Properties of Star-forming Galaxies Based on SED-fitting

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Introduction

- FAST SED fitting code (Kriek et al. 2009)

  - Will SED fitting give reasonable results?

- Colors of galaxies depend on SFH and Dust

  - If we have more realistic SFHs, we can tell the dust and SFR more accurately

  - We hope to find such realistic SFHs.

- Parameters that count:

  - Age , M_* , SFR , sSFR , A_V

Different models and FAST fitting

- Exponential tau Model $\mathrm{SFH}(t) \propto e^{-\frac{t}{\tau}}$
- Delayed tau Model $\mathrm{SFH}(t) \propto te^{-\frac{t}{\tau}}$
- Constant Model $\mathrm{SFH}(t) = const.$
- Others: Inverted-tau Model, Burst Model …

➢ Q1 : How to check these models?

- Use BC03 (Bruzual & Charlot, 2003) / astro-smpy (by Duncan) to get synthetic SEDs from the models and then put them into FAST.

➢ Q2 : Will FAST recover the correct parameters?

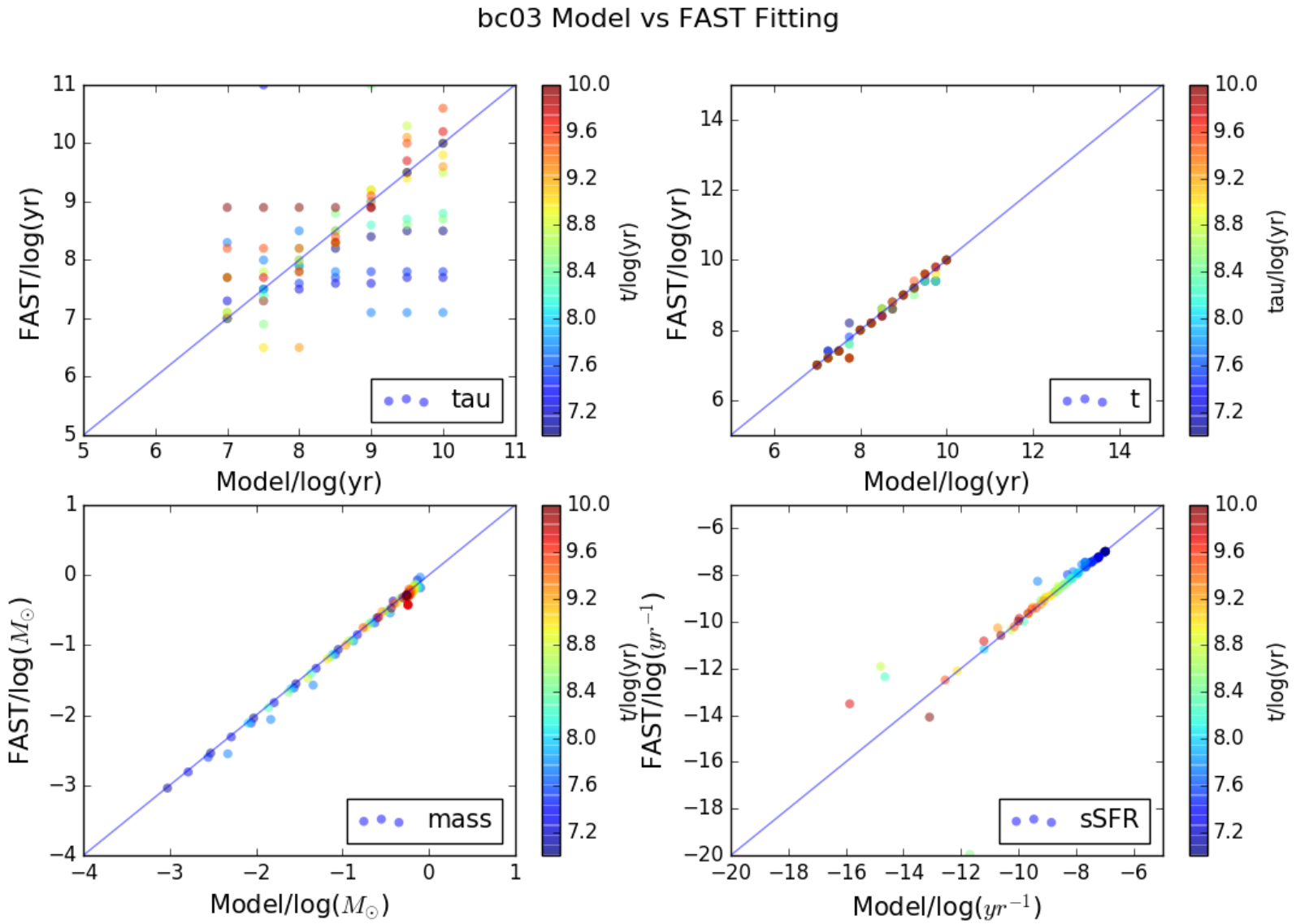


Fig 1: Comparisons of parameters which are input and FAST returns

Inputs (exponential tau model)

- Fit with tau templates
- SEDs with different taus and ages
- No dust
- Solar metallicity
- 1% photometric error

Outputs

- Age, stellar mass, sSFR are relatively good
- Tau with large scatter

Can the models explain the real data?

- UVJ diagram: U-V vs V-J, a good 2-color diagram to understand galaxies
- See where real data are on the UVJ diagram

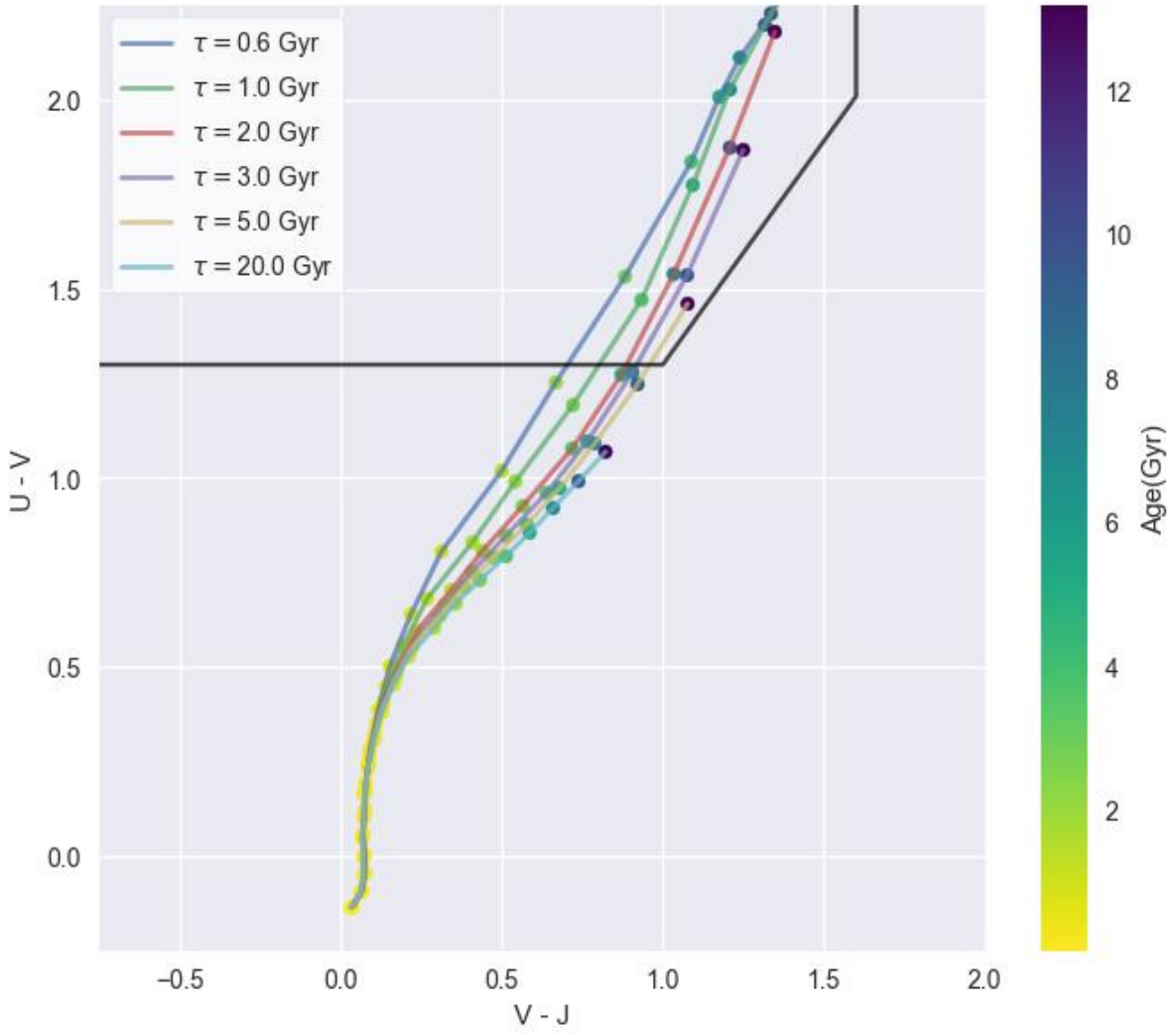


Fig 2: UVJ tracks of different exponential tau models

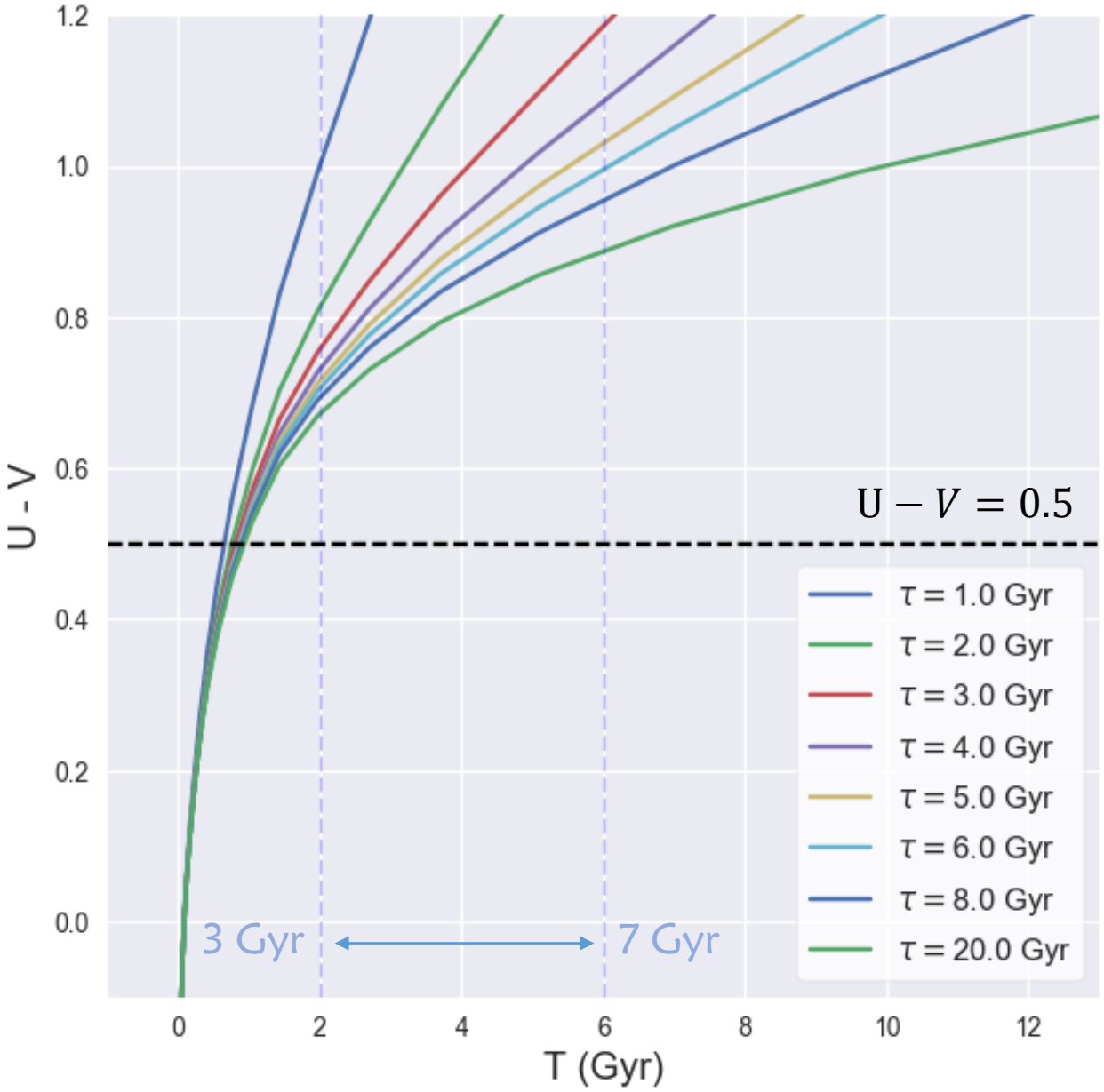
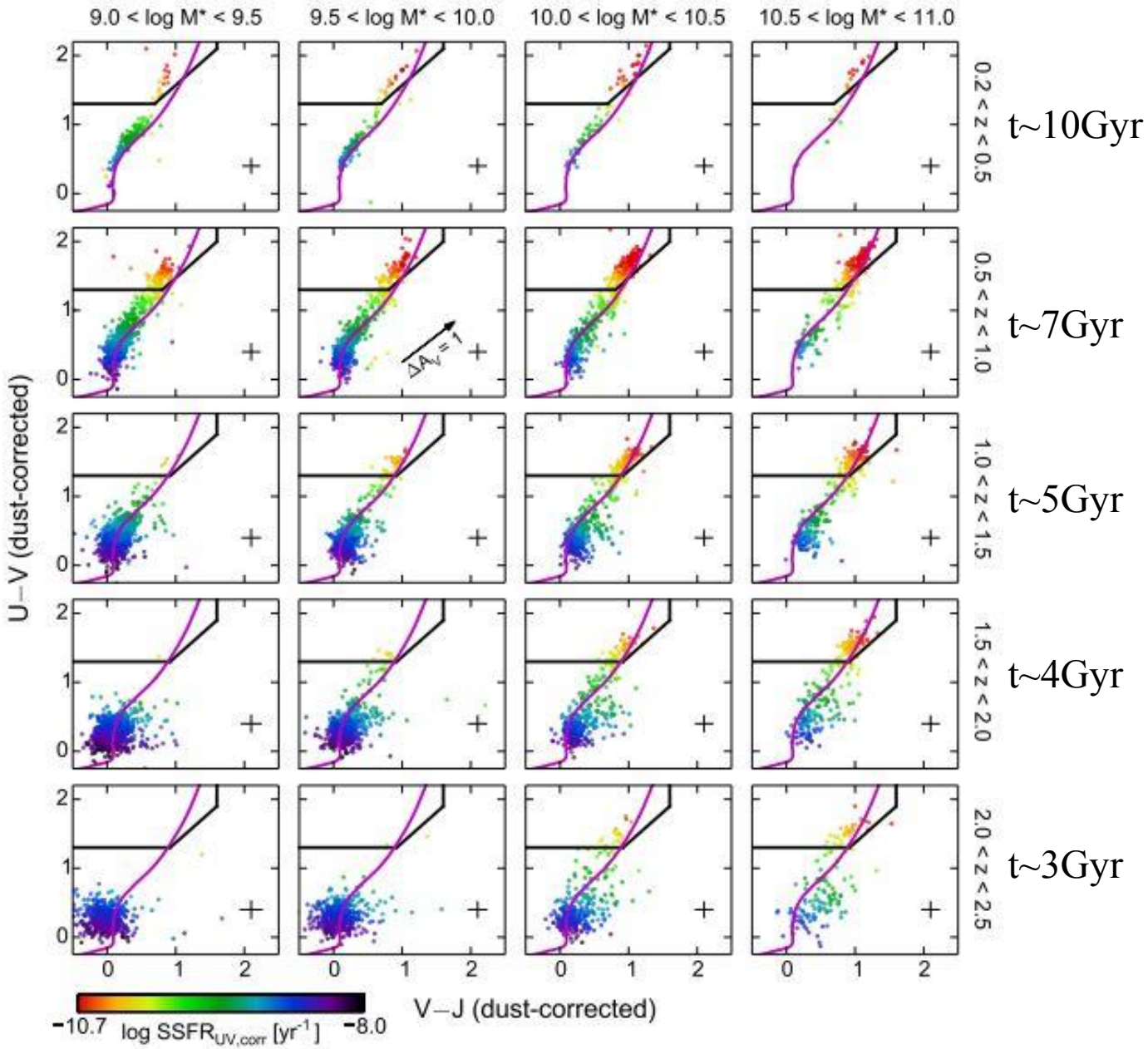


Fig 3: U-V vs t of different tau models

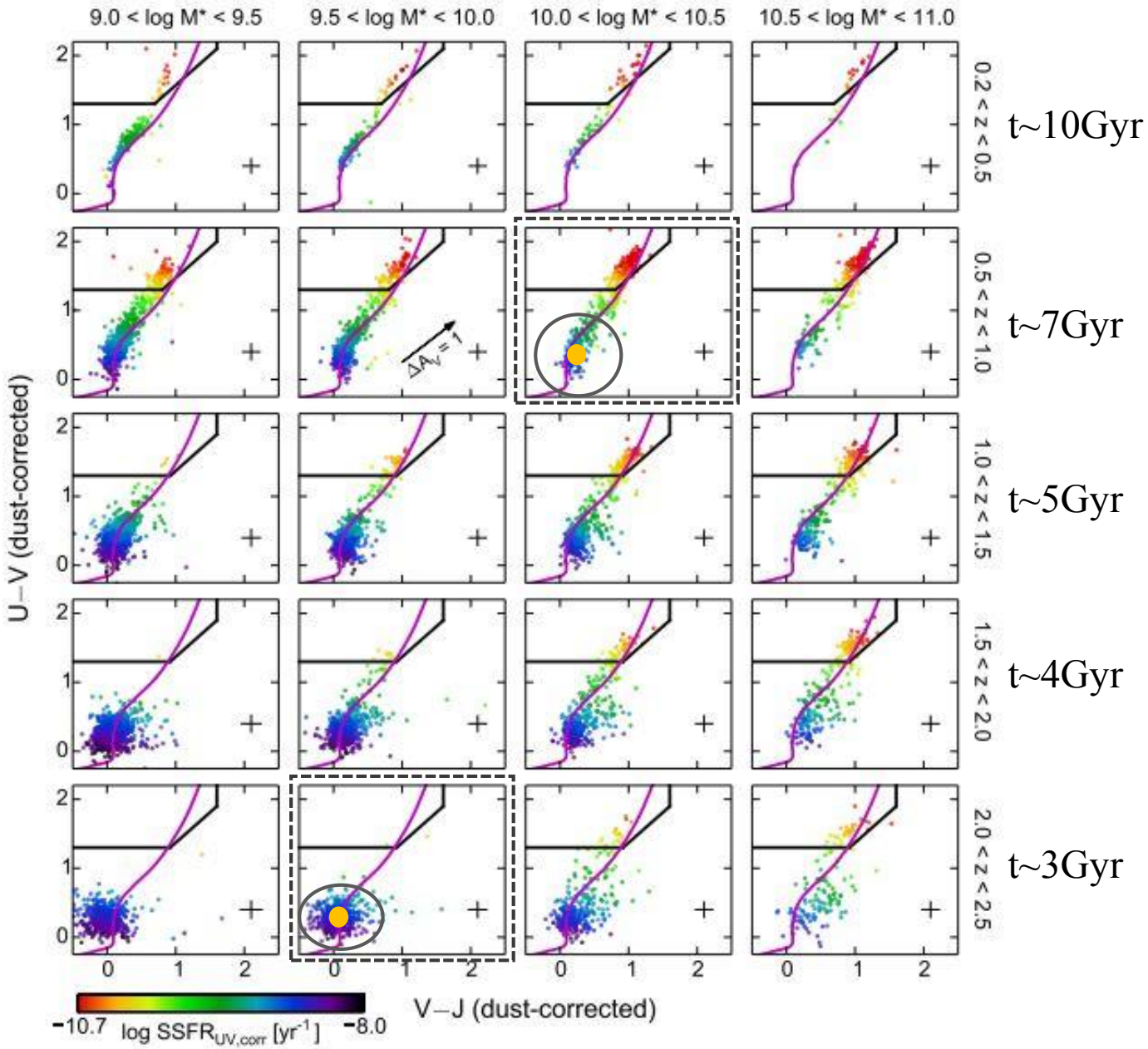
- U-V vs age of different exponential tau models
- Recognize U-V < 0.5 as strong star-forming

Galaxies go red rapidly !



- CANDELS data on UVJ diagram
- UVJ track of tau model ($\tau = 3$Gyr)
- It seems that CANDELS data do follow the tau model UVJ track

Fig 4: (Fang et al. 2017) CANDELS data with different stellar mass and redshift bins



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- UVJ track of tau model ($\tau = 3$Gyr)
- It seems that CANDELS data do follow the tau model UVJ track
- A large group of blue galaxies exist until 7 Gyr

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Blue color problem

- Tau model is not so good to explain why CANDELS data are so blue
- Delayed tau model is somewhat bluer than tau model but not enough
- We expect SFH with similar UVJ track but stay longer at blue region

How to solve the ‘Blue Color Problem’?

- Approach I : try composite tau models to make the aged population bluer;

  - Choose 4 SSP with tau models:

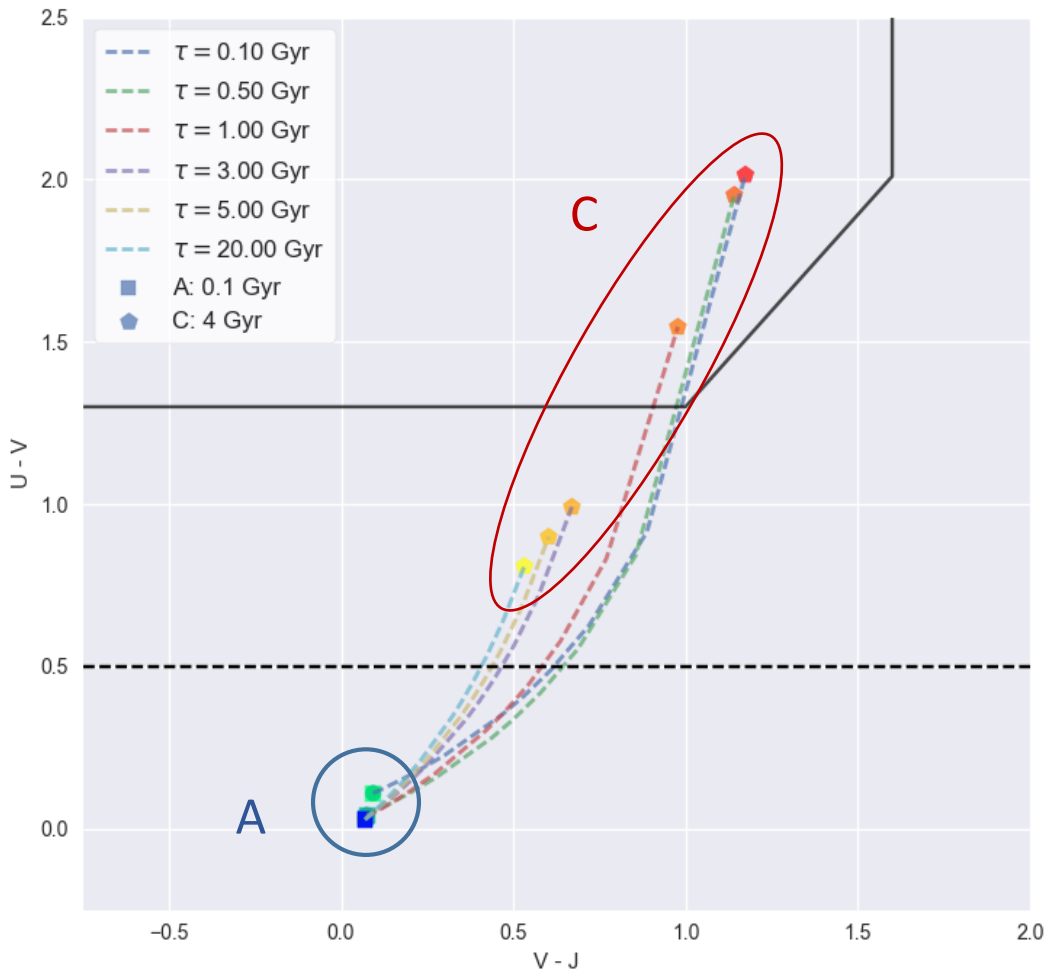
    A: Very blue star-forming B: Blue star-forming

    C: Green valley / blue quiescent D: Red quiescent

  - Add in combinations: A+C / A+D / B+C / B+D

    mass-weight from 0.0 to 1.0

  - Where are they located on the UVJ diagram?



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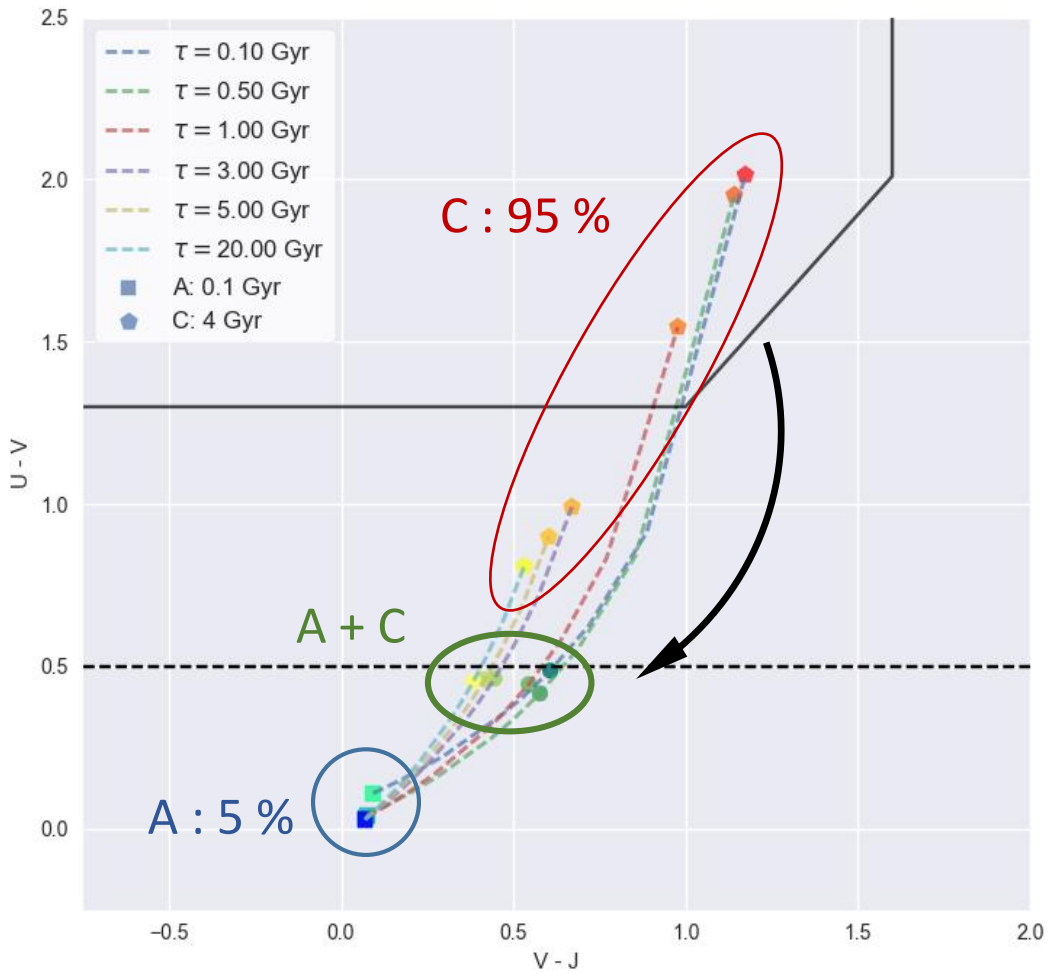
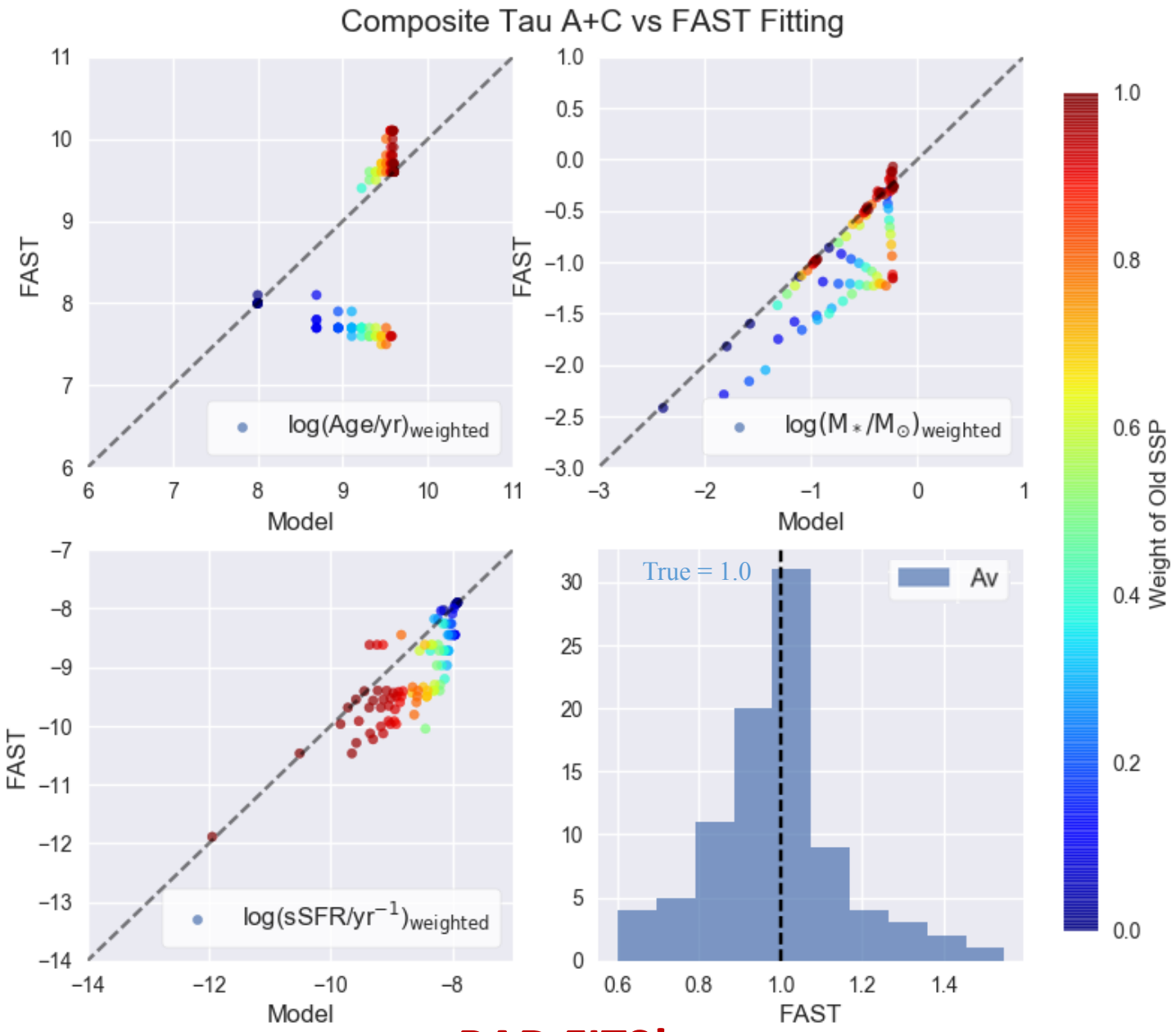


Composite tau models are able to explain the blue colors of observed galaxies **given** a certain proportion of a young population



BAD FITS!

Q : Can FAST figure out these composite models and return reasonable results?

- **No.** FAST returns bad values for these composite stellar populations assuming tau / delayed templates.

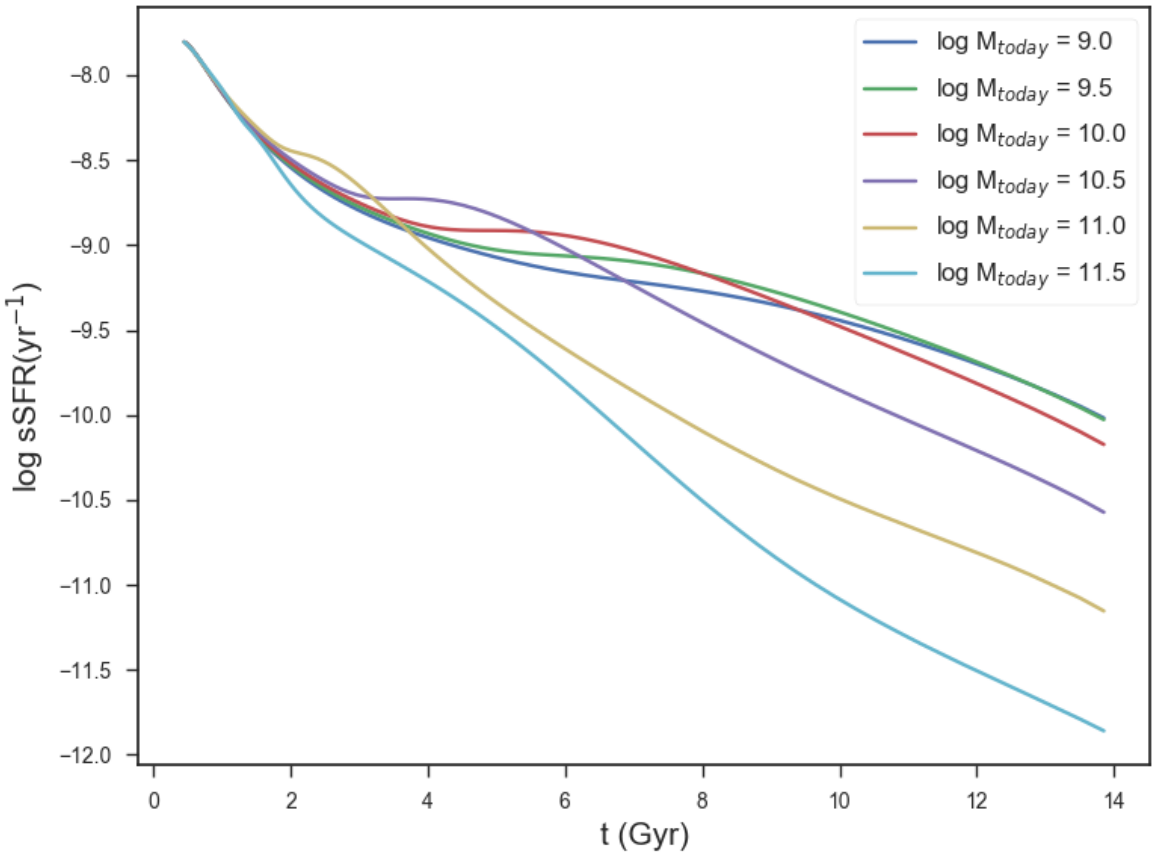
Need more realistic SFHs!

- Approach II : turn to more realistic SFHs in Rodriguez-Puebla et al. (2017) :

  - use SFHs derived from Abundance Matching (Mo, van den Bosch & White 2010; Conroy & Wechsler 2009, etc.) ;

  - Put them into BC03 and compute their UVJ tracks;

  - Compare with tracks of tau / delayed models.



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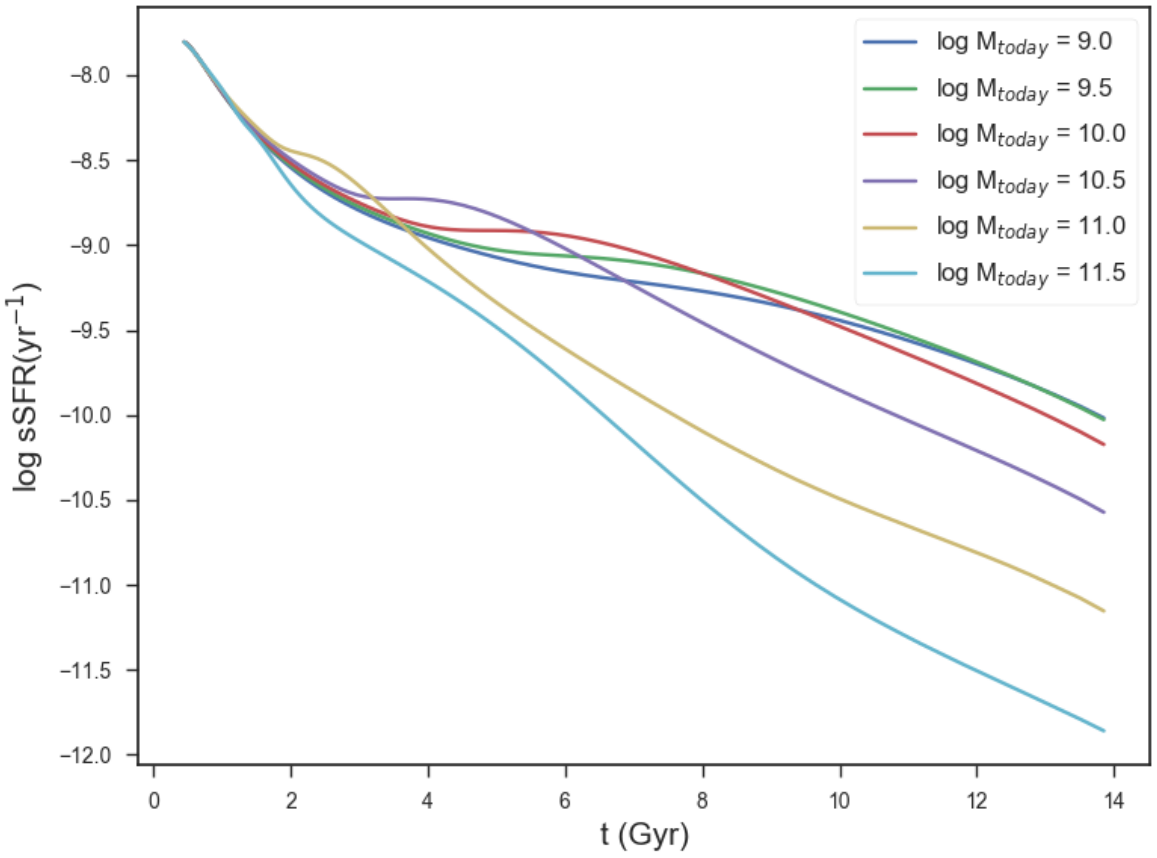
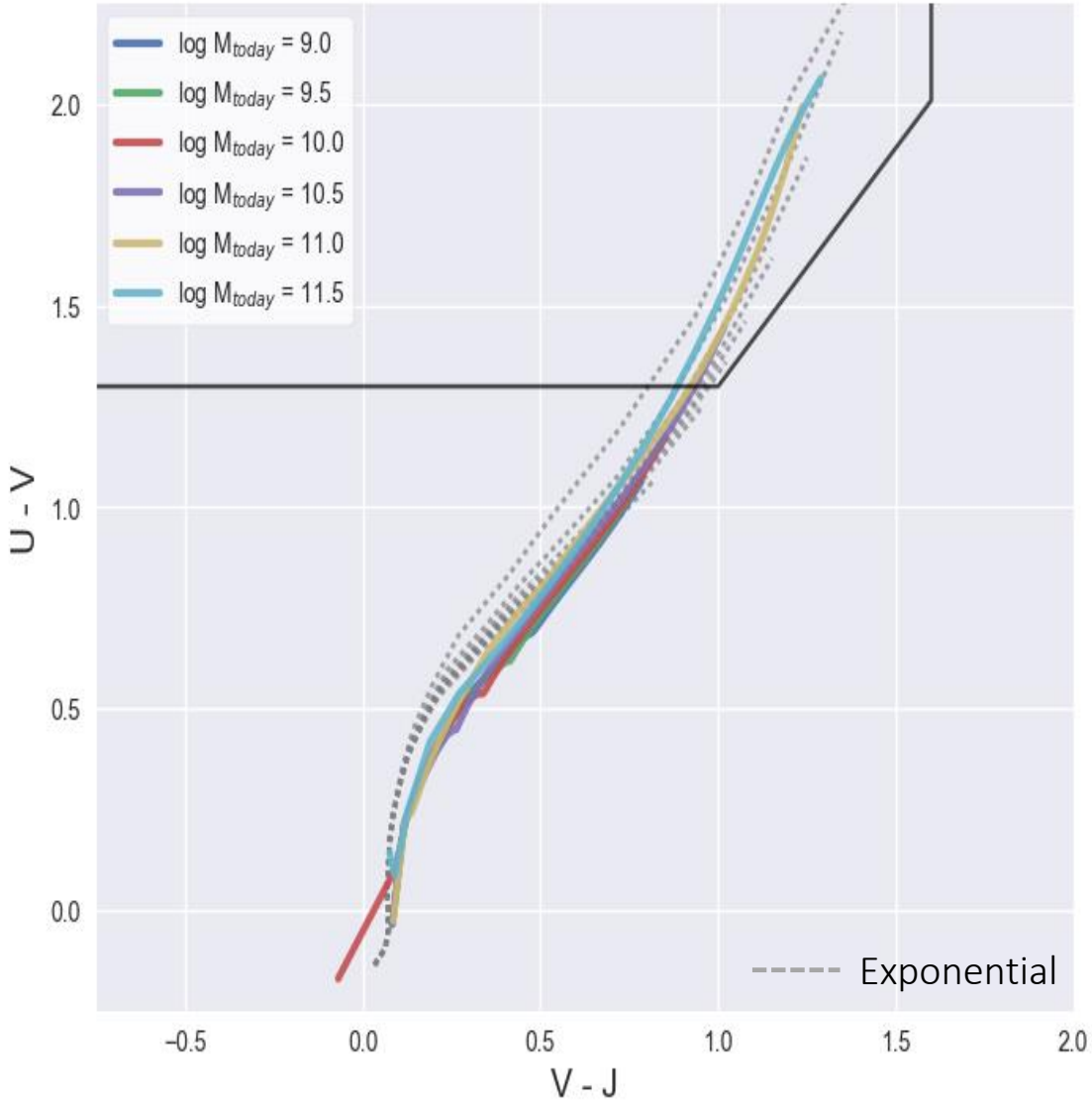
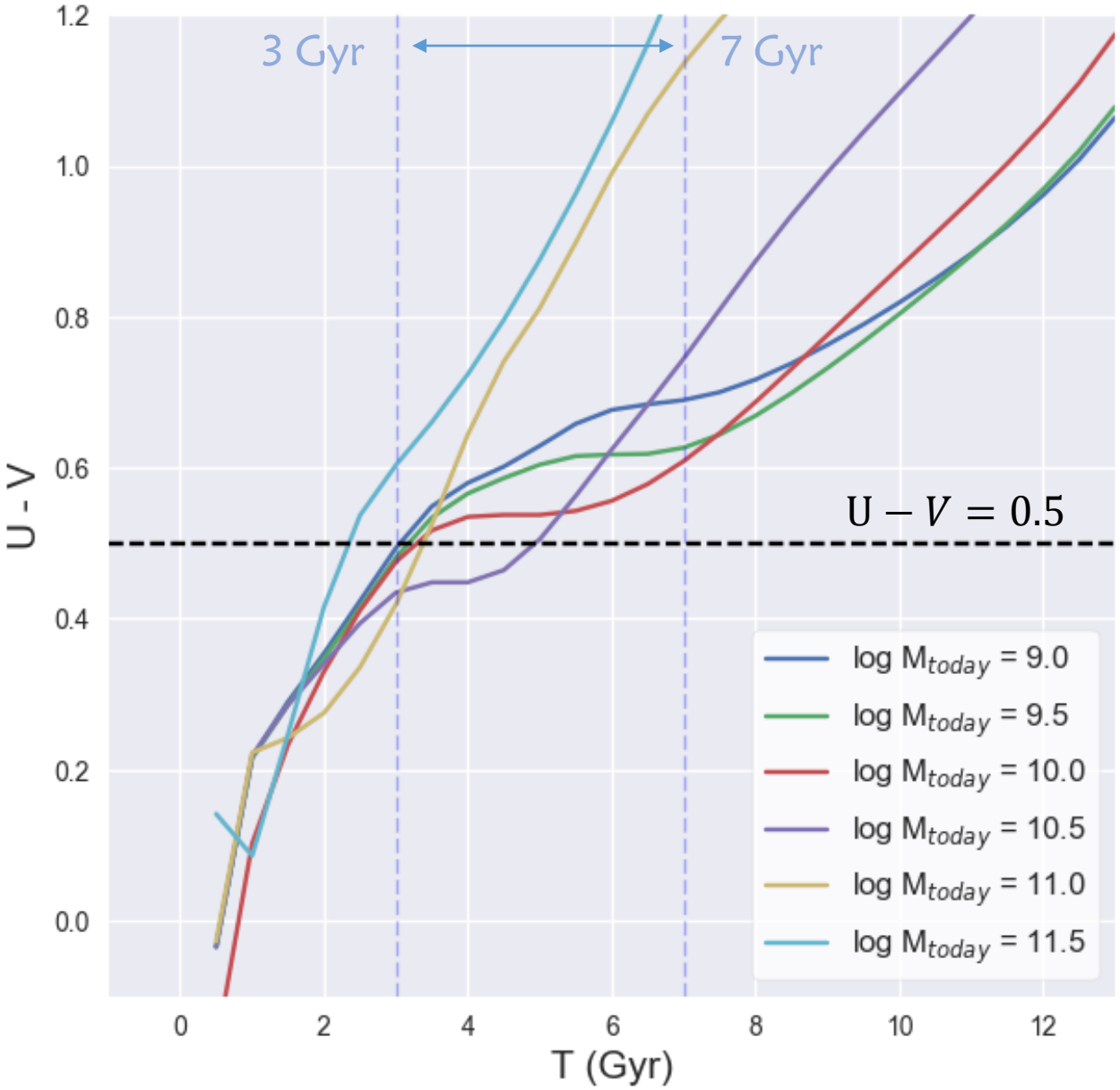
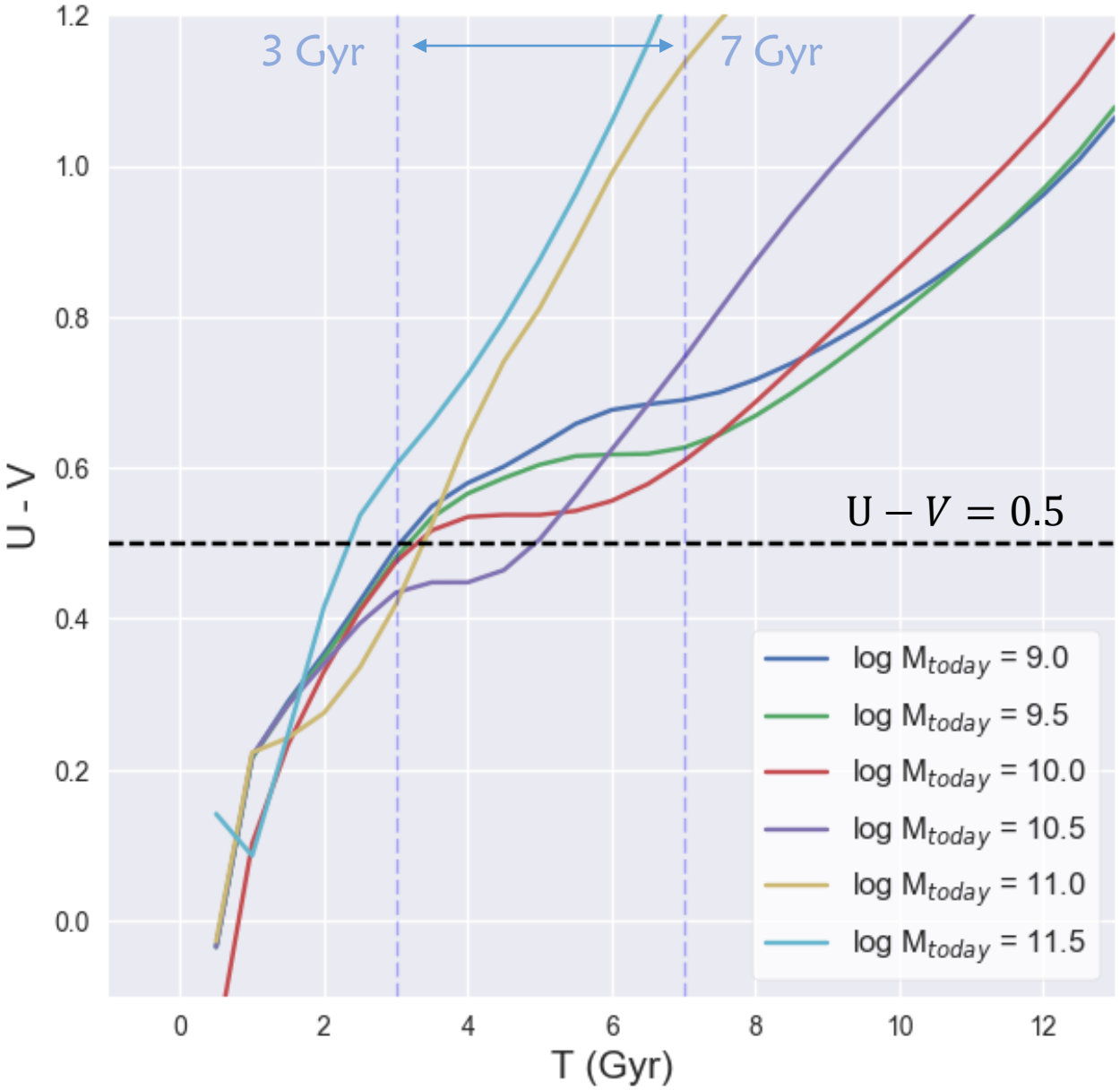






- While the UVJ tracks of Abundance Matching SFH (AM-SFH) look quite similar to tau / delayed SFH models, their residence times at the blue stage are much longer.
- Thereby the wide spread of age to be very blue in real galaxies can be well reproduced.



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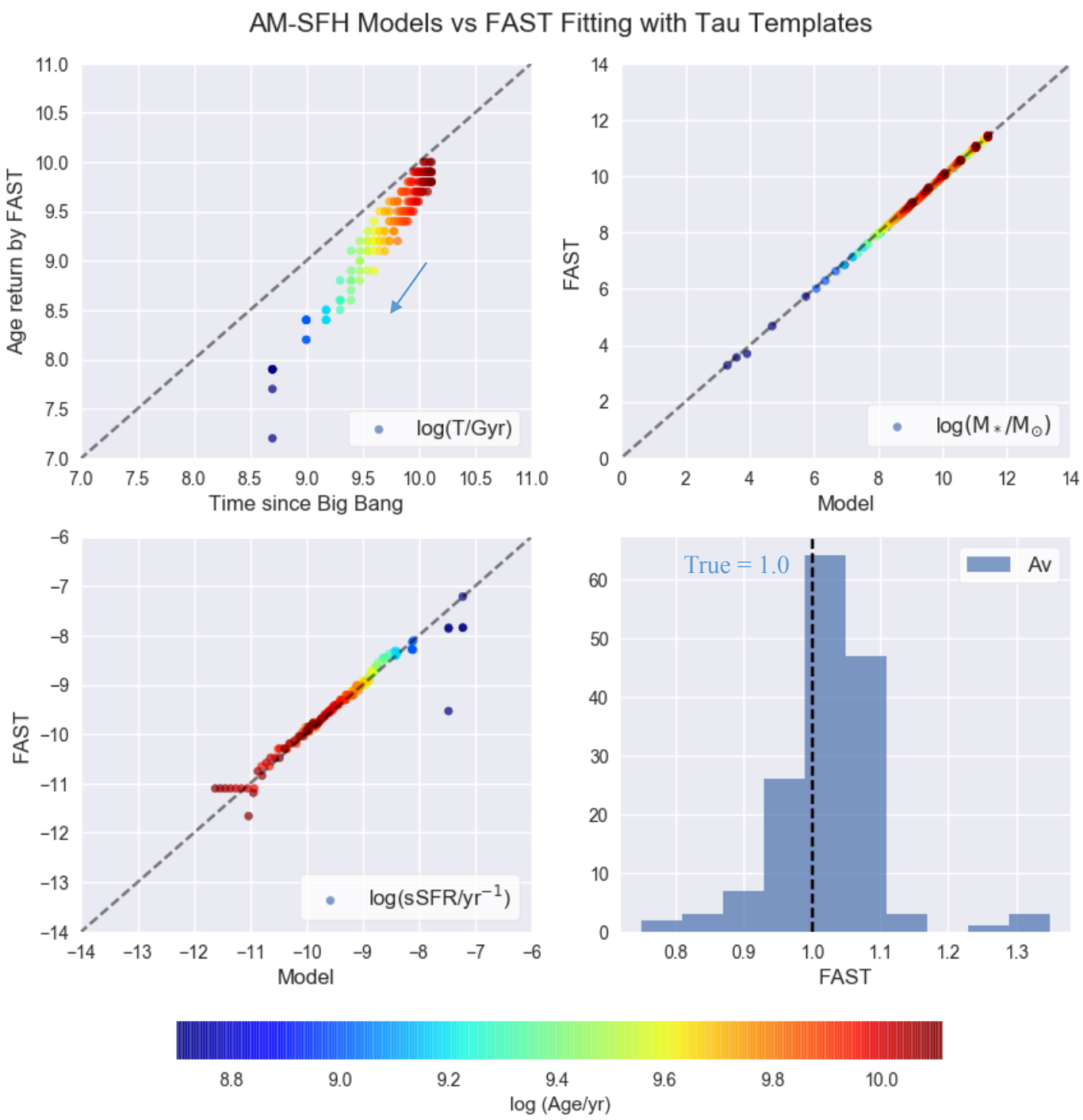
Q : Can FAST return the correct values of physical parameters for these AM-SFHs?

- **Yes.** FAST gives rather good estimates assuming tau / delayed templates!

- With assumptions of unrealistic tau / delayed models, we can still retrieve the values of M*, SSFR and Av of galaxies following realistic SFHs.



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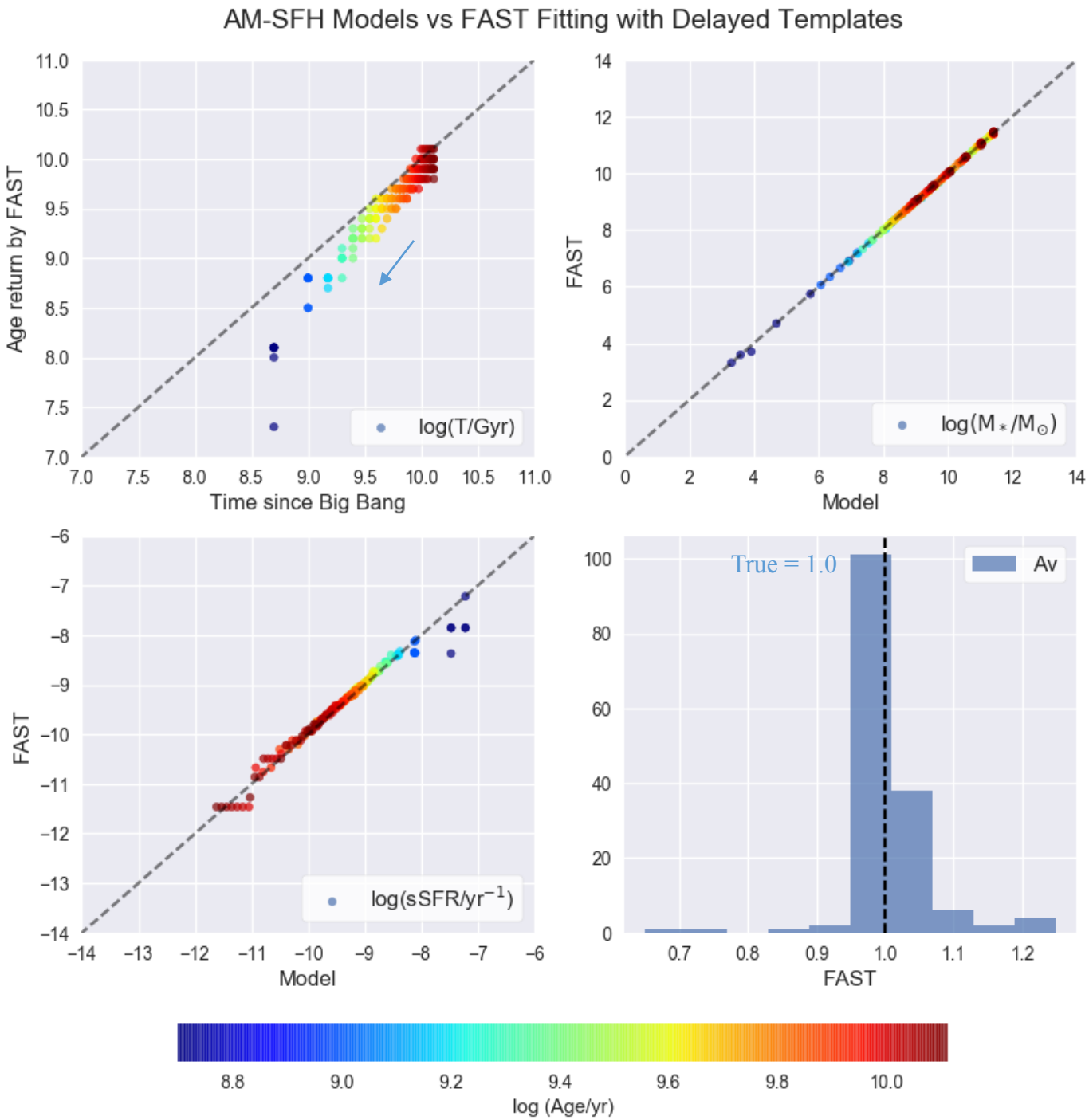
- The derivation of parameters is more precise when using delayed templates.



Further Exploration

☐ metallicity problem:

- Up till now no issue about metallicity is concerned yet.
- In actuality the metallicity is degenerated with dust, therefore would influence the derivation of quantities.
- Change metallicity in our experiments (sub-solar/super-solar) and see the results.

☐ comparison with Main Sequence derived SFH (MS-SFH)

- Self-consistent SFHs derived from the observed redshift-dependent main sequence (Ciesla et al. 2017).
- Put them into BC03, compute UVJ trajectories and see differences with results of AM-SFH.

☐ fine-tuning the current model

- Adding sinusoidally perturbation on these SFHs.
- What would they look like? Could they match scatter of UVJ and SFMS in observations?