

FAST RADIO BURSTS

MYSTERIOUS PROBES OF THE UNIVERSE



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Background image: astrometry.fas.harvard.edu/skymaps/halpha

FAST RADIO BURSTS

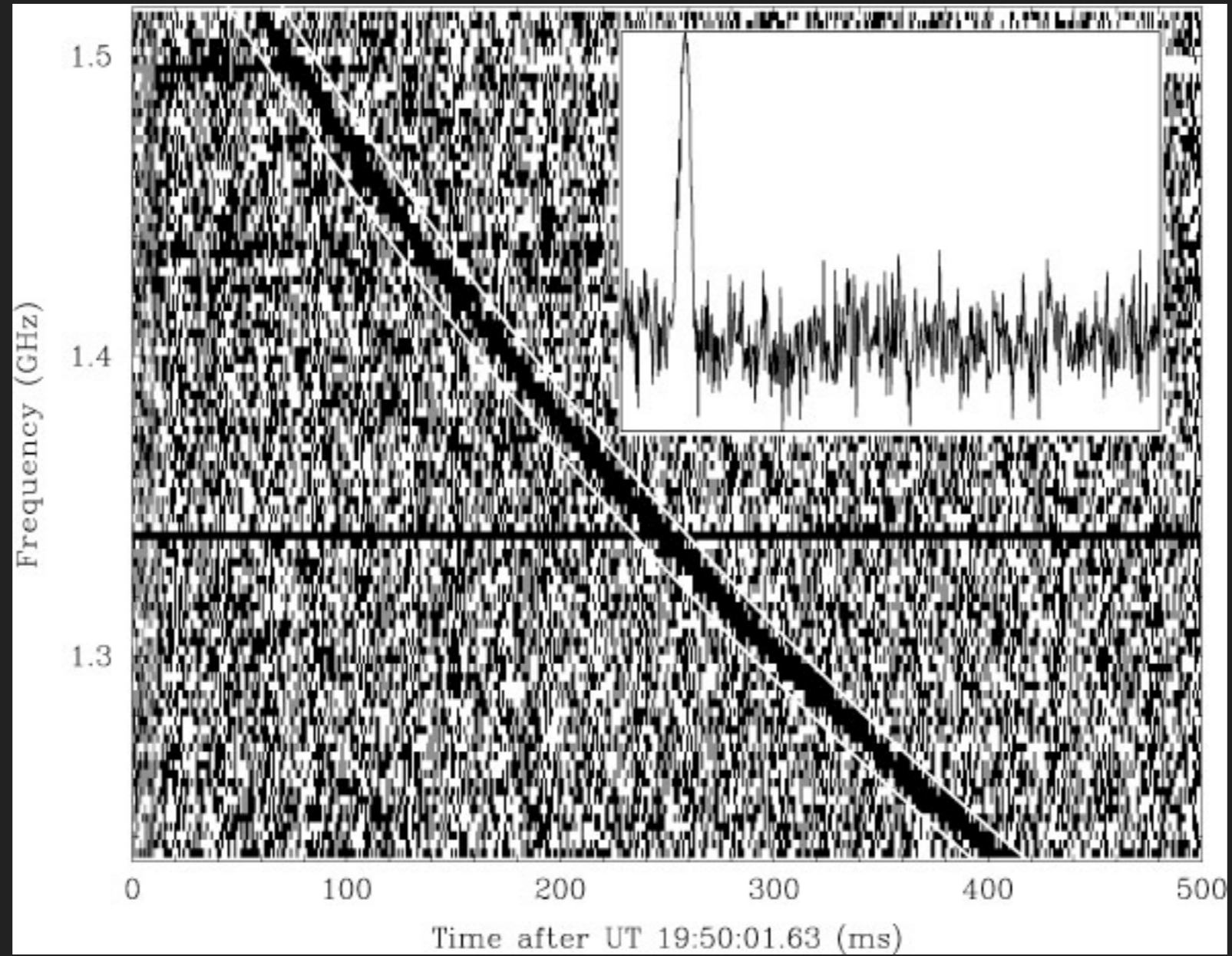
MYSTERIOUS PROBES OF THE UNIVERSE



- ▶ **F**ast: millisecond duration
- ▶ **R**adio: detected in radio
- ▶ **B**ursts: sudden, very energetic

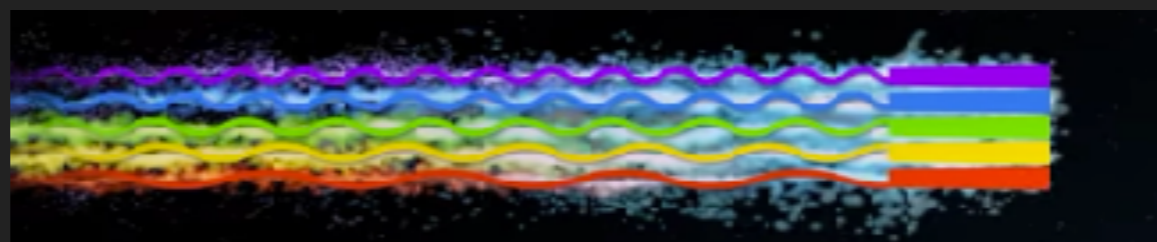
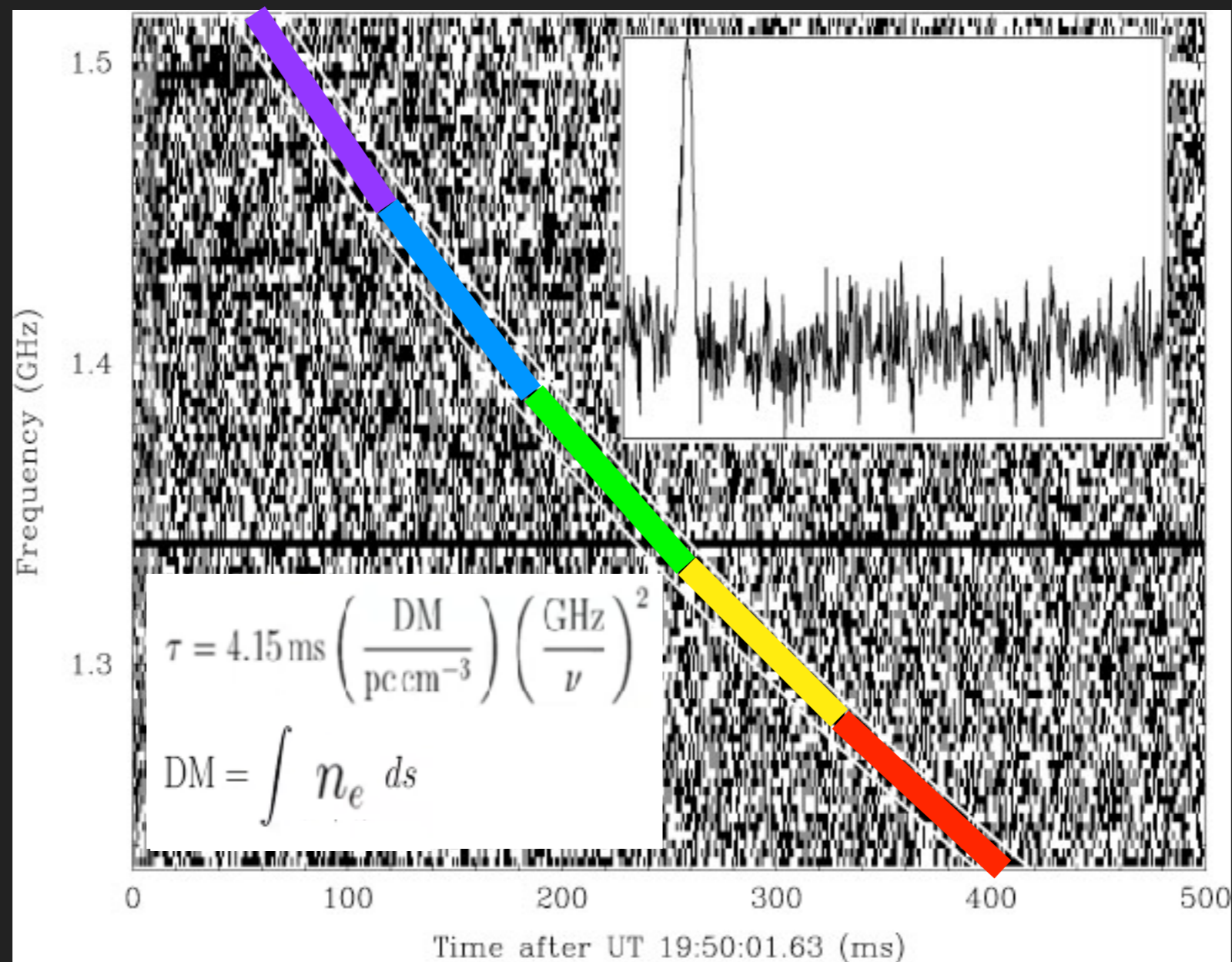
THE FIRST FRB

Lorimer et al 2007



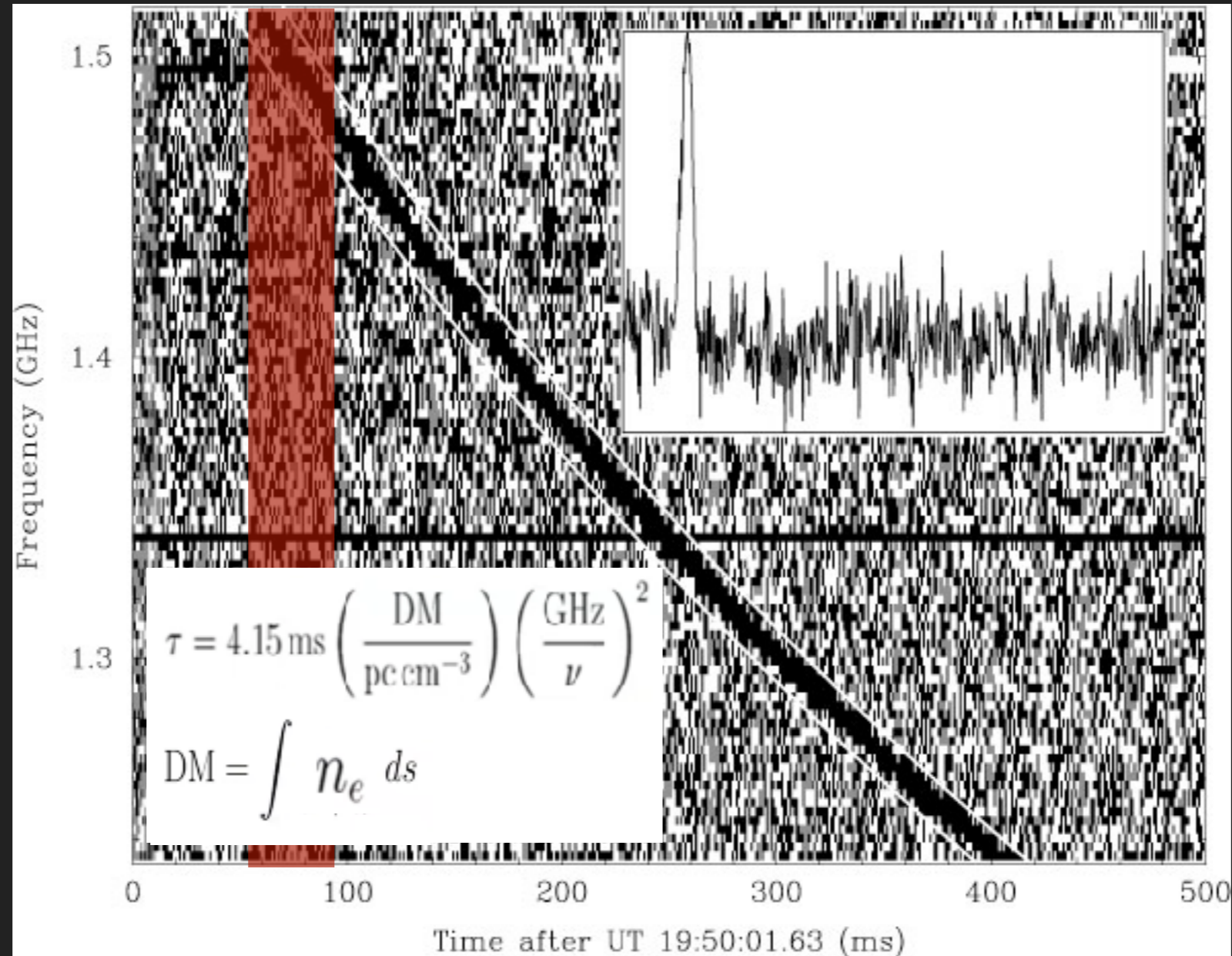
THE FIRST FRB

Lorimer et al 2007



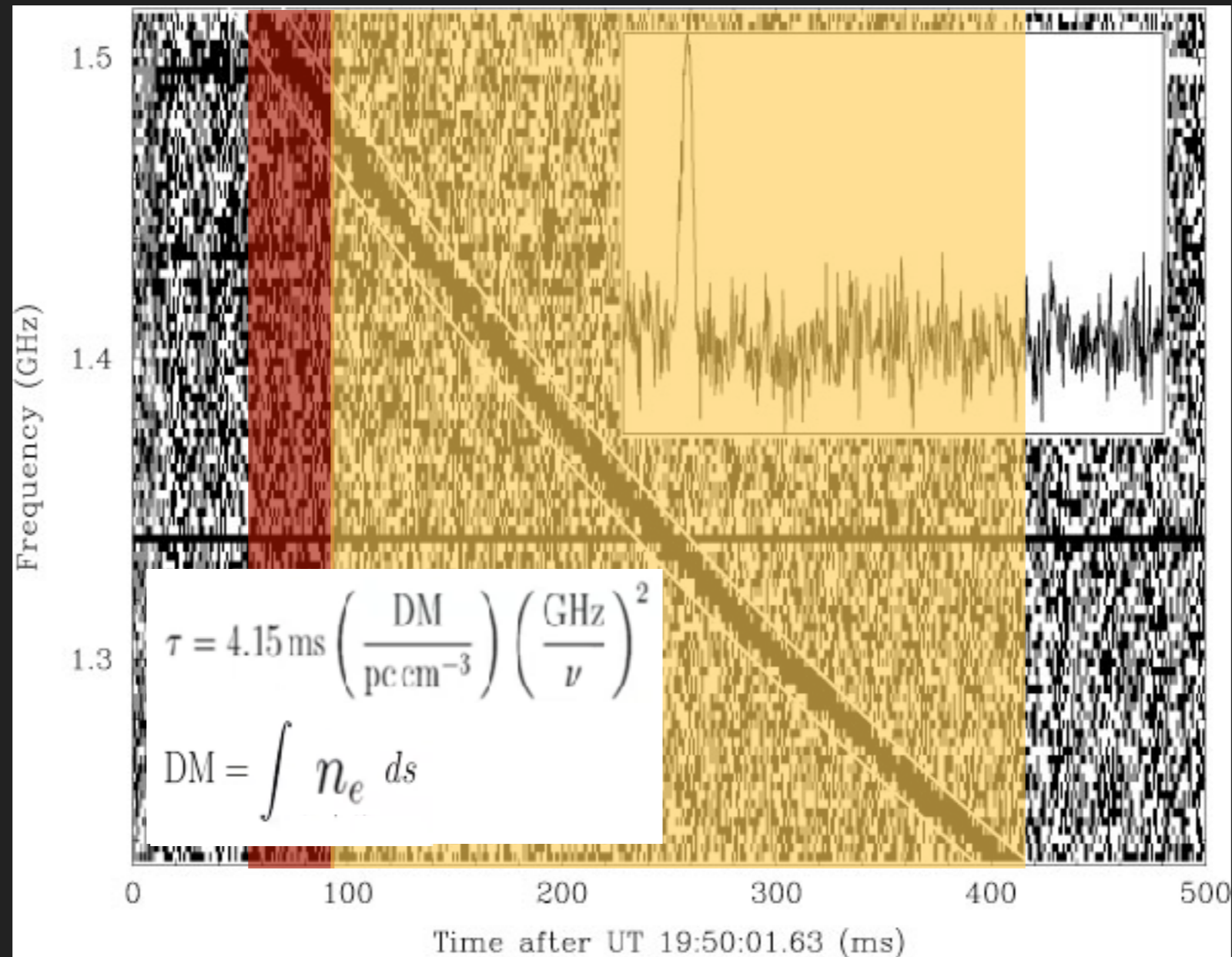
THE FIRST FRB

Lorimer et al 2007

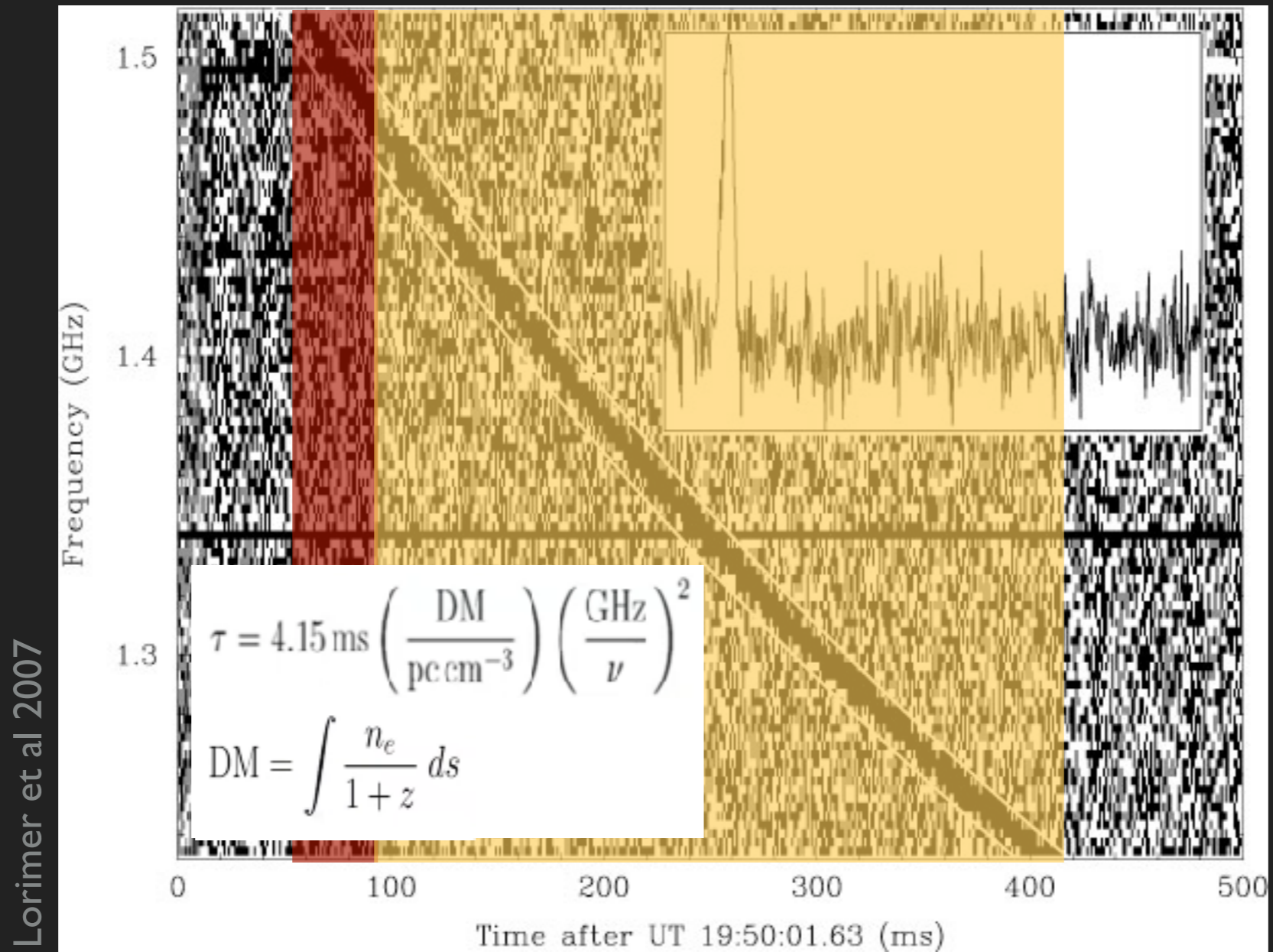


THE FIRST FRB

Lorimer et al 2007



THE FIRST FRB



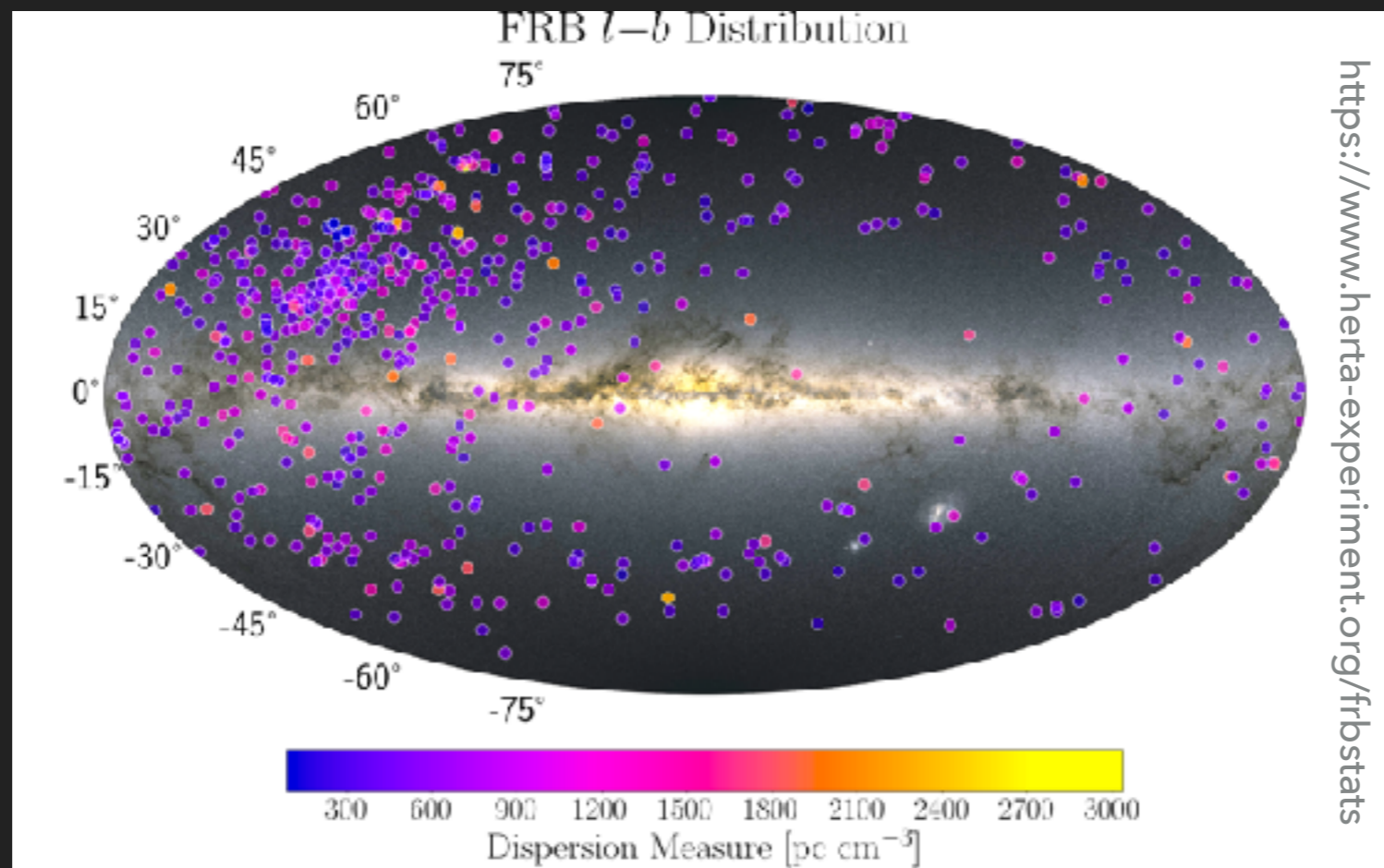
ABOUT 8% SHOW REPEATED BURSTS

THE CURRENT FRB POPULATION

813 total FRBs

66 repeaters

45 host galaxies



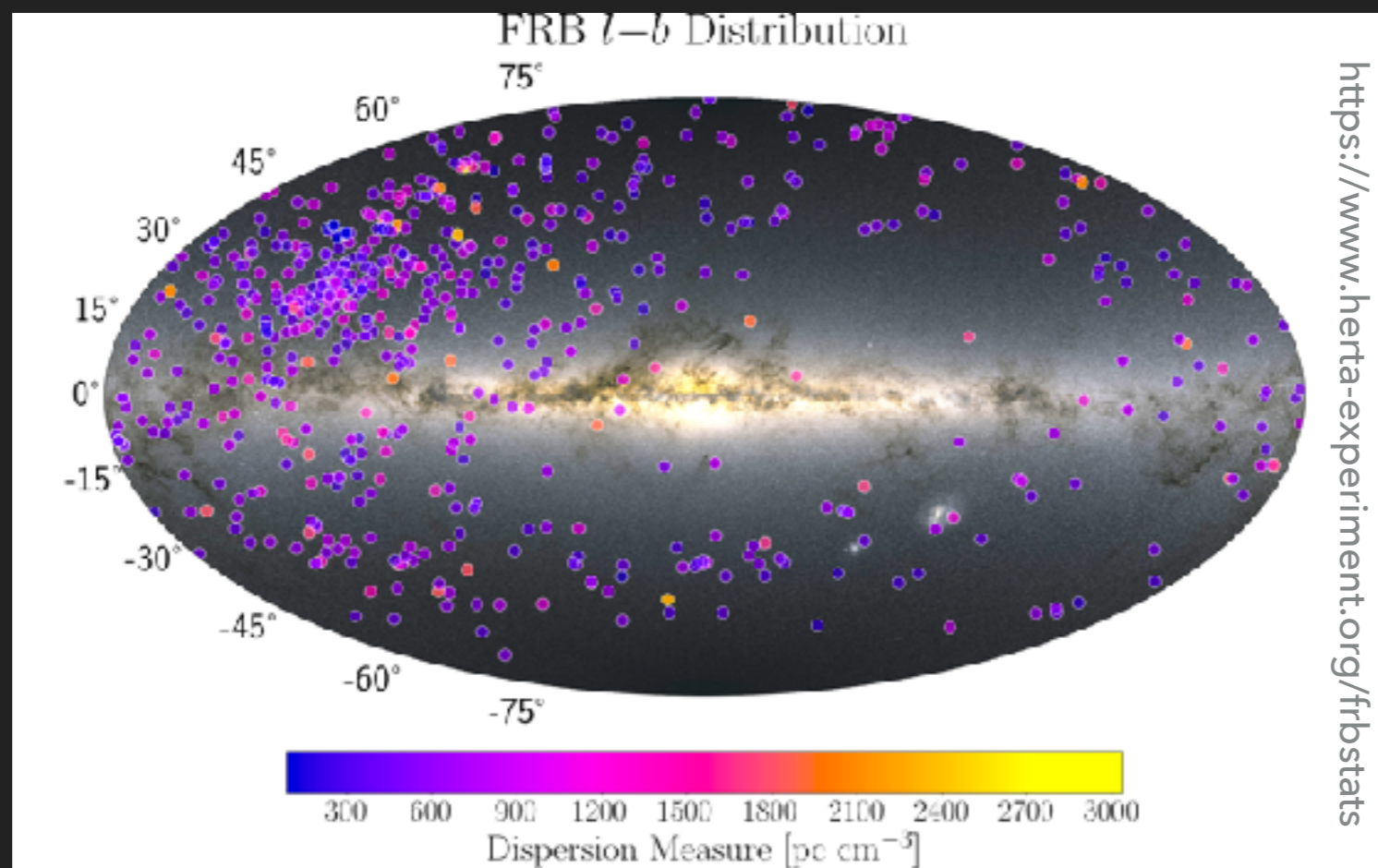
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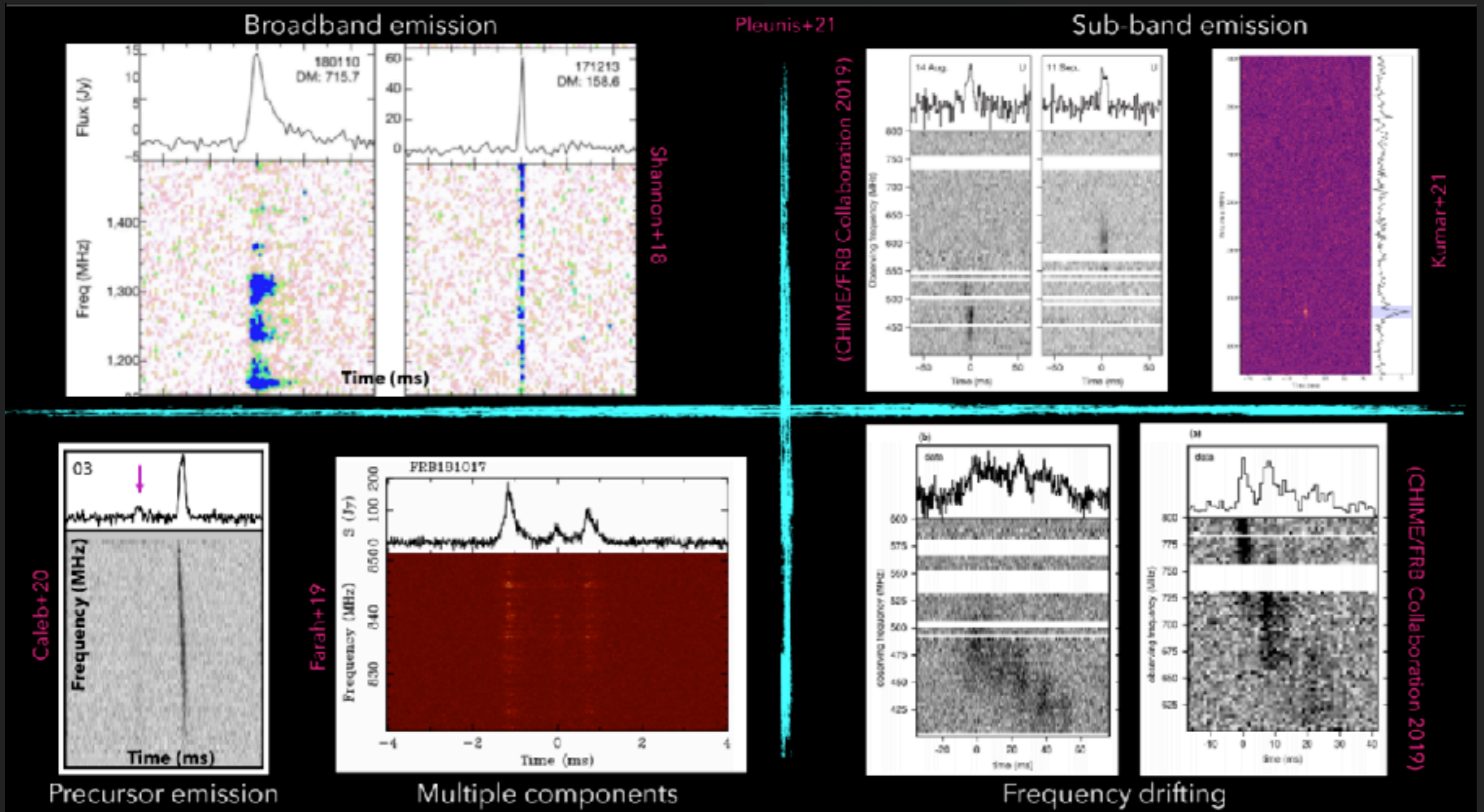
FRB BASIC PROPERTIES

- ▶ micro-millisecond durations
- ▶ DM ~ 100-3000 pc/cm³
- ▶ Peak flux densities ~ 0.1 - 300 Jy
- ▶ 813 observed so far
- ▶ Small emission region
- ▶ Distances ~ 0.1 - 3 Gpc
- ▶ Isotropic energy ~ 10³⁸⁻⁴¹ erg
- ▶ Event rate ~ 3000 sky/day

$$DM \cong n_0 f_e D_L [1 + 0.932z + (0.16\Omega_m - 0.078)z^2]^{-0.5}$$

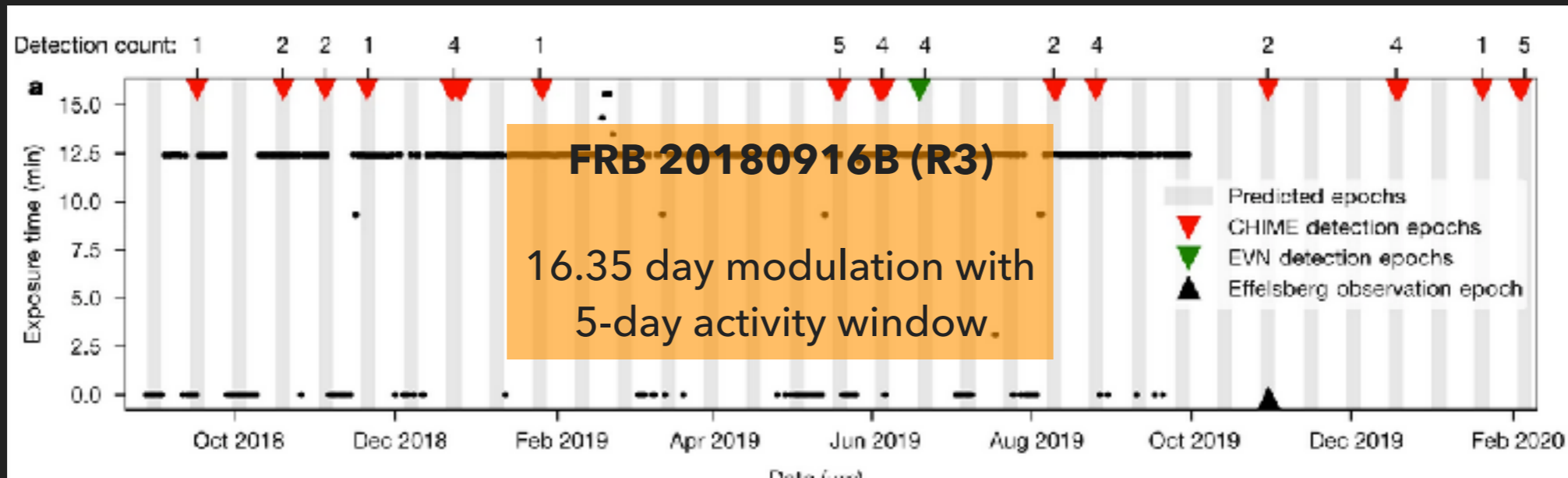
Zheng et al. 2014

BURST MORPHOLOGIES

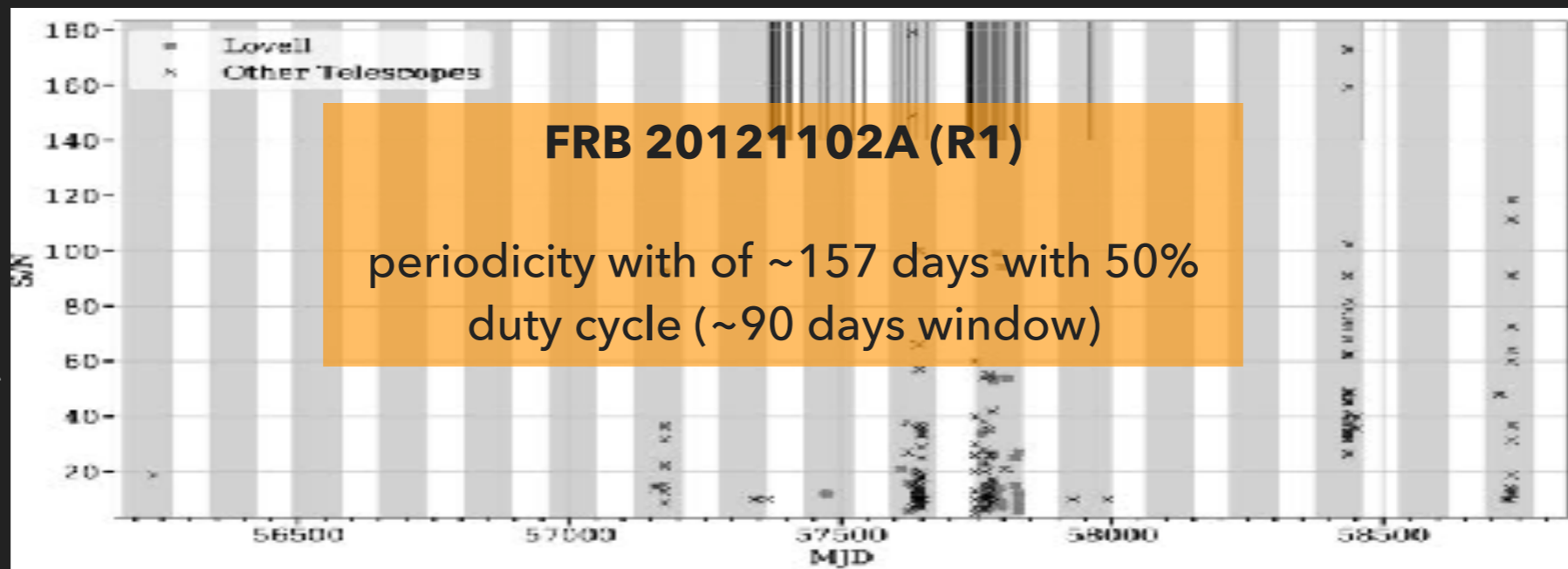


PECULIAR SOURCES

The CHIME/FRB Collaboration 2020,

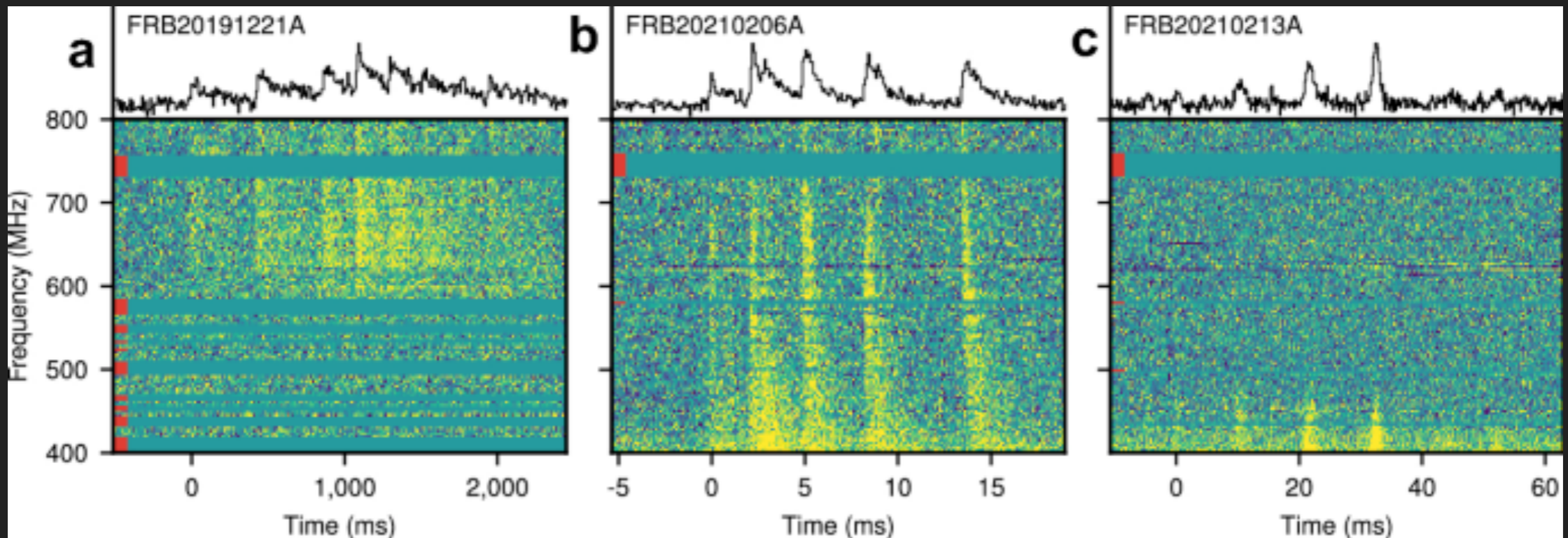


Rajwade et al 2020,



PECULIAR SOURCES

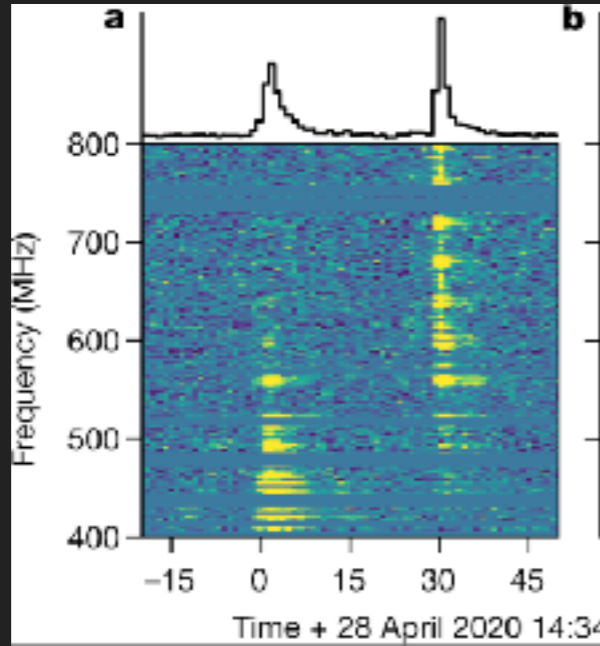
The CHIME/FRB Collaboration 2022



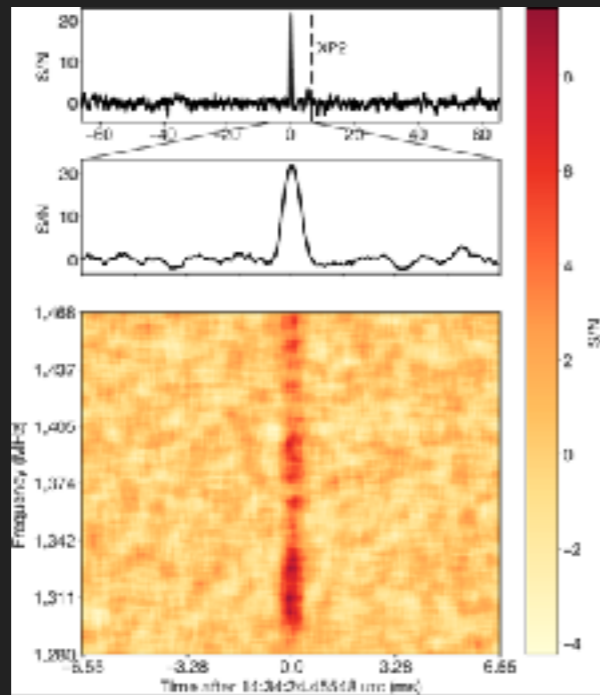
Point towards a NS origin

PECULIAR SOURCES

The CHIME/FRB Collaboration 2020

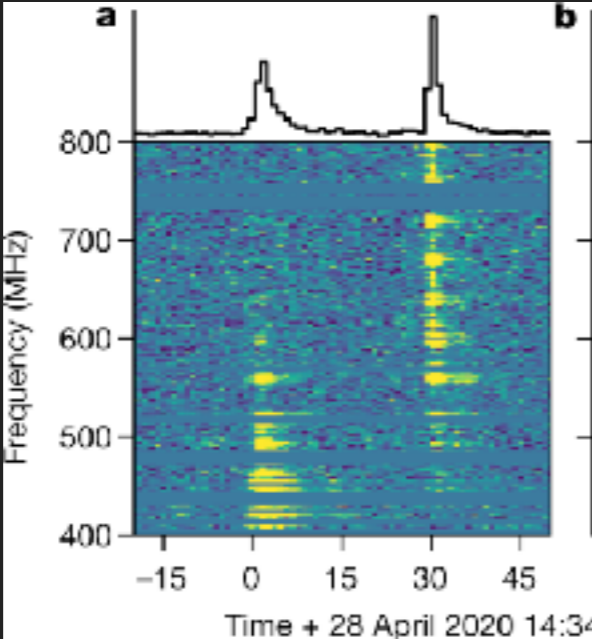


Bochenek et al. 2020

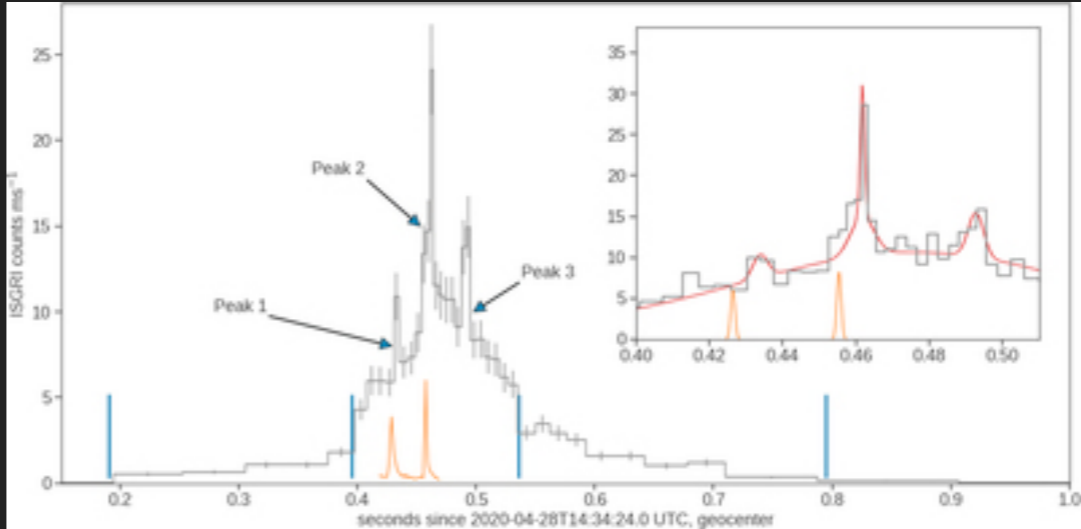


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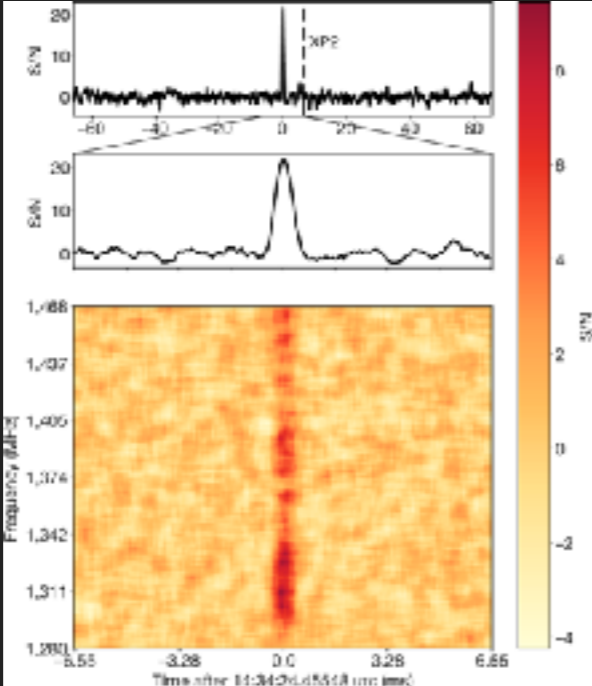
The CHIME/FRB Collaboration 2020



Mereghetti et al. 2020

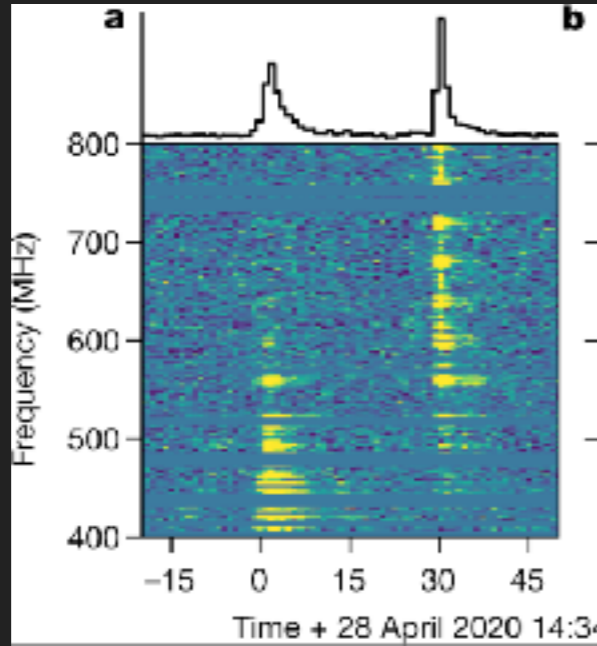


Bochenek et al. 2020

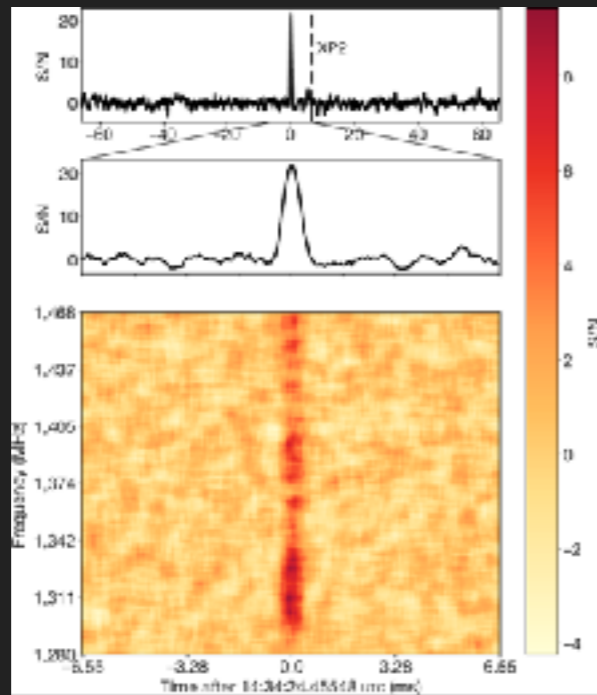


PECULIAR SOURCES

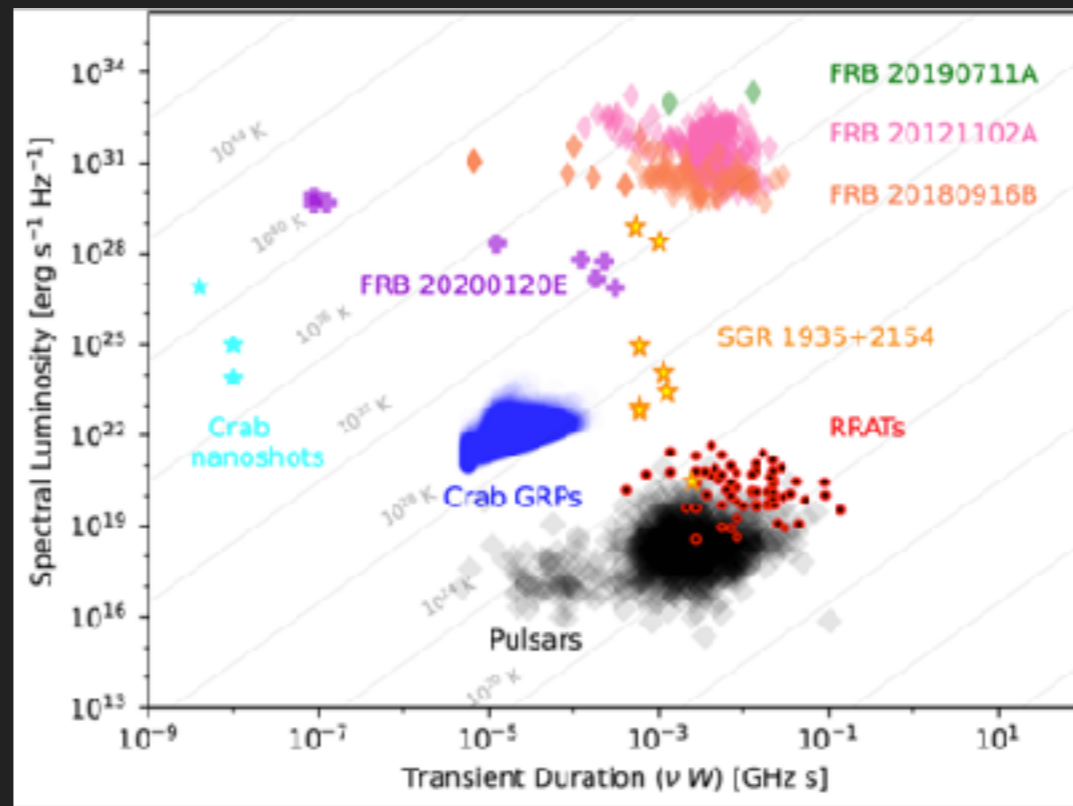
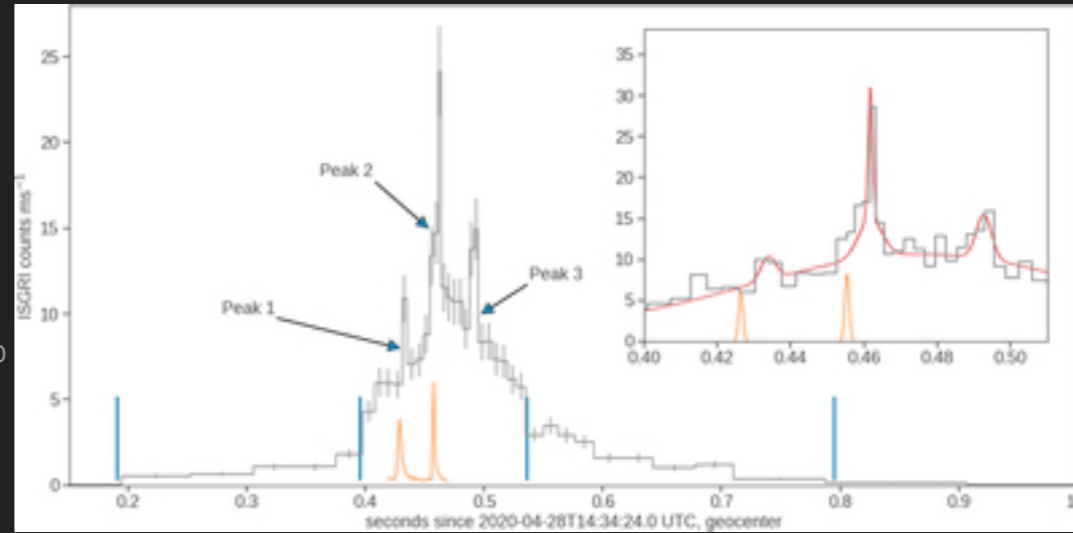
The CHIME/FRB Collaboration 2020



Bochenek et al. 2020

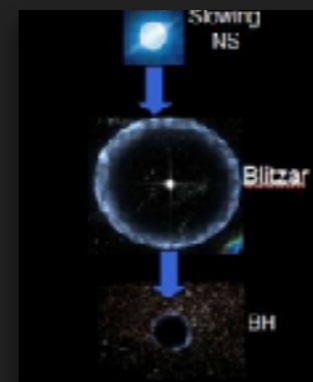


Mereghetti et al. 2020

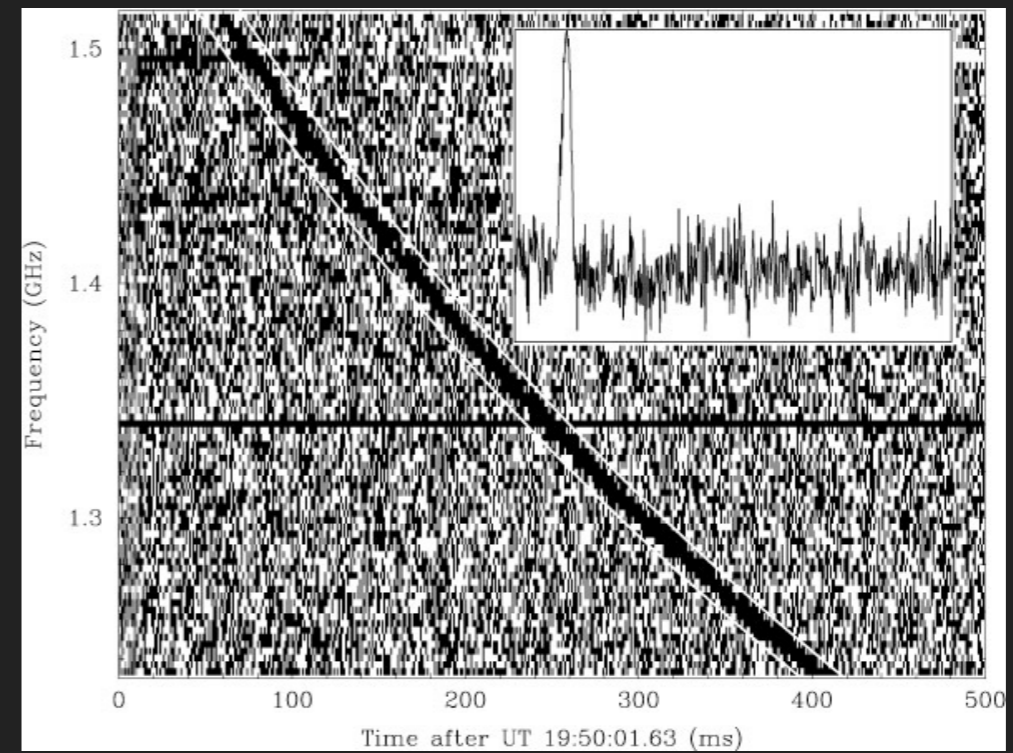
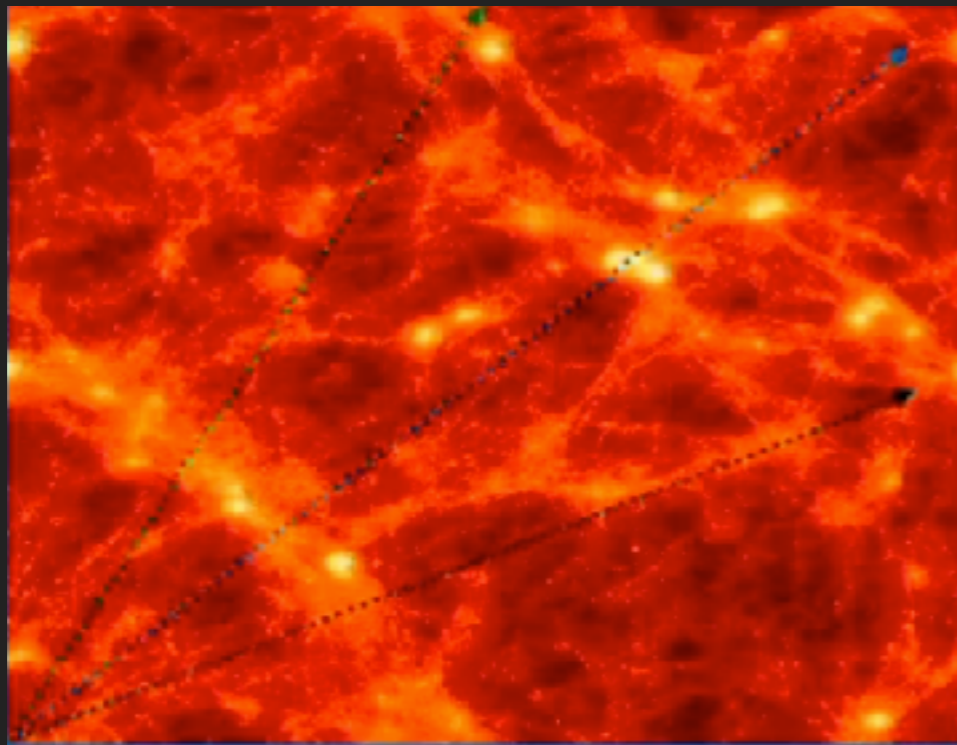


FRB MODELS

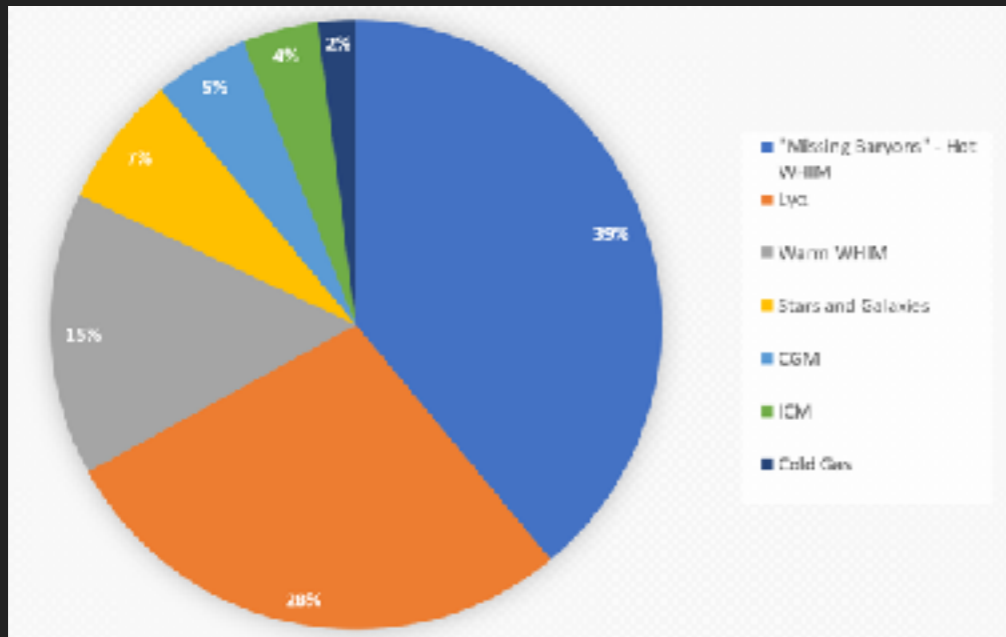
- ▶ Neutron stars, and in particular magnetars, are favoured as FRB progenitors, either through magnetospheric emission (e.g. curvature radiation or reconnection), or emission triggered at higher distances by a flare of the star (e.g. synchrotron maser)
- ▶ Many more progenitors especially for one-off events have been proposed: mergers (NS-NS, WD-WD, BH-NS, BH-BH), collapses (WD AIC, NS to BH 'blitzar',), axions, superconducting cosmic string loops...



FRBS AS PROBES





FRB AS PROBES



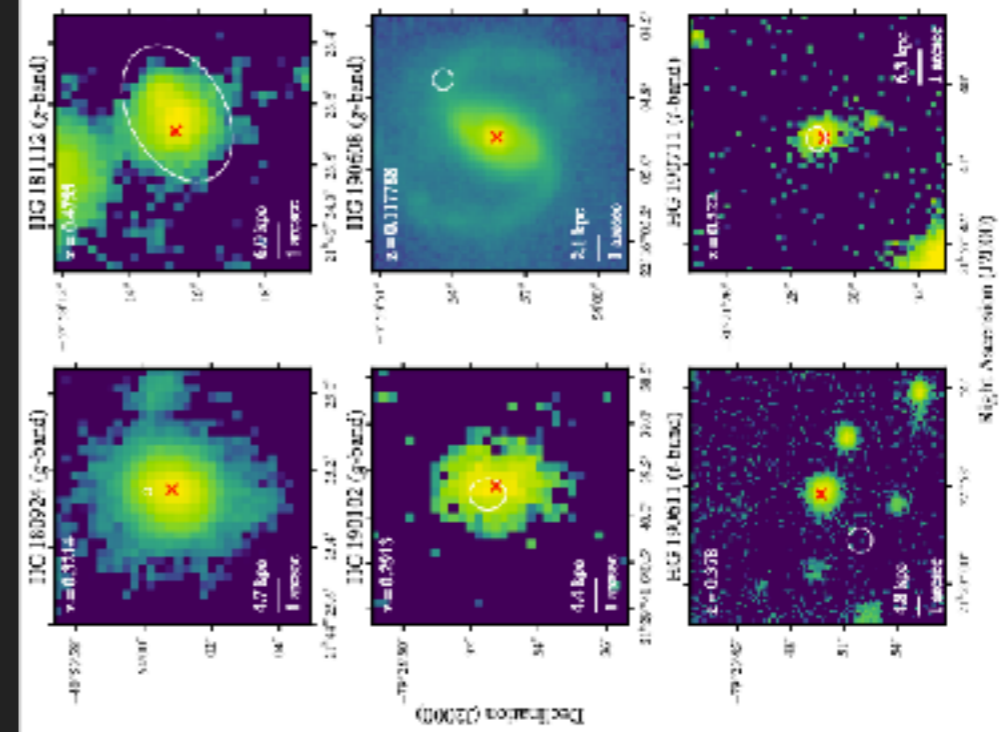
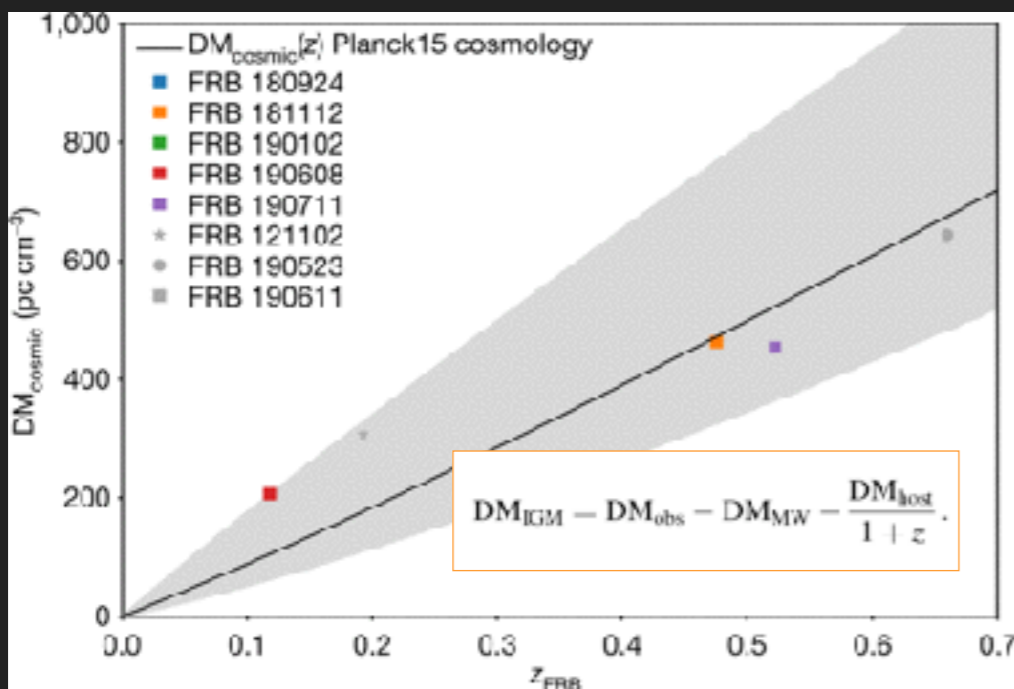
$$\langle \text{DM}_{\text{IGM}} \rangle = \Omega_b \frac{3H_0 c}{8\pi G m_p} \int_0^z \frac{(1+z') f_{\text{IGM}} \left[\frac{3}{4} X_{e,\text{H}}(z') + \frac{1}{8} X_{e,\text{He}}(z') \right]}{\left[\Omega_M (1+z')^3 + \Omega_A (1+z')^{3[1+w(z)]} \right]^{1/2}} dz'$$

Article Published: 27 May 2020

A census of baryons in the Universe from localized fast radio bursts

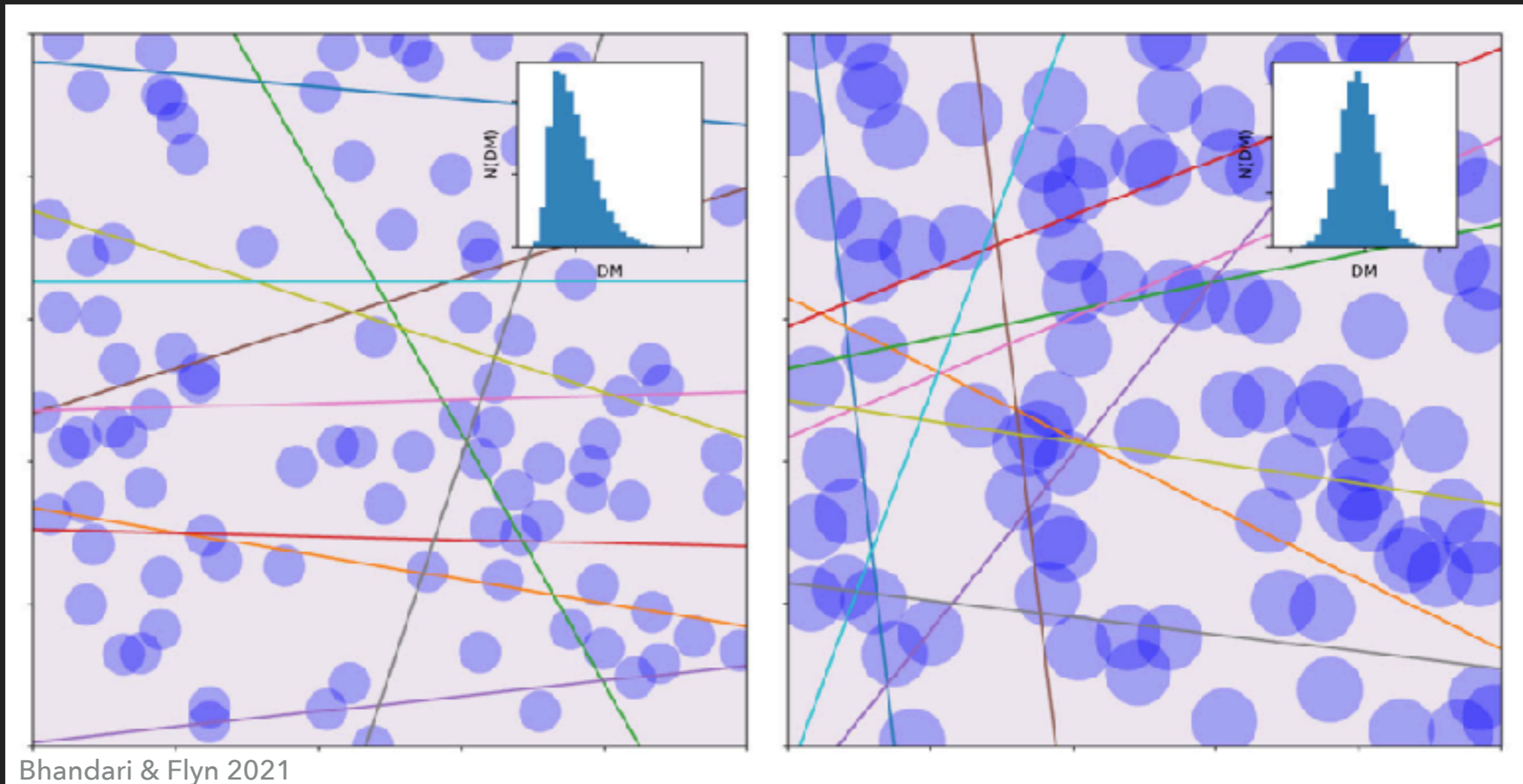
J.-P. Macquart , J. X. Prochaska , M. McQuinn, K. W. Bannister, S. Bhandari, C. K. Day, A. T. Deller, R. D. Ekers, C. W. James, L. Marnoch, S. Osłowski, C. Phillips, S. D. Ryder, D. R. Scott, R. M. Shannon & N. Tejos

Nature 581, 391–395 (2020) Cite this article



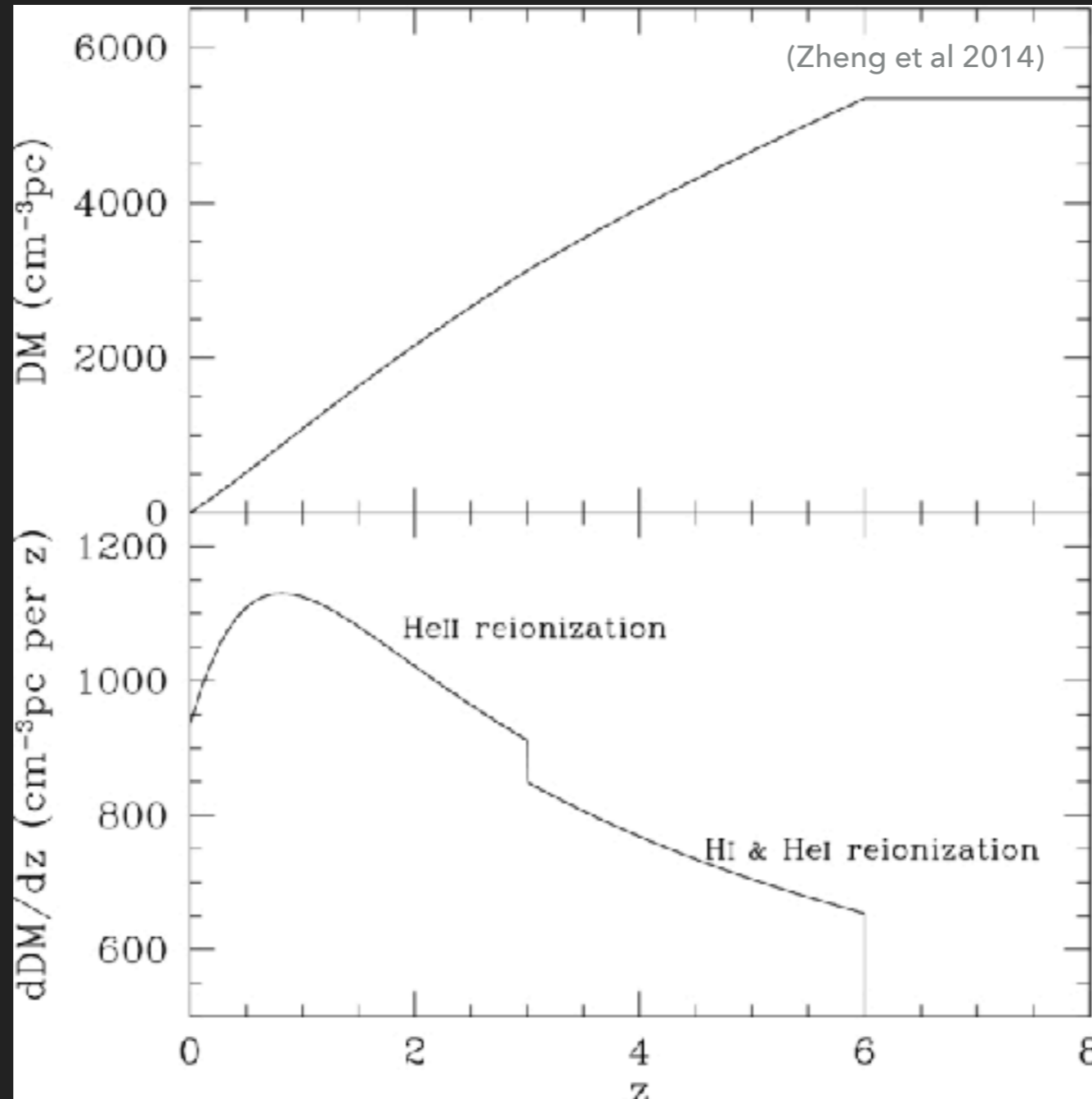
FRB AS PROBES

Going beyond the proportionality in the DM-z plane



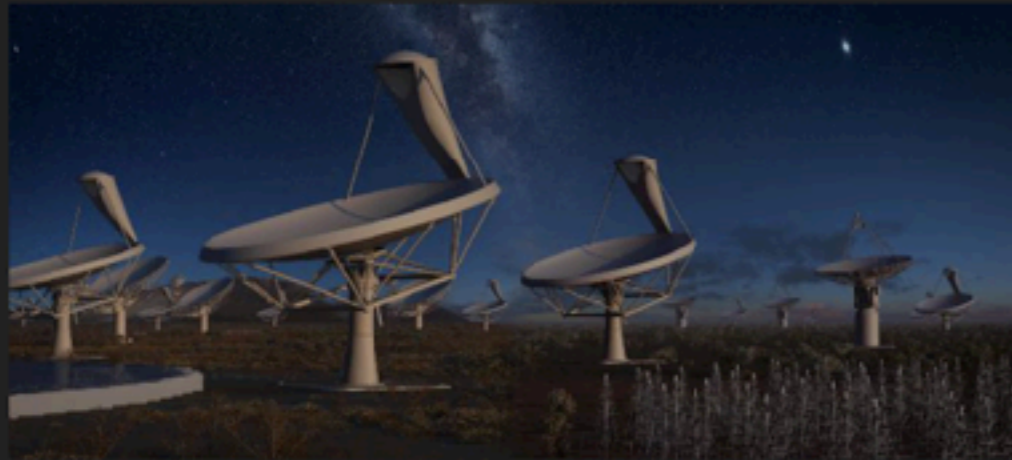
observed variance of the DM constrains info about galaxy haloes

FRB AS PROBES

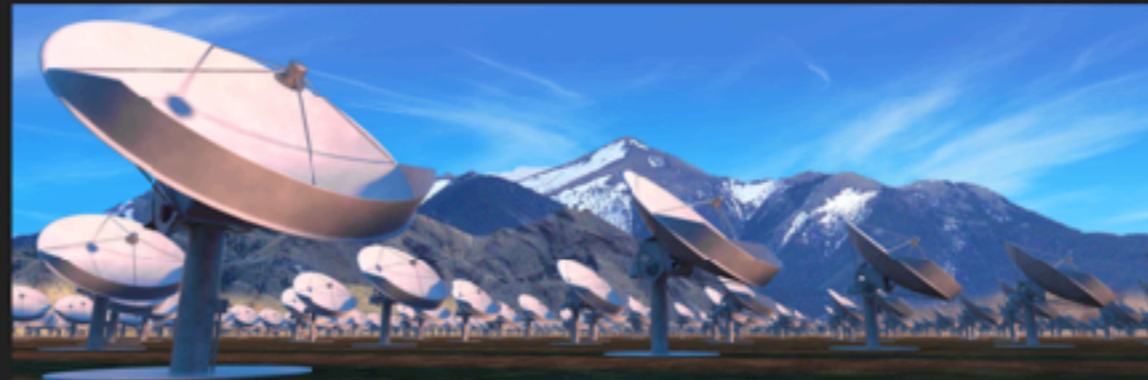


FUTURE EXPERIMENTS

Hallinan+19, Newburg+16, Vanderlinde+19, Fialkov+17



Meerkat



DSA-2000



CHIME-CHORD

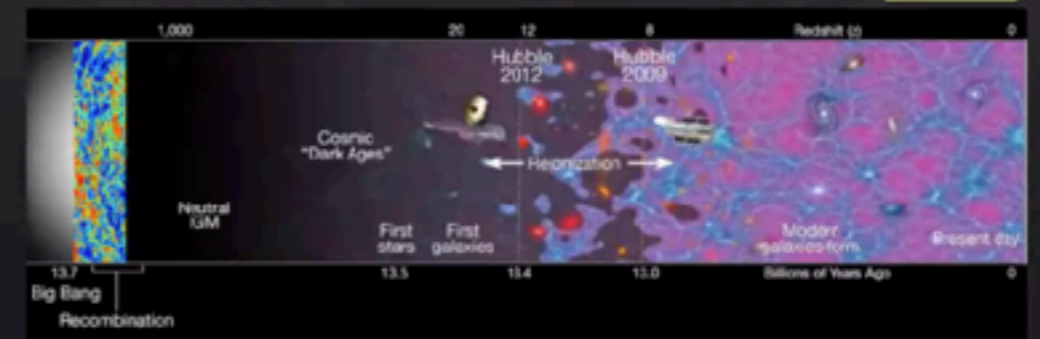


HIRAX Instrument



LOFAR 2.0 (ASTRON)

SKA MID and LOW



FRBs today

FRBs with Future telescopes (SKA)



STAY TUNED!

THANK YOU