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A stochastic model to reproduce the star formation history of individual galaxies in hydrodynamic simulations

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Motivation

- SFH of galaxies encodes the information of physics in their growth
- Can we use a universal form to describe the shape of SFH of individual galaxy?
- Do different simulations share the same shape of SFHs?

Two parts form of SFH

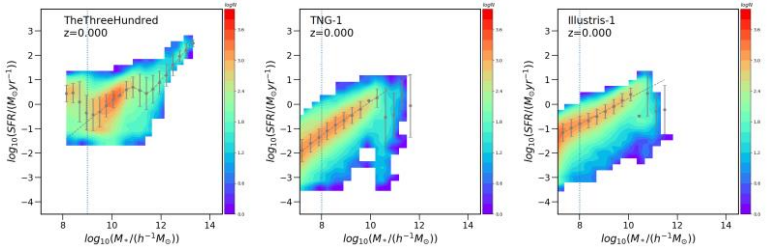
$$logSFR(t_L) = \Psi_{MS} + \Delta$$
$$= k(t_L)logM_*(t_L) + \Psi_0(t_L) + \alpha t_L + \beta + \mathcal{A} \times B_H(t_L)$$

Main Sequence Part — **Variation Part**

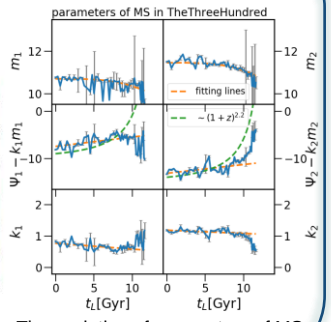
t_L: lookback time $\mathcal{A}$: random numbers follows $N(\mu_A, \sigma_A)$ B_H: fractional Brownian Motion with H parameter

Fitting the MS in simulations

$\Psi_{MS} = k(t_L)logM_*(t_L) + \Psi_0(t_L)$



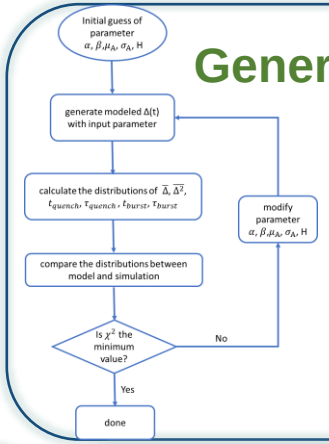
The contour of $SFR - M*$ distribution of galaxies at z = 0 in simulations TheThreeHundred (left), Illustris-1 (center) and TNG100-1 (right).

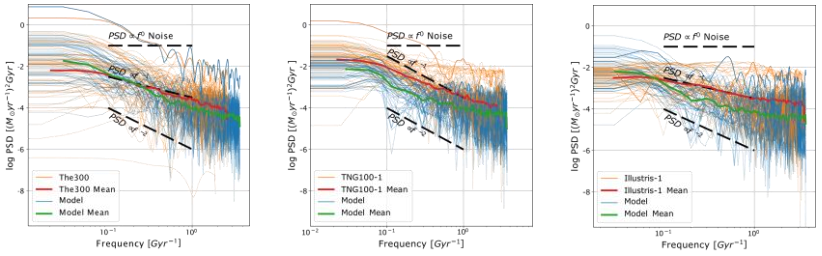


The evolution of parameters of MS of simulation TheThreeHundred

Generating variations following simulations

$\Delta = \alpha t_L + \beta + \mathcal{A} \times B_H(t_L)$

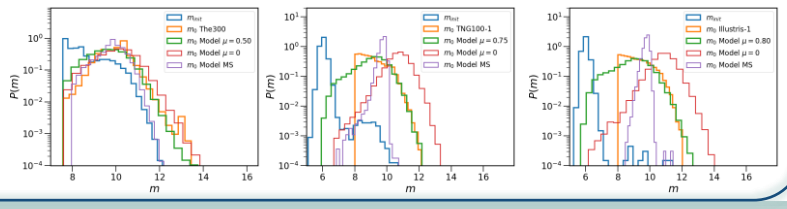




The PSDs of variations of each galaxies from simulations (orange lines) and models (blue lines)

Galaxy Formation model $\frac{dM_*}{dt_L} = -(1-\mu)10^{\Psi_{MS}+\Delta}$ μ: mass loss rate

- Modeled galaxy formation process can well reproduce the higher mass end of mass function at z=0



Conclusion

- The evolution of the MS varies among simulations
- Fractional Brownian motion can reproduce many features of SFHs, but it can not recover all features
- The variations and mass-loss rate is crucial for reconstructing the SFHs

Details are referred to the paper DOI: 10.1093/mnras/stac1956

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