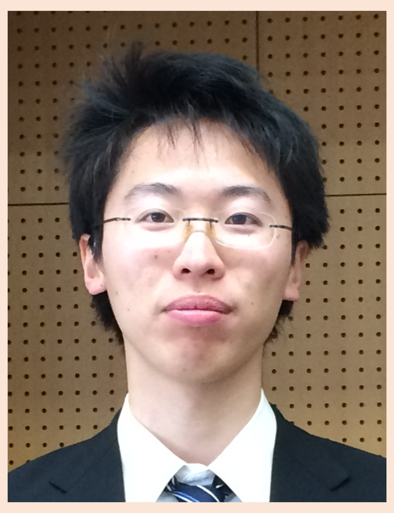
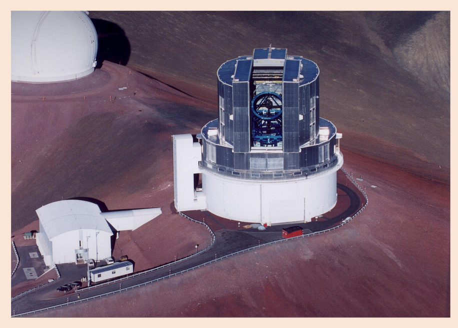


Top-heavy IMF in star-forming galaxies at z~1.4?



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Abstract

We tried to constrain the IMF slope in star-forming main sequence galaxies at z ~ 1.4. The sample was obtained with Fibre Multi-Object Spectrograph (FMOS) on the Subaru Telescope. We examined the HαEW against the rest $g - r$ color of the SF galaxies, and compared the distribution with the model evolutionary tracks from population synthesis code of PEGASE. We found that the Salpeter/Chabrier IMF cannot reproduce the observed distribution, but the top-heavy IMF can reproduce it well with a modest reddening, suggesting the slope of IMF at the epoch is flatter than that of the local universe. However, star bursts on continuous star formation with Saltpeter IMF or the same amount of extinction to the stellar continuum and the emission line can also reproduce the distribution.

1.Introduction

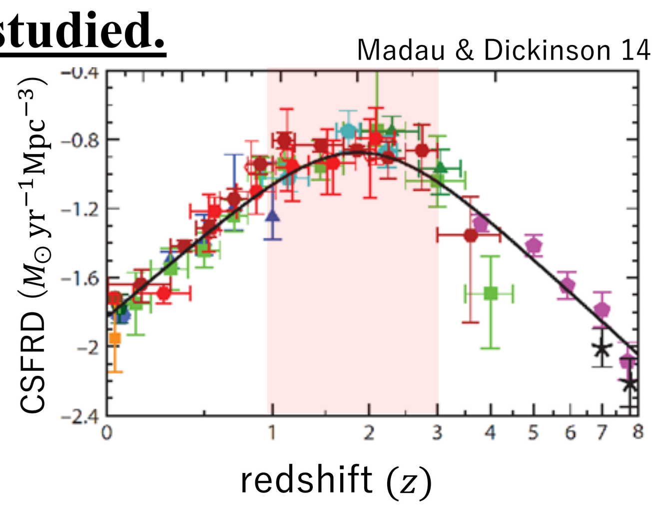
Initial Mass Function (IMF)

- The IMF plays an essential role in estimating star formation activity of galaxies.
- In the local universe, the IMF is usually believed to be Salpeter or Chabrier IMF (Γ ~ 1.35).
- **However, in high-z galaxies, IMF is not well studied.**

$$\frac{dN}{d\log m} \propto m^{-\Gamma}$$

Especially, the epoch of z = 1 − 3 is an important phase in the evolutionary history of galaxies, because the cosmic SFR density peaks at the epoch.

We investigate the IMF of SFGs at z ~ 1.4.



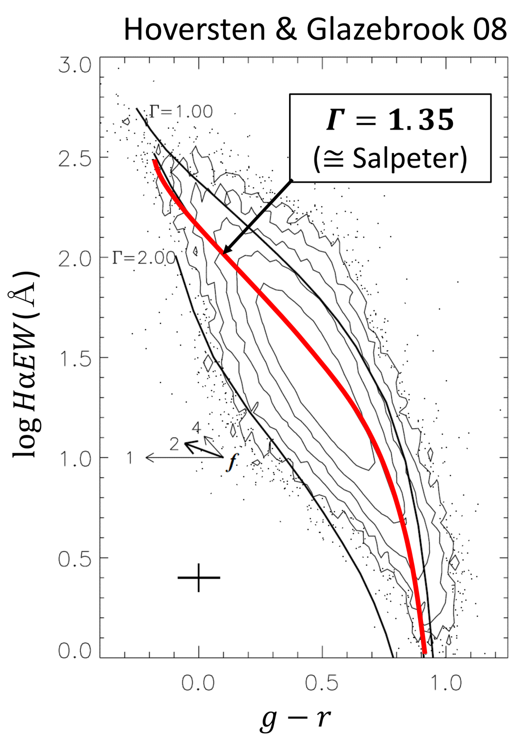
2.Method

The Hα equivalent width is sensitive to the IMF slope.

We constrain IMF slope by comparing evolutionary model to the observed distribution in the Hα equivalent width (EW) vs. $g - r$ plane.

Previous work

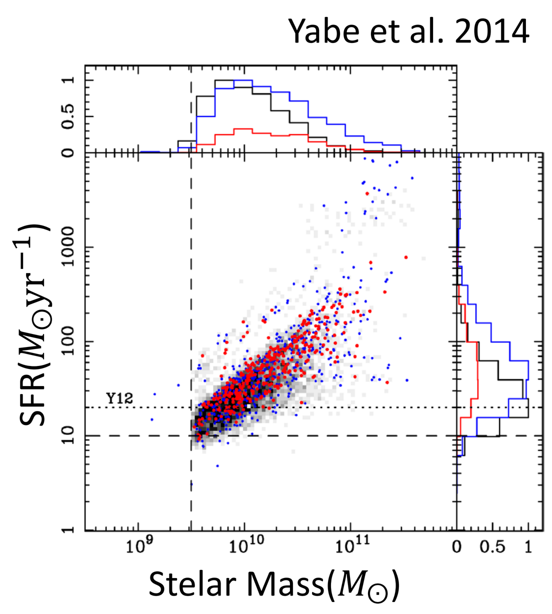
- Hoversten & Glazebrook 08 showed IMF slope is similar to that of Salpeter IMF among luminous SF galaxies at z ~ 0.1.
- Gunawardhana+11 found a slightly flatter IMF (Γ = −1 ~ −1.2) at z ~ 0.35 than Salpeter IMF.



3.Data & Model

Observation

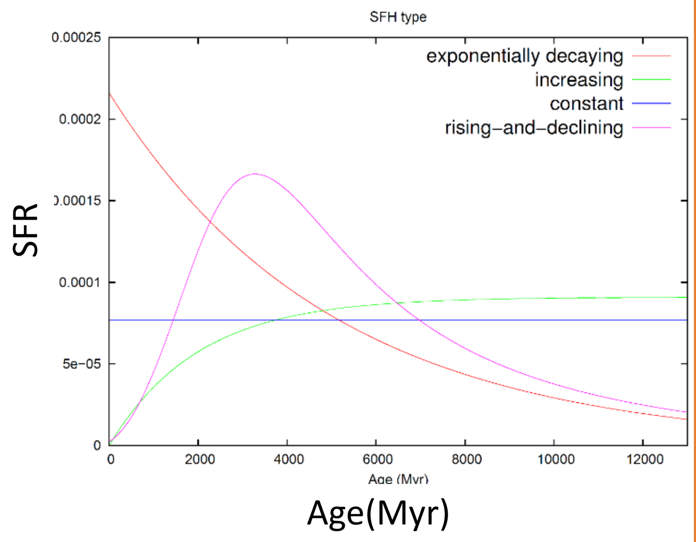
- We constructed a sample of main sequence star-forming galaxies at z ~ 1.4 ($1.2 < z_{ph} < 1.6$, $Ks < 23.9$ mag, $M_{star} > 10^{9.5}$ $M_\odot$) in the SXDS field.
- We observed Hα emission line by using FMOS on the Subaru telescope and detected the emission line toward 280 galaxies (red dots)
- We derived the HαEW and $J - H$ (corresponding to rest $g - r$) from this data set.



Model

We use **PEGASE.2** population synthesis code.

- IMF slope … ***Γ* = 0.5, 1.0, 1.35 (Salpeter)**
- mass range… 0.1 – 100 $M_\odot$
- metallicity… $Z_\odot$
- 4 smooth SFHs (right figure)
- Calzetti's extinction law
- the ratio of the color excess of the continuum to that of nebular emission $\frac{E(B-V)_{star}}{E(B-V)_{line}}$ **=0.44 (Calzetti+00)**
- ages from 3.5 to 5 Gyr (corresponding to z = 1.6 to 1.2, if the formation epoch is z_f = 10 − 5)



4.Result

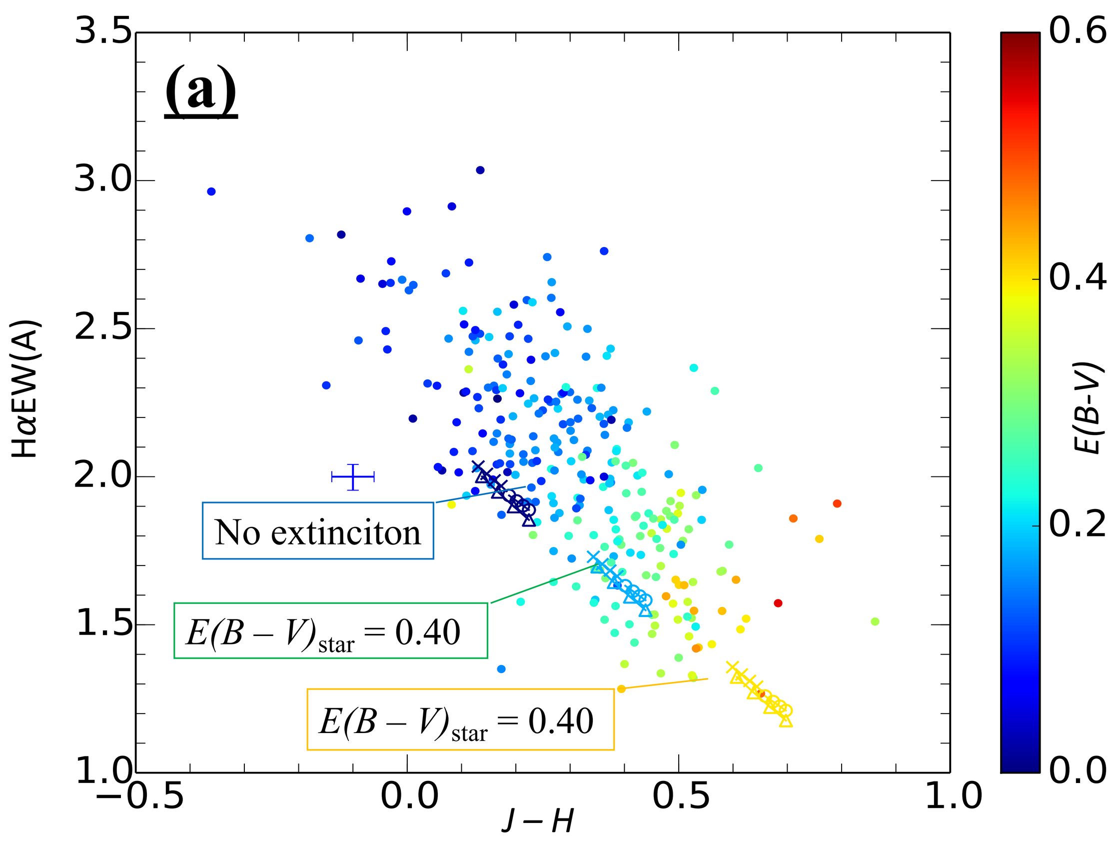
(a) Salpeter IMF

- *Γ* = 1.35
- the continuous SFHs

Cannot reproduce

✓ Kroupa, Chabrier IMF do not change the model locations.

✓ Changing metallicity or mass range does not affect the tracks so much.

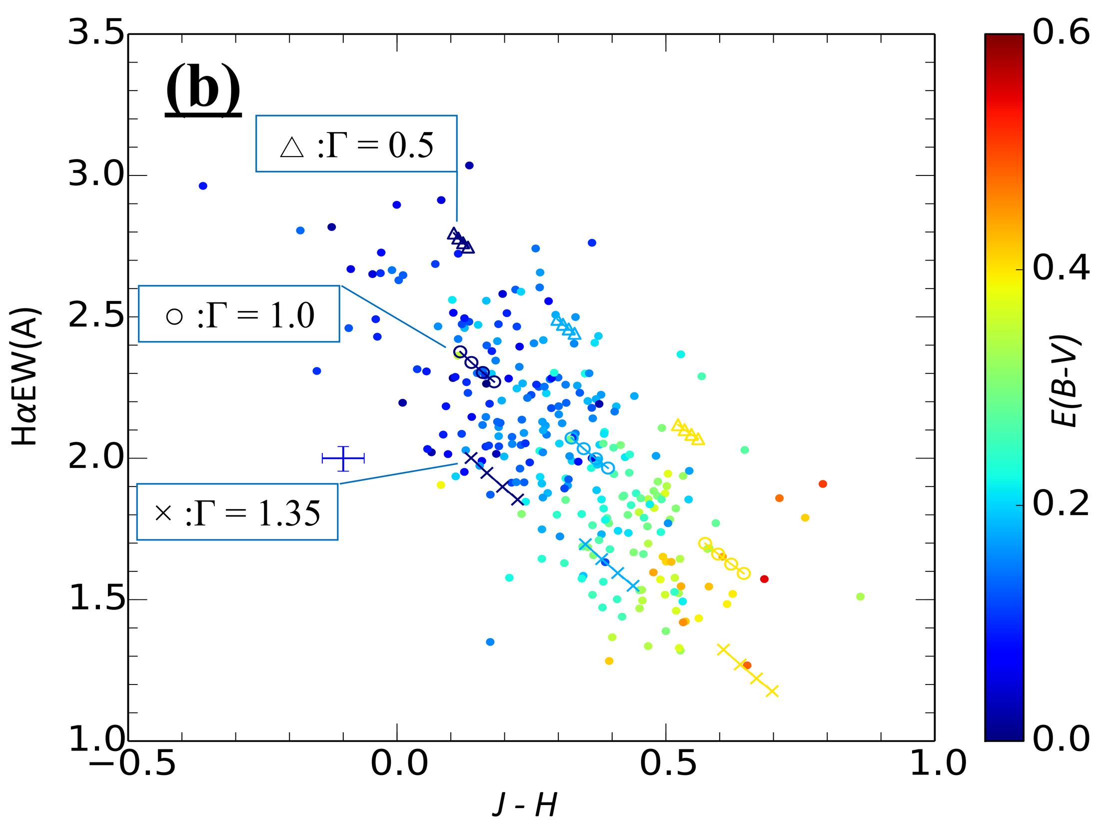


(b) Top-heavy IMF

- ***Γ* = 1.0, 0.5**
- the continuous SFH (rising-and-declining)

Reproduce

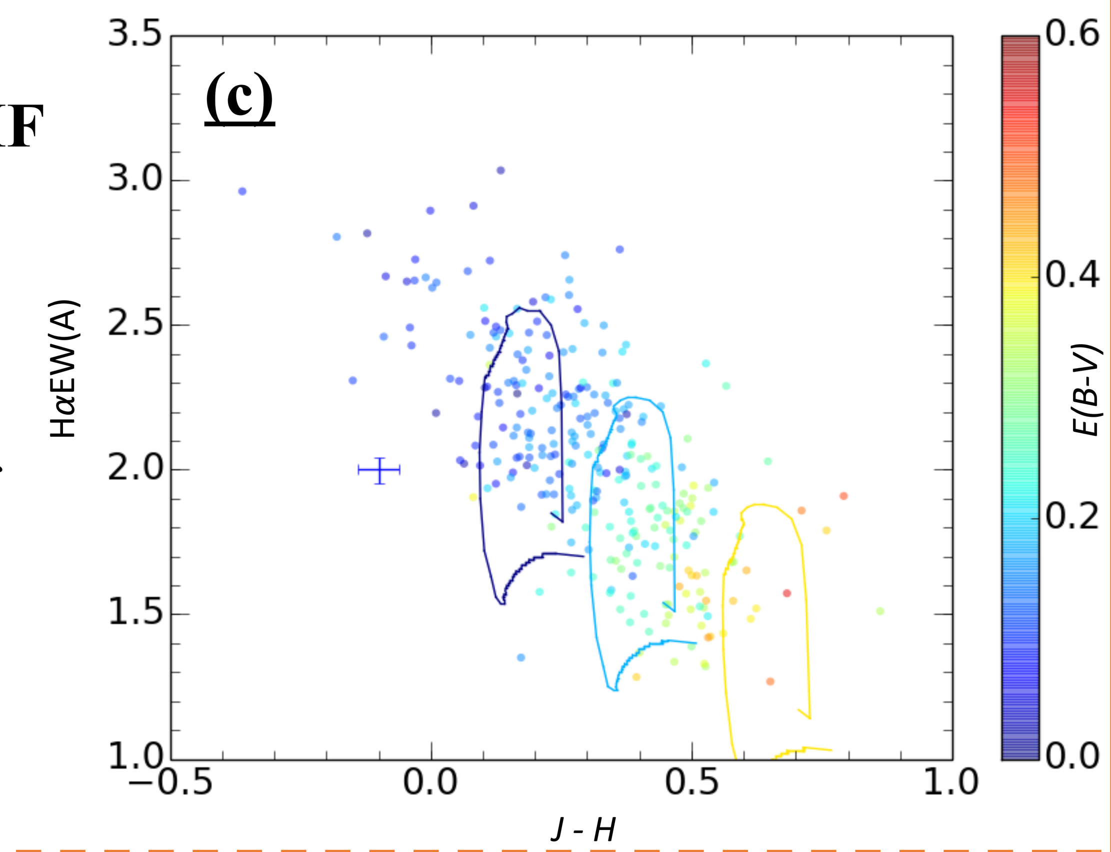
✓ Top-heavy IMF (Γ ~ 1.0) can reproduce well with a modest reddening



(c) Star bursts with Saltpeter IMF

- *Γ* = 1.35
- 10% strength burst on the continuous SFH
- The burst occurs at an age of 4Gyr with a duration of 100Myr.

Reproduce

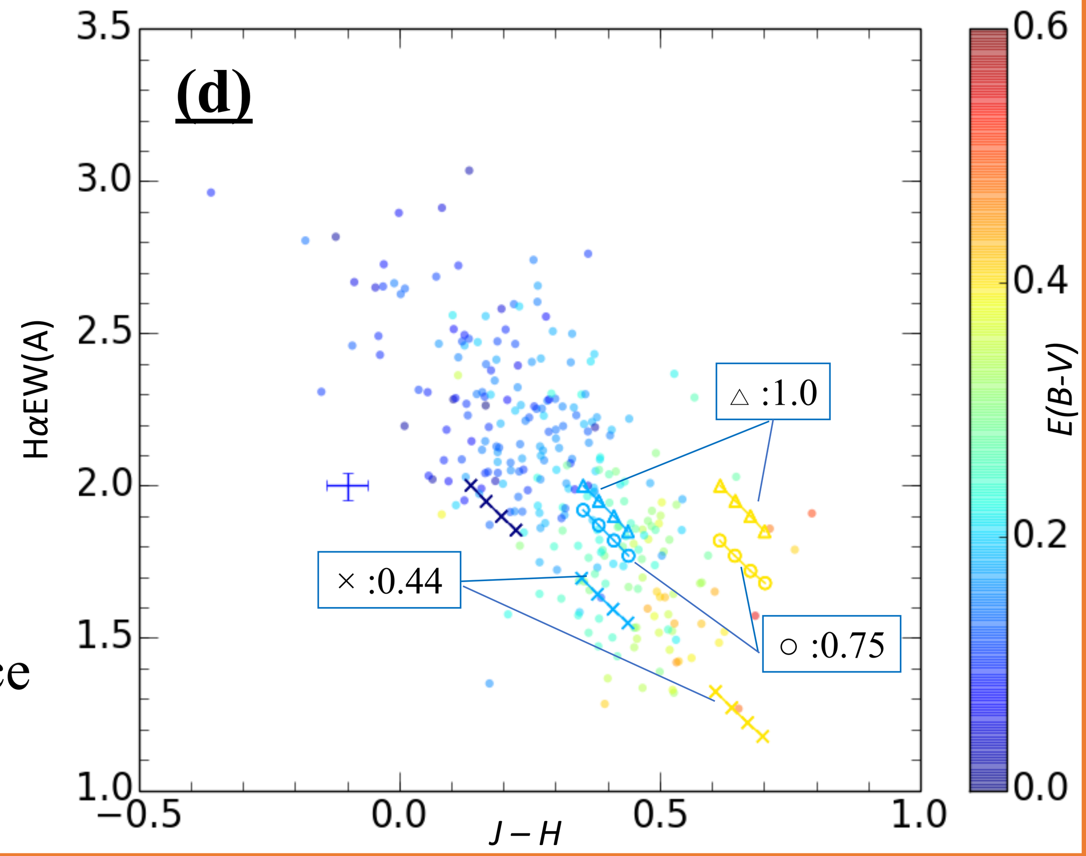


(d) $\frac{E(B-V)_{star}}{E(B-V)_{line}}$ ~ 1.0 with Salpeter IMF

- *Γ* = 1.35
- $\frac{E(B-V)_{star}}{E(B-V)_{line}}$ = 0.7, 1.0
- the continuous SFH

Partially reproduce ?

✓ This model cannot reproduce the upper part of the observed distribution



5.Discussion & Conclusion

We find that if the IMF slope at the epoch is Γ~1.0, the observed HαEWs and colors of the SF galaxies at z ~1.4 are well reproduced, suggesting that the IMF slope is flatter than that of the Salpeter/Chabrier IMF. Price+16 and Wuyts+16 find that the baryonic mass (stellar mass + gas mass) against the dynamical mass in SF galaxies at z ~ 2 is large, disfavoring the Salpeter IMF. Our result may reduce this tension. However, a starburst with the Salpeter IMF or the same amount of extinction to the stellar continuum and the emission line can also reproduce the distribution. Kashino+13 suggested $E(B-V)_{star}/E(B-V)_{line}$ is 0.7-0.8 at z ~ 1.6, supporting the latter scenario, but the distribution is not very well reproduced. At this moment, it is hard to distinguish these scenarios.