

What do modelers want to see
from observers, and vice versa?

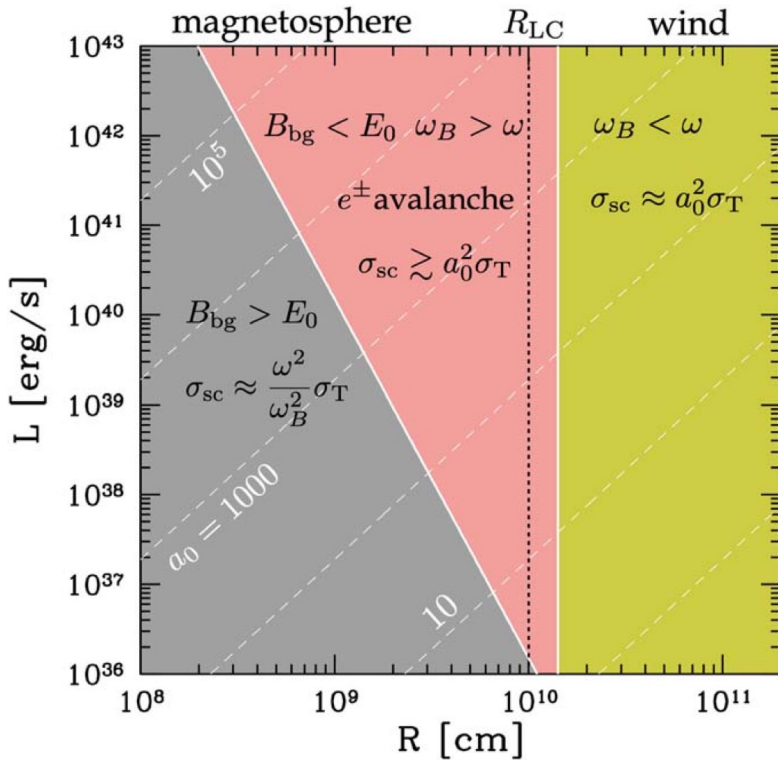
Ziggy Pleunis

Brian Metzger

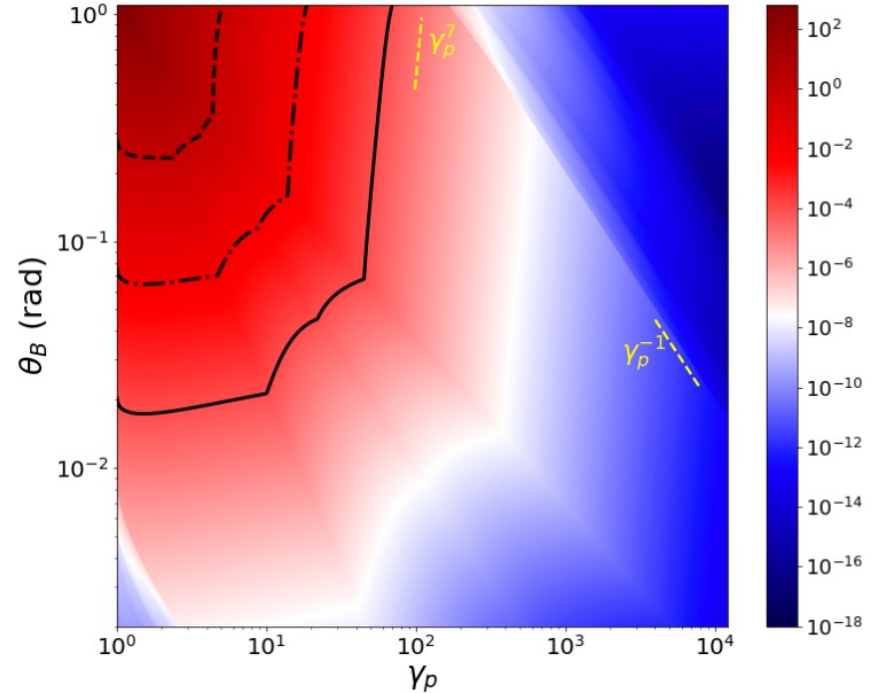
Questions

- Can FRBs propagate in magnetospheres?
- What constraints are placed from the observations with the FAST observations, including PA swing (do PA swings require magnetospheric models), short waiting times, large energy budget, complicated RM evolution
- What is the origin of QPO-like time structure in some FRBs?
- Does diversity in prompt emission properties point to multiple FRB populations?
- What is the shortest time scale your model can produce (e.g. nano-scale bursts)? What is the longest timescale? (e.g. seconds-long MWA source)
- What constraints imposed by the arrival time difference between X-ray and radio emission?
- What produces discrete sub-bursts in “sad trombones”?
- **Your question!**

Can FRBs propagate in magnetosphere?



Beloborodov 2021



Qu, Kumar & Zhang 2022

What is maximum allowed density/mass-loss rate for escape?

From e.g. Ioka's talk, substantial mass ejection from powerful FRB.

Powering persistent RM-generating synchrotron nebula of FRB 121102 requires trans-relativistic electron-ion outflow with average $\dot{M} \sim 10^{-5} M_\odot \text{yr}^{-1}$ and $\dot{E} \sim 10^{40} \text{erg s}^{-1}$

Constraints placed from the observations with the FAST observations, including PA swing (do PA swings require magnetospheric models), short waiting times, large energy budget, complicated RM evolution

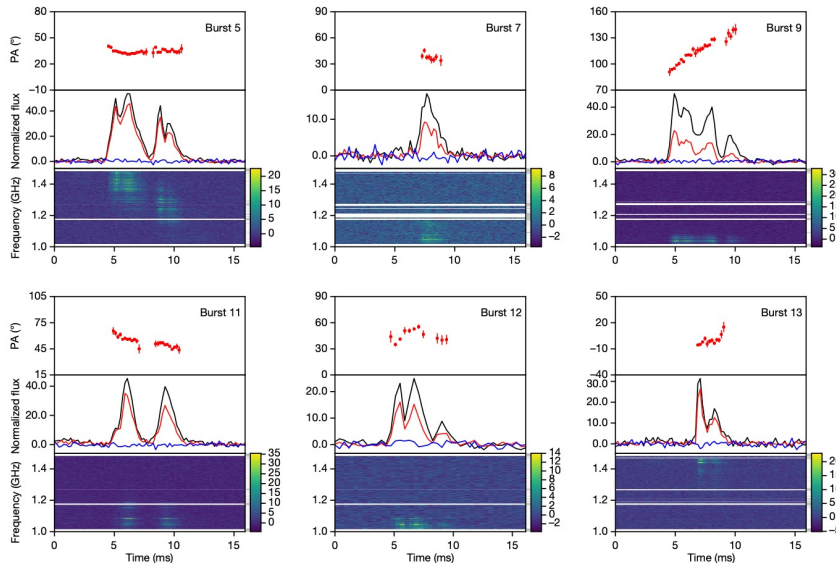
ENERGETICS

(FRB 20121102 in 47 days)

$$E_{\text{bursts}} = (6.4 \times 10^{45} \text{ erg}) \left(\frac{E_{\text{radio}}}{3.4 \times 10^{41} \text{ erg}} \right) \left(\frac{F_b}{0.1} \right) \left(\frac{\eta}{10^{-4}} \right)^{-1} \left(\frac{\zeta}{0.053} \right)^{-1}$$

(3.85×10^{45} erg) (FRB 20201124A in 4 days)

PA SWINGS



Energy Reservoir:

$$E_{\text{mag}} \sim 3 \times 10^{49} \text{ erg} \left(\frac{B}{10^{16} \text{ G}} \right)^2$$

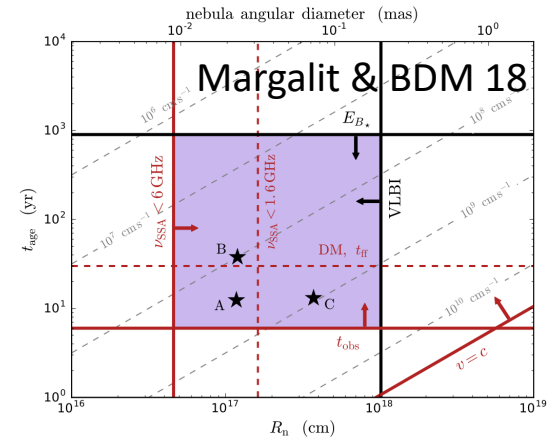
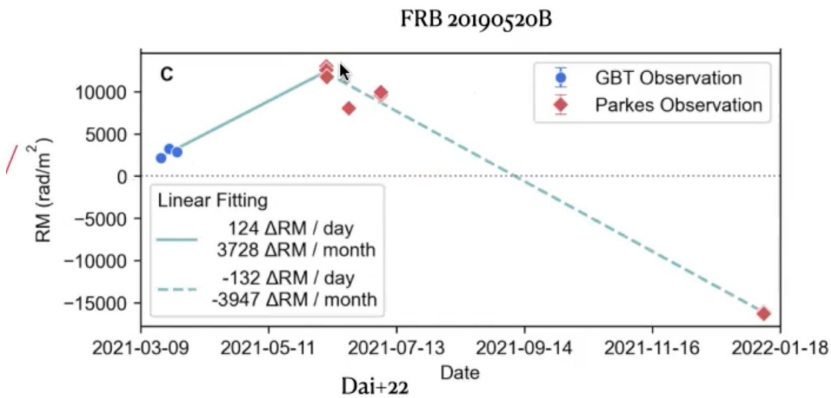
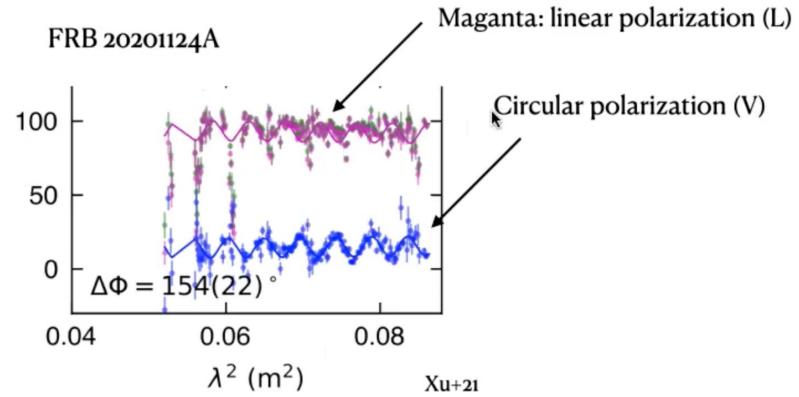
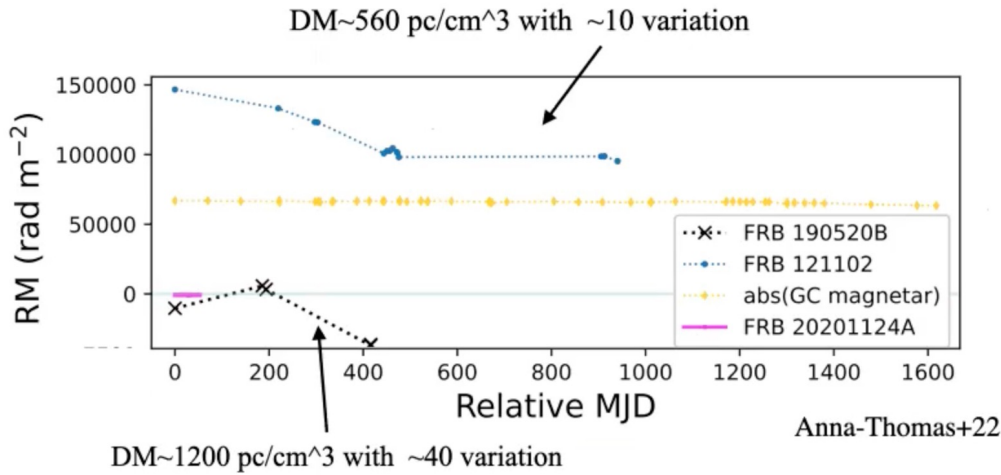
Engine Lifetime:

$$t_{\text{mag}} \sim (30 - 1000) \text{ yr} \left(\frac{B}{10^{16} \text{ G}} \right)^{-1}$$

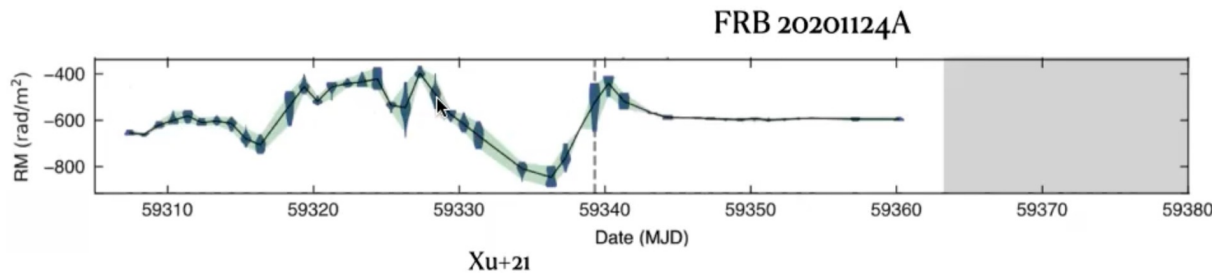
(e.g. ambipolar diffusion from core)

birth-rate of very active repeaters is \ll CCSN rate

Unusual magneto-environment of FRBs: large RM



$$R_n / c \sim \text{months} - \text{years}$$



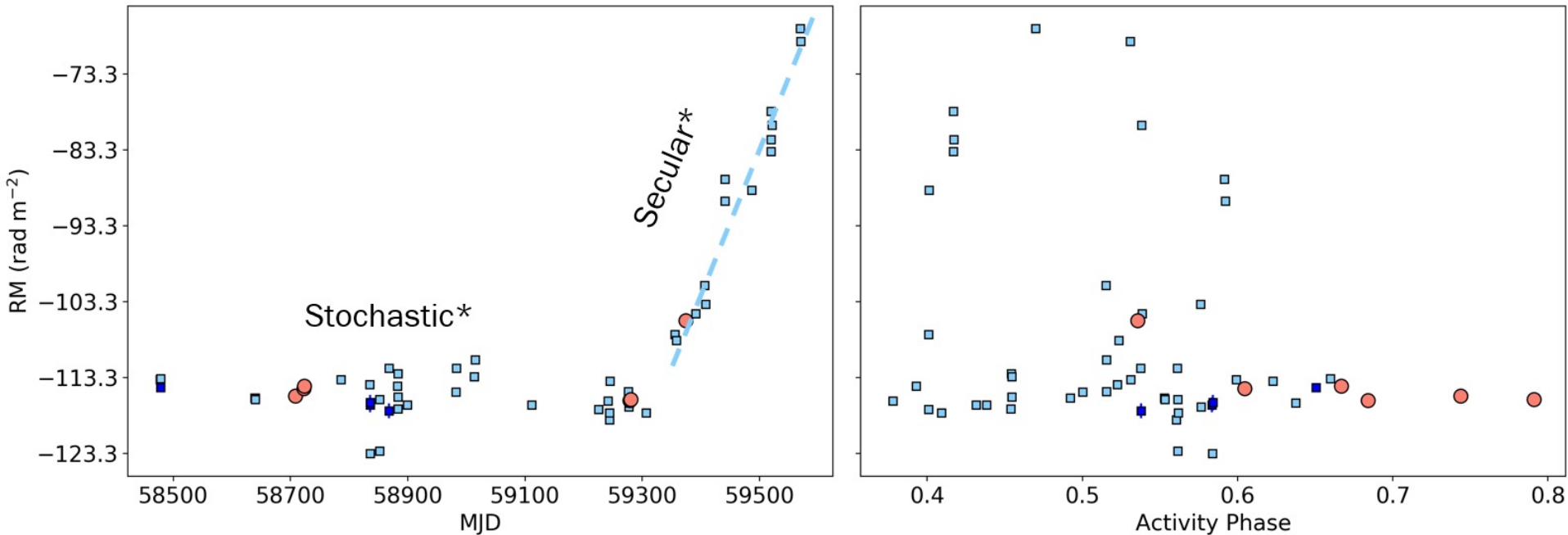
Changes in the local environment?

Work led by
Akshatha Gopinath
at the University of
Amsterdam



FRB 20180916B (R3)

- LOFAR bursts
- Chawla et al. (2020) and CHIME/FRB et al.(2019a)
- Mckinven et al. (2022)



Faraday rotation traces
magnetic field in the
local medium

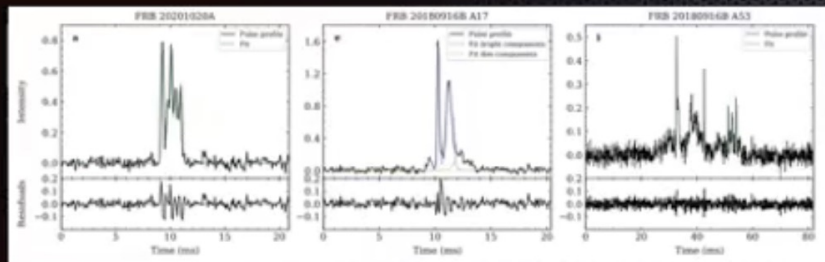
Gopinath+ in prep.

*As identified by Mckinven+ 2022

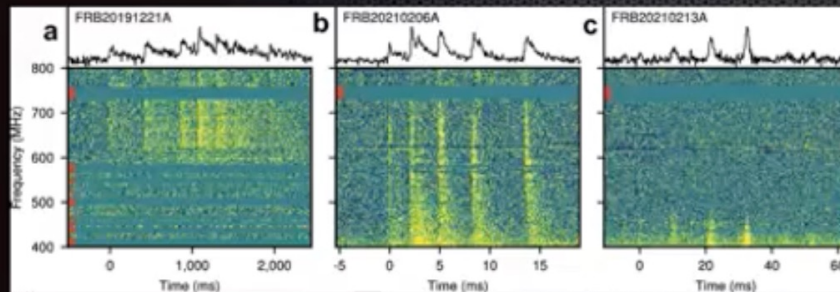
What is the origin of QPO-like time structure in some FRBs?

FRBs

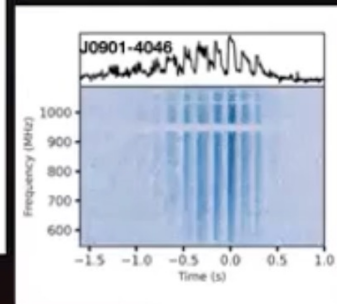
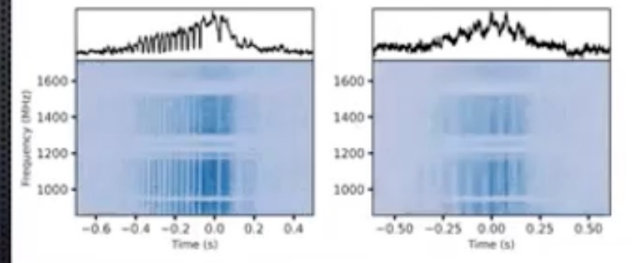
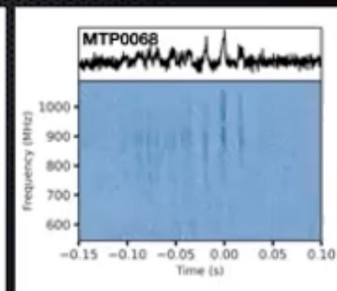
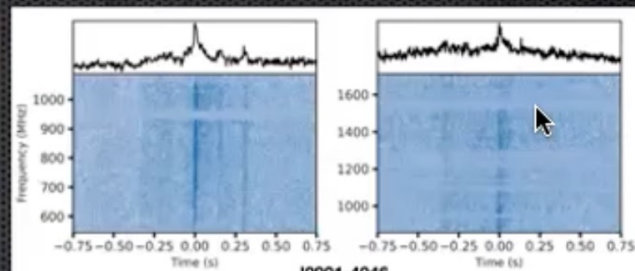
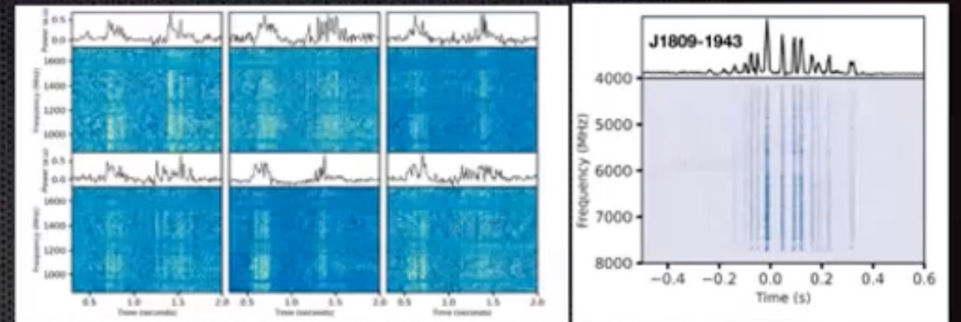
Pastor Marazuela et al. 2021



CHIME FRB collaboration 2019



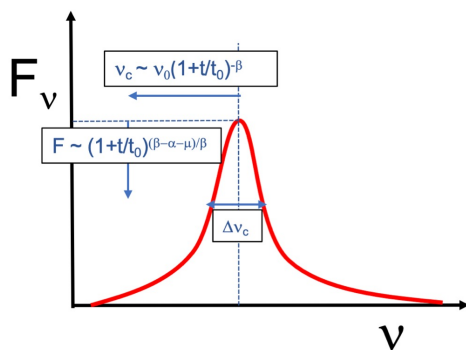
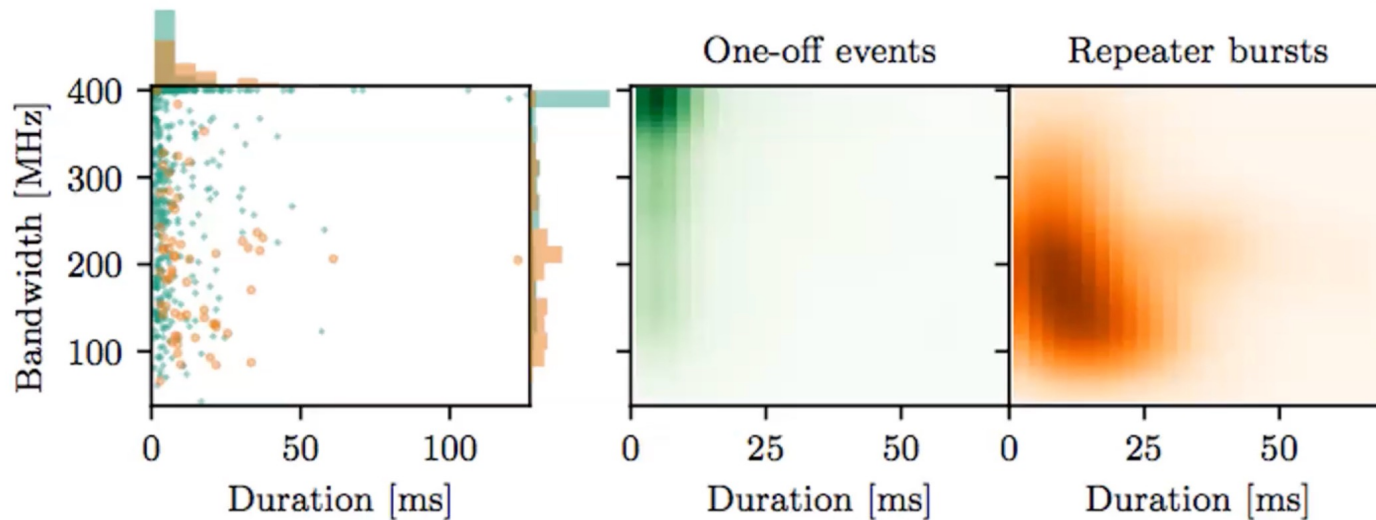
Galactic sources



Not the rotational period in Galactic magnetars

Does diversity in prompt emission properties point to multiple FRB populations?

Significance of correlations between burst duration, bandwidth, drift rate and central frequency?



BDM+22

high $\beta \Rightarrow$ fast sweep across band \Rightarrow broad time-averaged spectra

low $\beta \Rightarrow$ slow sweep across band \Rightarrow narrow resolved spectra

(bursts accumulate their SNR over a narrower frequency bandpass when the intrinsic SED drifts downwards in time more slowly.)

How important is it to constrain dispersion and rotation indices?

Dispersion index: no deviations
from f^2 greater than $1e-3$

Thornton+2013, Masui+2015

Should we keep trying?

How important is it to constrain dispersion and rotation indices?

Talk by Lyutikov:

Polarization: non-standard

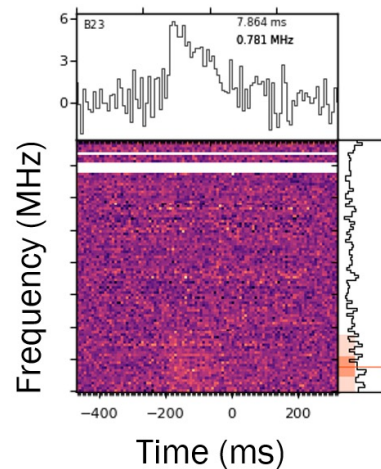
$$RM \propto \lambda^\alpha, \alpha \neq 2$$

Depolarization towards lower frequencies

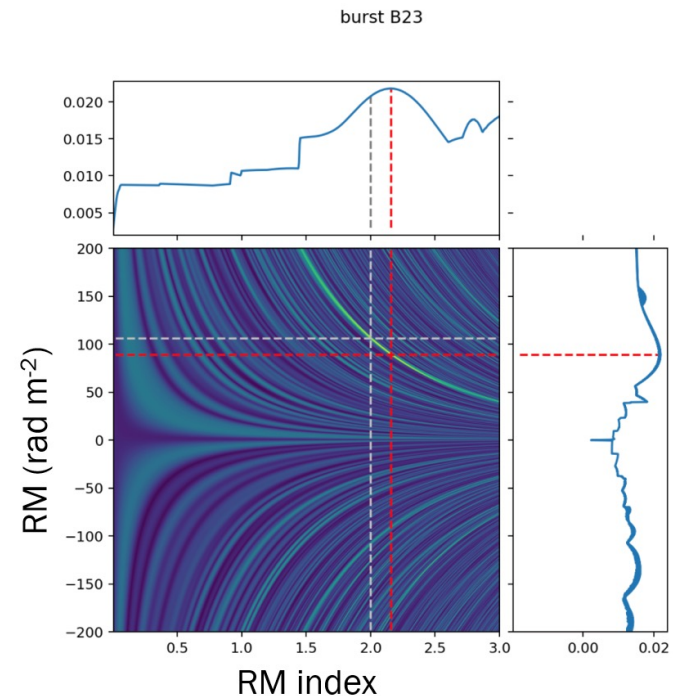
Work led by
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From talk by ZP at LOFAR
family meeting in June:



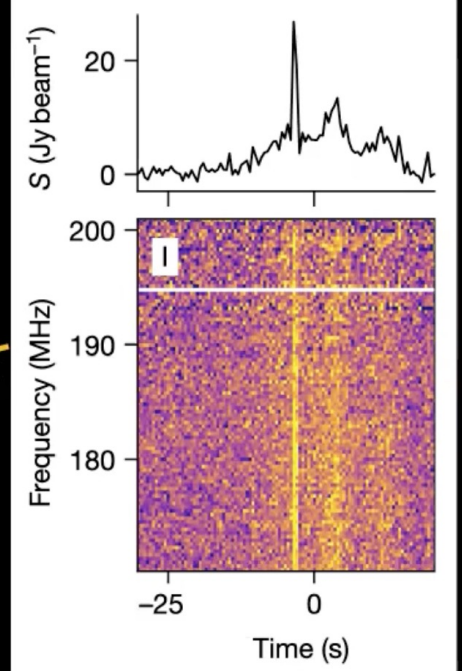
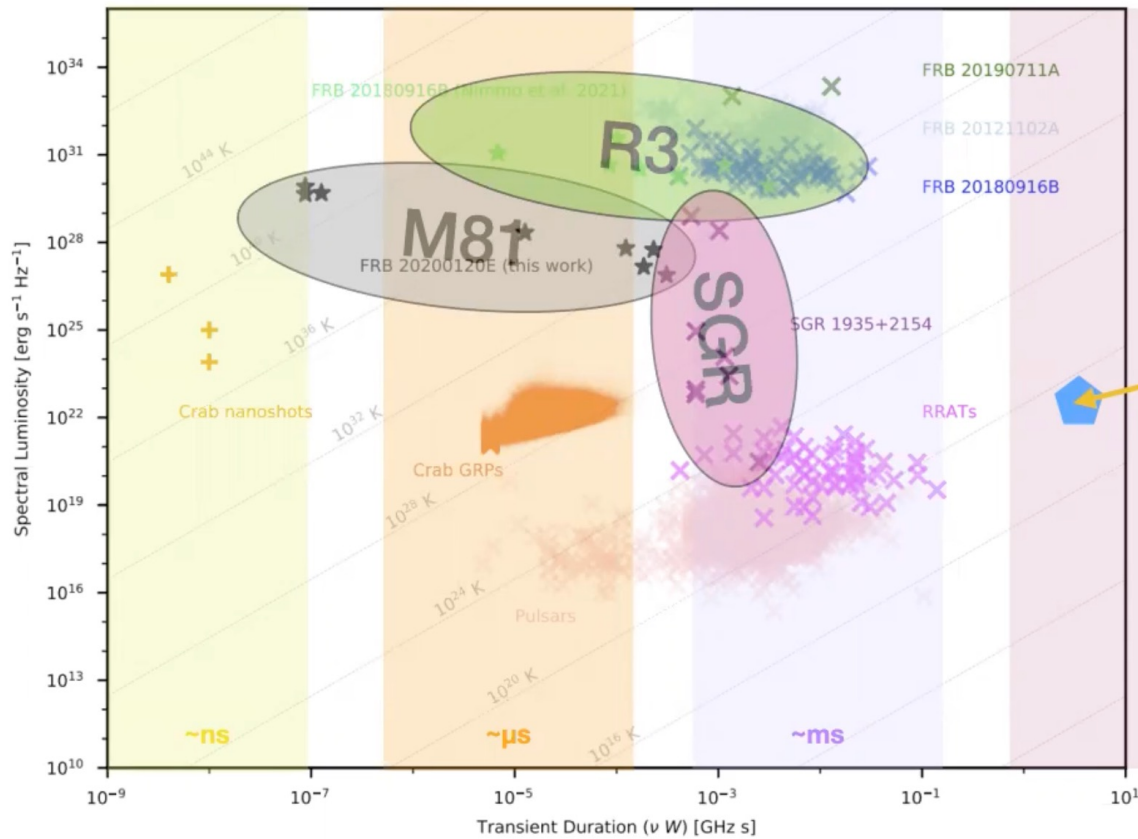
Polarization angle
best fit with $\lambda^{2.15}$
dependence; not just
Faraday rotation?



Having multiple populations of FRBs, should we focus more attention on calculating relative progenitor rates?

That is, move from saying “model x could produce an FRB” to “model x is likely to produce y FRBs/sky/day and that matches the rate of [subpopulation of FRBs.]”

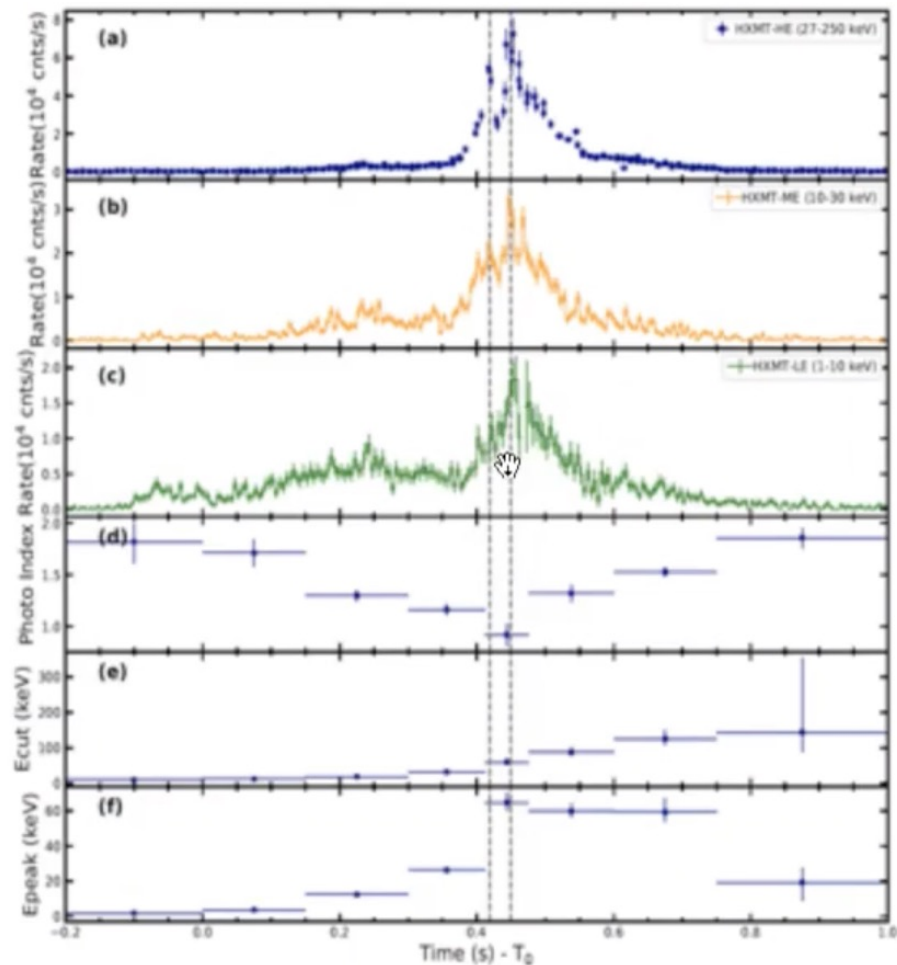
What is the shortest time scale your model can produce (e.g. nano-scale bursts)? What is the longest timescale? (e.g. seconds-long MWA source)



Hurley-Walker et al. 2022

Nimmo

What constraints imposed by the arrival time difference between X-ray and radio emission?



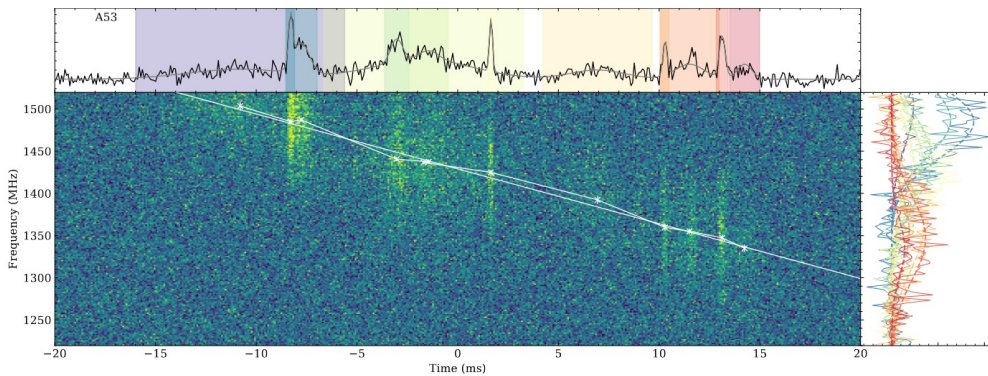
How can we explain discrete sub-bursts in “sad trombones”?

Intrinsic or propagation?

Why no continuous drift?

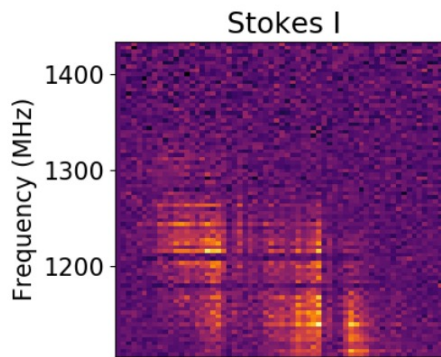
How interesting is the exact drift rate?

How relevant is the dependency (i.e., linear? power law?)

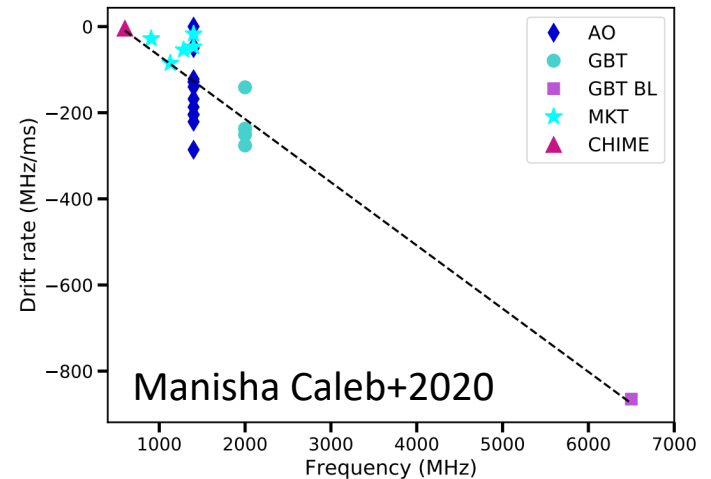
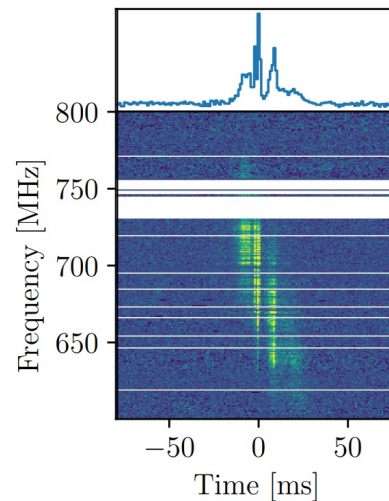


Inés Pastor-Marazuela+2021

FRB 190711



Cherie Day+2020



Plasma Self—Modulation (Sobacchi et al. 2022)

