

(非)参数化的恒星形成 历史

Iyer & Gawiser 2017

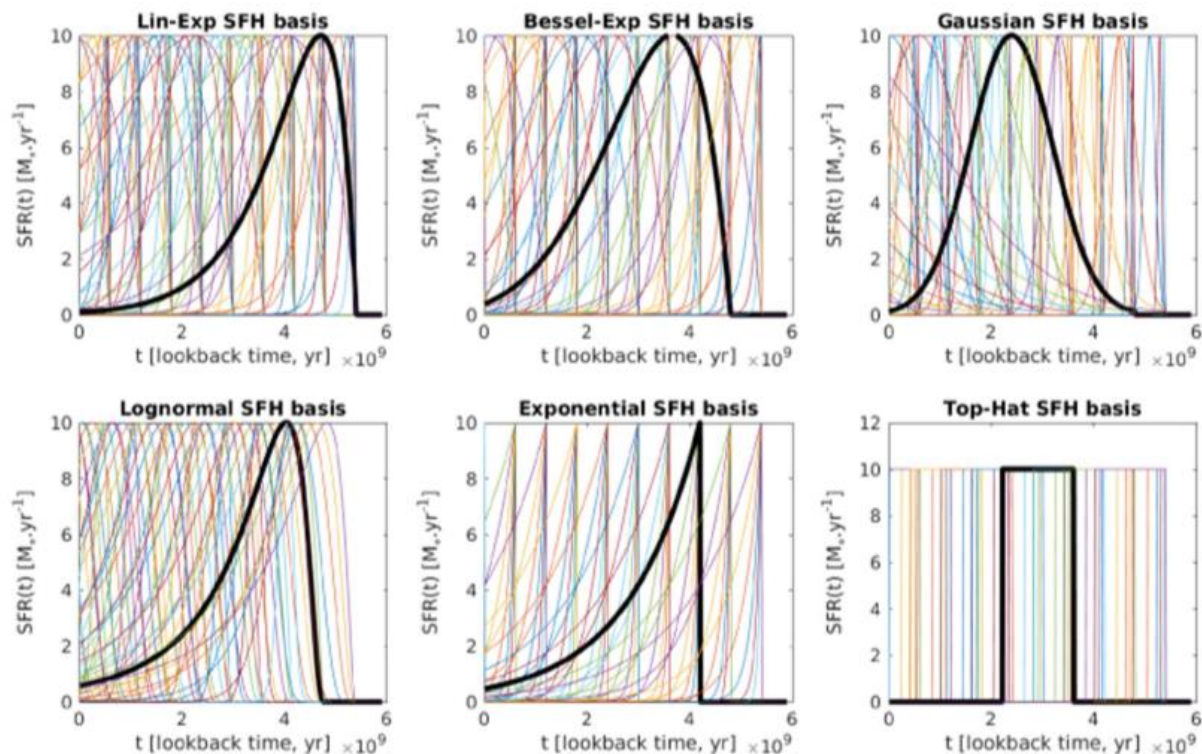
arXiv 1901.07556

arXiv 1901.02877

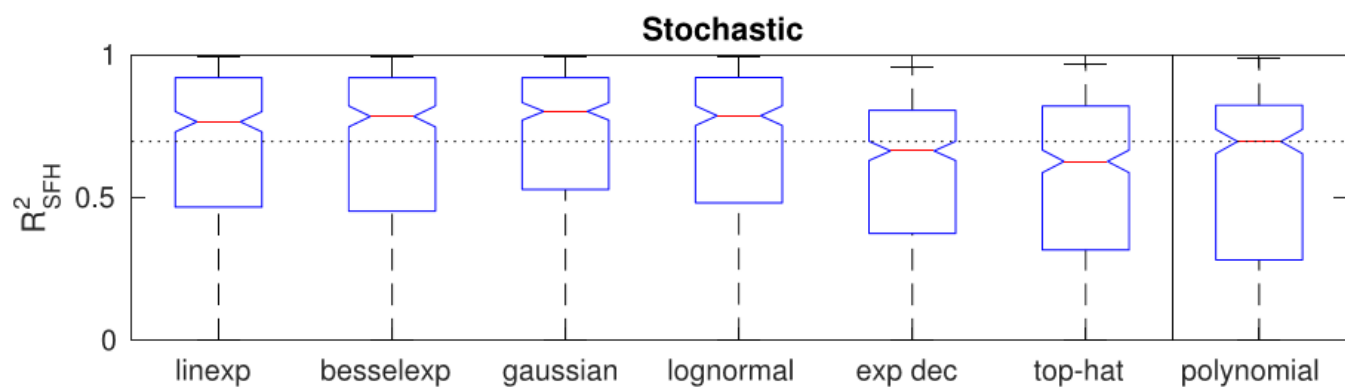
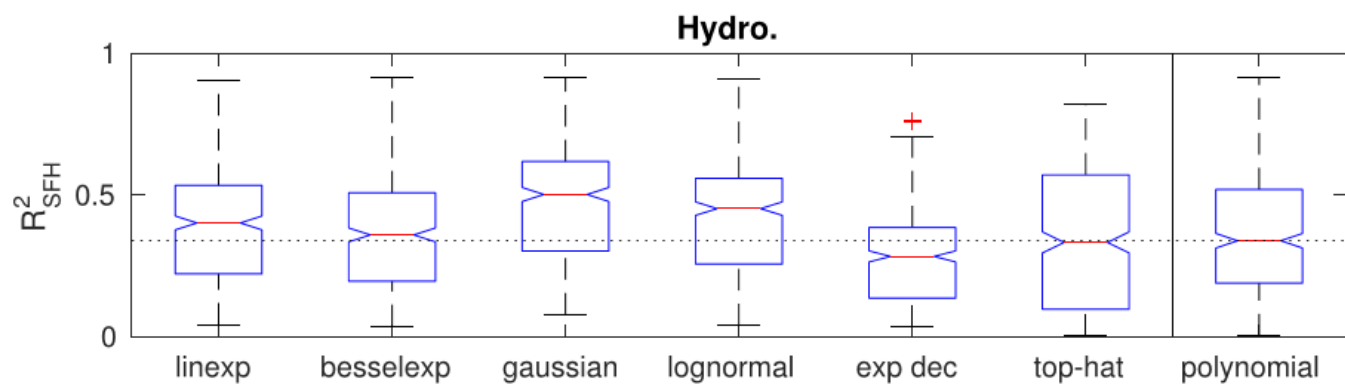
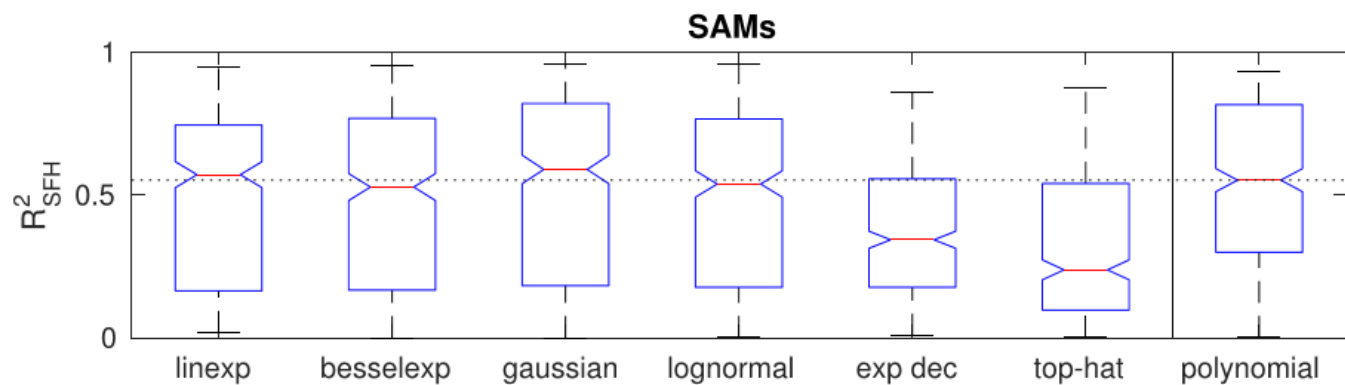
SFH

- Critical ingredients needed to understand the evolution of galaxies
 - Evolving physical process: baryon cycling
 - Stochastic process: merger, in-situ star formation
- Encode information about the variability on short and long time scales that arise from different physical mechanisms
 - Inflow, outflow of gas
 - Mergers
 - Supernova/AGN feedback
- Zero order
 - Stellar mass, age, SFR

Dense Basis SFH



- 最少的参数,basis
- Physical motivated
- Un-biased (Dense basis)
- F-test, BIC, Bayesian evidence
- 正定, e.g. log-normal?
- Basis不独立



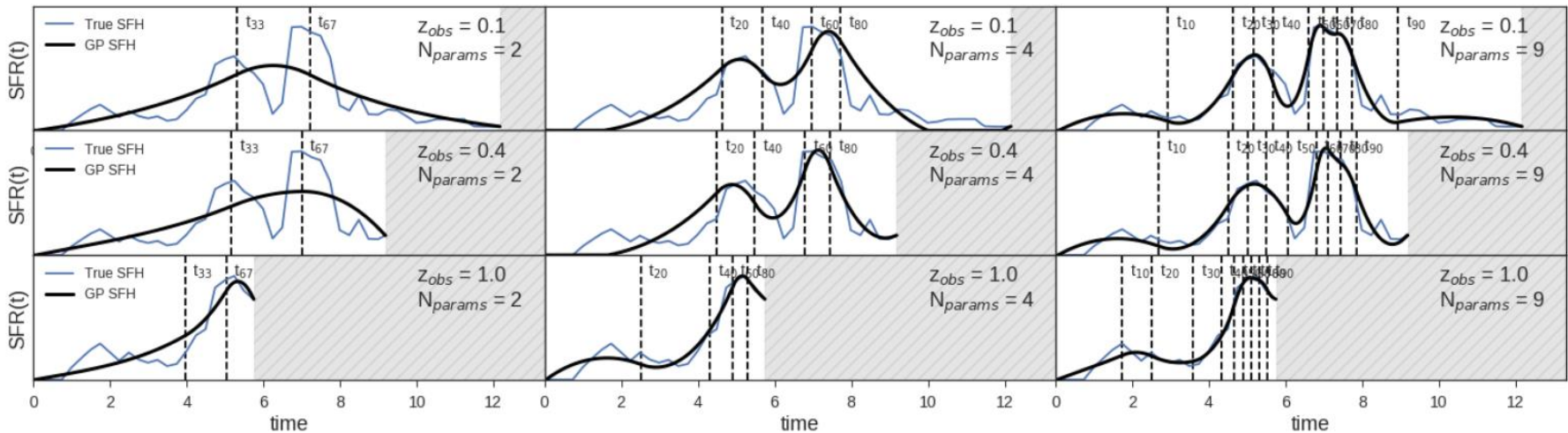
Gaussian process regression

$$N = 1 \quad P = \{t_{50}\}$$

$$N = 2 \quad P = \{t_{33}, t_{67}\}$$

$$N = 3 \quad P = \{t_{25}, t_{50}, t_{75}\}$$

$$N = 4 \quad P = \{t_{20}, t_{40}, t_{60}, t_{80}\}$$



- Python package: *george*
- 核函数 --> 协变信息
- 非参数化, 独立basis?

Stochastic modeling

- 恒星形成星系
- 平均的恒星形成历史, Main sequence ridge-line: smooth
- 单个星系的SFH, 在MS ridge-line上存在涨落
 - 对数正态分布 (观测)
 - 完全随机 (白噪声)? 相关性 (随机行走)?

功率密度

(PSD) power-spectrum density

$PSD(f) \propto f^\alpha$, with $\alpha = 0$. This process is perfectly uncorrelated, i.e., for a white noise process it holds that $ACF(t) = 0$, for all times when $t > 0$.

Other processes can be defined by modifying the slope α of the PSD. By decreasing the slope α the nature of process changes and values separated by a given Δt become more similar. Some well known examples are given by $\alpha = -1$ (pink noise) and by $\alpha = -2$ (red noise); the latter corresponding to a random walk or Brownian motion.

自相关函数

$$ACF(\delta t) = \frac{\lim_{T \rightarrow \infty} \frac{1}{T} \int_{(T)} \Delta(t) \Delta(t + \delta t) dt}{\sigma_\Delta^2}$$

- See also Hurst parameter (Kelson 2014)

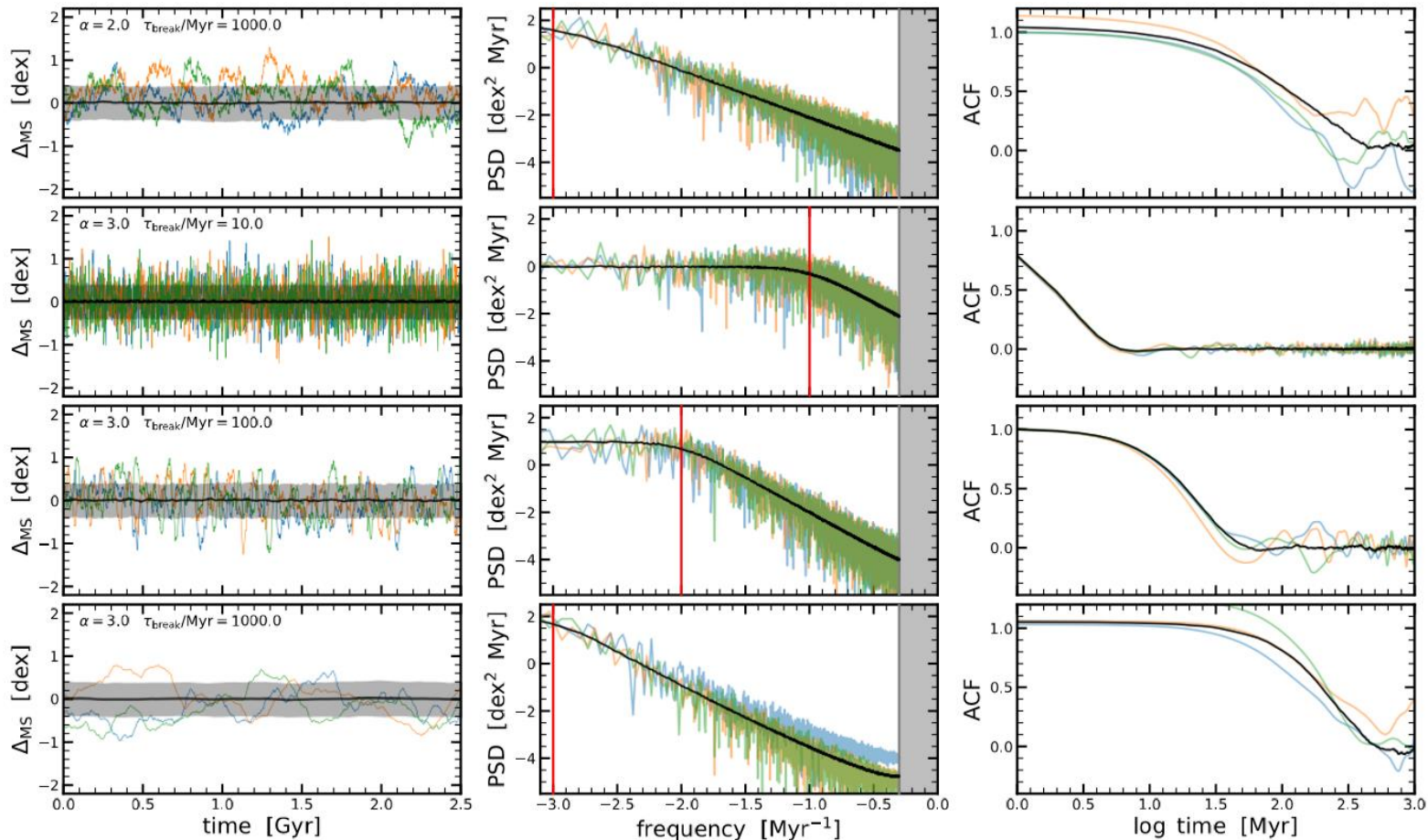
Damped random walk

$$ACF(t) = \exp(-t/\tau_{decor}).$$

$$PSD(f) = \frac{\sigma_{int}^2}{1/\tau_{decor}^2 + (2\pi f)^2} = \frac{\sigma^2}{1 + (\tau_{break} f)^2}.$$

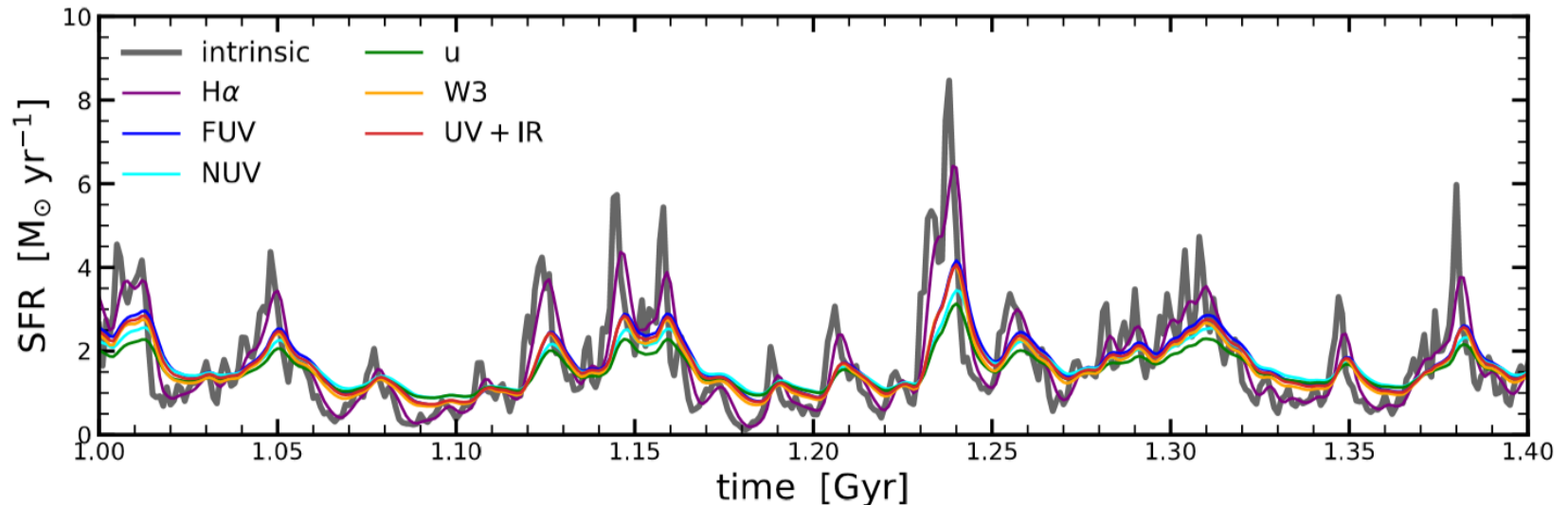
$$\tau_{break} = 2\pi\tau_{decor}$$

$$PSD(f) = \frac{\sigma^2}{1 + (\tau_{break} f)^\alpha}.$$

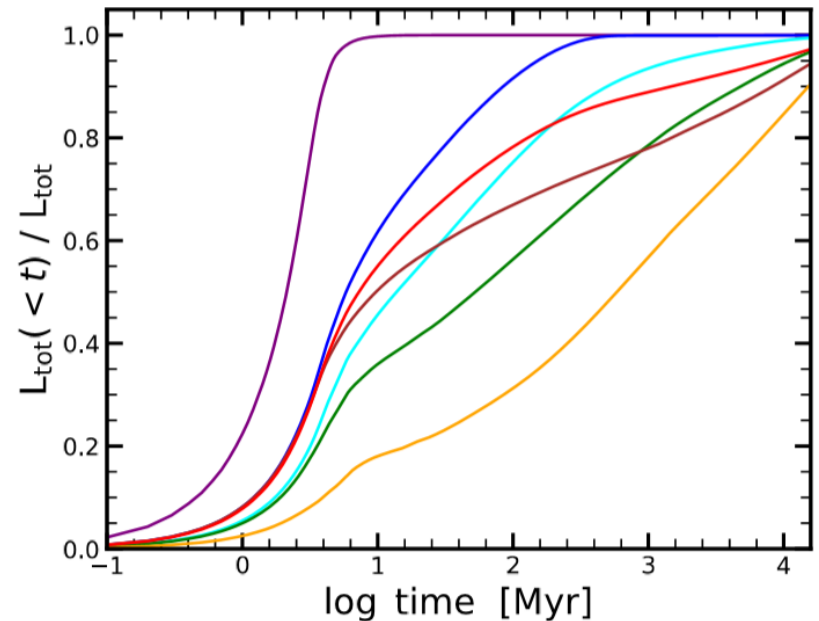
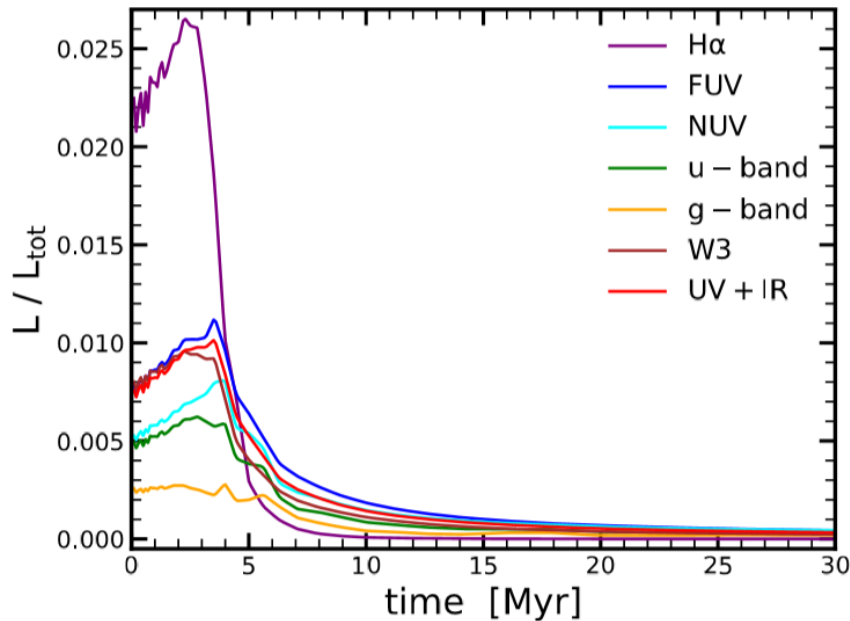


SFR: different indicators

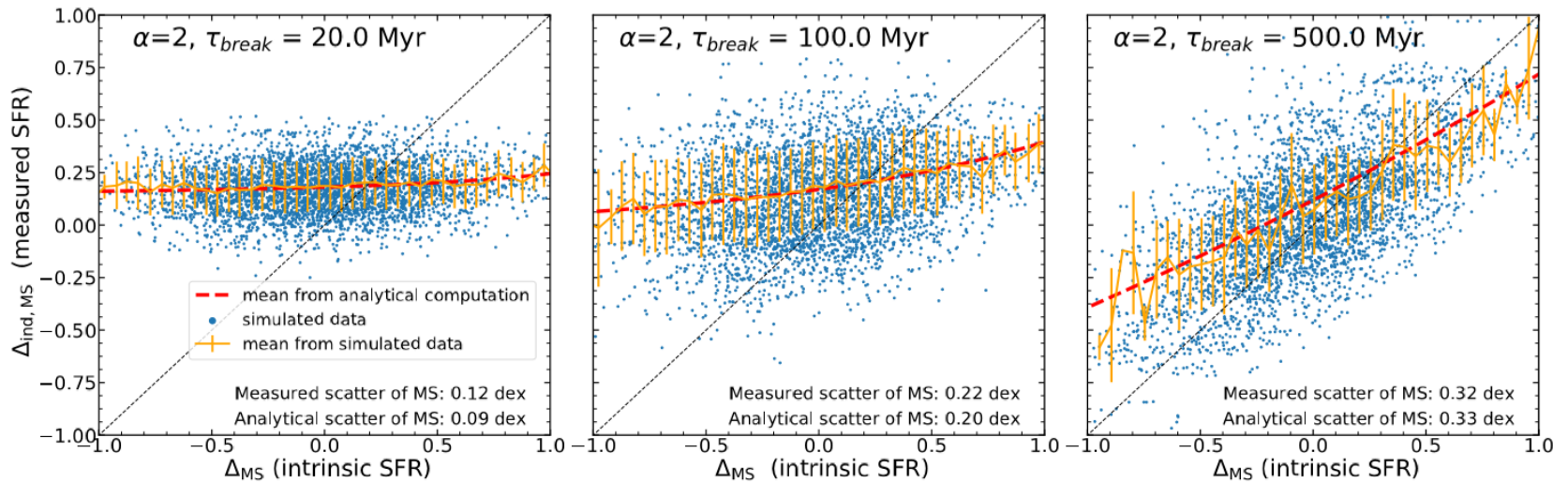
- H α : $\sim 10^6$ - 7 yr ($> 20 M_{\odot}$)
- FUV/NUV: $\sim 10^7$ - 8 yr ($> 3 M_{\odot}$)
- u band: $> 10^8$ yr

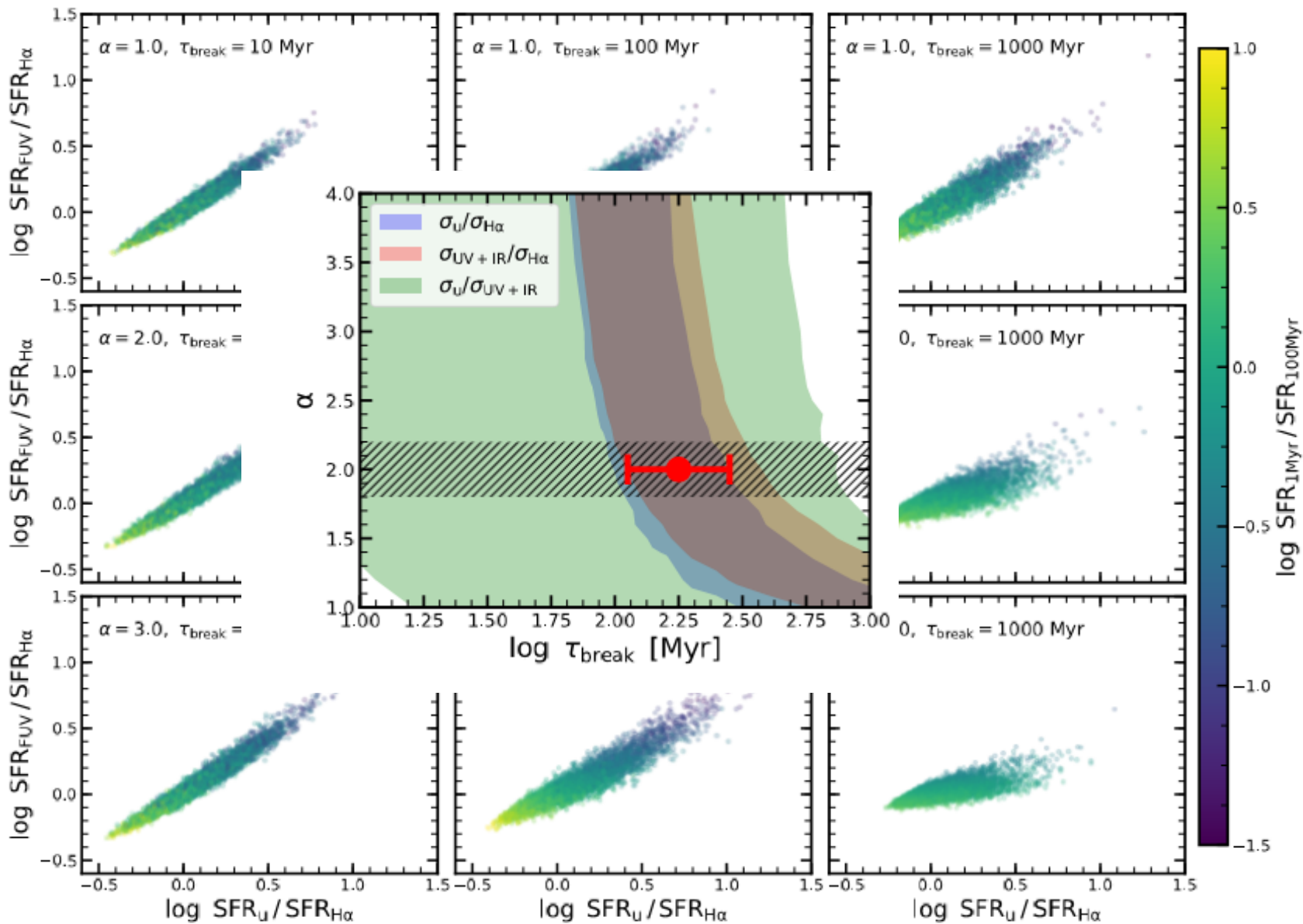


SFR: different indicators



Biased measurement





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