

The hints to the origin of different log-normal luminosity distributions for repeating and non-repeating fast radio bursts

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Summary: We investigated radio luminosity distribution of the two samples of fast radio bursts (FRBs) from FRB Catalogue and CHIME/FRB catalog 1. Applying statistical methods, we found that the repeaters and non-repeaters have different statistical distributions, and log-normal form is proper for them. These results imply that repeaters and non-repeaters may both originate from the neutron stars (NSs) like outbursts on magnetars or supergiant pulses, but they have different mechanisms or physical processes.

Introduction

Basic information: Fast radio bursts (FRBs) are extremely strong radio flares lasting several milliseconds, most of which come from unidentified objects at a cosmological distance (Lorimer et al., 2007; Cordes & Chatterjee, 2019).

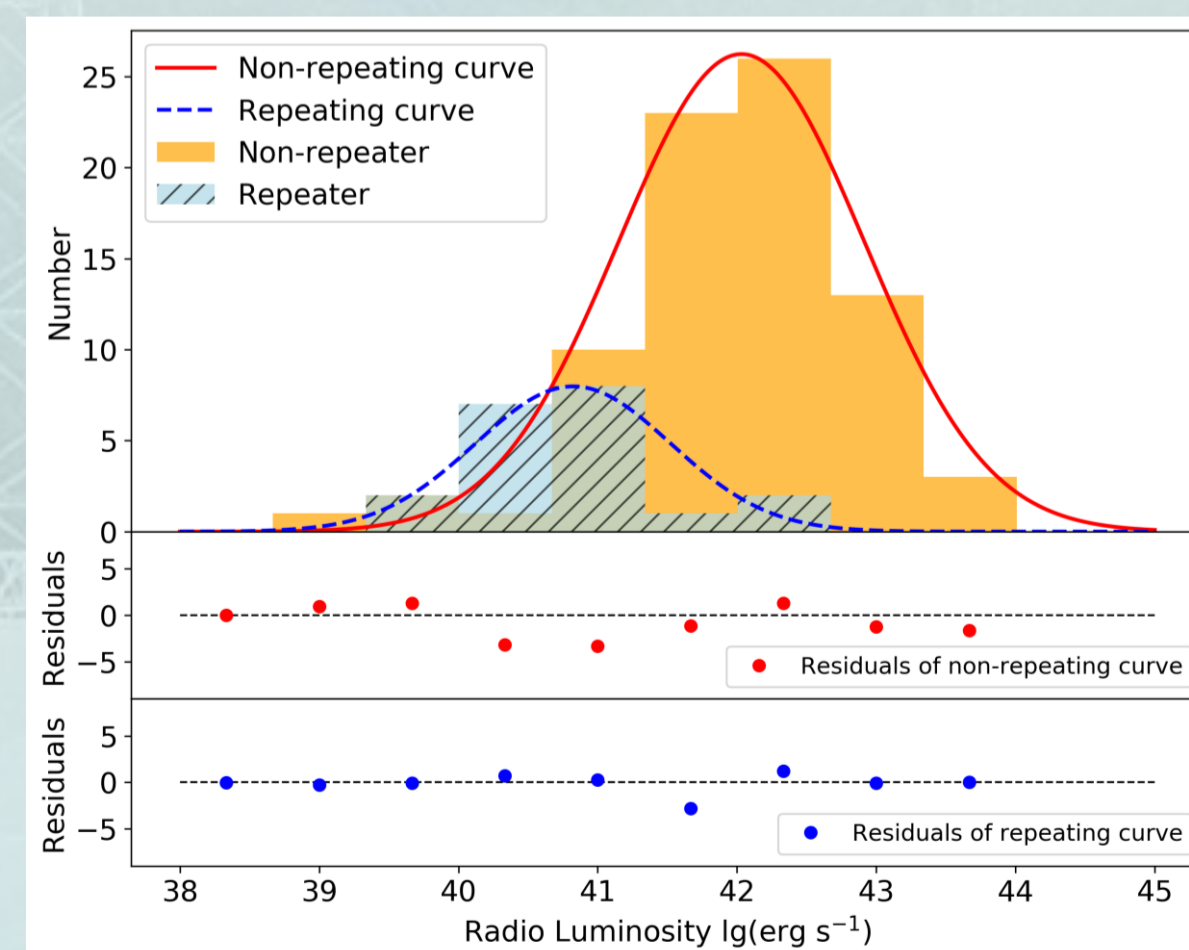
Statistical Methods: Kolmogorov–Smirnov (K-S) and Mann–Whitney–Wilcoxon (M-W-W) tests are used to compare the radio luminosity distribution of repeaters and non-repeaters. Anderson–Darling (A–D) method is used to test log-normal features.

Conclusions:

1. Log-normal luminosity distribution support the **neutron star origin models**.
2. Repeaters and apparent non-repeaters may be from **different types of neutron stars or processes**, like outbursts on magnetars or supergiant pulses.

Test in FRB Catalogue

Through statistical testing, as well as drawing histograms, fitting curves, and residual plots, we found that the radio luminosity of repeaters and non-repeaters both conform to the log-normal distribution (Cui et al., 2021a,b). But the two groups have different statistical distributions under K-S and M-W-W tests.

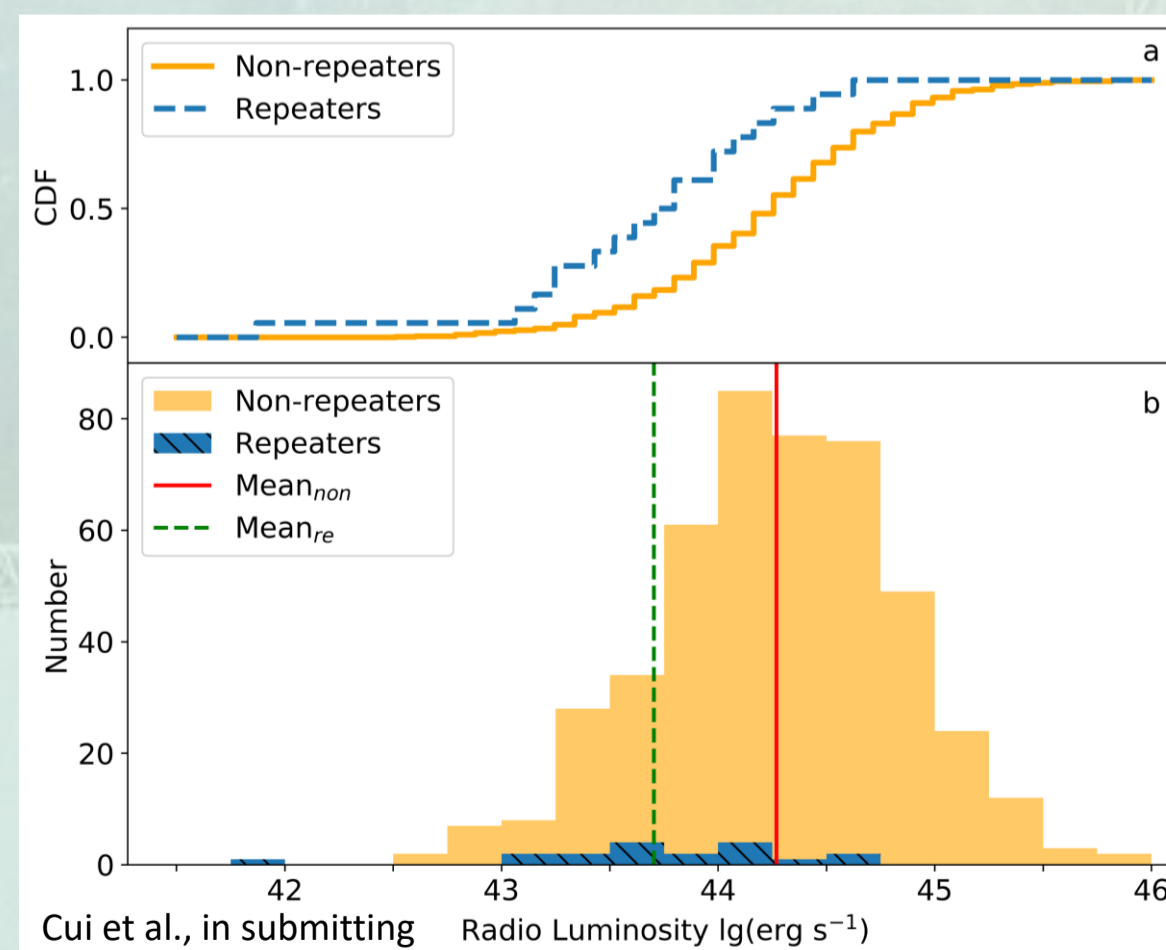


References:

Cordes J. M., Chatterjee S., 2019, ARA&A, 57, 417
Cui X.-H. et al., 2021a, MNRAS, 500, 3275

Test in CHIME/FRB catalog 1

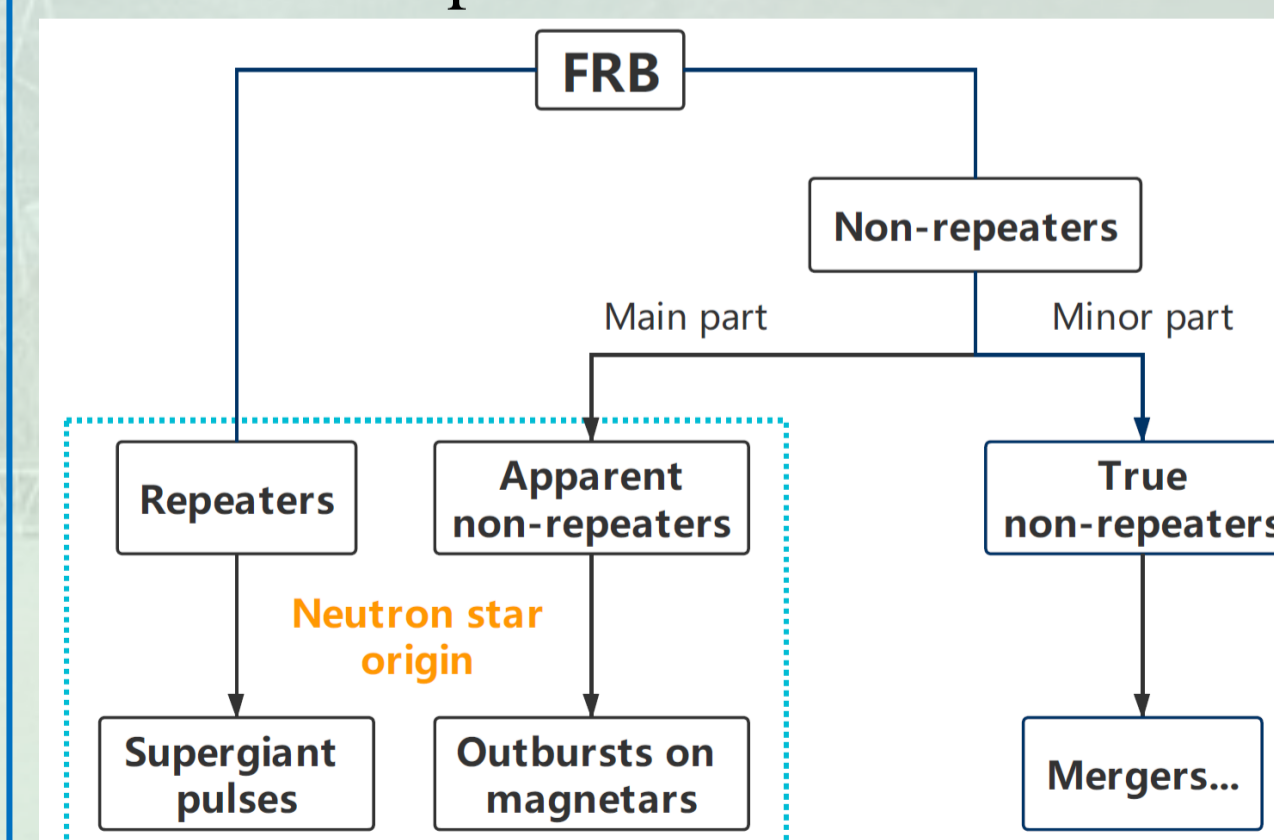
We used the latest CHIME data (The CHIME/FRB Collaboration et al., 2021) to re-examine the luminosity distribution that was estimated by the Macquart relation (Macquart et al., 2020). The results are consistent with the previous conclusions based on K-S and M-W-W tests.



Cui X.-H. et al., 2021b, RAA, 21, 211
Lorimer D. R et al., 2007, Science, 318, 777
Macquart J.-P. et al., 2020, Nature, 581, 391

Constraint on FRB models

The luminosity distribution of repeaters and non-repeaters are all in log-normal form, implying that they may both originate from NSs. However, different distributions hint that the two groups may be from different types of NSs. Meanwhile, we can't rule out the merger origins of non-repeaters, but it is certain that they are a minor part.



Inspired by Zhang, 2020

The CHIME/FRB Collaboration et al., 2021, arXiv:2106.04352
Zhang B., 2020, Nature, 587, 45