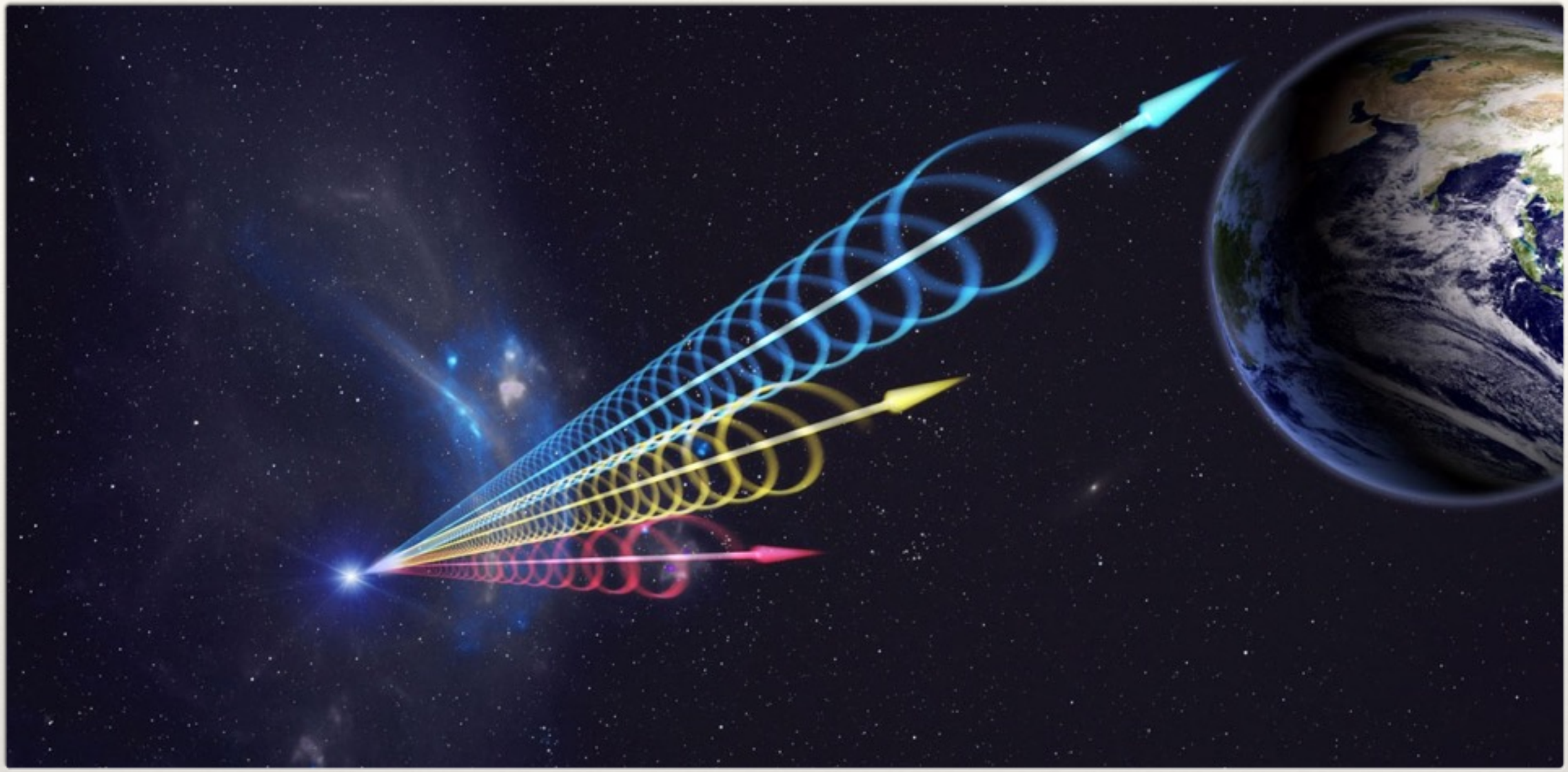

Fast Radio Bursts (FRBs)

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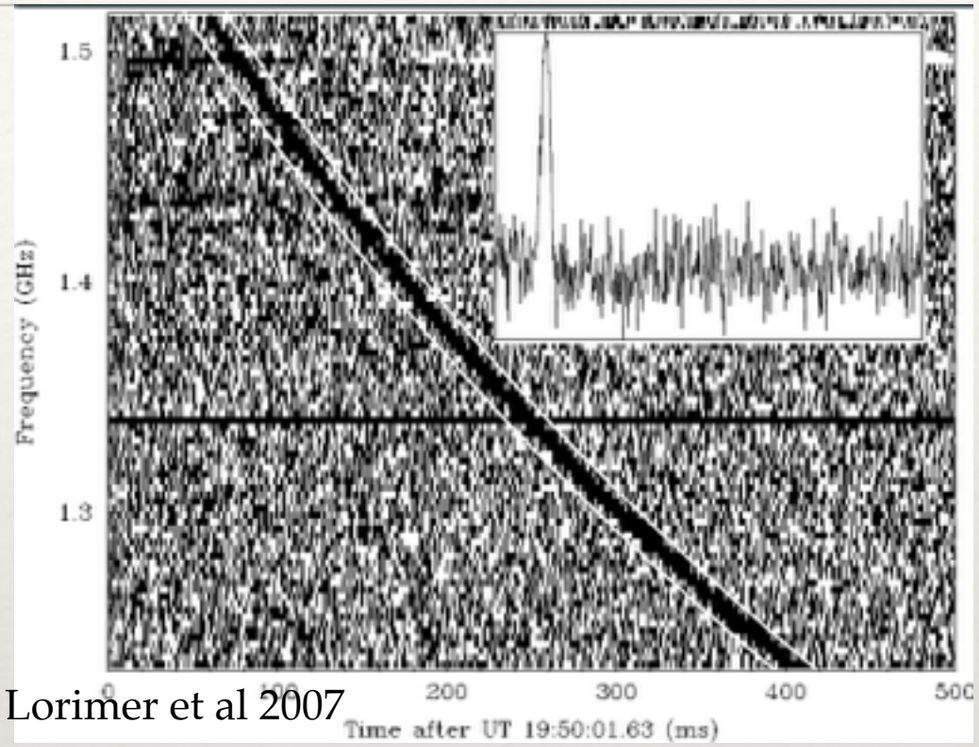
Outlook

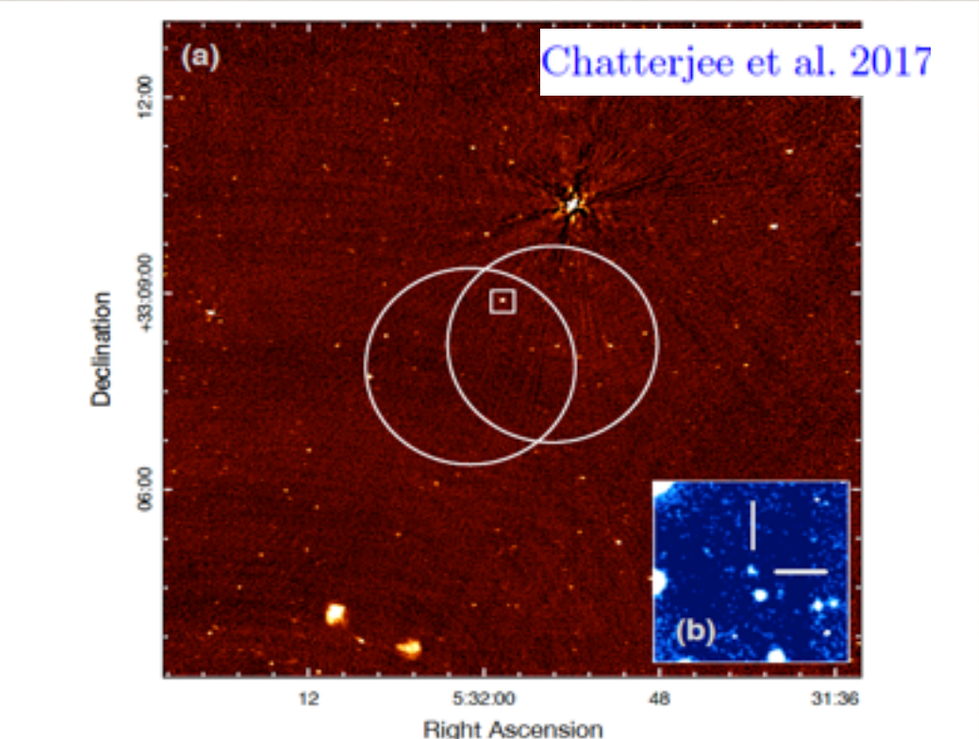
- What do we know about Fast Radio Bursts?
- What do think we know!
- How can we understand FRB source and their evolution?
- Is Repeating FRB 121102 representative for FRBs?
- Can we test FRB progenitor models?
- Do we see any high energy counterparts to FRBs?

Fast Radio Bursts -What do we know?

- Mysterious, milli second duration radio transients;
- First FRB was discovered by Prof Duncan Lorimer and his student David Narkovic in 2007 - Lorimer Bursts
- So far, 26 bursts have been discovered and 21 bursts reported
- 80% are high galactic plain;
- High dispersion - 200 - 1600 pc/cc
- Pulse widths - 0.3 - 10 ms
- Ridiculously bright: Flux ~ 0.2 - 30 Jy, Fluence ~ 1.04 - 150 Jy ms;
- Luminosity - 10^{44} erg/s - no known source population
- Four FRBs were detected at 800 MHz - wide spectrum;
- FRB 121102 found repeating and potential host galaxy identified at z ~ 0.2;
- Potential host galaxy identified at z ~0.49 for FRB 150418!

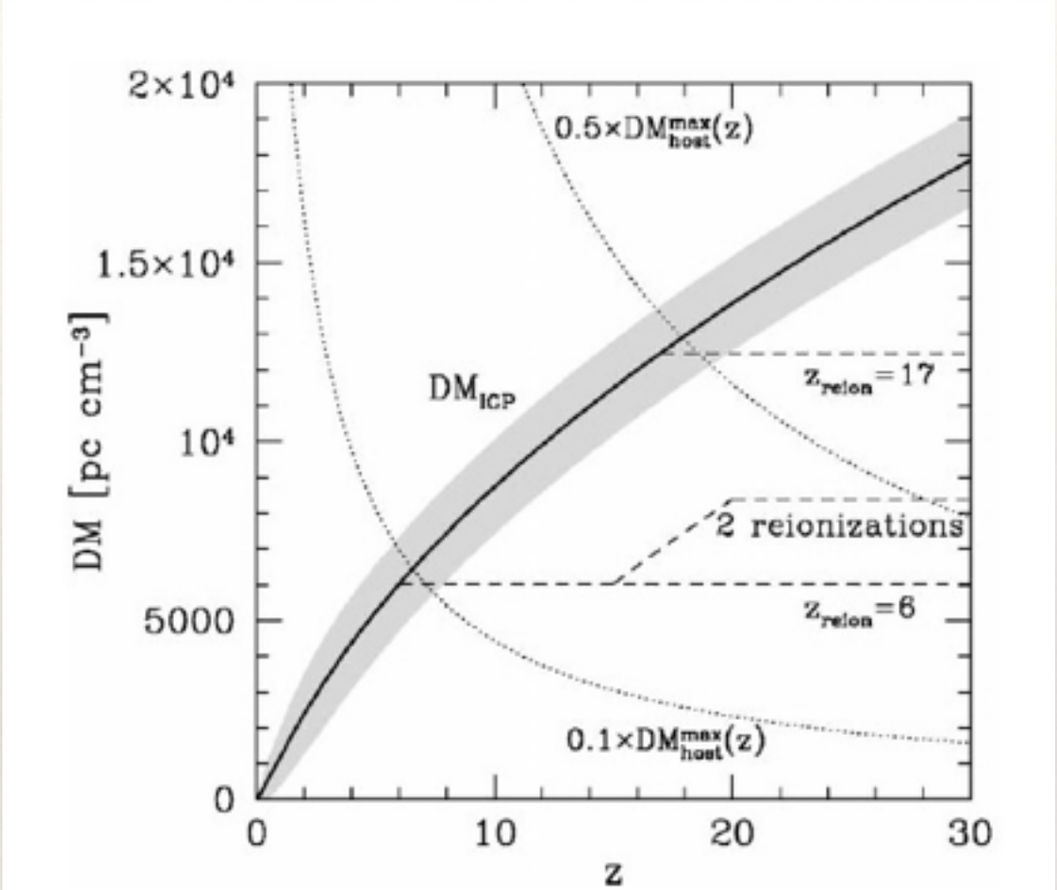


Lorimer et al 2007



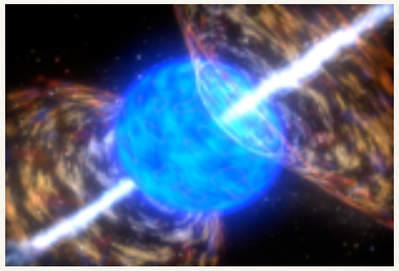
What do we think we know!

- Two classes of FRBs - repeating and non-repeating
- Based on measured DM the redshift are estimated to be around 0.1- 1.3 (distance 1-5 Gpc)..cosmological?
- Estimated FRB rate ~ 5000 /sky/day
- Luminosity - 10^{44} erg/s..can be used as standard candles?
- Non-repeating FRBs could be from catastrophic events from distant galaxy?
- Neutron stars are possible progenitor for repeating FRBs?

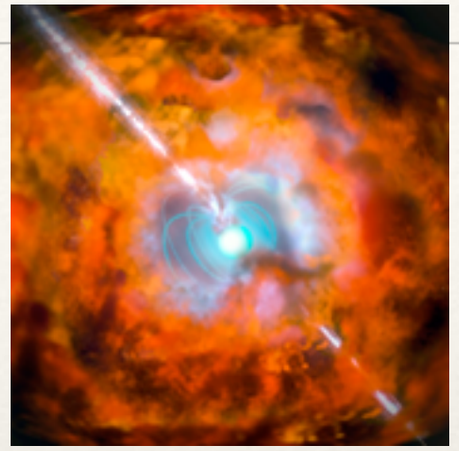


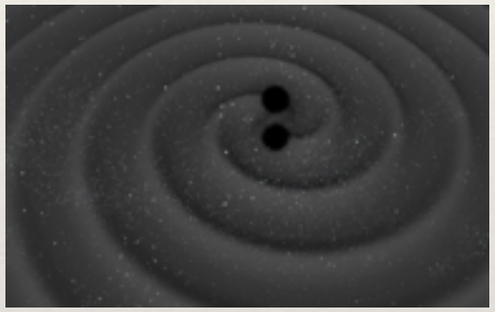
$$\mathrm{DM_{IGM}} = \frac{3cH_0\Omega_b f_{\mathrm{IGM}}}{8\pi G m_p} \times \int_0^z \frac{\left[\frac{3}{4}y_1\chi_{e,\mathrm{H}}(z) + \frac{1}{8}y_2\chi_{e,\mathrm{He}}(z)\right](1+z)dz}{[\Omega_m(1+z)^3 + \Omega_\Lambda]^{1/2}}.$$

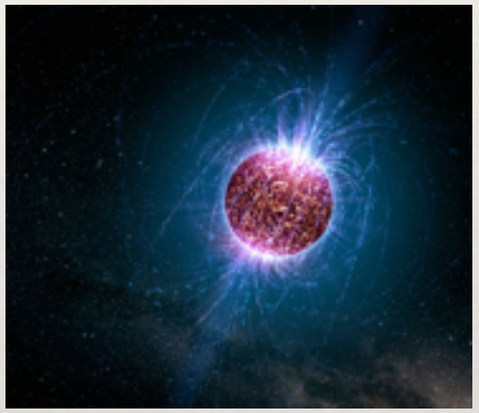
What could FRBs be?

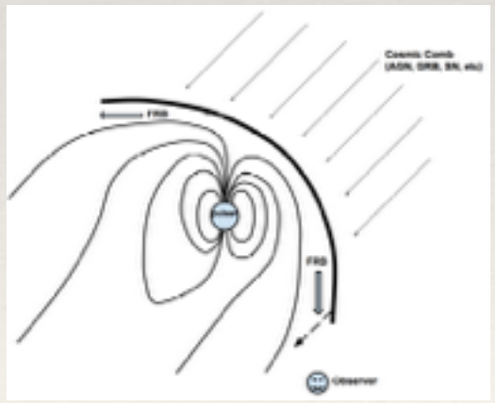


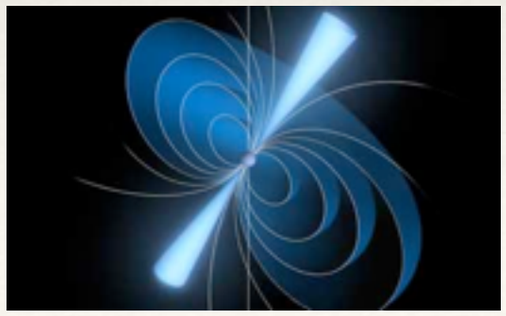
- FRB progenitor are yet to be identified and is highly debated topic;
- There are more progenitor models than FRBs!
- Except for one FRB, no other FRBs have been detected to repeat;
- Even though we are looking for one single type of progenitor may explain all the FRB, their might be multiple progenitors;











How can we understand FRB source and their evolution?

In order to understand the progenitor system of the FRBs and their evolution, we need to constrain the distance, energy distribution and emission spectrum of FRBs- two ways

1. Radio telescopes should be able to localize the FRB with high angular resolution to get a better estimates on distance, energy distribution, emission spectrum and event rate;

2. Alternatively, one could consider ensemble properties of observed FRBs and compare them to simulated FRBs.

Results

- The observed DM, Flux and pulse widths are generally consistent with the cosmological models (see also Caleb et al.(2016));
- All the three redshift models can be made to verify the observational constraints;

In Prep..

A Test of Cosmological Models of Fast Radio Bursts

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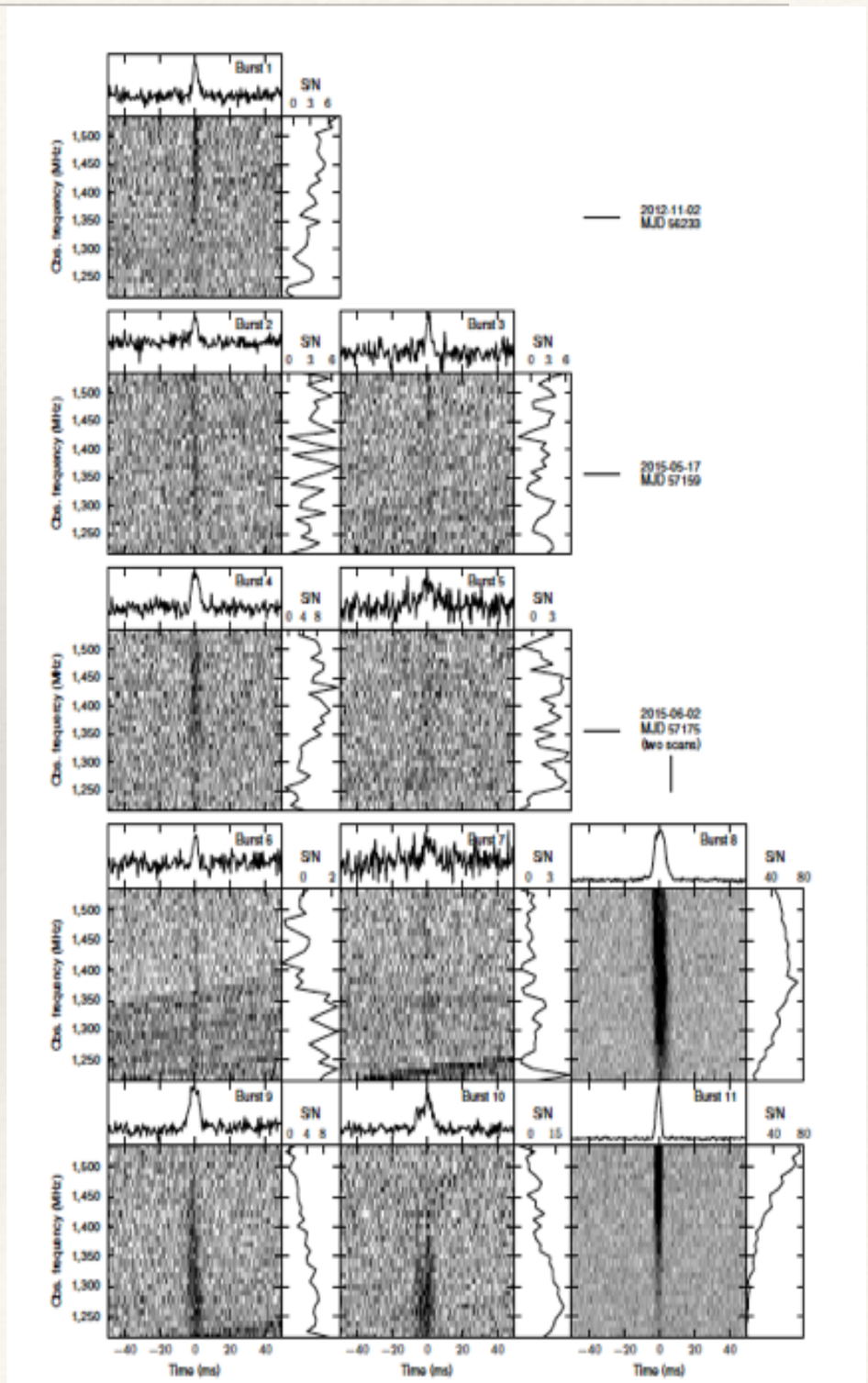
ABSTRACT
Fast Radio Bursts (FRBs) are mysterious millisecond-duration transient radio bursts. The large dispersion measure (DM) of FRBs and especially the identification of the host galaxy of FRB 121102 at $z = 0.193$ firmly established the cosmological origin of FRBs. The physical origins and progenitors of FRBs, however, remain a puzzle and a highly debated topic. Proposed progenitor models range from young pulsars or magnetars that track star formation history of the universe, mergers of compact stars that have a delay with respect to star formation, and the events without significant cosmological evolution. In this paper, we test the cosmological origin of FRBs using the observational data and attempt to constrain the energy and redshift distributions of FRBs using Monte Carlo simulations. By confronting the model predictions with the observed peak flux, pulse width, and DM distributions, we discuss compatibility of three redshift-distribution models (no evolution, tracking star formation history, and compact star mergers) with the observational data. We find that with the limited data, all cosmological models can be made to be consistent with the data, with each model having different preferred values of the spectral index α and the energy-distribution index α_E. Future observations may pin down these parameters, and hence, provide better constraints on the redshift distribution models of FRBs.

Key words: Fast Radio Bursts, Cosmological population.

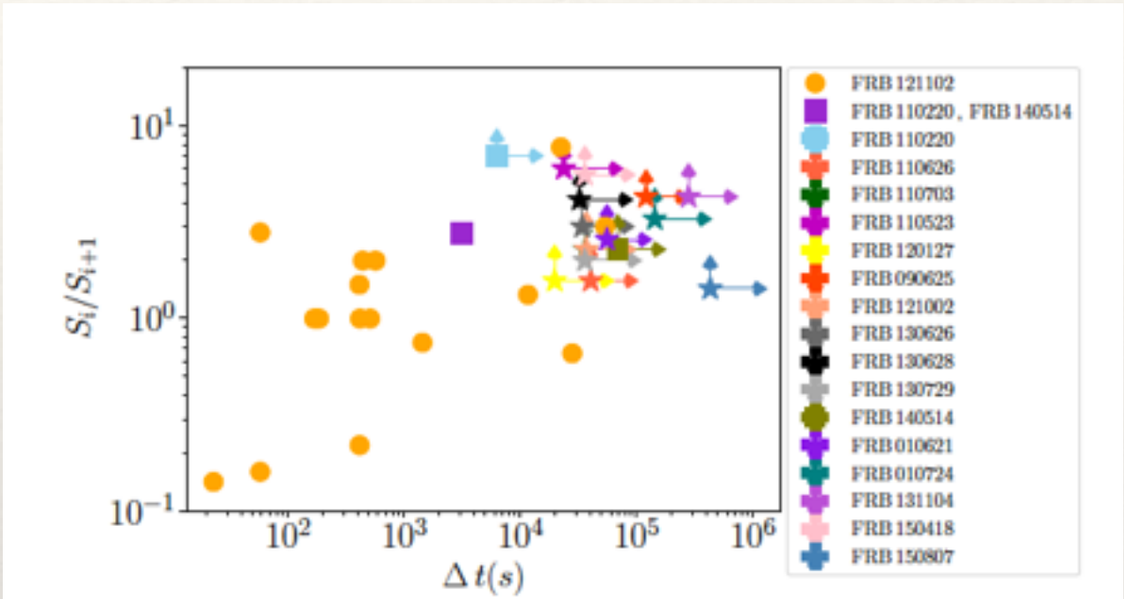
Is Repeating FRB 121102 representative for FRBs?

- Repeating FRB 121102
- 100+ bursts found
- Clustered in time, with long duty cycle
- Pulse width with varying width and structure
- Detected from 5 GHz - 1.4 GHz
- Localized to a host galaxy (z~0.2)!



Non-Repeating FRBs

- Several hours of follow-up observation - no other FRB seem to repeat;
- Yet it is being speculated that FRB 121102 is prototype for FRBs;
- If they are similar, other FRB should show similar repeating patrons;
- We compare the repeater with other FRBs in the observed time interval - flux plane phase;
- We think that repeater may have a different progenitor system from other FRBs or if it shares same progenitor then it must be unusually active
- In any case, FRB121102 is not a representative of FRBs



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IS THE REPEATING FRB 121102 REPRESENTATIVE OF FRBS?

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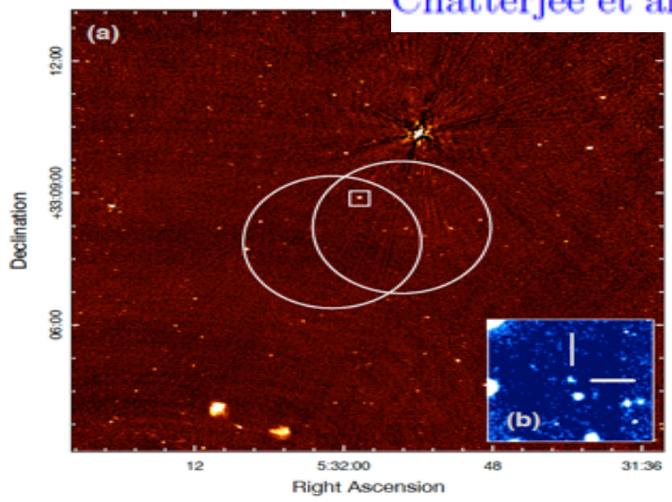
Can we test FRB progenitor models?

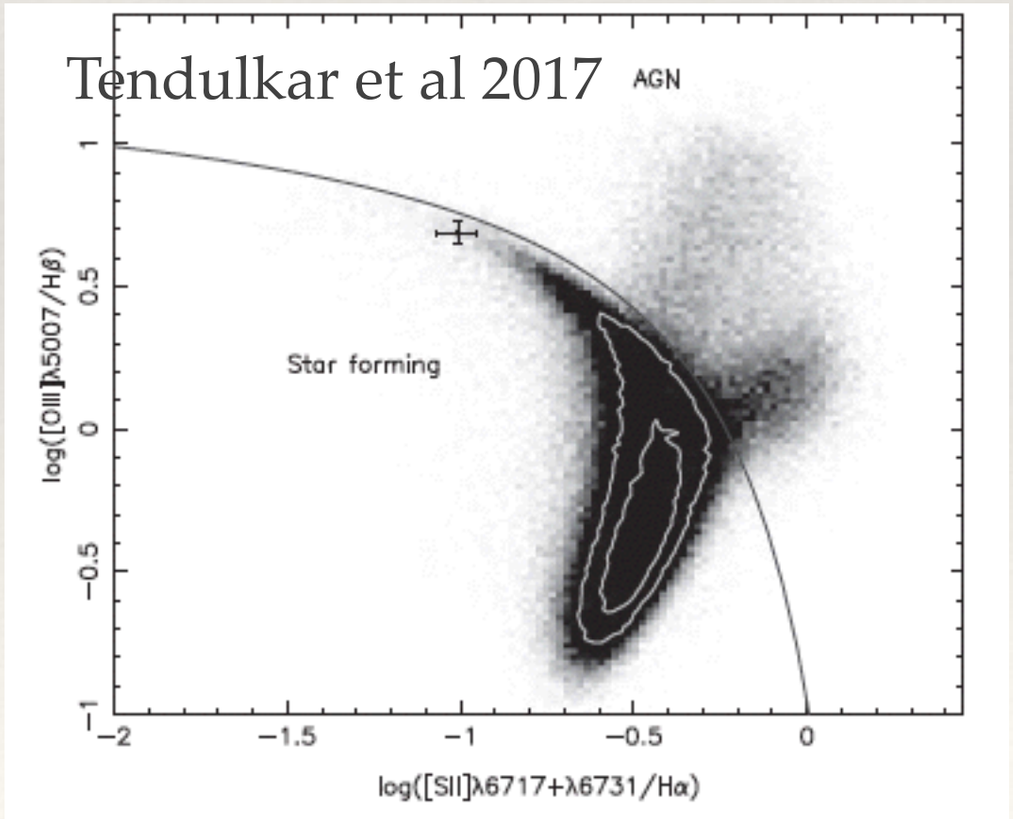
- The sub-arcsecond localization of the repeating FRB revealed its coincidence with a dwarf galaxy at a redshift of z=0.193 and a steady (`quiescent') non-thermal radio source;

Chatterjee et al. 2017



- The star forming host galaxy of FRB 121102 suggests a possible connection between FRBs and death of massive stars;
- Based on repetition and energetics of FRB 121102, one possibility is that source is a new-born millisecond pulsar or an magnetar;

Tendulkar et al 2017



Do we see any high energy counterparts to FRBs?

- So far no significant MeV/GeV emissions were detected;
- Further more sensitive analysis is being warranted;
- This summer we intend to look in to Eight years of Fermi-LAT data in all the FRB fields.

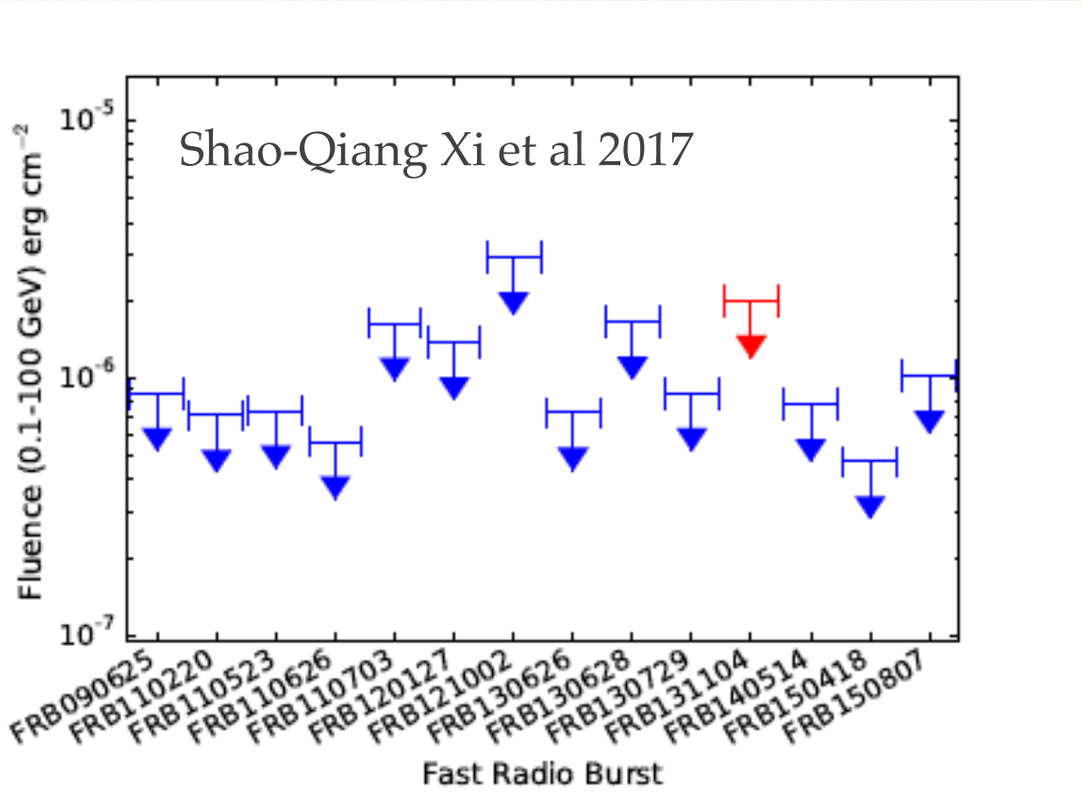


Fig. 1.— Upper limit fluence of each FRB in 0.1–100 GeV. The red one represents FRB 131104, which is possibly associated with the *Swift*/BAT transient.

Thank you