Analysis of observational data, to calculate the Delayed-Tau model parameters

Δ Π

Π E

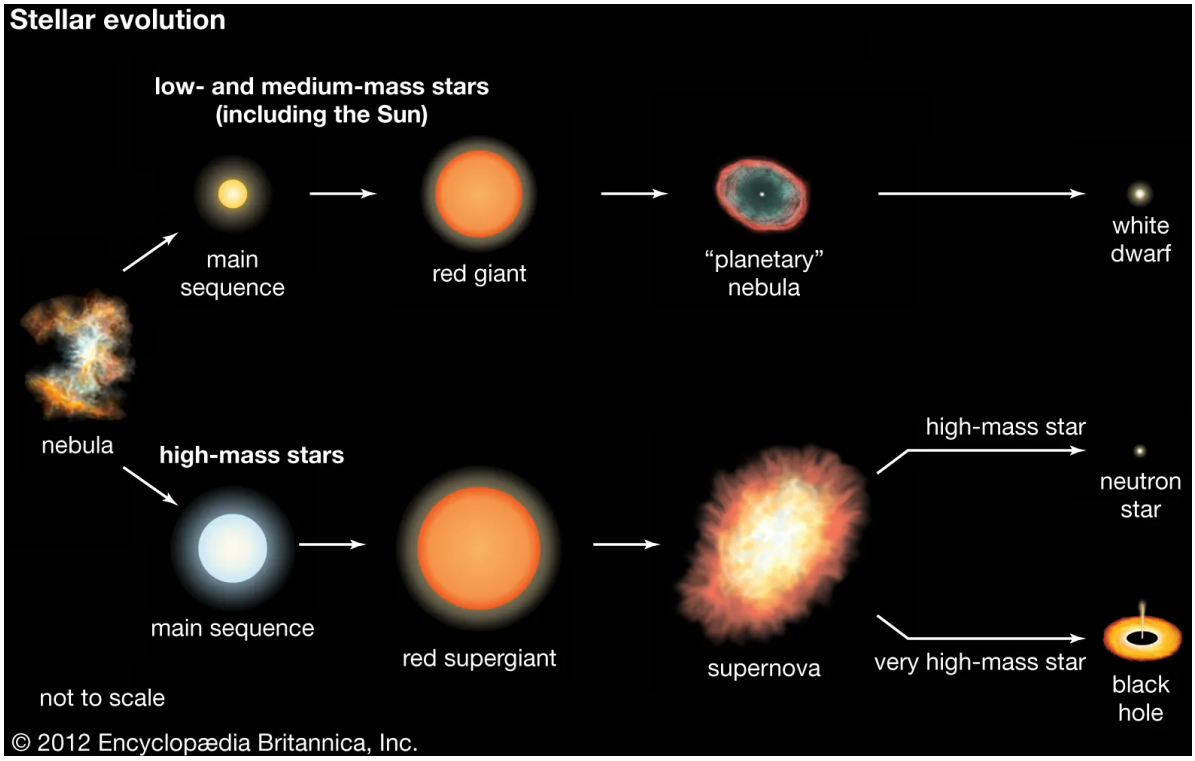
- **A & E** : Π Σ .
  T delayed -model .
- **Π & A** : ϒ .
  Π redshift .

H Σ . T
“delayed -model” . O Pavel
Kroupa (2023) [@haslbauer2023] ,
(star formation rate)
(time scale).

H
. Ω , “delayed -model”
, (
redshift) (z 2). E ,
.

A

H



O (SFR = Star Formation Rate)

.

Σ $(M_{\odot} \cdot yr^{-1})$

E SFR

- **P H**
- **P (FUV)**
- **P (IR)**

E ,

. O /

, .

- *E H* : Π ,

. A , (

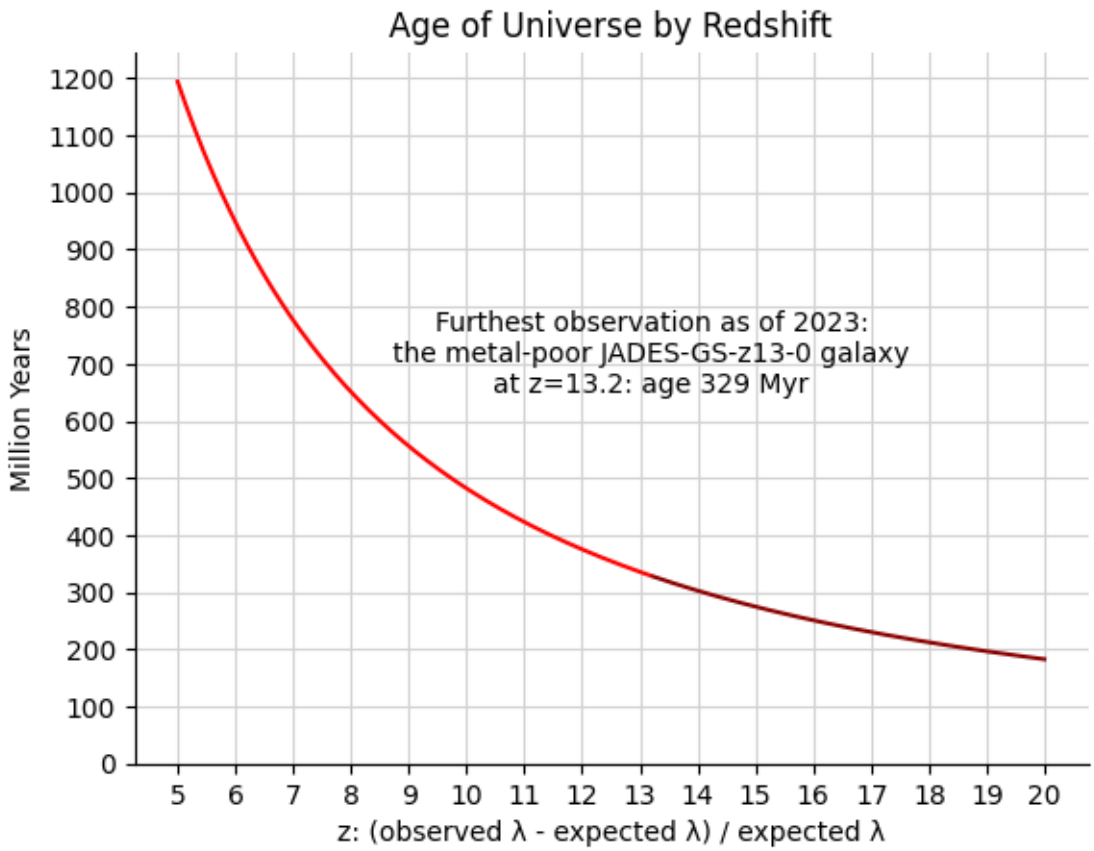
O, ~10 Myr). H . A

(wavelength: ~6563 Å).

- *P* *(FUV)*: E ( ) ,
  (B, ~100 Myr), H . E
  . (wavelength: ~1300–2000 Å).
- *P* *(IR)*: ϒ ,
  , . A
  (wavelength: ~8–1000 m).

N Hubble

- **N** **Hubble**:
  - O Σ .
  - $V = H_0 \times d$, $H_0 \approx 69.8$ km/s/Mpc Hubble.
- **E** **(Redshift)**:
  - T :
    * .
    * ( ).


Age of Universe by Redshift
Million Years
1200
1100
1000
900
800
700
600
500
400
300
200
100
0
Furthest observation as of 2023:
the metal-poor JADES-GS-z13-0 galaxy
at z=13.2: age 329 Myr
5
6
7
8
9
10
11
12
13
14
15
16
17
18
19
20
z: (observed λ - expected λ) / expected λ

Lilly-Madau Plot

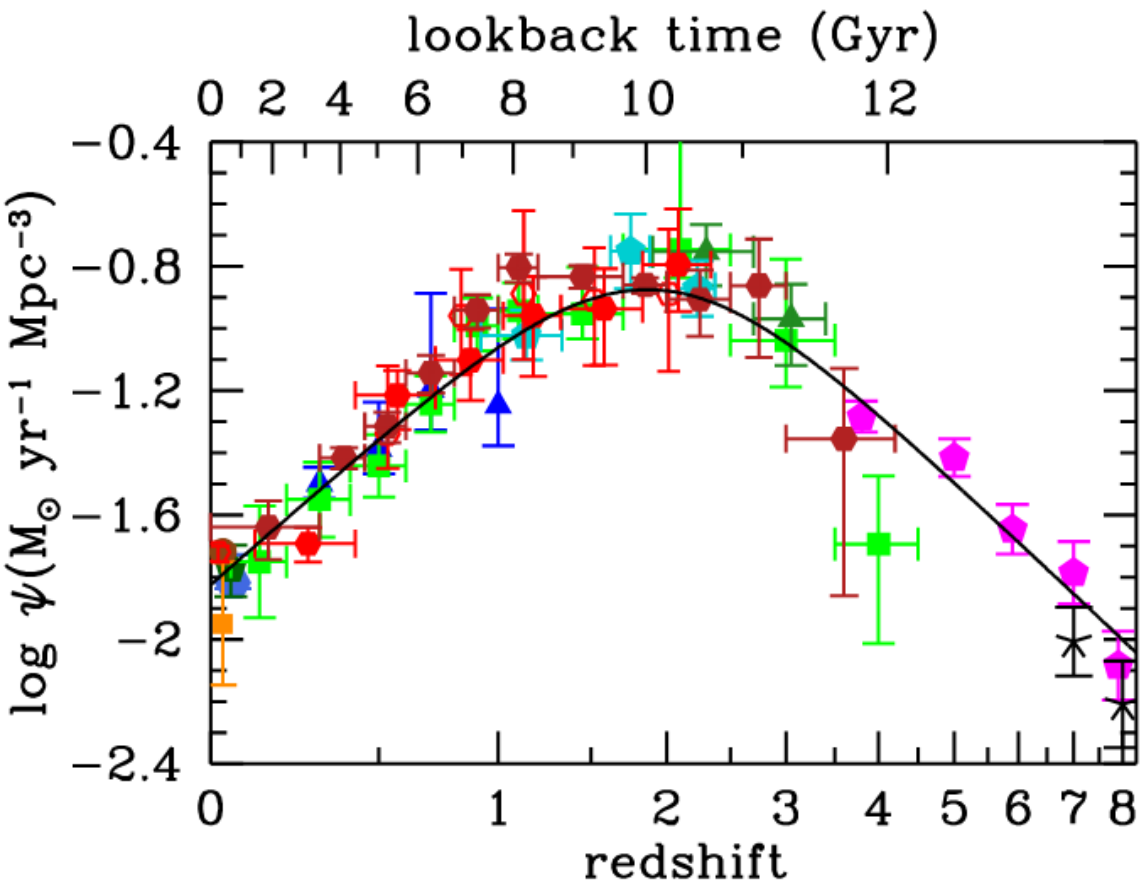
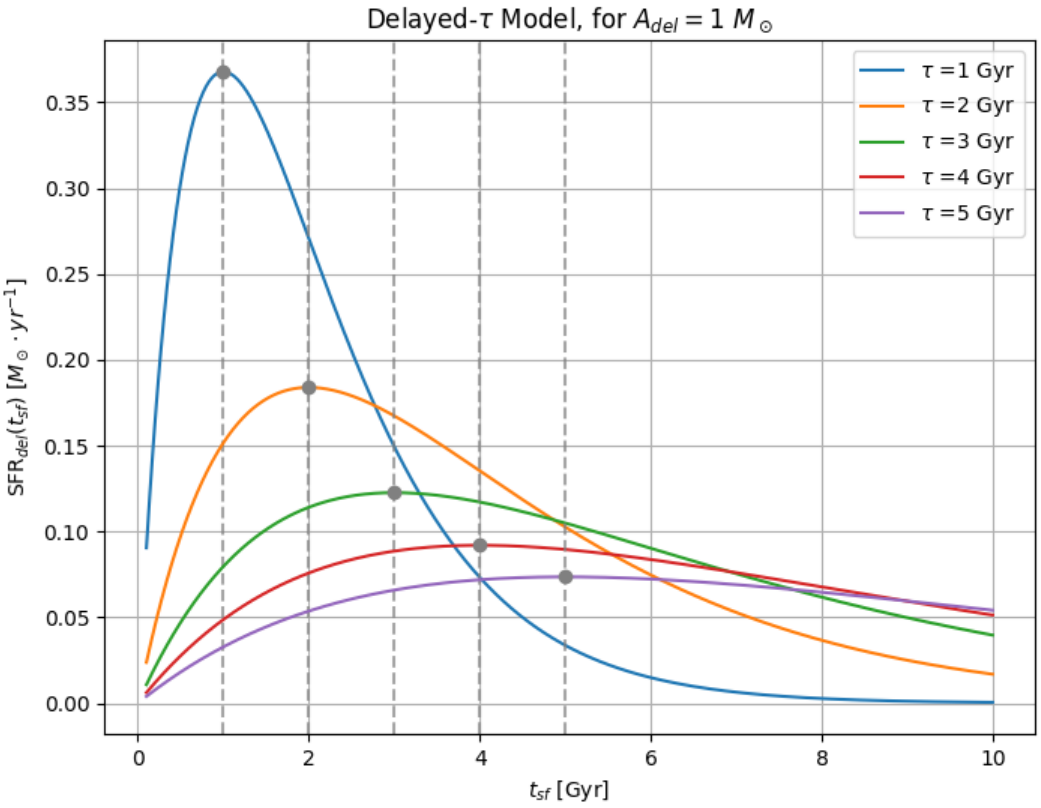


Figure 1: @madauCosmicStarFormation2014

Delayed-τ model

$$SFR_{del} = A_{del} \frac{t_{sf}}{\tau^2} e^{-\frac{t_{sf}}{\tau}} \left[\frac{M_\odot}{yr}\right], \; t_{sf} = T_{\text{universe}} - t_{\text{start}}$$



$$\int_0^{t_{sf}} \mathrm{SFR(t)dt} = \mathrm{M_*}$$

- **T delayed-τ** model (SFH) , (SFRs) .
- K sfr kai M_* , lilly madau
- **Speagle et al. (2014):**[@speagle2014] T SFH ,

Δ

Γ Local Cosmological Volume

- $D \leq 10$ Mpc
- Redshift: $z = 0 \rightarrow t_{sf} = 13.8 - t_{\text{start}}$
- Γ :
  - SFR H , FUV IR
  - A

Table	Number of galaxies
UNGC	1321
HECATE	2901
Join	**3934**

Π

- Σ 2 2 $(A_{del},\ \tau)$, $t_{sf} = 13.6$ Gyr .
- Λ
  - Python fsolve
- Θ .

H fsolve SciPy Powell, Newton-Raphson
,

ϒ τ

- **Π M :**
  - E τ
  - $t_{sf} = 13.6\,\text{Gyr}$, t_{sf}

Markov Chain Monte Carlo

- ϒ 3
- Σ 2 3 $(A_{del},\ \tau, t_{sf})$, $t_{sf} = 13.6$ Gyr .
- M
- M

Α Markov: Σ .

Δ Monte Carlo: Χ .

Σ MCMC: Δ Markov .