The formation rate and luminosity function of fast radio bursts

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Summary

- Sample: non-repeating FRBs from the first CHIME/FRB catalog.
- Method: Lynden-Bell's c^- method.
- Result
  - A relatively strong luminosity evolution. The luminosity function of FRBs can be well fitted with a broken power-law model.
  - The formation rate decreases rapidly,with similar to the GRBs.
  - FRBs are associated with older stellar populations.

Introduction

- **what is the source of FRBs?**
  - old neutron stars
  - binary neutron star (white dwarf) mergers
  - neutron star Colliding/black hole?
  - Exploding/colliding stars?
  - Colliding neutron stars?
  - Bursting magnetars?
  - Comets/asteroids impacting neutron stars?
  - Evaporating black holes?

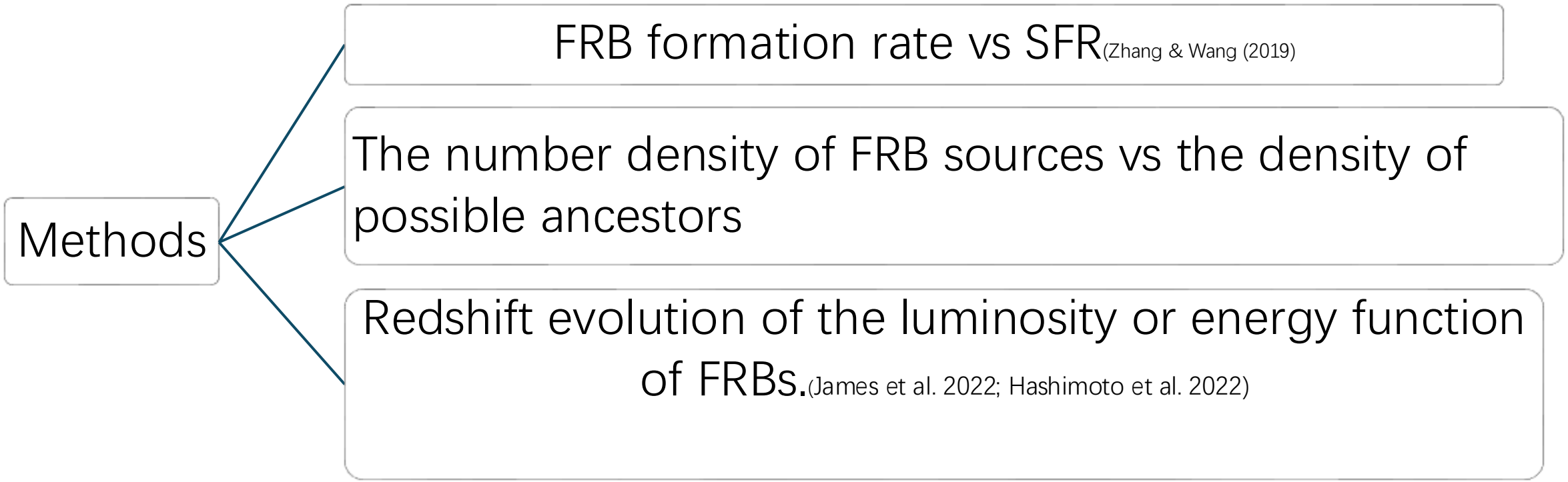
Introduction

- **Observationally**
  - **FRBs: repeaters and non-repeaters.**
  - Some FRBs are produced by magnetars(Death of massive stars),eg.,FRB 20200428, FRBs follow the star formation history(SFR).
  - Some FRBs are related to ancient star populations ,eg.,FRB 20200120E, FRBs do not follow the SFR.

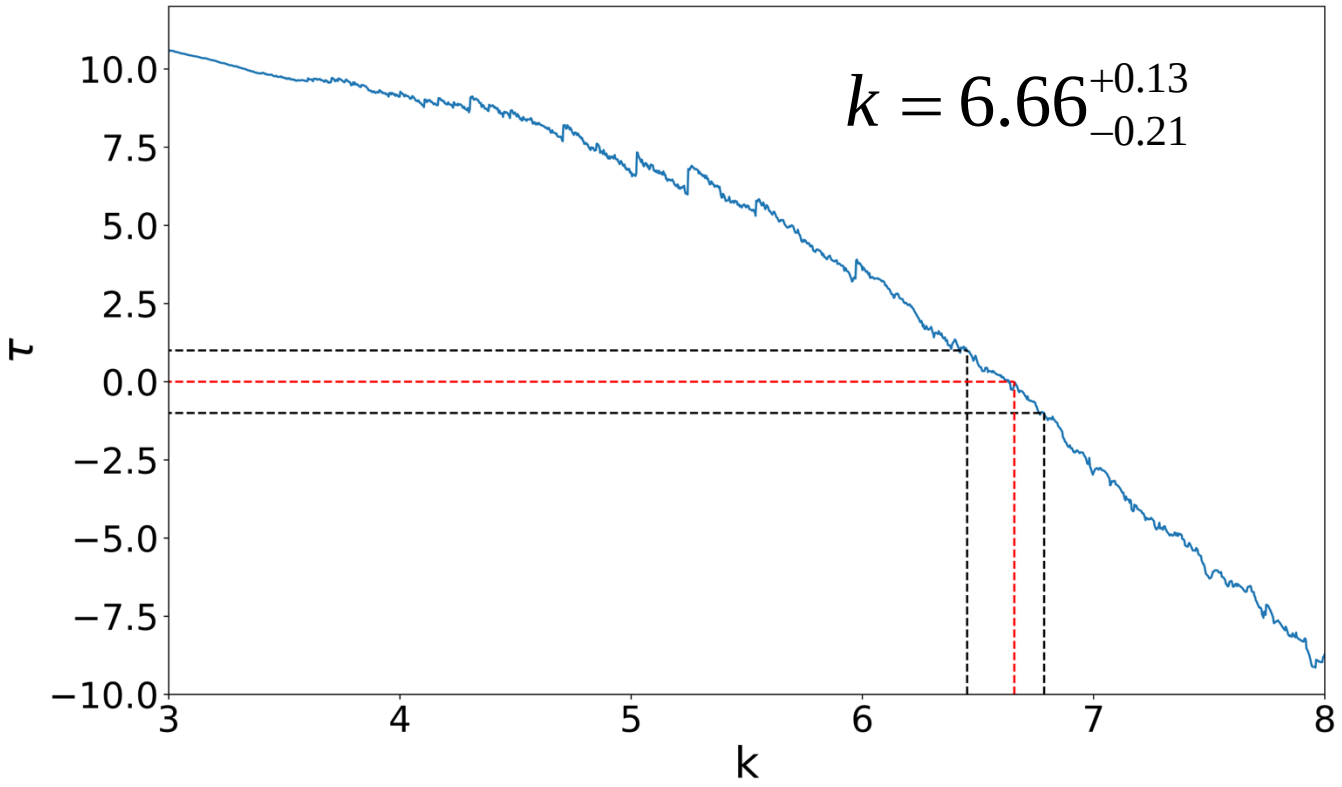
Research questions: Unveiling the Physical Origin of FRBs.

Introduction

●Related Methods



Result:

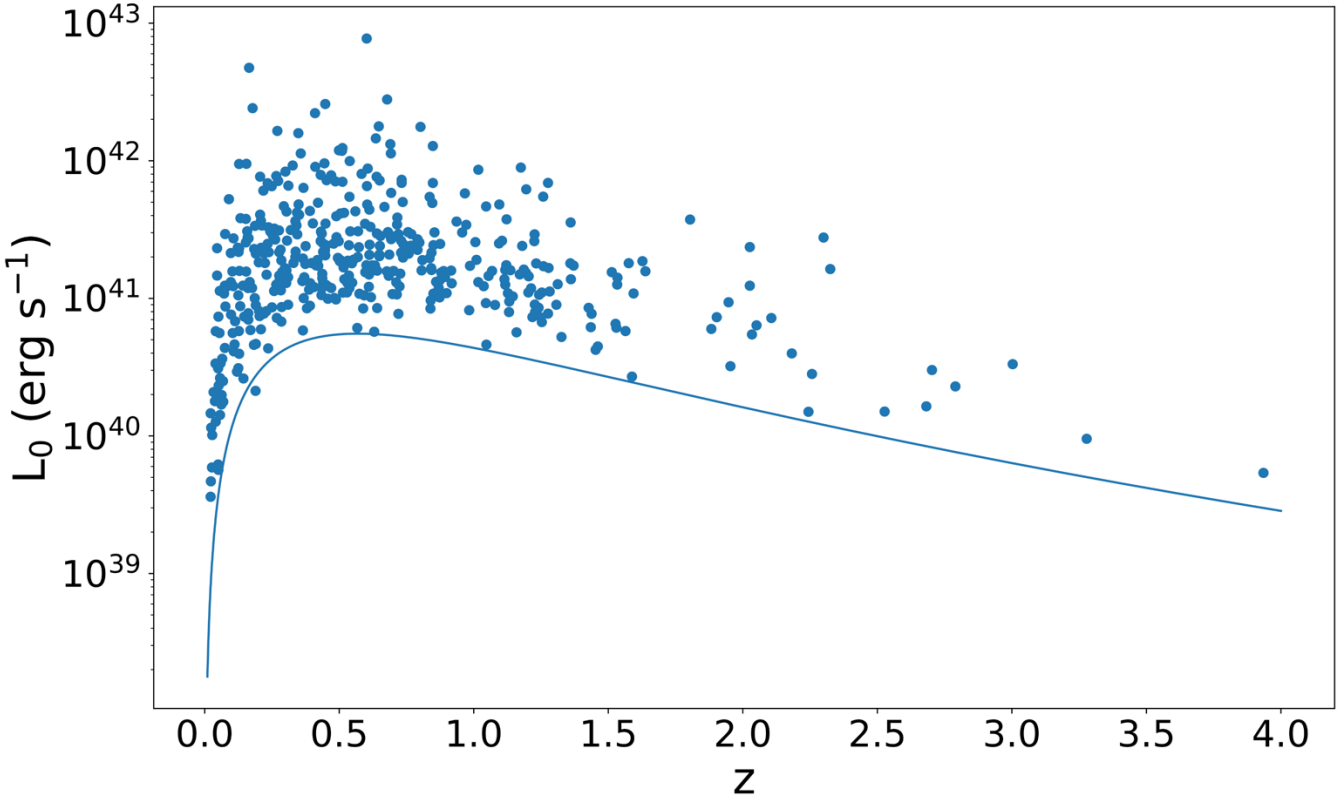


Luminosity-redshift distribution

The degeneracy between the luminosity function and formation rate.

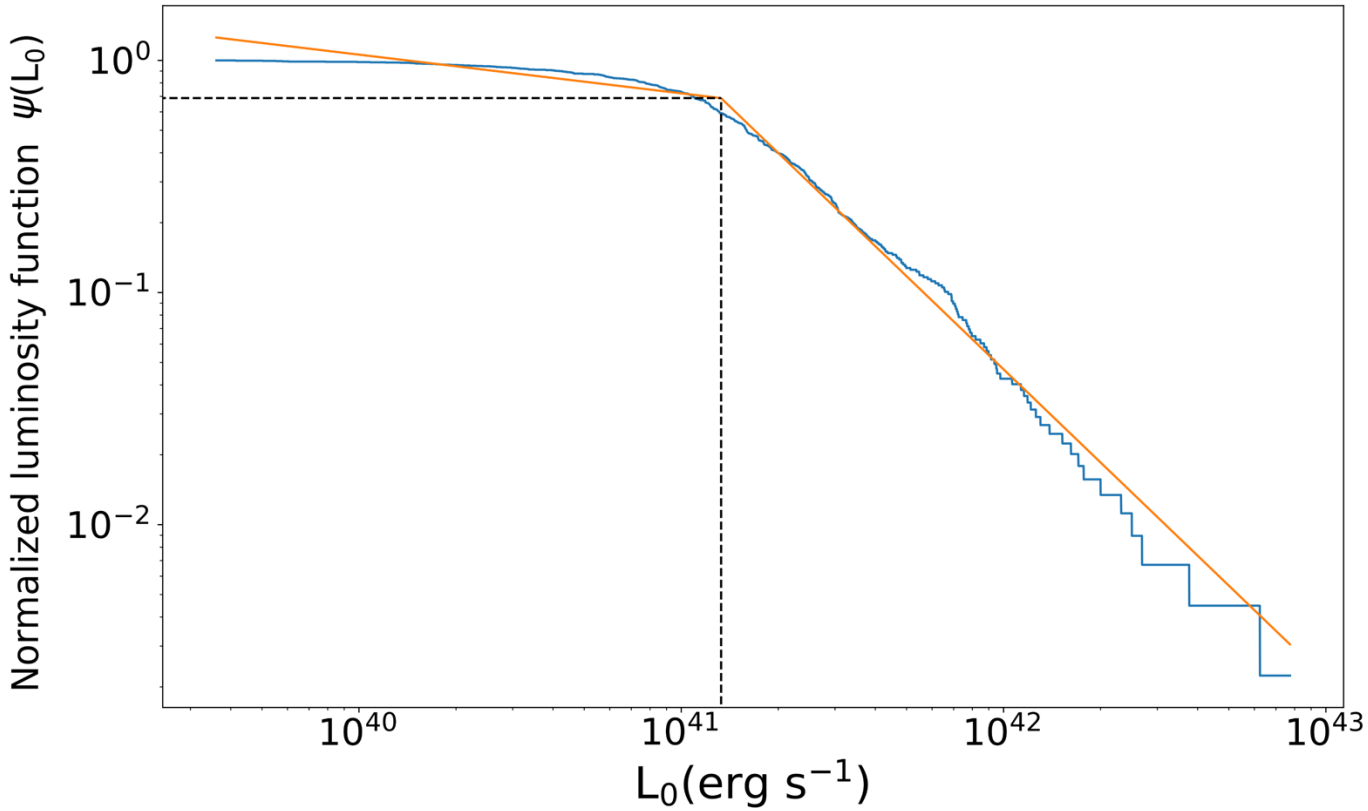
$$\begin{cases} \Psi(L,z) = \psi_z(L)\phi(z) = \psi\left(L_0\right)\phi(z) \\ L_0 = L / g(z), \quad g(z) = (1+z)^k \end{cases}$$

Result:



Non-evolving luminosity-redshift distribution

Result:

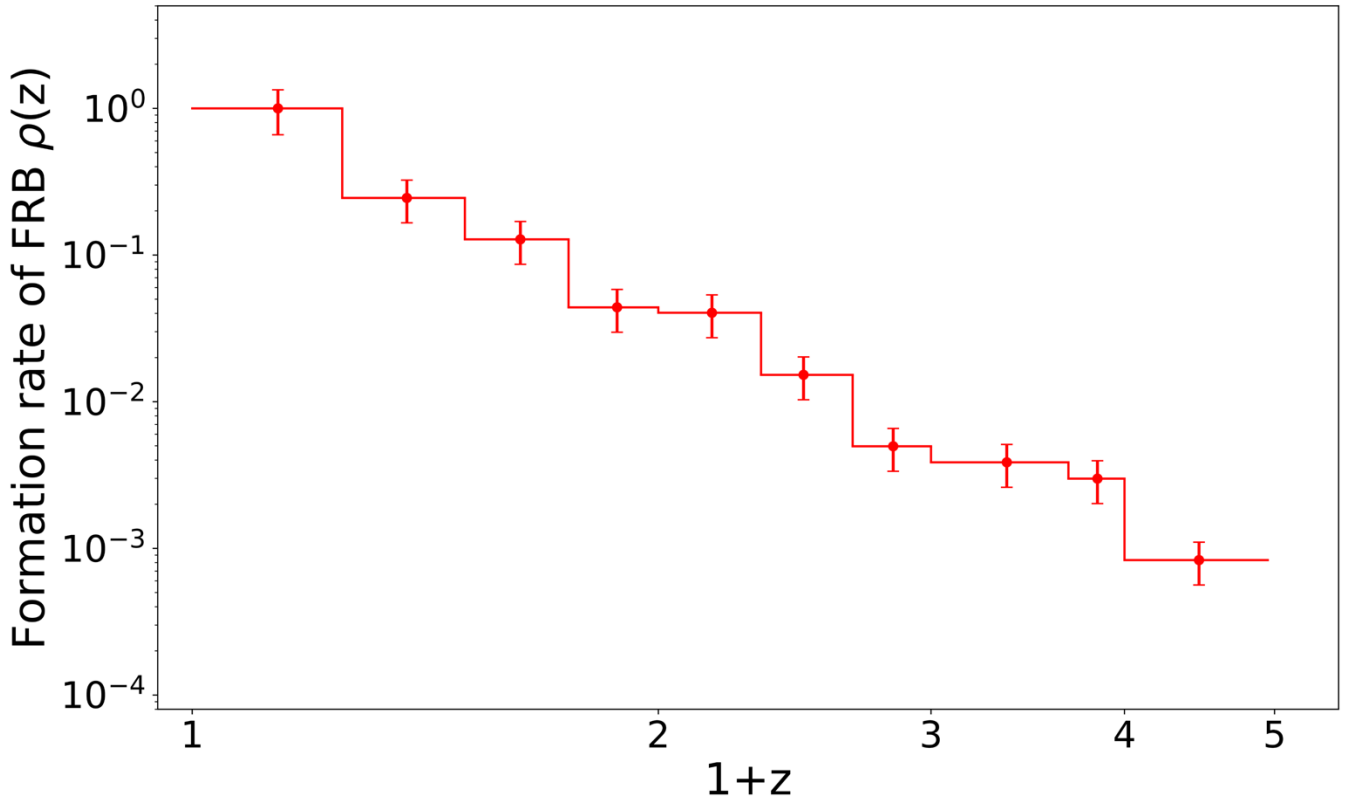


$$\psi(L_0) \propto \begin{cases} L_0^{-0.17\pm0.01} & L_0 < L_0^b \\ L_0^{-1.33\pm0.01} & L_0 > L_0^b \end{cases}$$

$$L_0^b = 1.33\times10^{41}\,\mathrm{ergs}^{-1}$$

Cumulative luminosity function

Result:

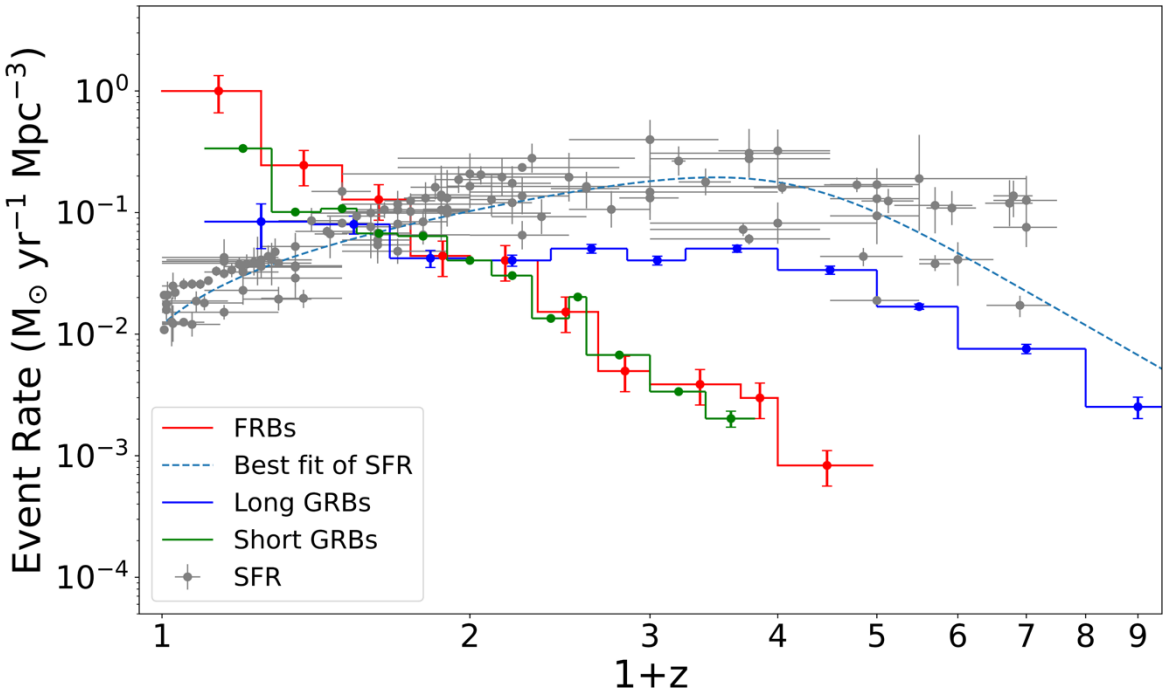


$$\rho(z) \propto (1+z)^{-4.9\pm0.3}$$

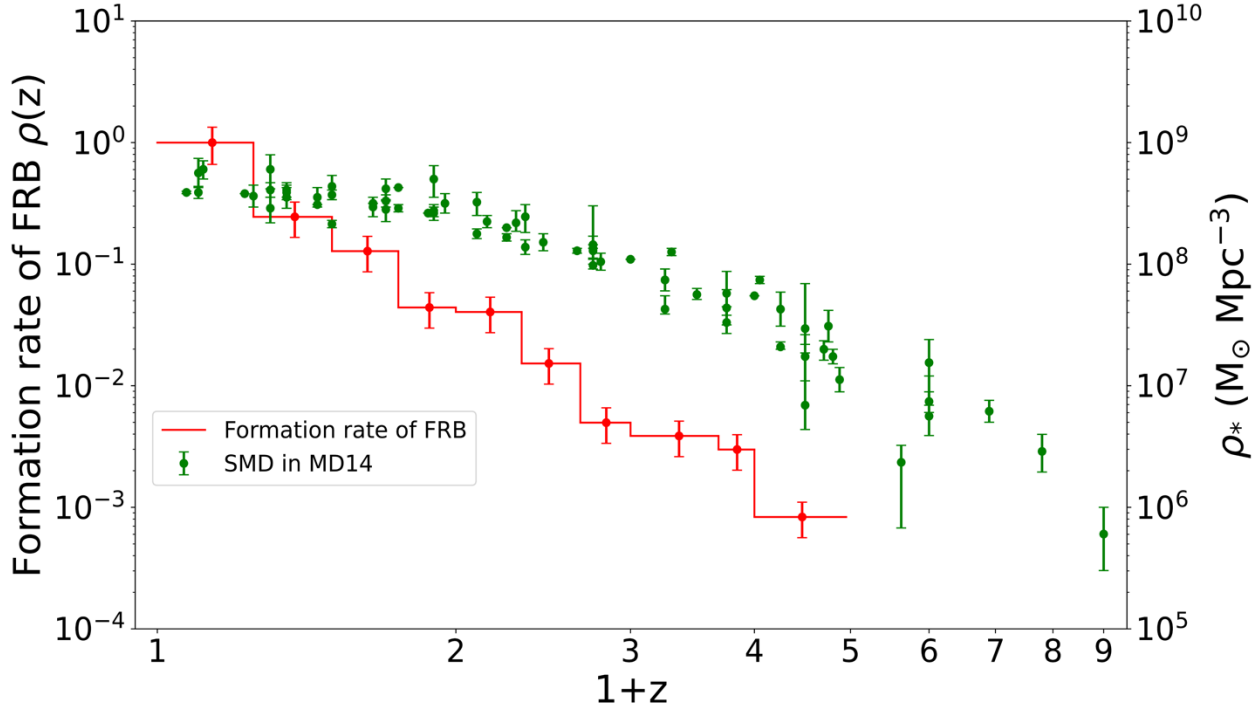
Comoving formation rate ρ(z) of FRBs.

Result:

1. FRB rate deviates from SFR, with a similar redshift dependence as short GRBs.
2. They show similar decreasing trend at z > 1.0.



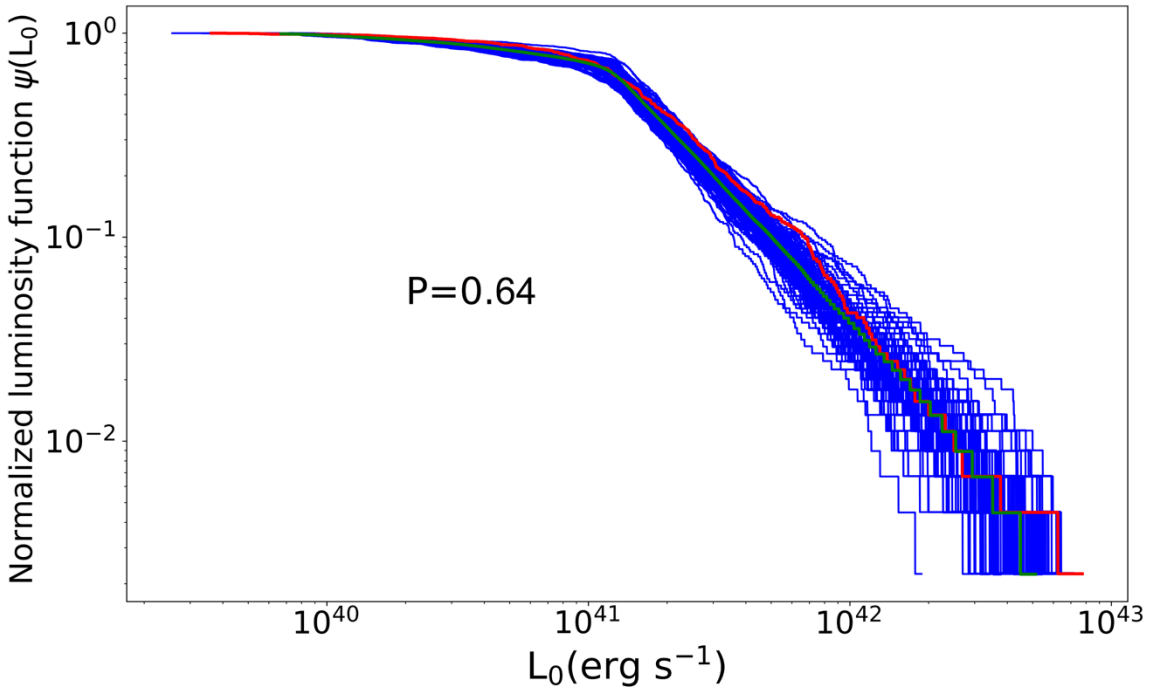
FRB formation rate vs other events.

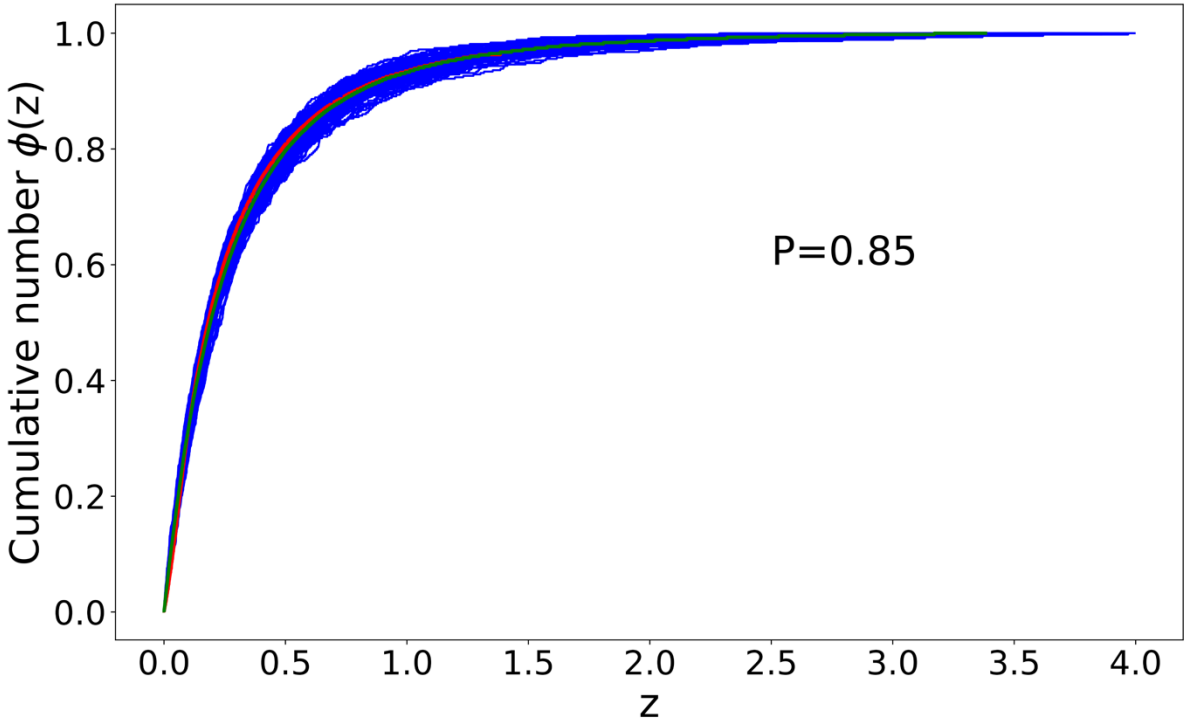


FRB formation rate vs the observed SMD.

Result:

Monte Carlo simulation





Comparison between the formation rate of FRBs and other events.

Thanks for your listening!

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