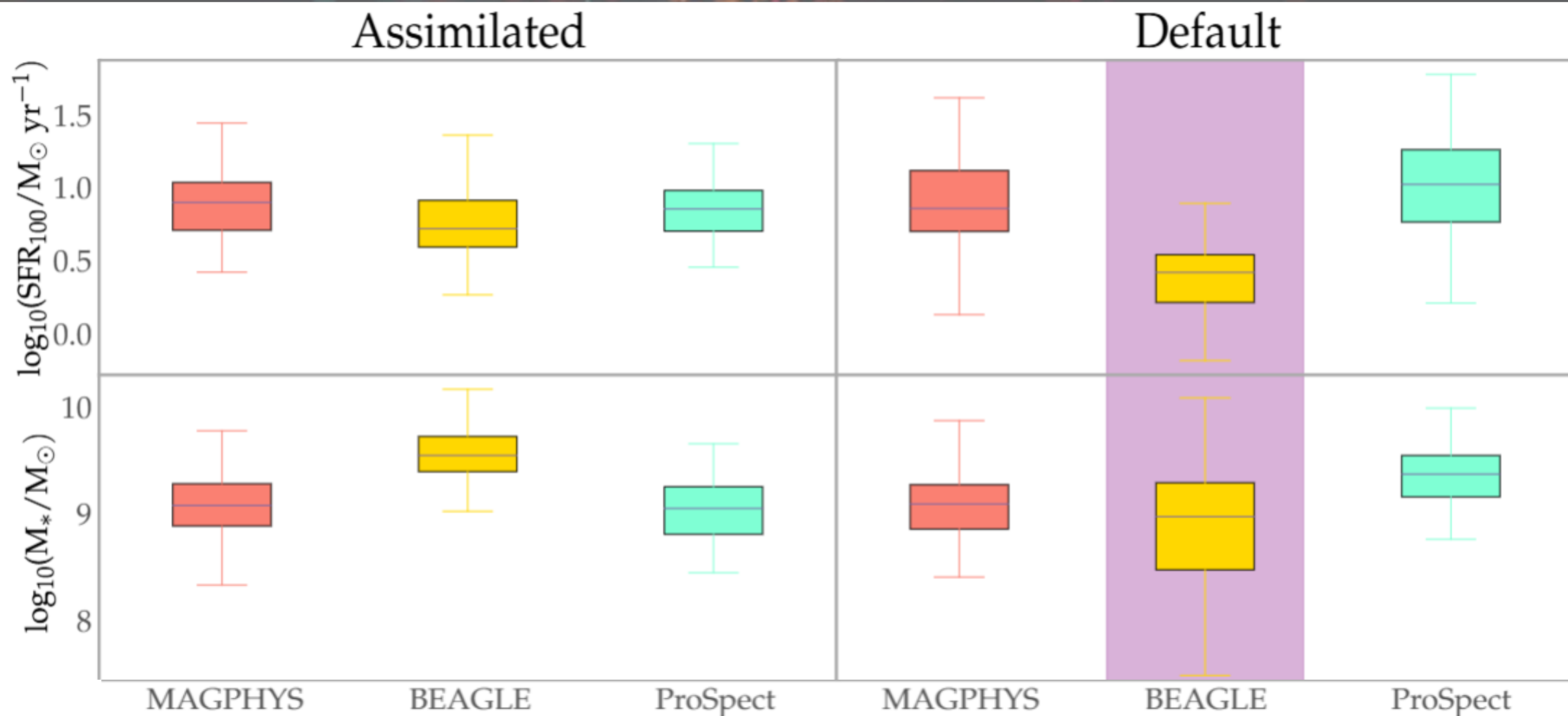


Proof of concept



The exact same galaxies

Proof of concept



Star Formation History

MAGPHYS

Delayed
Exponentially
declining

DaCunha 2008

Robotham 2020

ProSpect

Exponentially Declining

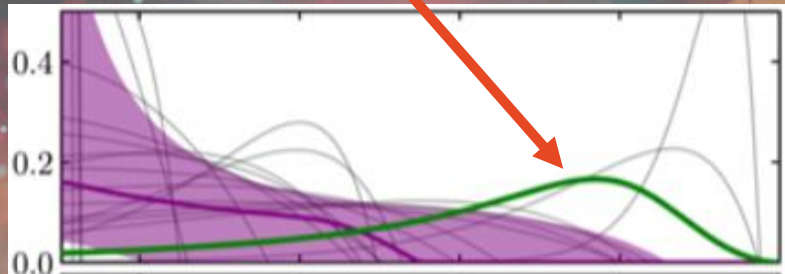
Constant

Truncated Skewed
Normal

Star Formation History

MAGPHYS

Delayed
Exponentially
declining



Carnall 2019

ProSpect

Exponentially Declining

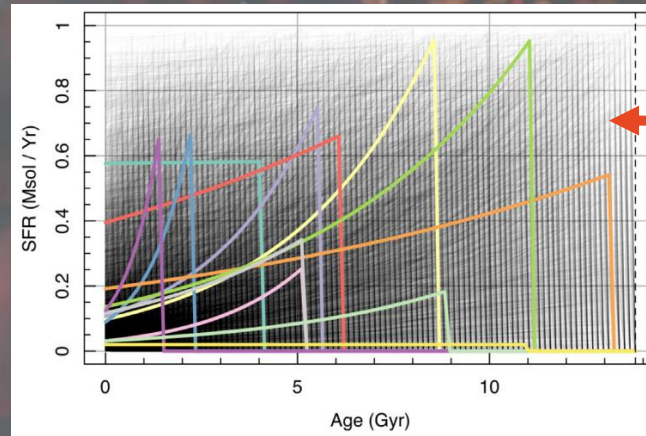
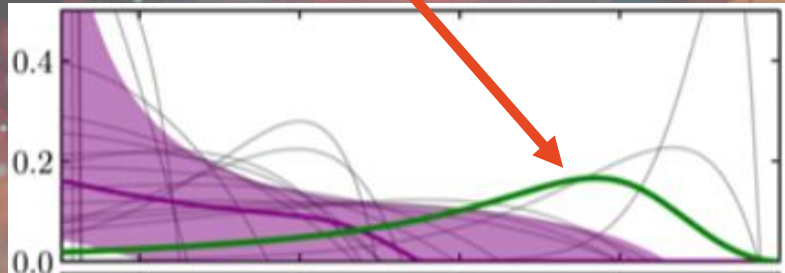
Constant

Truncated Skewed
Normal

Star Formation History

MAGPHYS

Delayed
Exponentially
declining

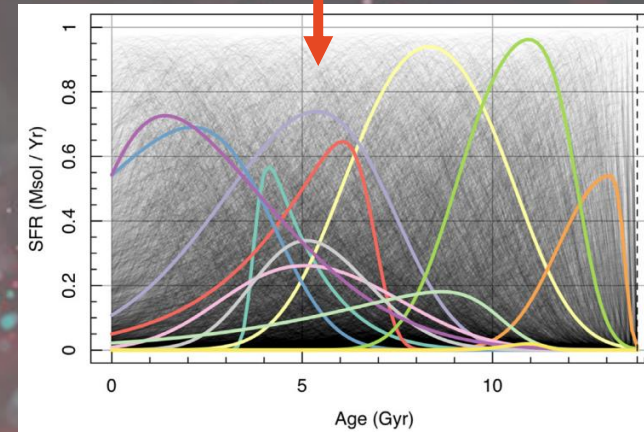
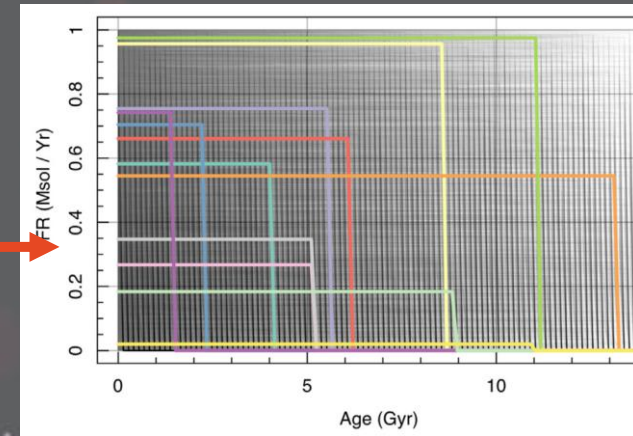


ProSpect

Exponentially Declining

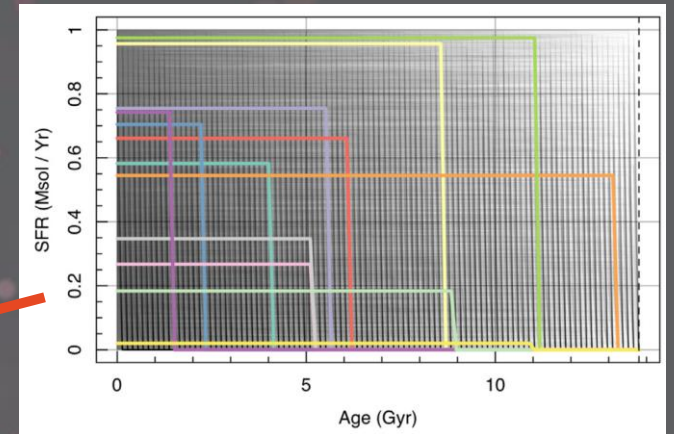
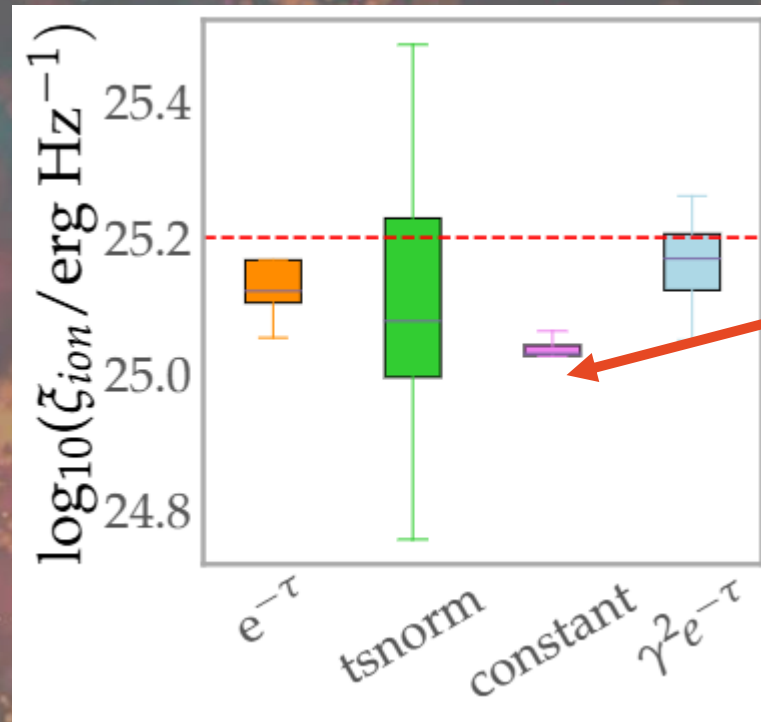
Constant

Truncated Skewed
Normal

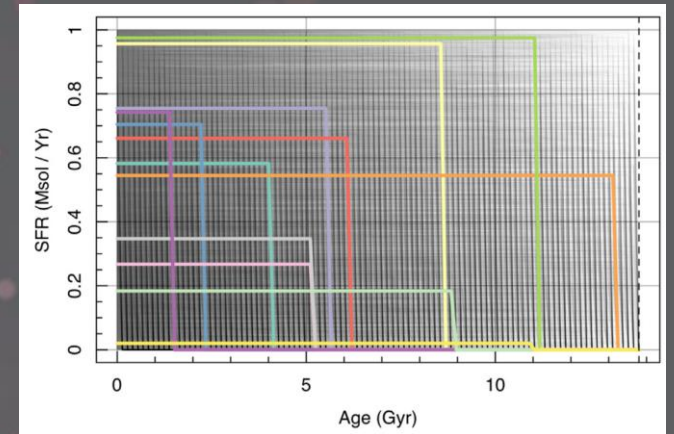
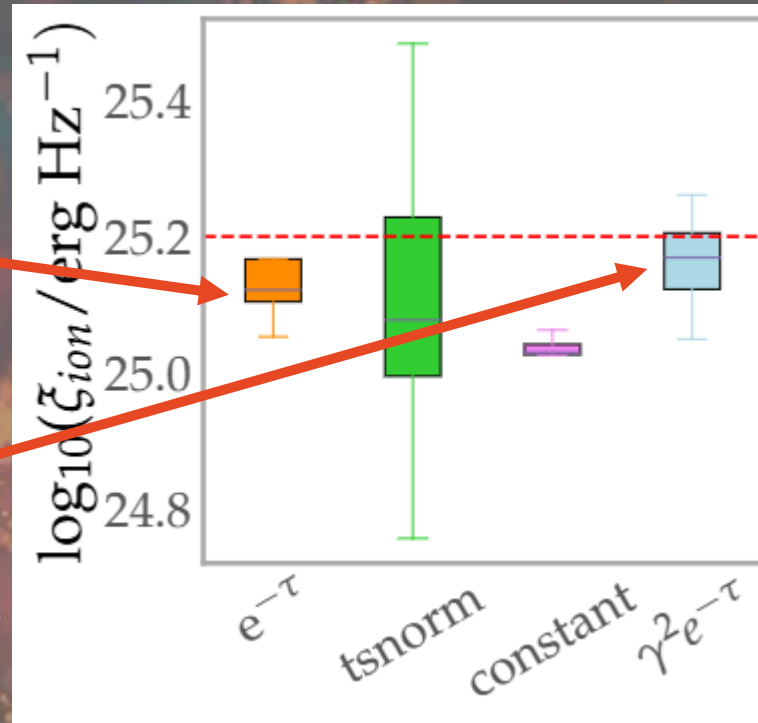
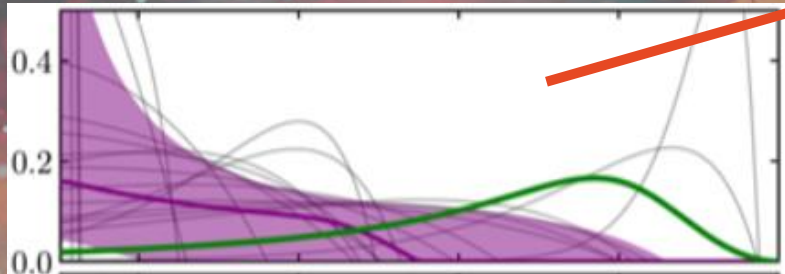
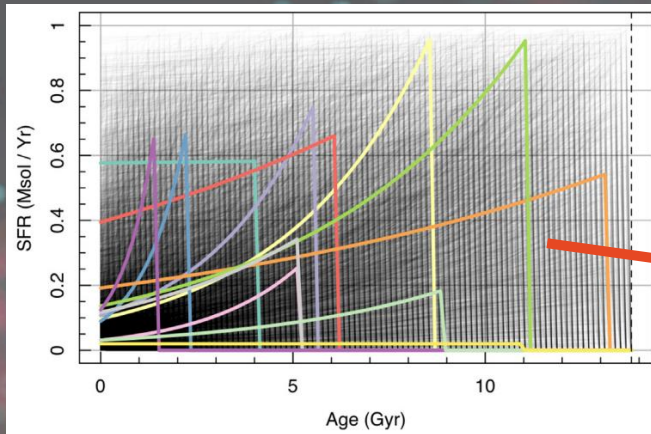


Robotham 2020

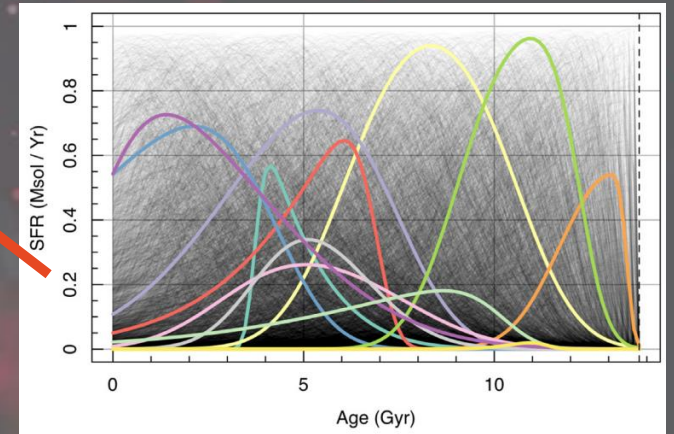
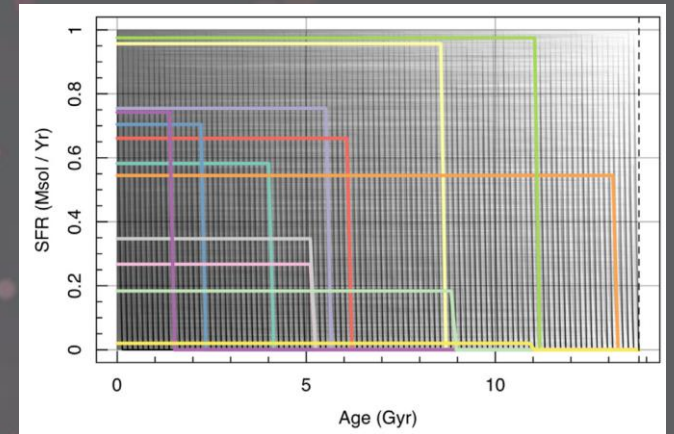
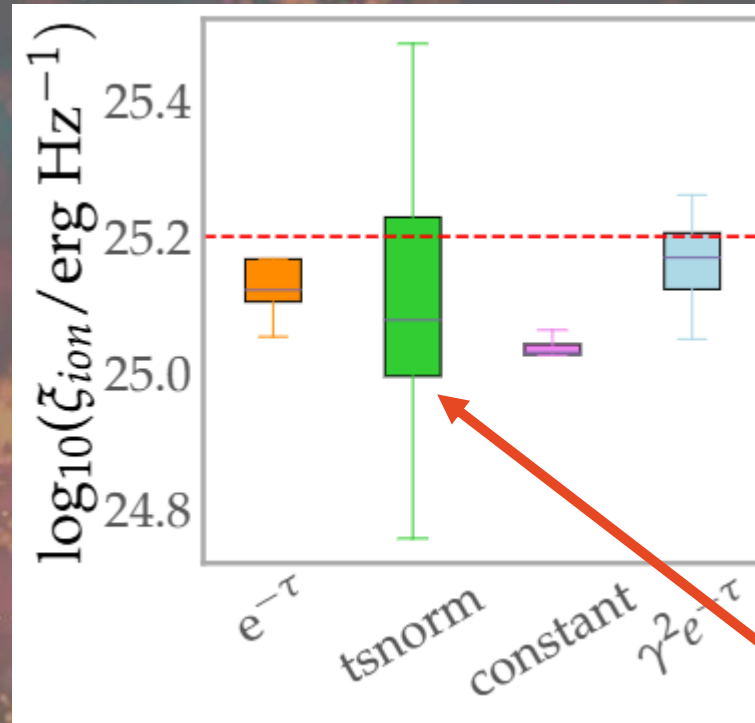
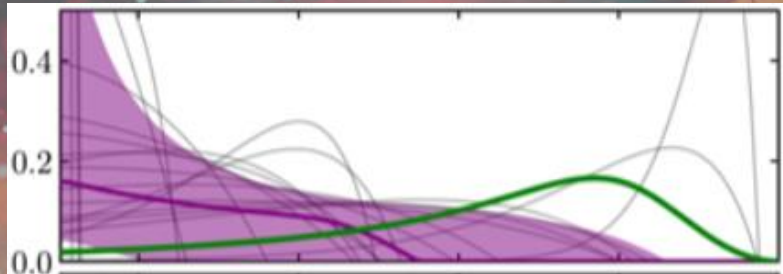
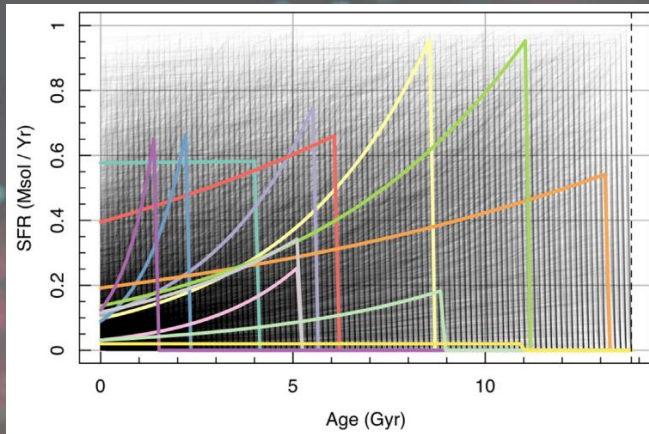
Star Formation History



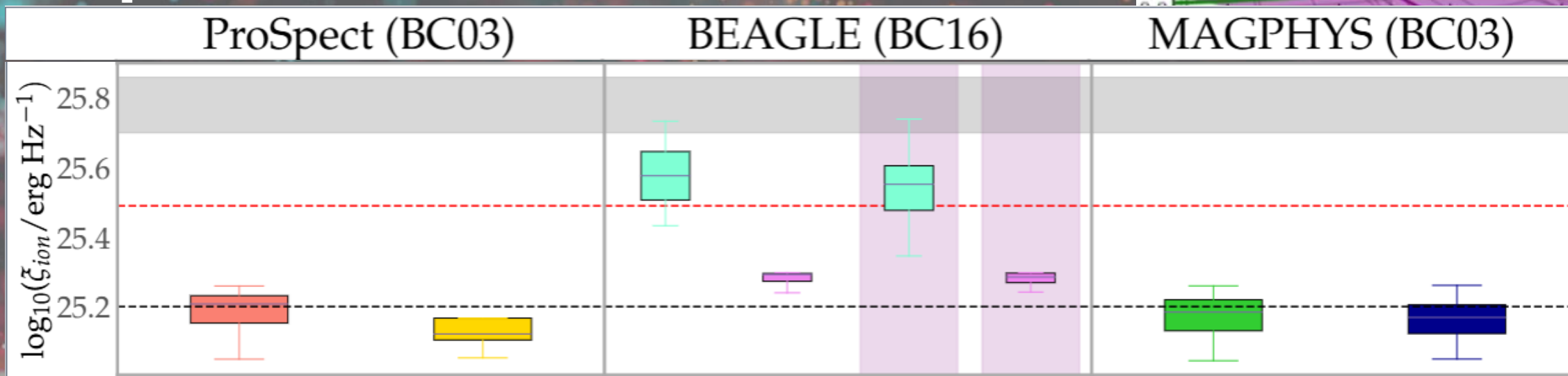
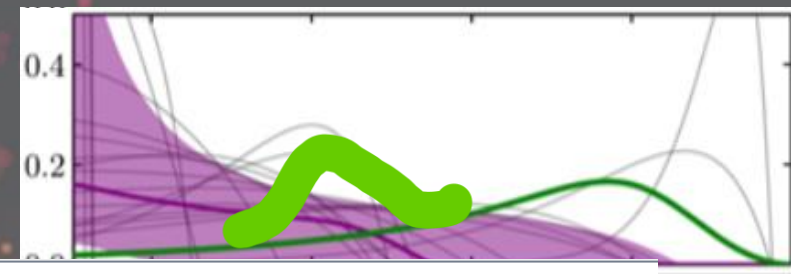
Star Formation History



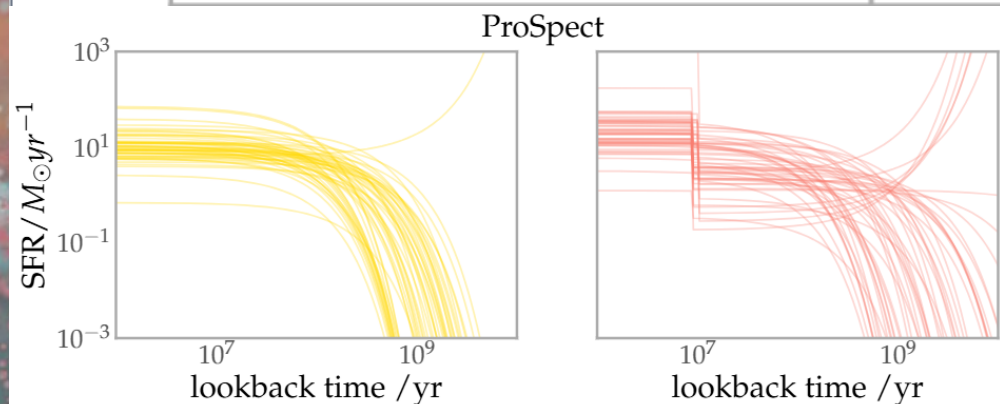
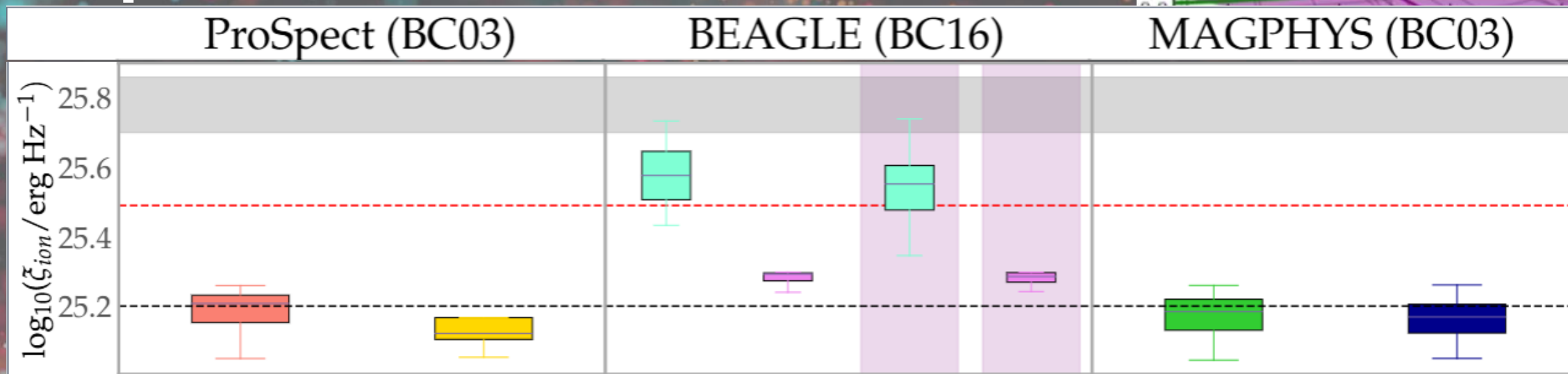
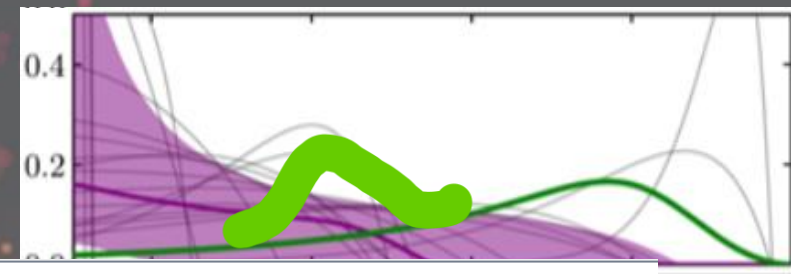
Star Formation History



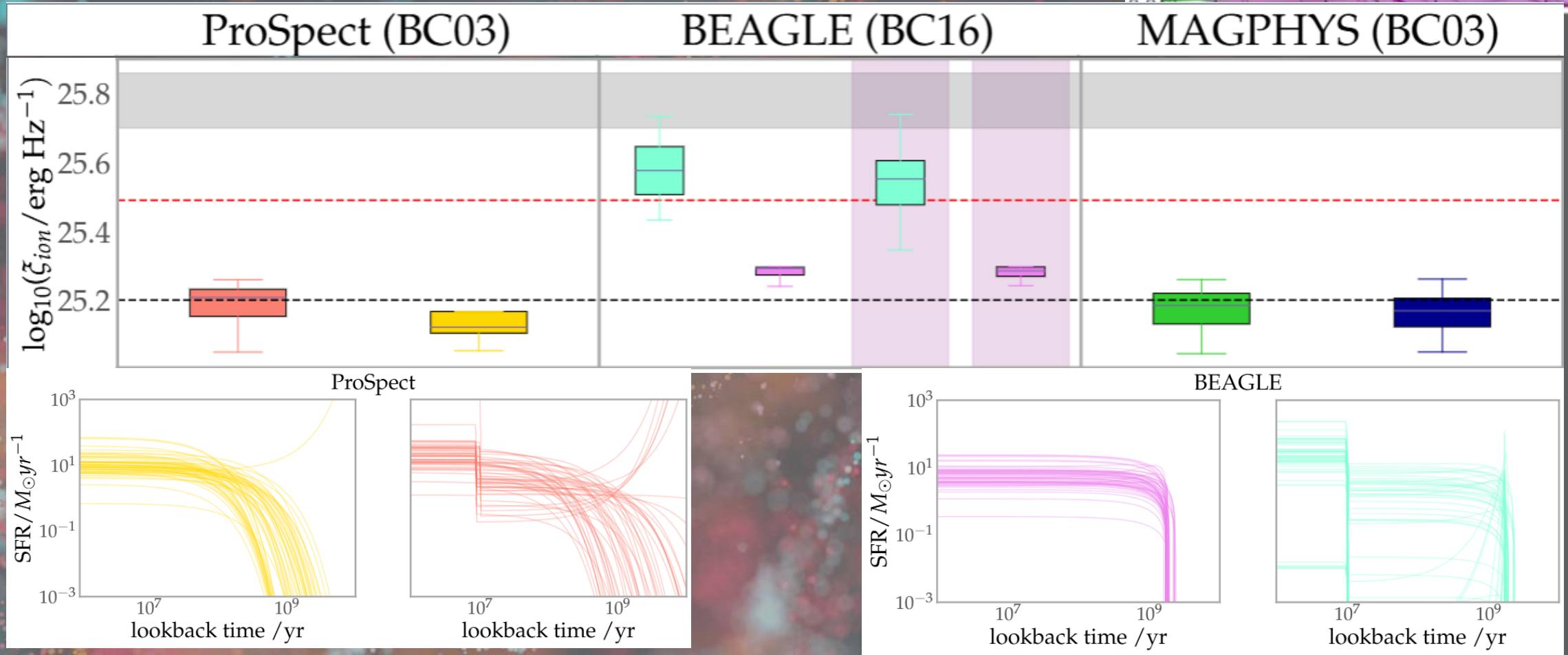
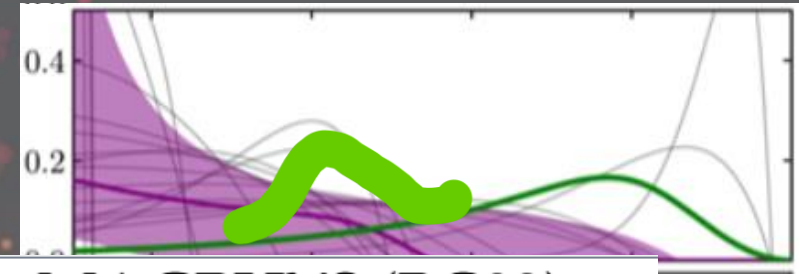
Star Formation History- Burst Implementation



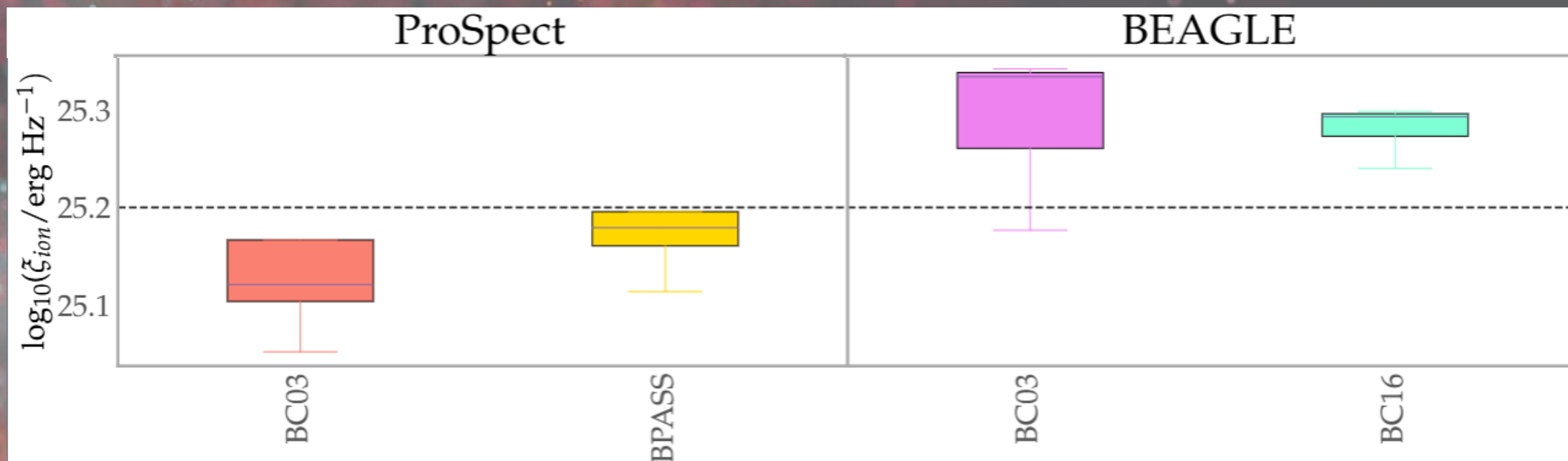
Star Formation History- Burst Implementation



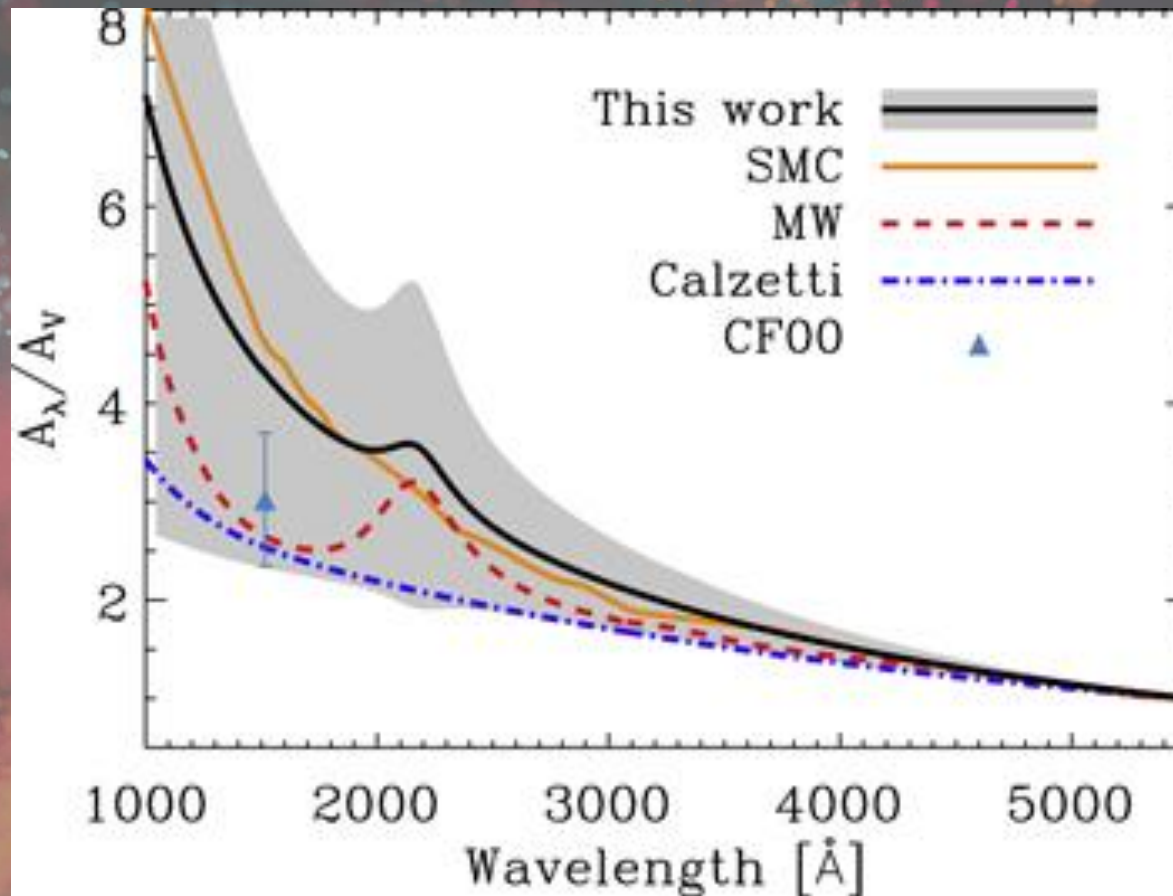
Star Formation History- Burst Implementation



Stellar Population Synthesis

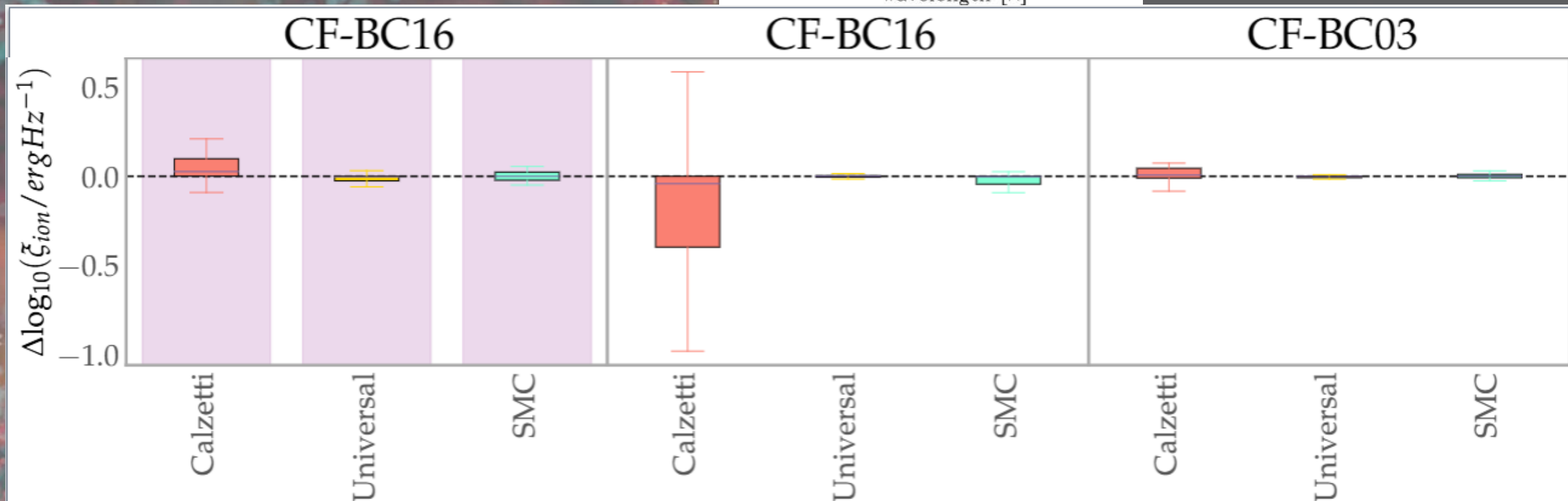
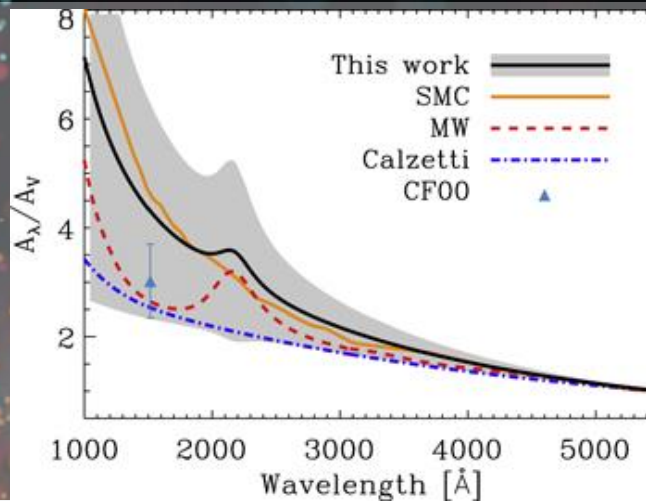


Dust Model

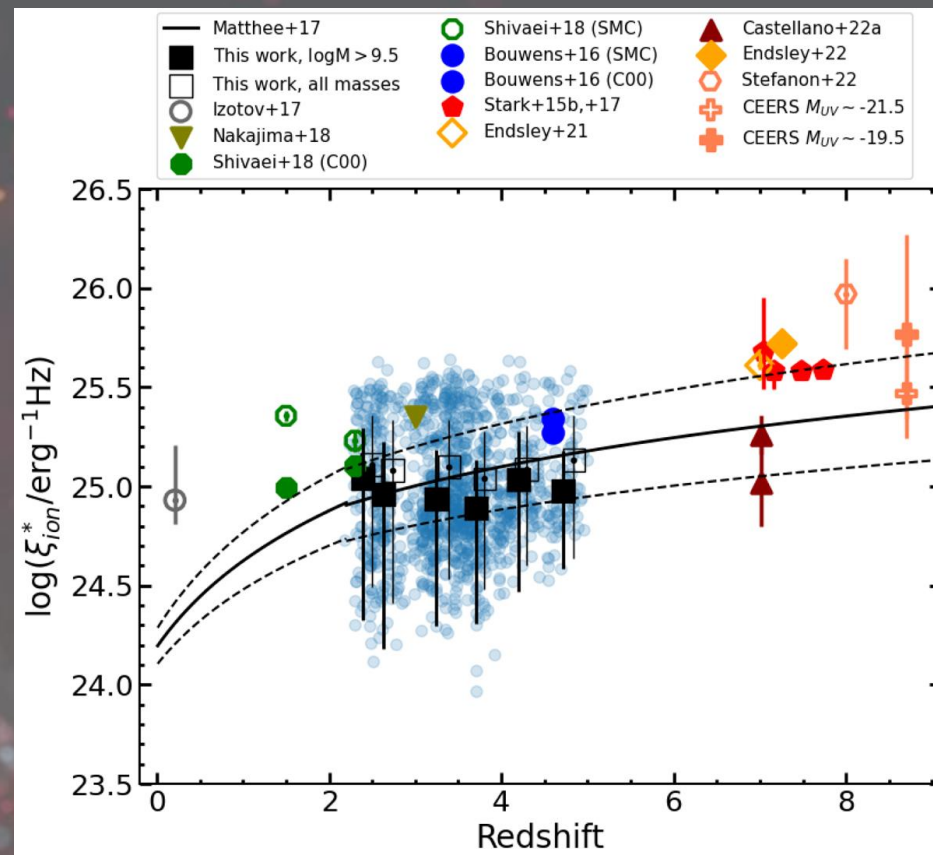
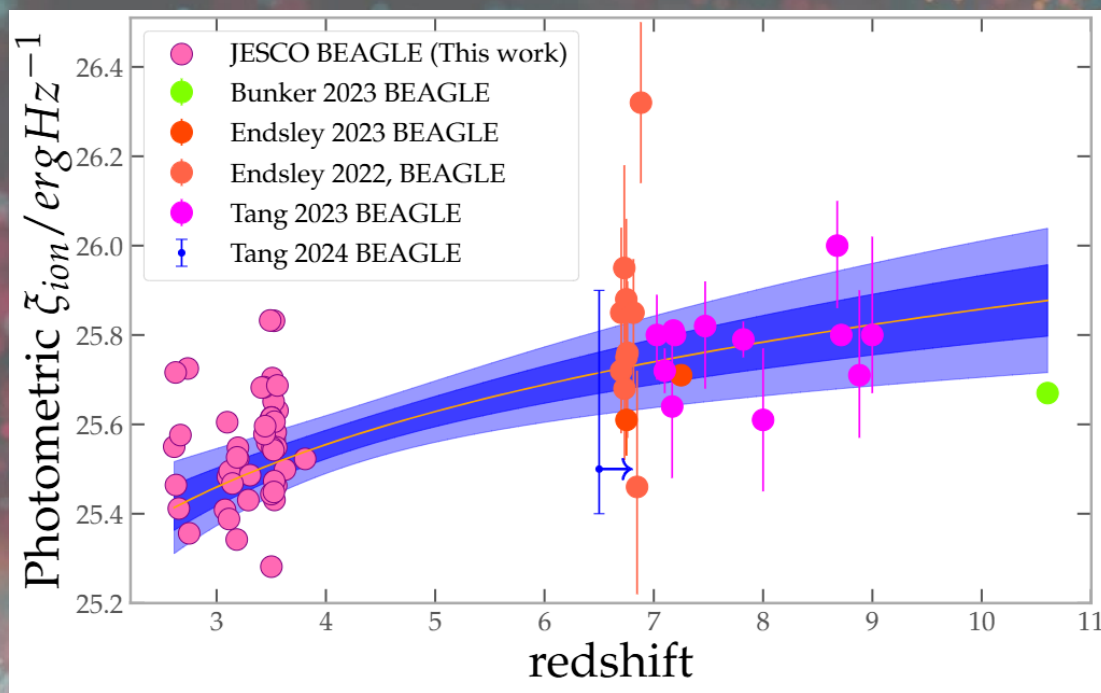


Salim 2020

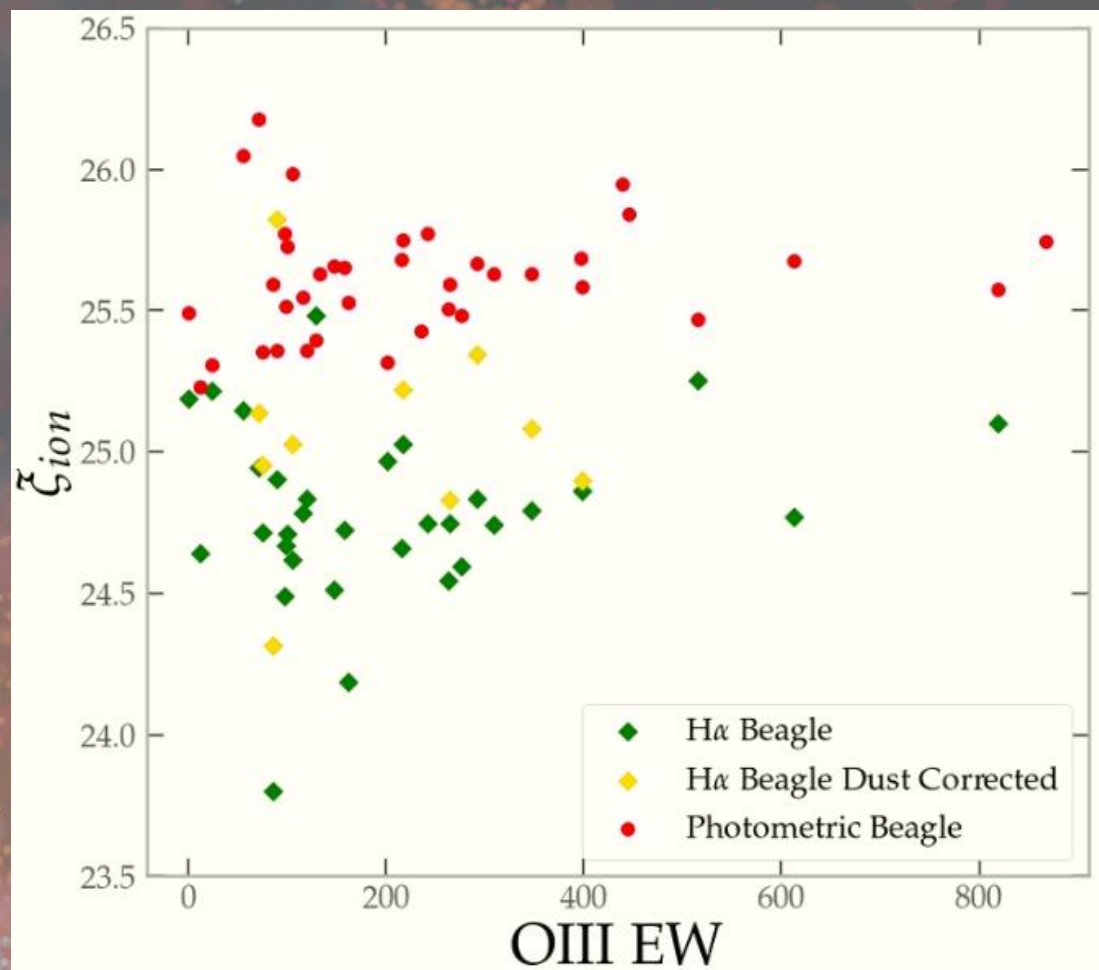
Dust Model



Redshift Evolution

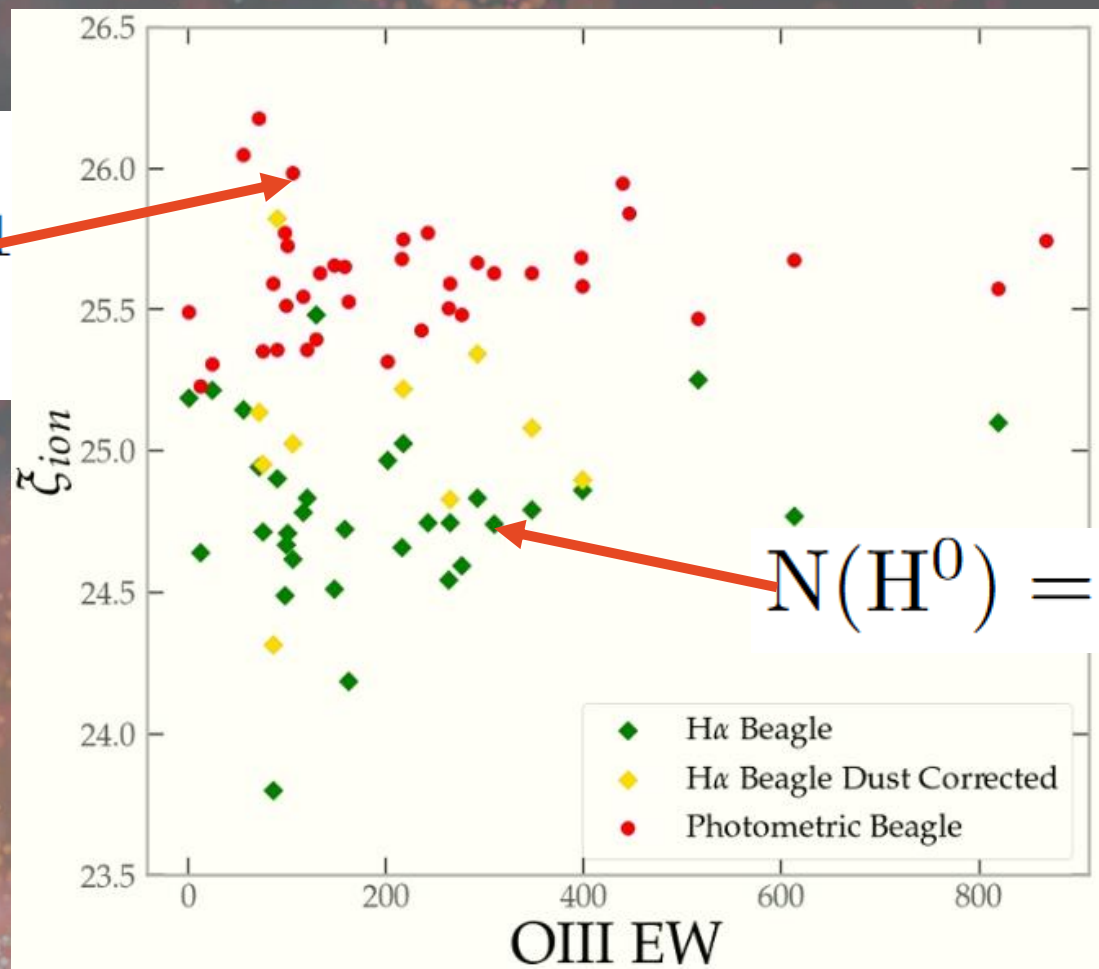


Other Factors



Other Factors

$$\int_{c/-\infty}^{c/912\text{\AA}} L_{\nu}(h\nu) d\nu$$



$$N(H^0) = 7.28 \times 10^{11} L(H\alpha)$$

On the Model Dependence of the ionizing photon production efficiency

What are we really measuring

Supplementary Slide

