MOSDEF Survey: The Main Sequence at z ~ 2

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Investigating Hα, UV, and IR SFRs at z ~ 2

INVESTIGATING Hα, UV, AND IR STAR-FORMATION RATE DIAGNOSTICS FOR A LARGE SAMPLE OF $z \sim 2$ GALAXIES

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ABSTRACT

We use a sample of 262 spectroscopically confirmed star-forming galaxies at redshifts $2.08 \leq z \leq 2.51$ to compare Hα, UV, and IR star-formation-rate diagnostics and to investigate the dust properties of the galaxies. At these redshifts, the Hα line shifts to the K_s-band. By comparing K_s-band photometry to underlying stellar population model fits to other UV, optical, and near-infrared data, we infer the Hα flux for each galaxy. We obtain the best agreement between Hα- and UV-based SFRs if we assume that the ionized gas and stellar continuum are reddened by the same value and that the Calzetti attenuation curve is applied to both. Aided with MIPS 24 μm data, we find that an attenuation curve steeper than the Calzetti curve is needed to reproduce the observed IR/UV ratios of galaxies younger than 100 Myr. Furthermore, using the bolometric star-formation rate inferred from the UV and mid-IR data ($SFR_{IR}+SFR_{UV}$), we calculated the conversion between the Hα luminosity and SFR to be $(7.5 \pm 1.3) \times 10^{-42}$ for a Salpeter IMF, which is consistent with the Kennicutt (1998) conversion. The derived conversion factor is independent of any assumption of the dust correction and is robust to stellar population model uncertainties.

Subject headings: galaxies: evolution — galaxies: high-redshift – galaxies: star formation

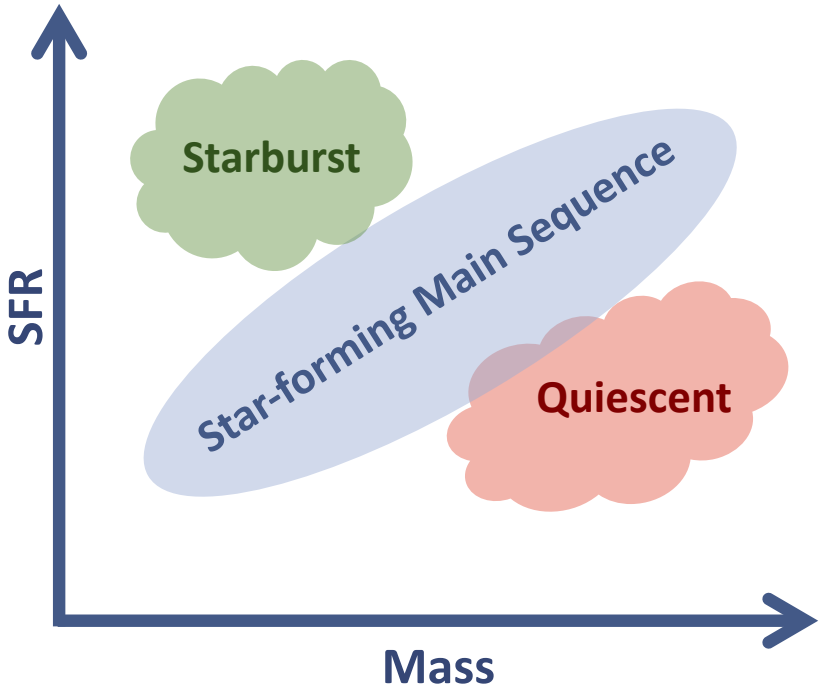
MOSDEF* Survey

* MOSFIRE Deep Evolution Field

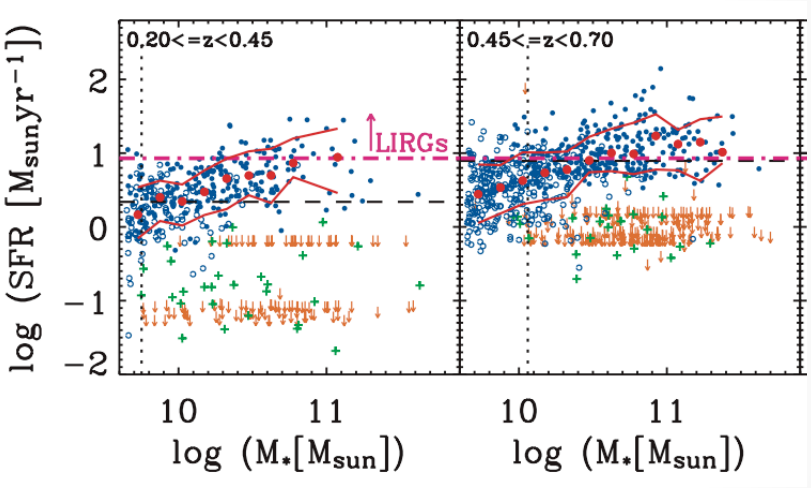
- Rest-frame optical spectra of ~ 1500 H-selected galaxies and AGNs to study the stellar, gaseous, metal, dust, and black hole content of these galaxies *(Kriek +2014)*
- $1.37 \leq z \leq 3.80$
- 47 nights in 4 years (24 by now)
- In three legacy fields containing extensive multi-wavelength datasets: COSMOS, GOODS-N, AEGIS

** Co-PIs: Alison Coil, Mariska Kriek, Bahram Mobasher, Naveen Reddy, Brian Siana, Alice Shapley*

The Star-Forming Main Sequence



Noeske +2007

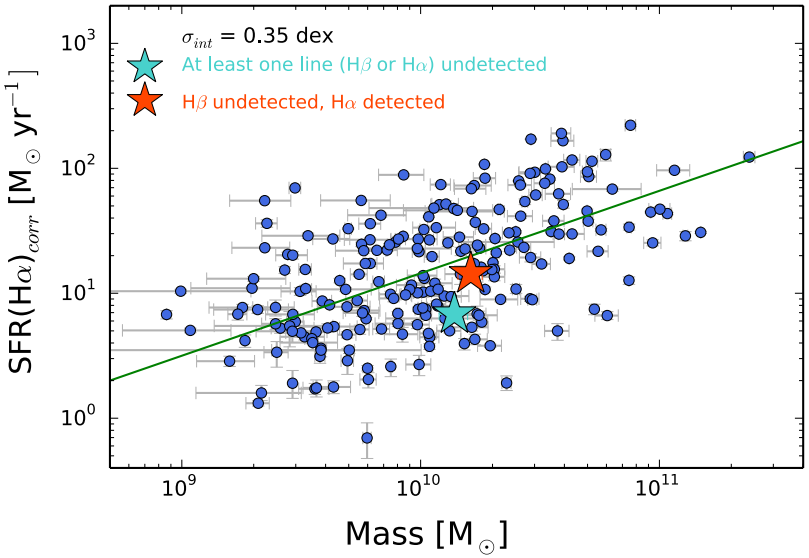


Sample and Measurements

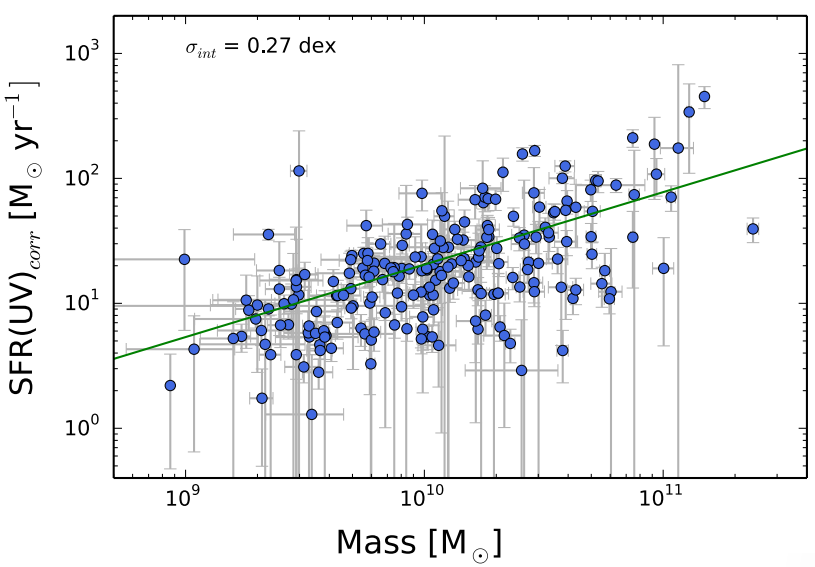
- Low and Middle redshift bins: $1.4 < z < 1.7$ and $2.1 < z < 2.6$
- AGNs are removed (Coil +2015)
- Quiescent galaxies are removed (UVJ criteria)
- Masses from SED models
  - Photometry is corrected for emission-line contributions
- SFRs from Balmer lines:
  - Absorption corrected
  - Dust corrected using Cardelli Galactic extinction curve
  - The sample is limited to those with Hα detection
    - 268 objects (52 undetected in Hβ)
- SFRs from UV:
  - Luminosity at 1600 A and UV slope inferred from the broad-band photometry

The Scatter

σ_{int} = 0.35 dex

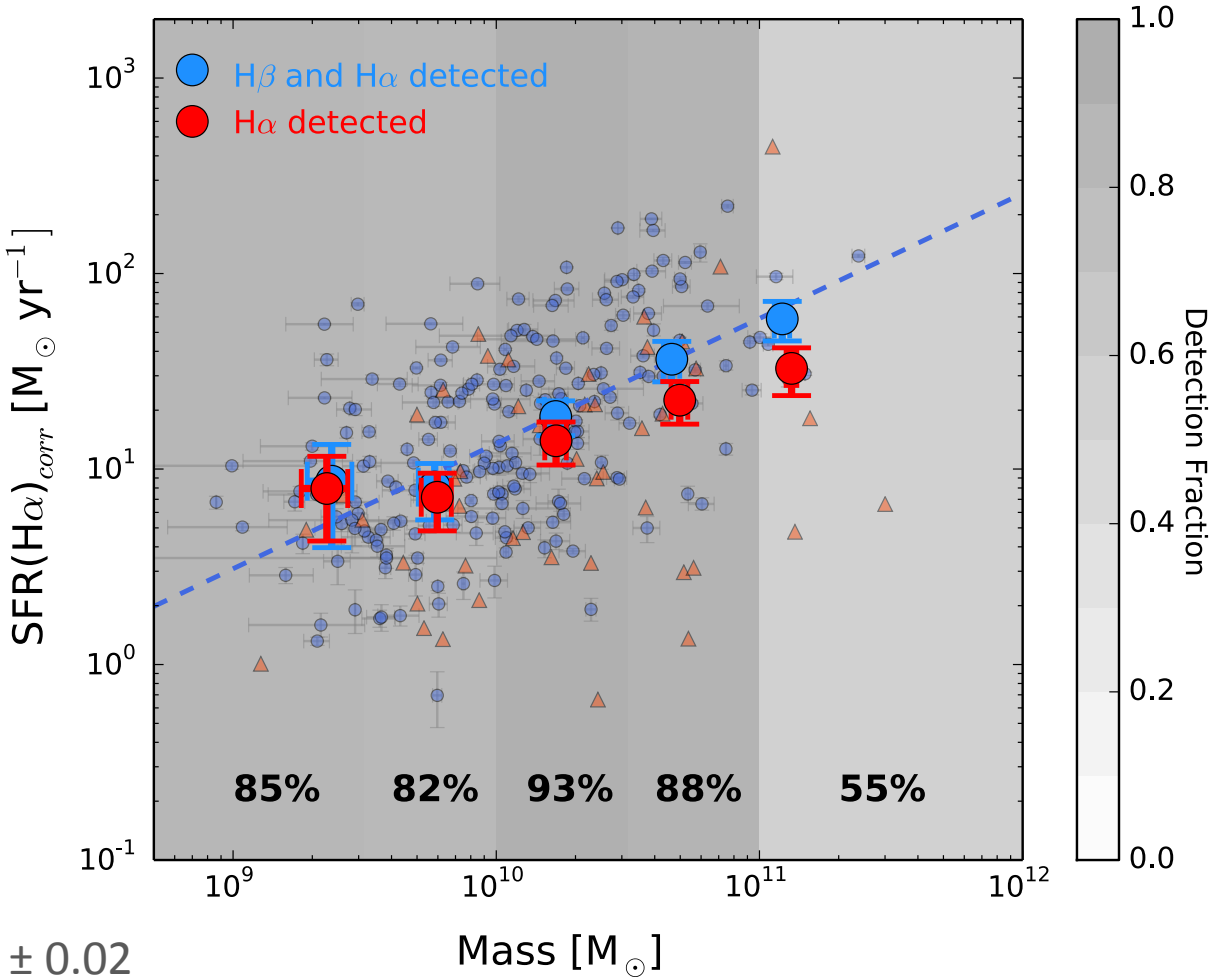


σ_{int} = 0.27 dex



SFR Indicator	Observed Scatter	Intrinsic Scatter
Hα[a]	0.36	0.35
UV$_\beta$[b]	0.30	0.27
SED[d]	0.25	0.24
UV$_{SED}$[c]	0.24	0.19

The Slope



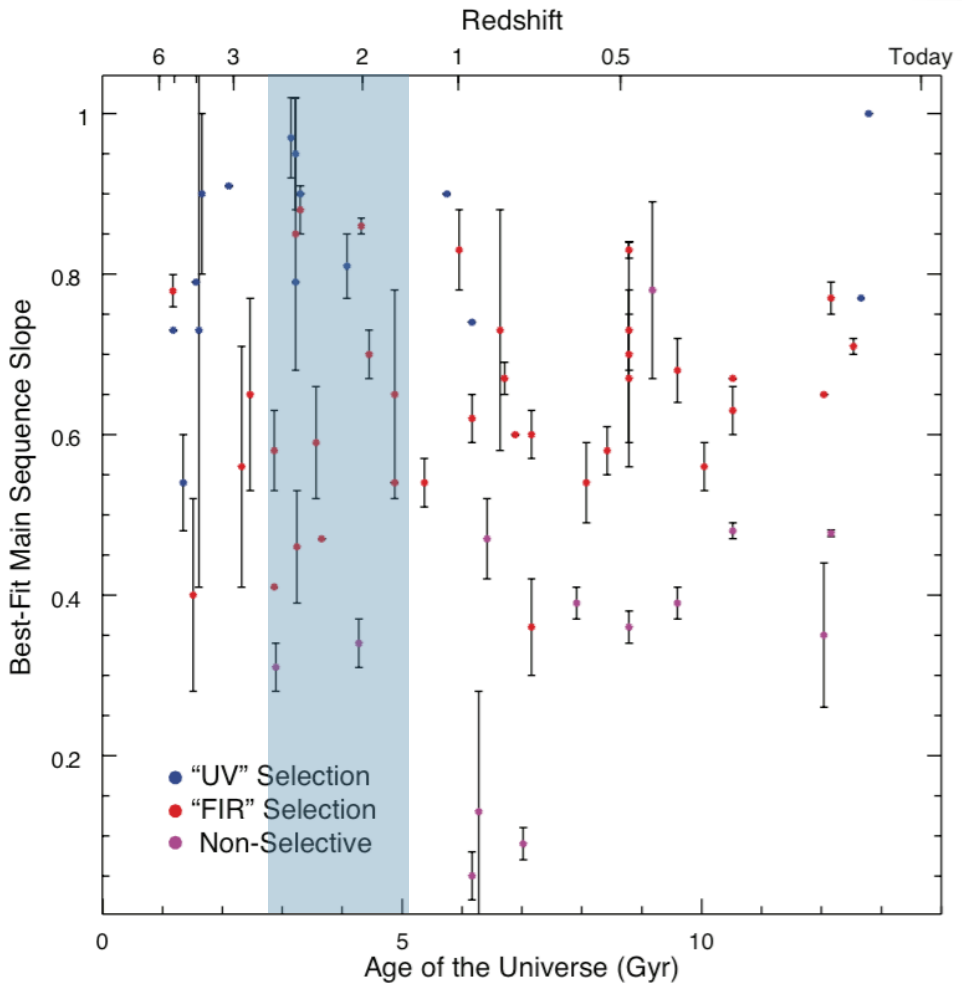
α = 0.64 ± 0.02

β = -5.27 ± 0.23

Slope _ Biases

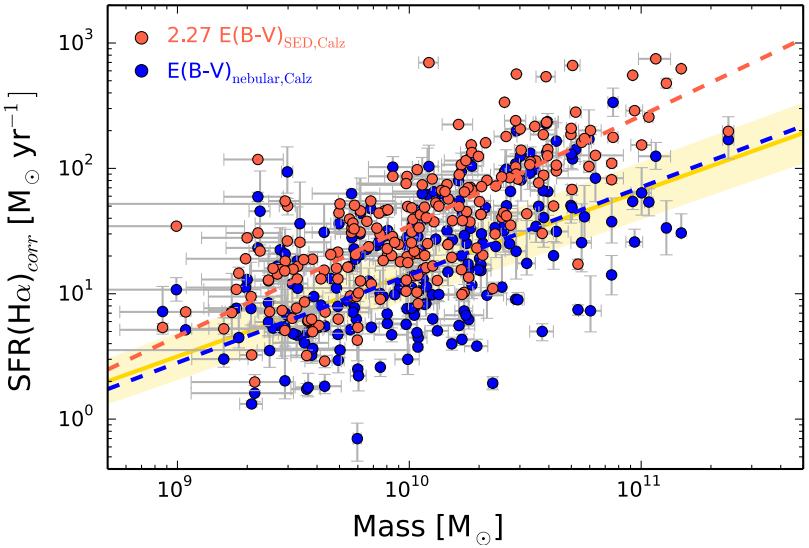
- Discrepancy in the literature:
  $\alpha \sim 0.3 - 1.0$

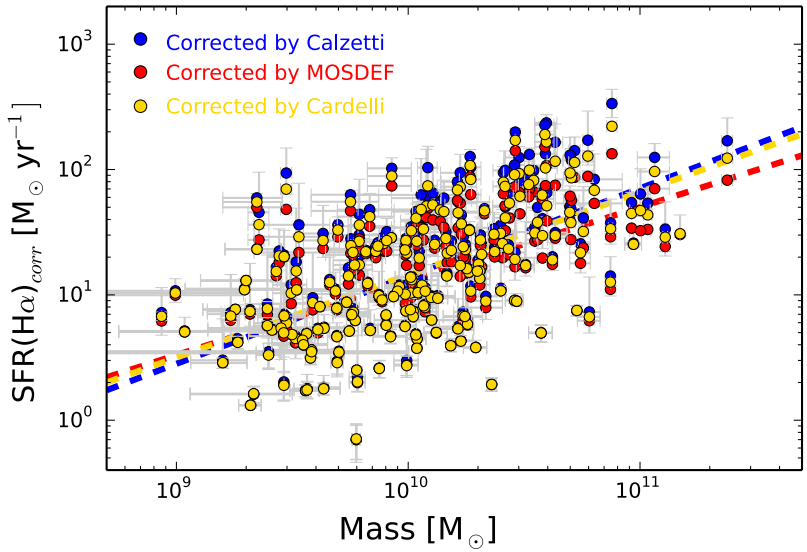
- Dust Correction
- Sample Selection
- Absorption Correction



Speagle +2014

Slope _ Dust Correction





2.27 E(B-V) $\kappa_{Calzetti}$ yields a slope of $\alpha = 0.88 \pm 0.06$

Three curves:

The Calzetti (Calzetti +2000)

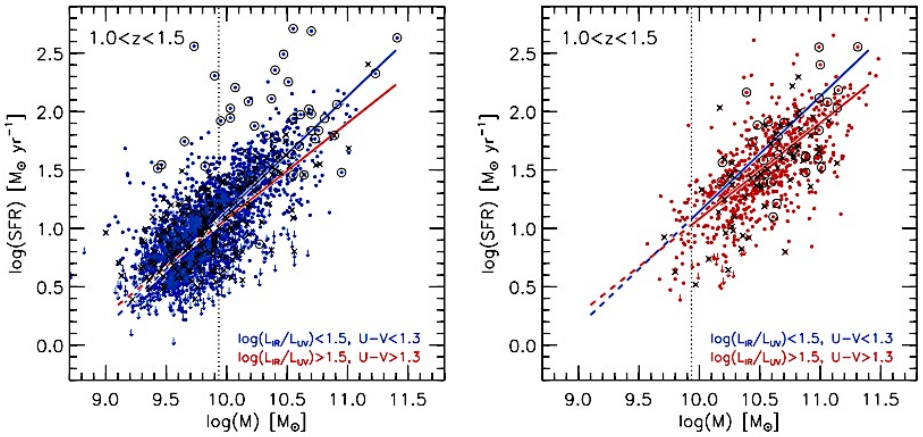
The Cardelli (Cardelli +1989)

The MOSDEF (Reddy +2015, submitted)

All result in consistent slopes

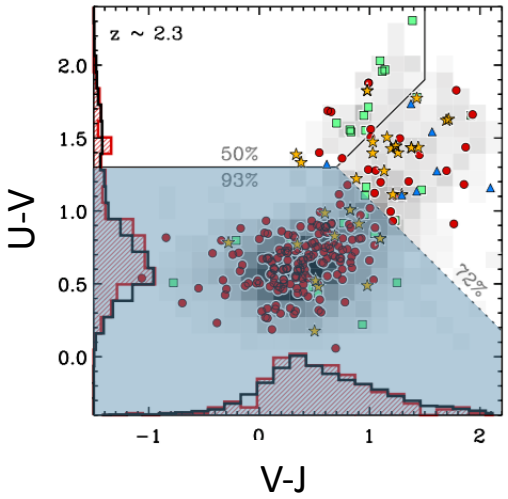
Slope _ Sample Biases

Whitaker +2012



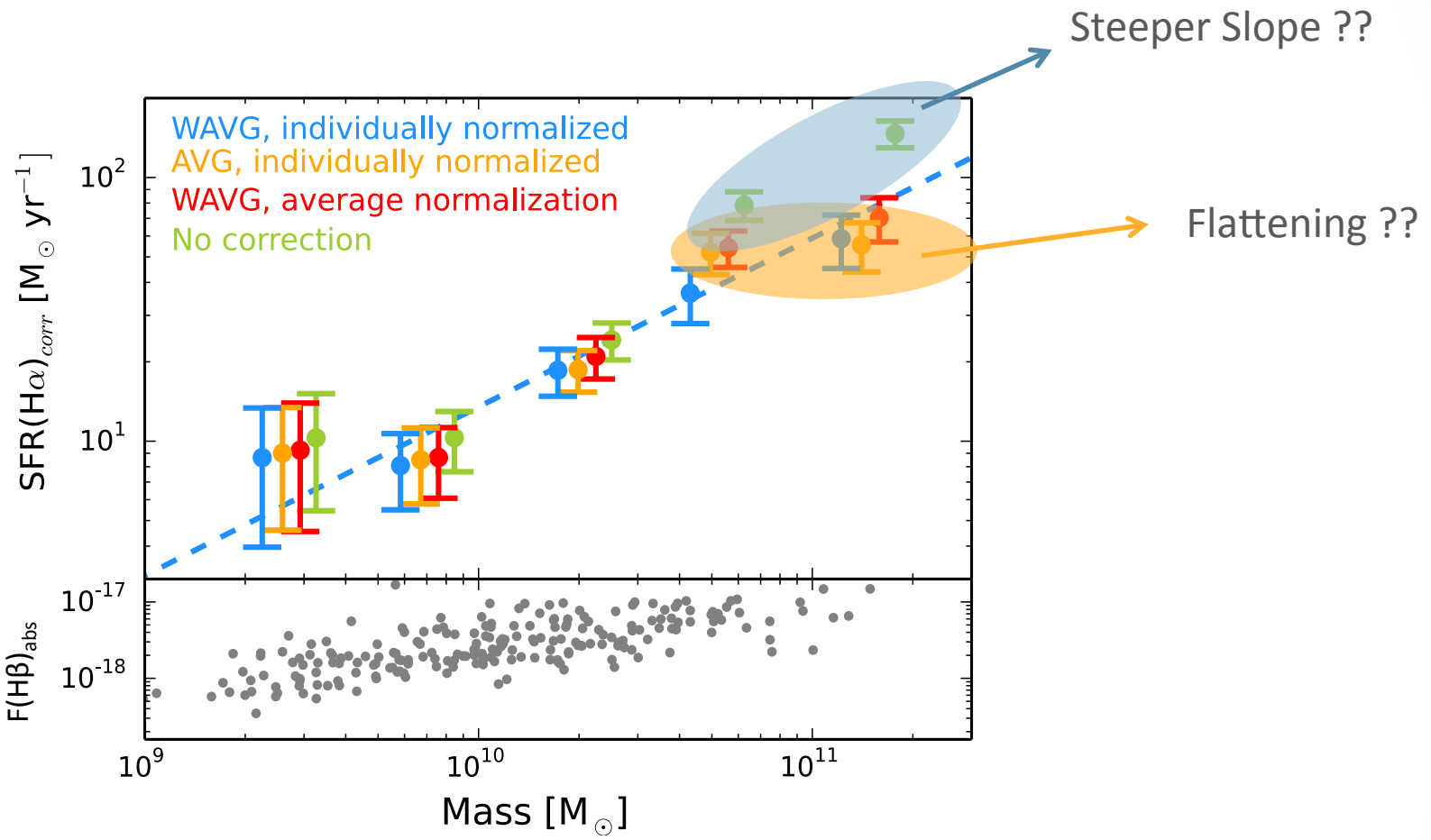
Star-formation selected samples (e.g., sBzK and Lyman-Break) are biased against dusty red *star-forming* galaxies (low sSFR), resulting in steeper slopes

Kriek +2014



Slope of the *blue* star-forming sample is $\alpha = 0.77 \pm 0.04$
($\alpha = 0.64 \pm 0.02$ for the whole sample)

Slope _ Absorption Correction



Summary

- As part of the MOSDEF survey, we used a large sample of 265 galaxies with nebular redshifts and Hα and Hβ observations. SFR(Hα) dust corrected with the Balmer decrement is an instantaneous tracer of star formation, which helps to better evaluate the main sequence relation

- The scatter of the main sequence is ~ 0.1 dex larger for SFR(Hα) compared to SFR(UV), mainly caused by
  - SFR(Hα) traces star formation on shorter timescales
  - SFR(UV) depends on the stellar mass (through SED fitting)

- We found a slope of $\alpha = 0.64 \pm 0.02$. We demonstrate that the slope can be affected by
  - Sample biases
  - Dust correction
  - Balmer absorption correction

MOSDEF Survey: *mosdef.astro.berkeley.edu*