Calculation of the Lyman-Continuum Photon Production Efficiency ξ_{ion} of z ~ 3.8—4.7 Galaxies Based on the IRAC Hα fluxes

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- Data
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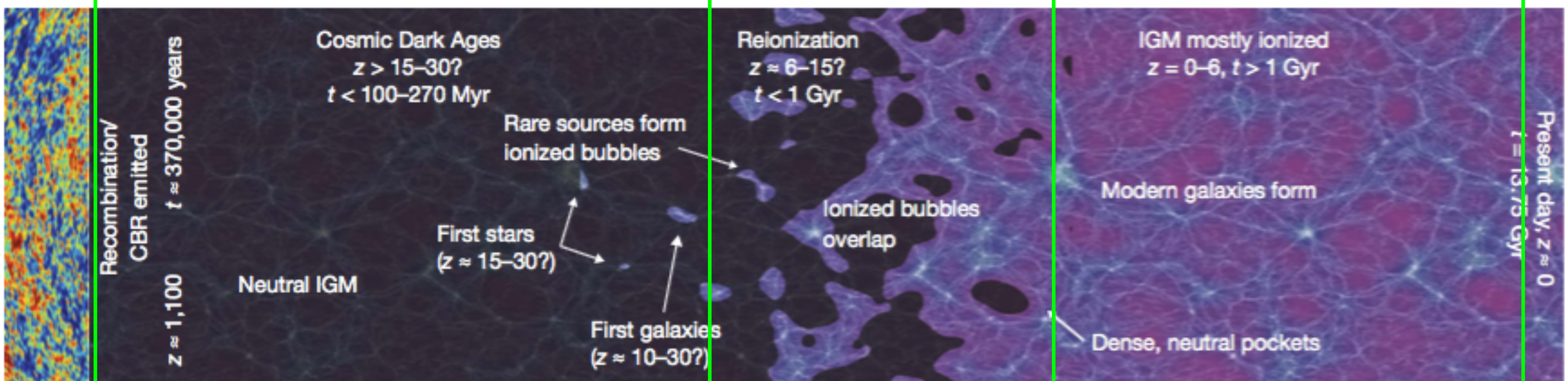
Introduction

Ionized



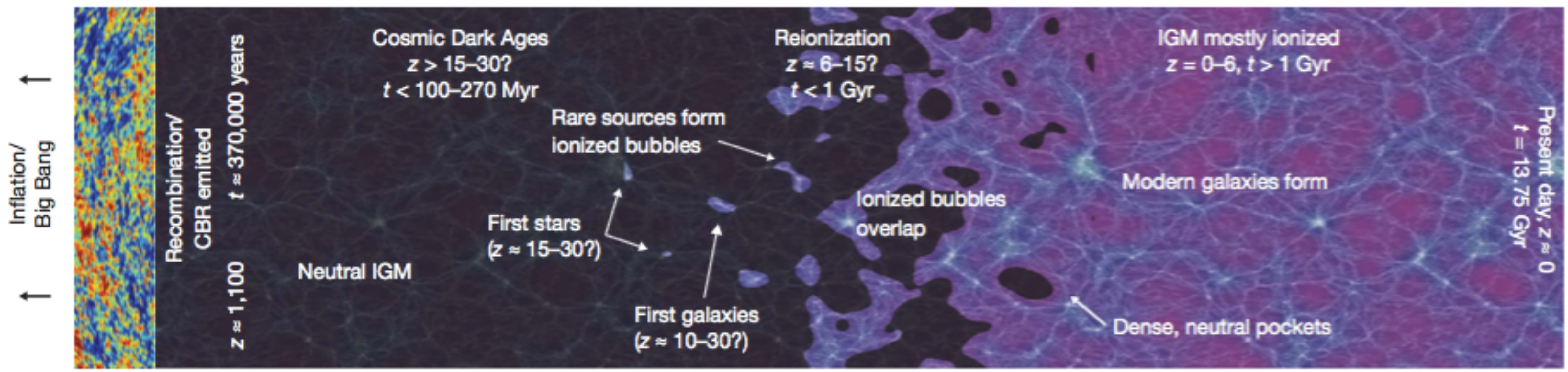
Robertson+ 2010

Neutral IGM

Ionized IGM

Cosmic Reionization

Introduction



Robertson+ 2010

- What is the source of cosmic reionization?
  - Ionizing photons escaping from star-forming galaxies?

$$\dot{n}_{\rm ion} = \int_{-\infty}^{M_{\rm trunc}} f_{\rm esc}(M_{\rm UV})\xi_{\rm ion}(M_{\rm UV})\Phi(M_{\rm UV})L(M_{\rm UV})dM_{\rm UV}$$

generated ionizing photons

escaping ionizing photons

Introduction

- What is ionizing photons production efficiency (ξ_{ion})?

production rate of ionizing photons [s^{-1}]

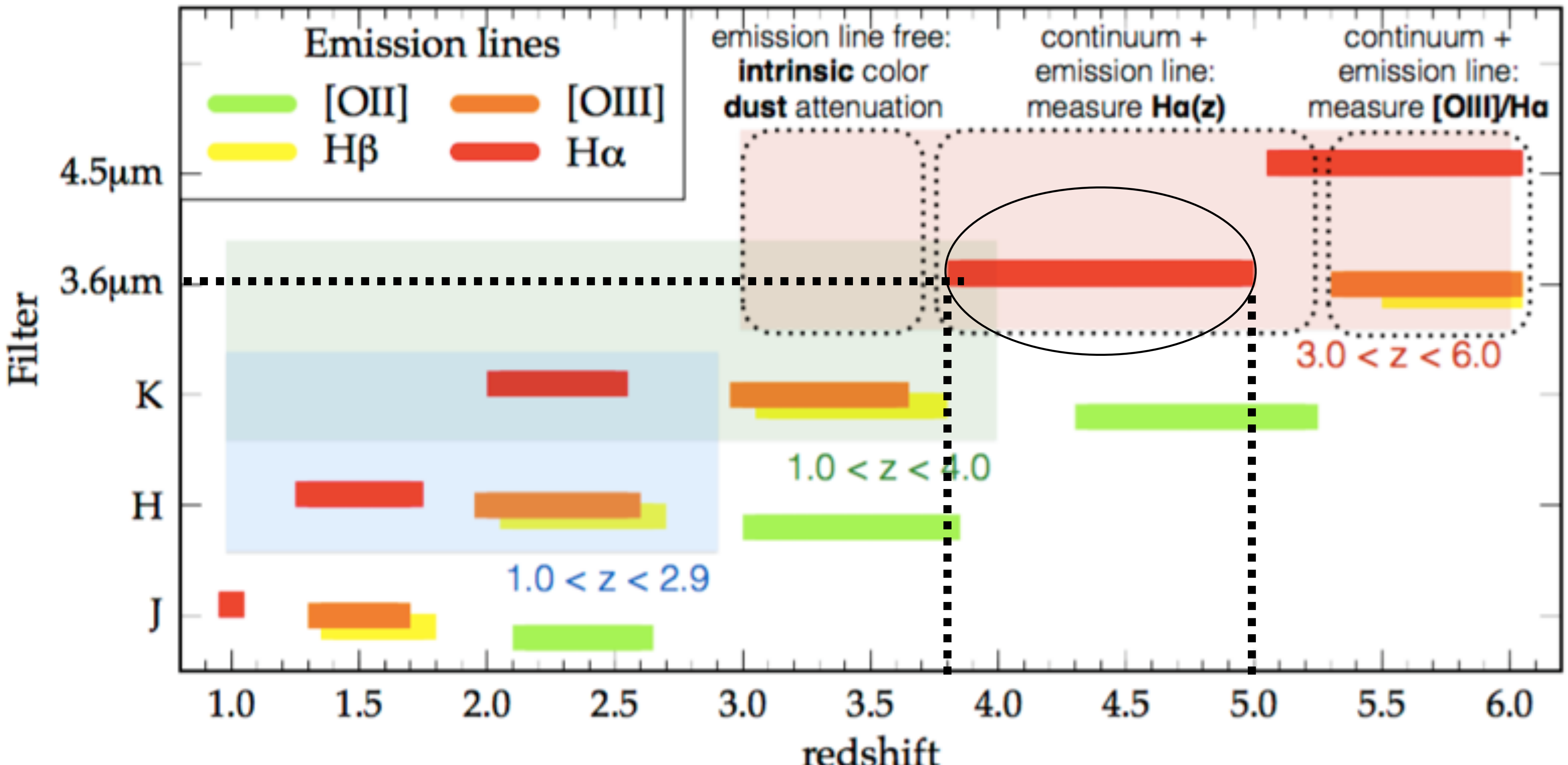
$$N(H^0)[s^{-1}] = \frac{L(H\alpha)[erg\ s^{-1}]}{1.36 \times 10^{-12}}$$

Leitherer & Heckman 1995

$$\xi_{ion,0} = \frac{N(H^0)}{L_{UV}^{corr}}[erg^{-1}Hz]$$

UV continuum luminosity [$erg\ s^{-1}\ Hz^{-1}$]

Introduction



Faisst+ 2016

Data

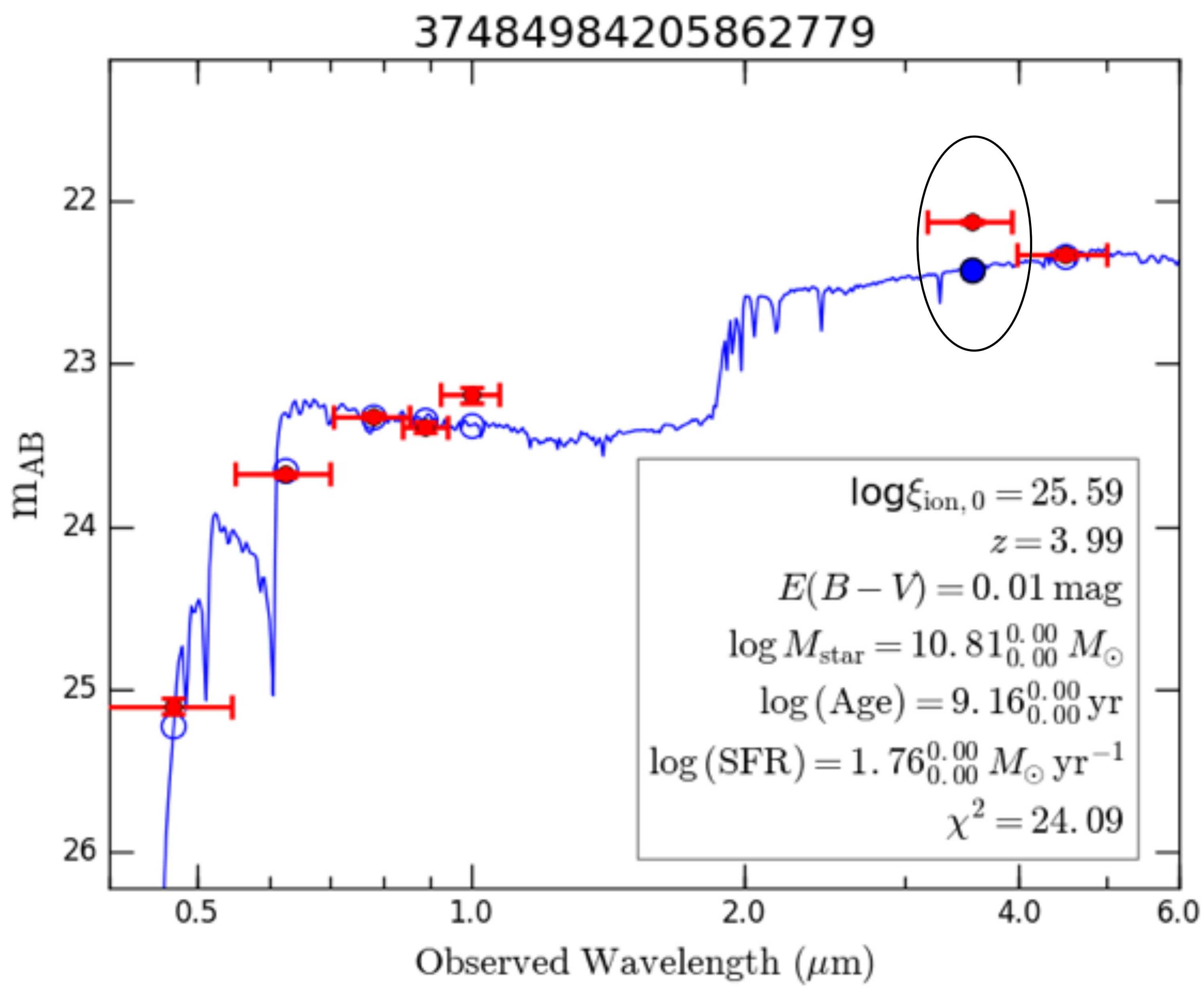
- GOLDRUSH (Great Optically Luminous Dropout Research Using Subaru HSC) Catalog (Ono+ 2017): 259 spectroscopically-confirmed LBGs.
- SPLASH (Spitzer Large Area Survey with HSC) data (PI: P. Capak) covering COSMOS and SXDS fields.
- Subaru/HSC: *g*, *r*, *i*, *z*, *Y*; and *Spitzer*/IRAC: Ch1, Ch2
- z=3.8—5.0 , $(m_{\mathrm{ch1}}, m_{\mathrm{ch2}}) < m_{3\sigma}$
- 56 SFGs with positive Hα flux.

Method

- SED fitting without nebular components and excluding the *Spitzer*/IRAC Ch1 magnitude data.
- Hα fluxes are calculated by using the difference in the observed magnitude in Channel 1 and the model magnitude from SED fitting.

Method

- SED fitting without nebular components and excluding the *Spitzer/*
- H*α* fluxes a
  observed m
  magnitude



Method

- The Hα fluxes and UV continuum luminosities are corrected by Calzetti extinction law (Calzetti+ 2000) and Meurer relation (Meurer+ 1999): $A_{UV} = 1.99(\beta + 2.23)$, assuming that the nebular extinction is same as the stellar extinction.

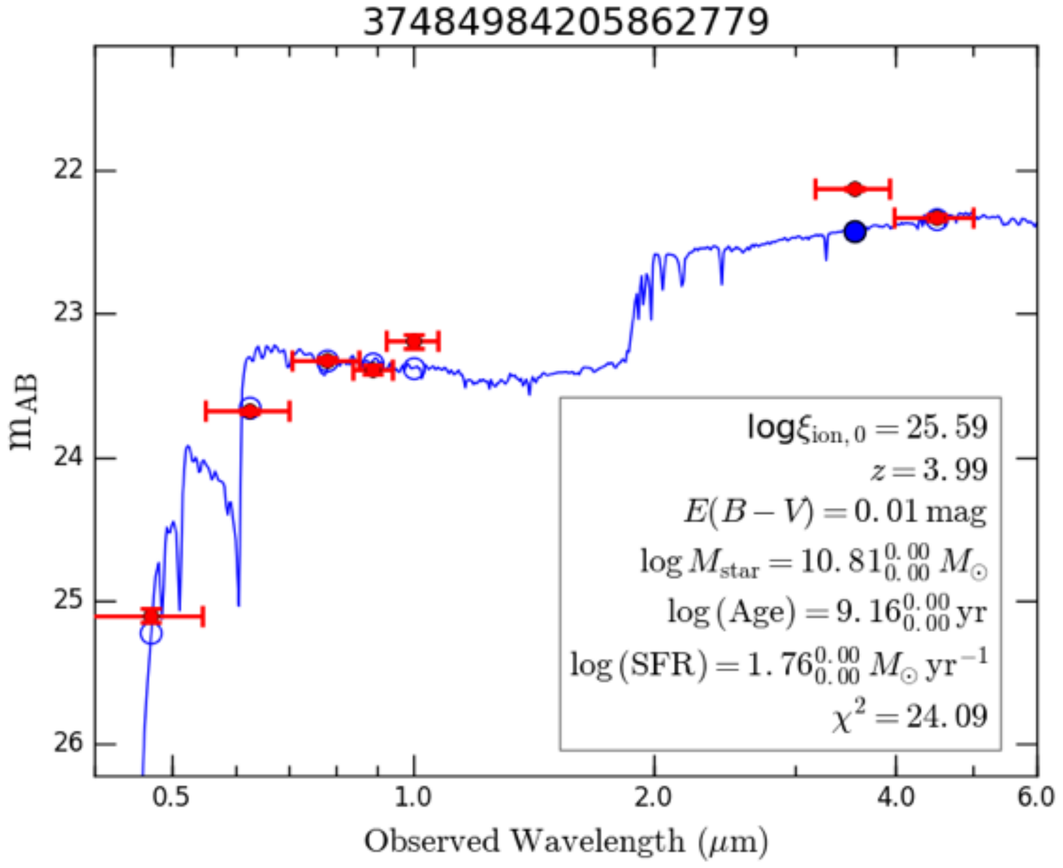
- UV-continuum slope, β calculated from ($f_\lambda \propto \lambda^\beta$):

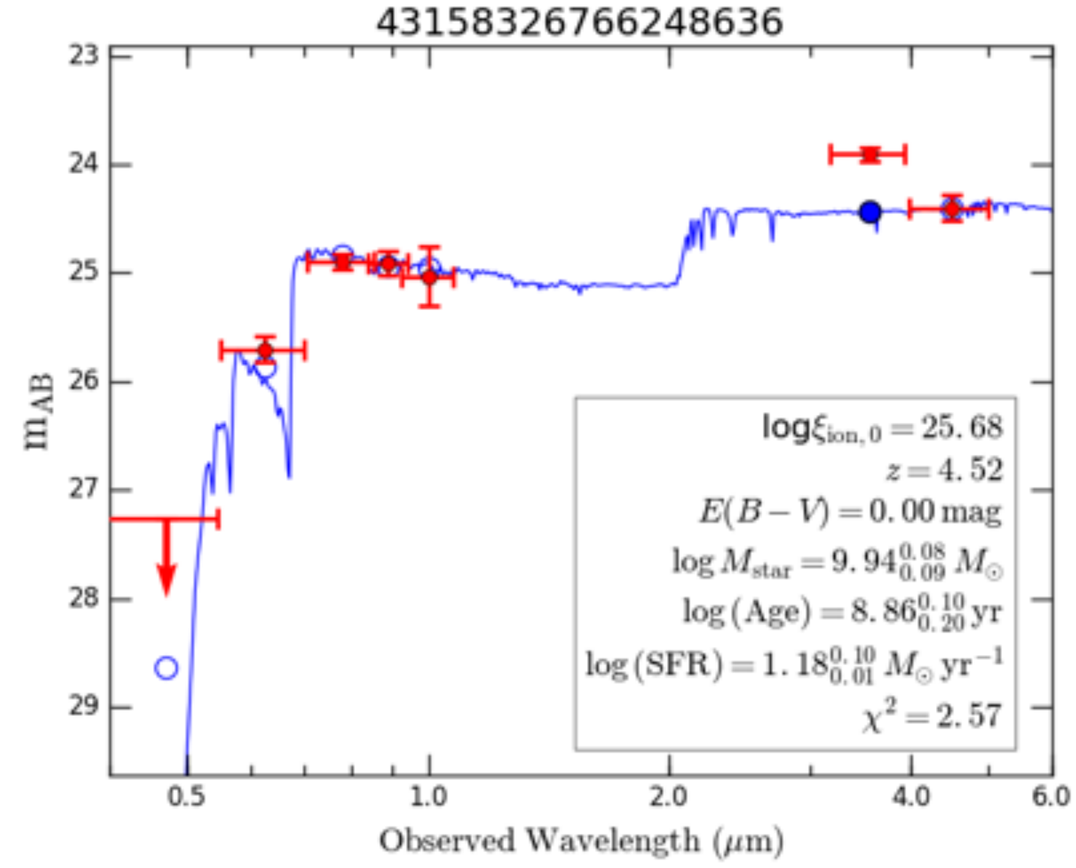
$$\beta = -\frac{m_1 - m_2}{2.5\log(\lambda_c^1 / \lambda_c^2)} - 2$$

- log ξ_{ion} calculated from:

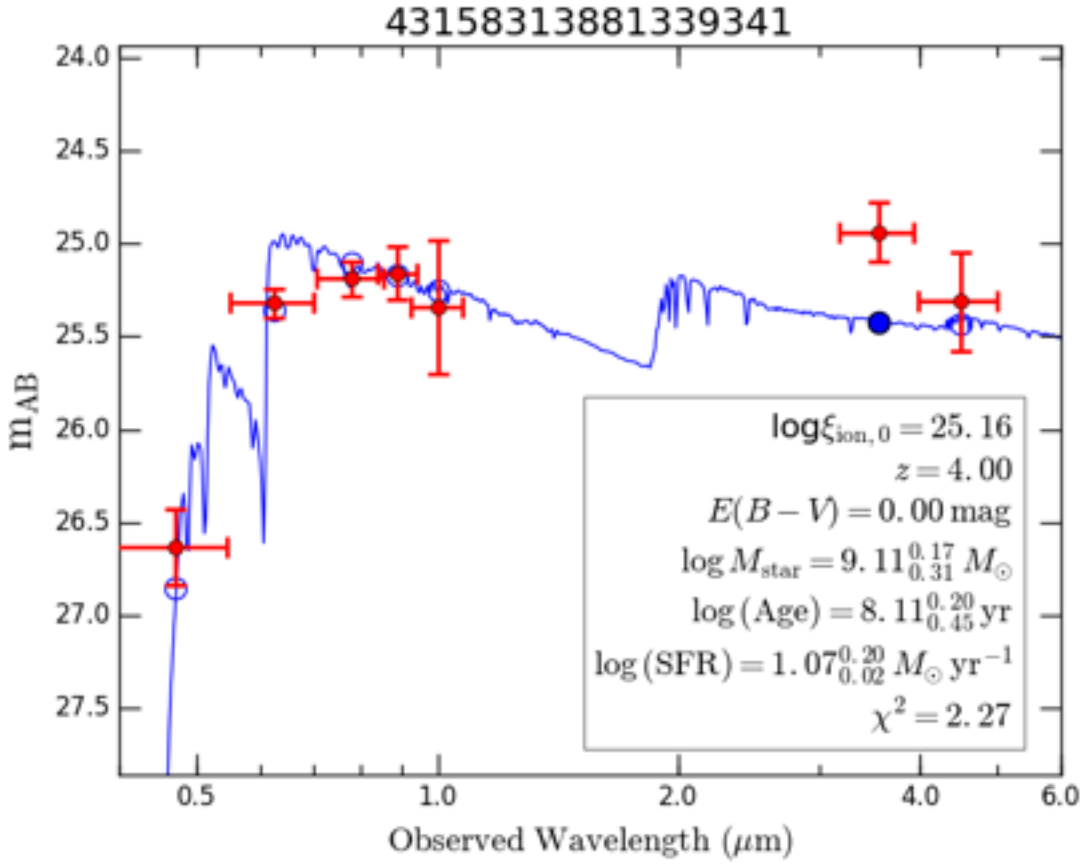
$$\xi_{ion,0} = \frac{N(H^0)}{L_{UV}^{corr}} \qquad N(H^0)[s^{-1}] = \frac{L(H\alpha)[erg\ s^{-1}]}{1.36 \times 10^{-12}}$$

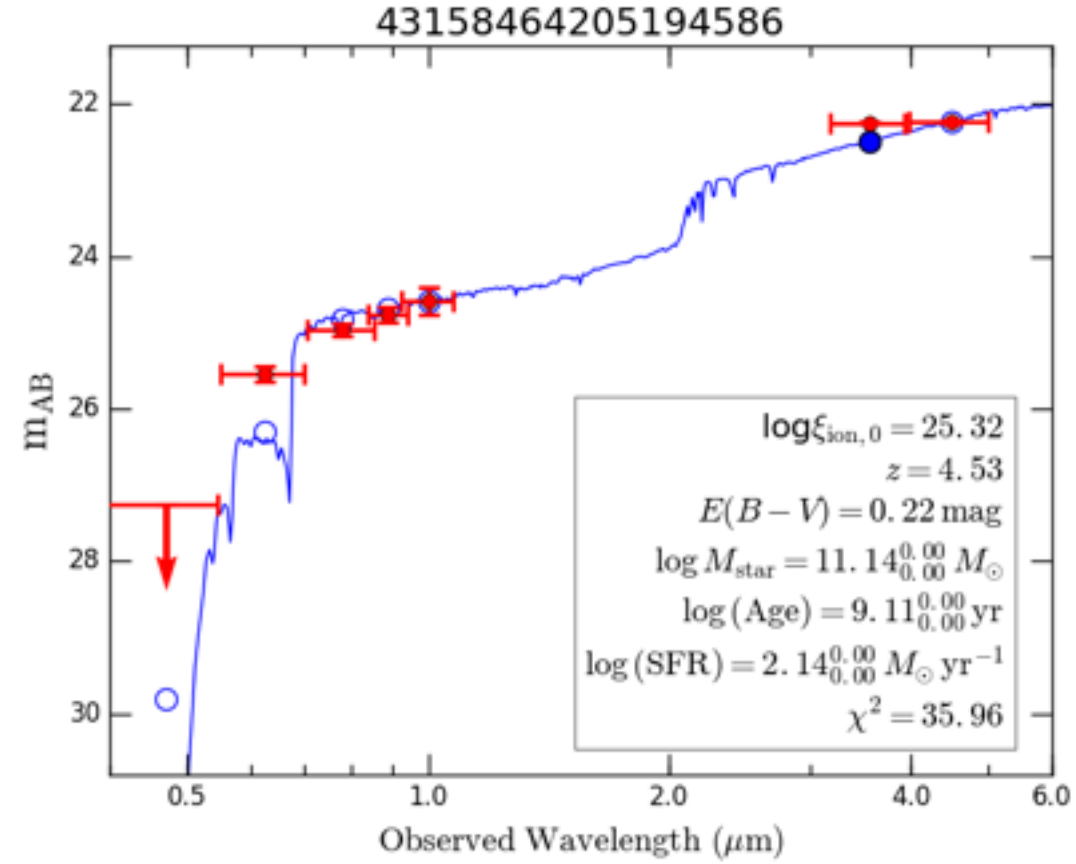
Result (SED fitting)



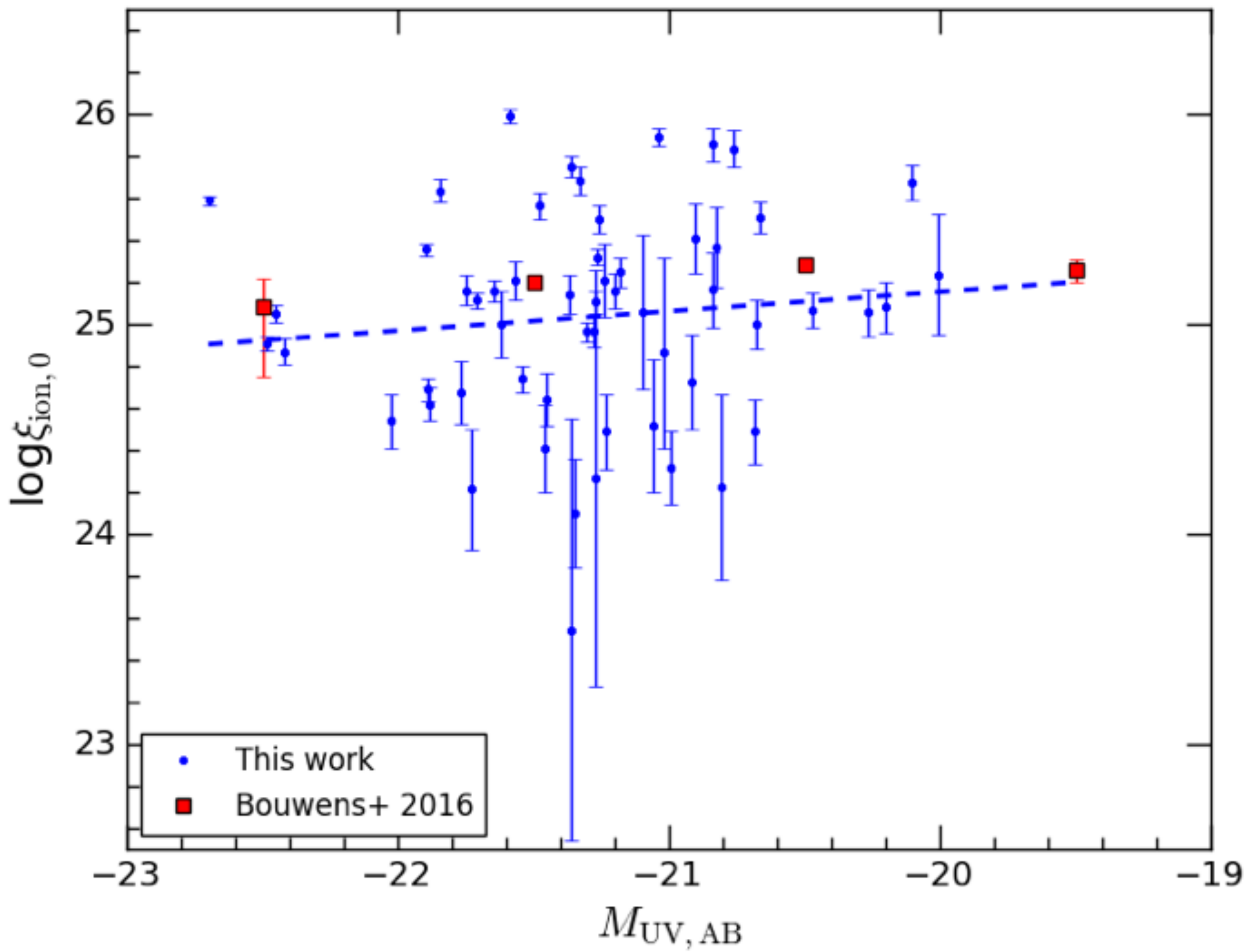


Result (SED fitting)

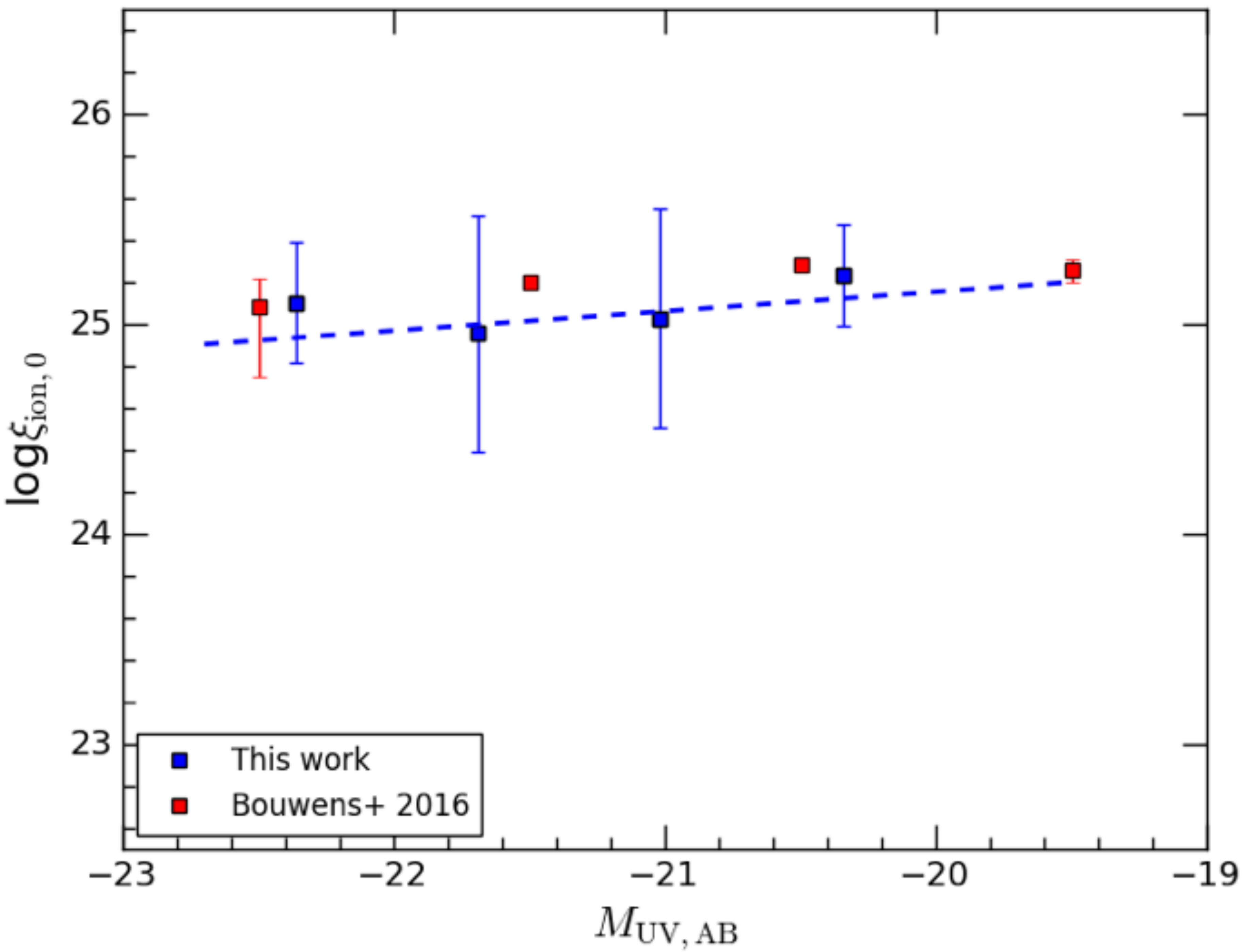




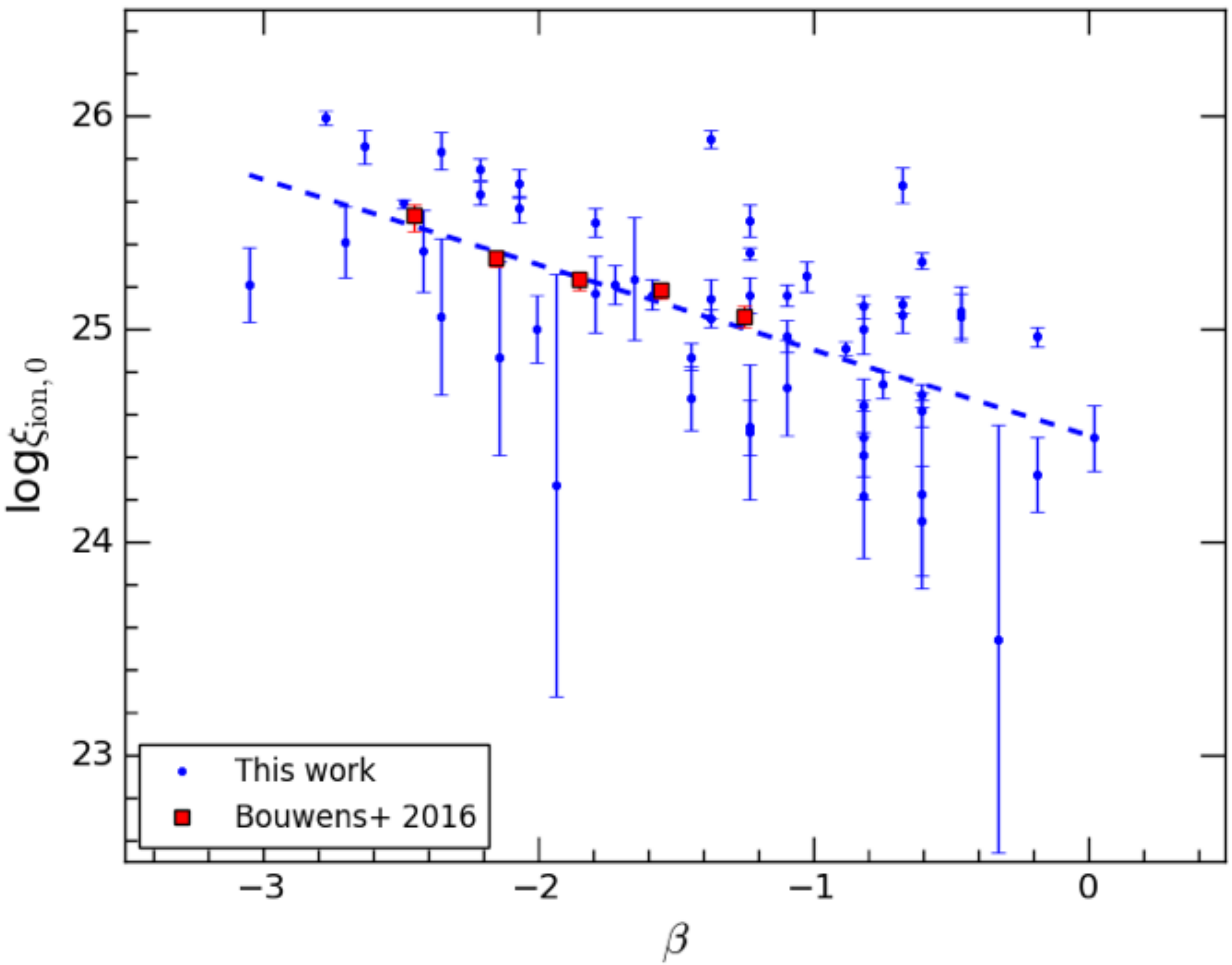
Result (M_{UV} vs log ξ_{ion})



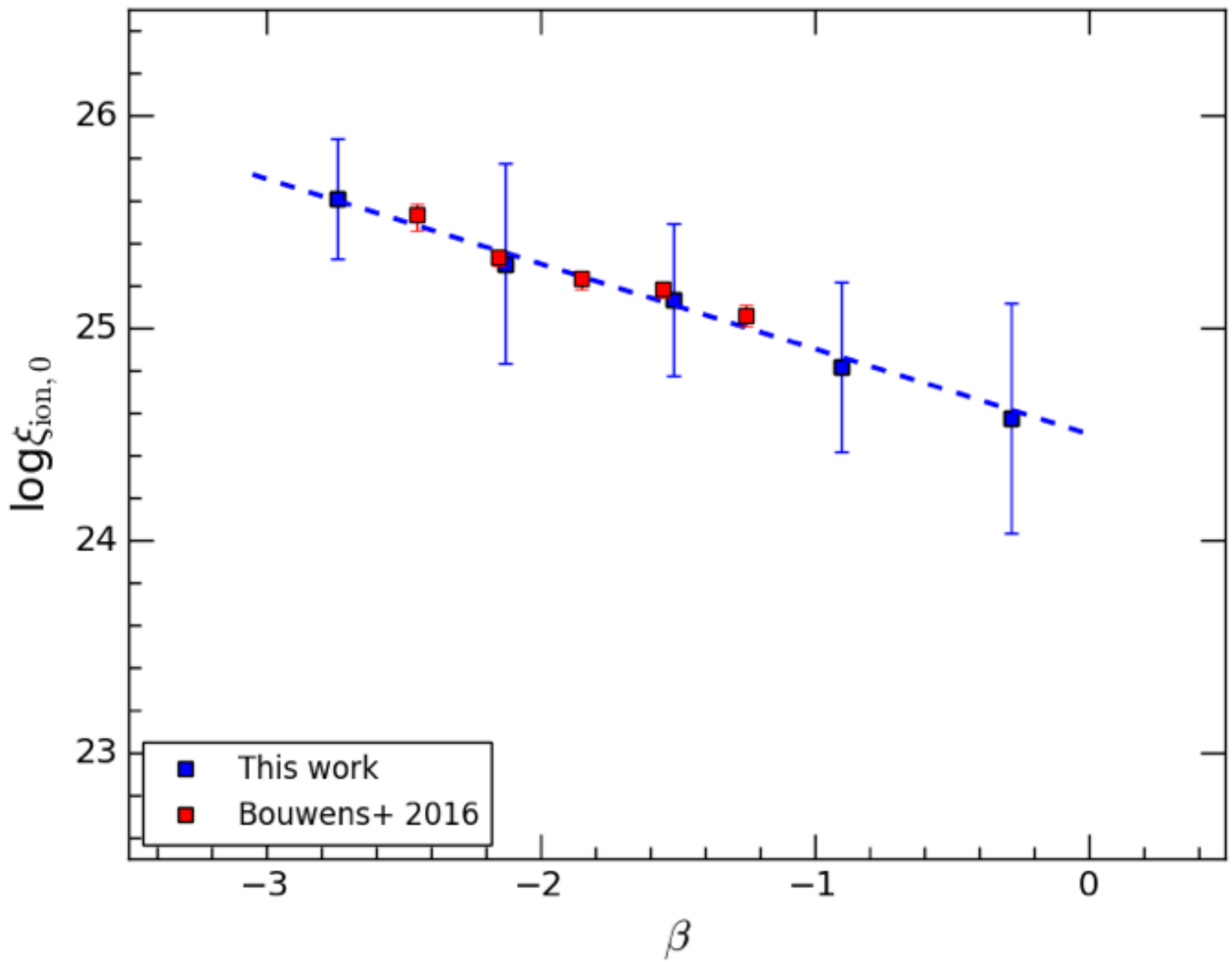
Result (M_{UV} vs log ξ_{ion})



Result (β vs log ξ_{ion})



Result (β vs log $\xi_{\rm ion}$)



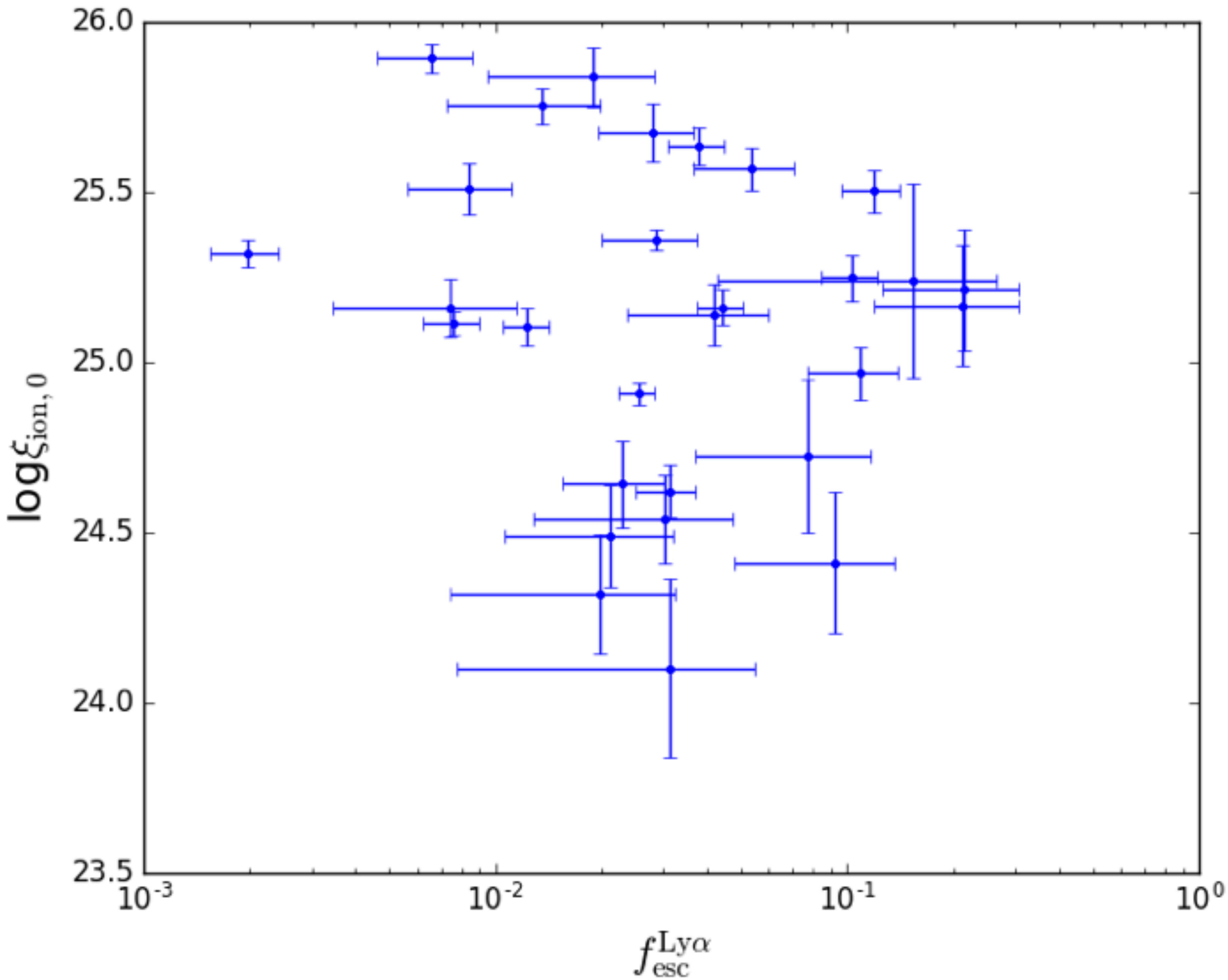
Result (Lyman Alpha Escape Fraction, $f^{Ly\alpha}_{esc}$)

- We also have the information of Lyman Alpha fluxes from the Mallery+ 2012

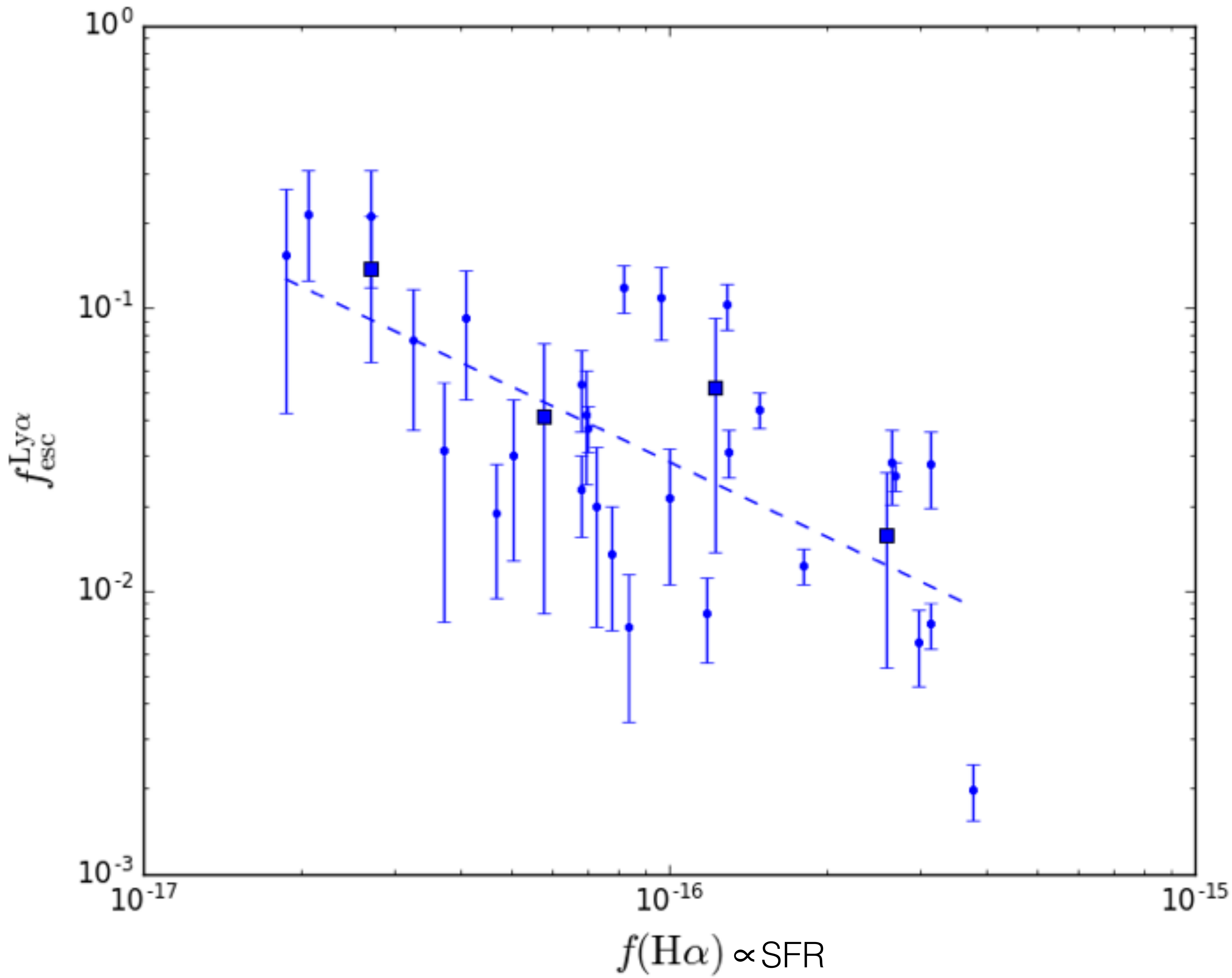
- We derive the Lyman Alpha escape fraction from:

$$f^{\mathrm{Ly}\alpha}_{\mathrm{esc}} \equiv \frac{L_{\mathrm{obs}}(\mathrm{Ly}\alpha)}{L_{\mathrm{int}}(\mathrm{Ly}\alpha)} = \frac{L_{\mathrm{obs}}(\mathrm{Ly}\alpha)}{8.7L_{\mathrm{int}}(\mathrm{H}\alpha)}$$

Result ($f^{Ly\alpha}_{esc}$ vs ξ_{ion})



Result (f(Hα) vs $f^{Ly\alpha}{}_{esc}$)



Summary

- We derive the Lyman-Continuum photon production efficiency ξ_{ion} using the Hα fluxes derived from the *Spitzer*/IRAC data. Our results are consistent with the previous work.

- We find an anti-correlation between β and ξ_{ion}. (bluer —> more ionizing photons) as predicted by Bouwens+ 2015

- No correlation between ξ_{ion} and $f^{Ly\alpha}_{esc}$, but anti-correlation between Hα fluxes and $f^{Ly\alpha}_{esc}$.