

# Observing potential hosts of repeating FRBs

---

Henning Hilmarsson

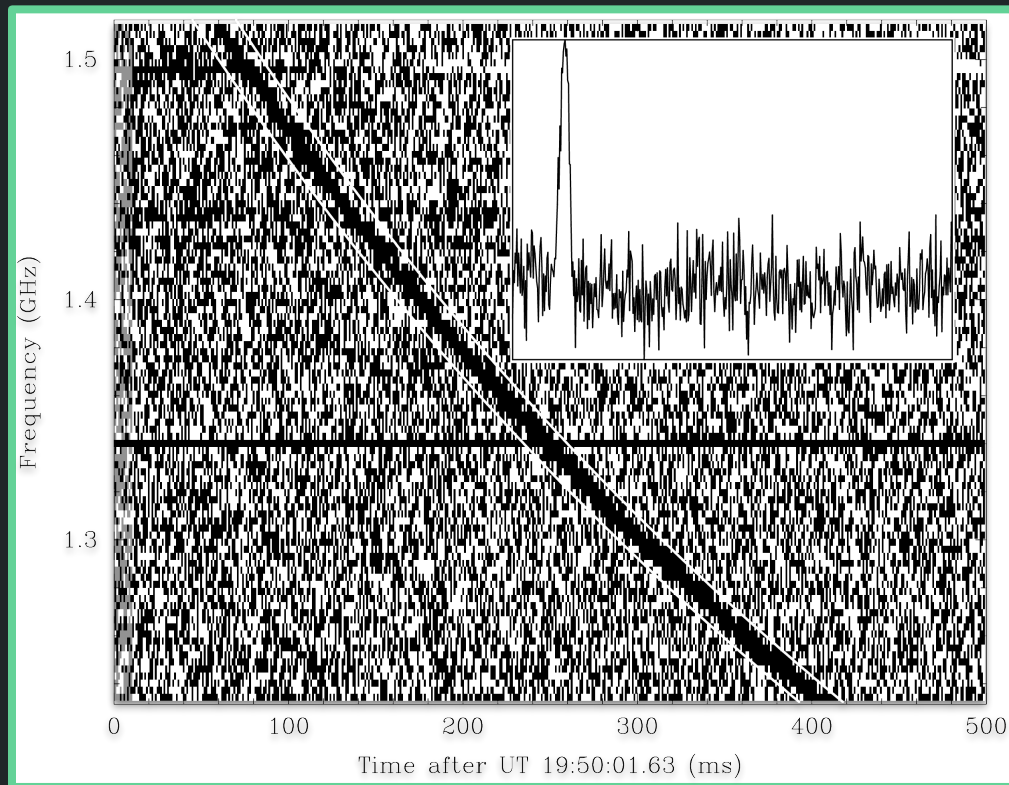
Peculiar Supernovae and Neutron Stars

17th Feb 2020

MPIfR Bonn

# FRB overview

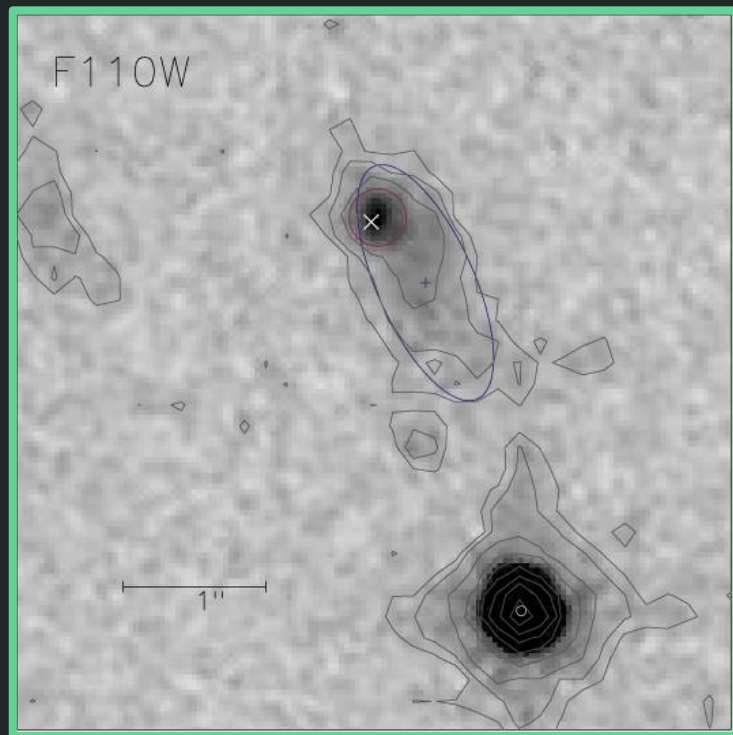
- ✦ Bright
- ✦ Short duration
- ✦ High DM
- ✦ 0.4 - 8 GHz
- ✦ Some repeat
- ✦ Localisations
- ✦ Origin uncertain
- ✦ Cosmological probes



Lorimer+2007  
DOI: [10.1126/science.1147532](https://doi.org/10.1126/science.1147532)

# FRB121102 - A special FRB?

- ◆ First repeating FRB
- ◆ First localised FRB
  - ★ Dwarf galaxy
  - ★ Star formation region
- ◆ Large RMs
  - ★  $\sim 10^5$  rad m<sup>-2</sup>
- ◆ Persistent radio source
- ◆ Activity periods
- ◆ Progenitor theories
  - ★ AGN
  - ★ Supernova remnant (SNR)



Bassa+2017

DOI: 10.3847/2041-8213/aa7a0c

# Progenitor theories

## ◆ AGNs

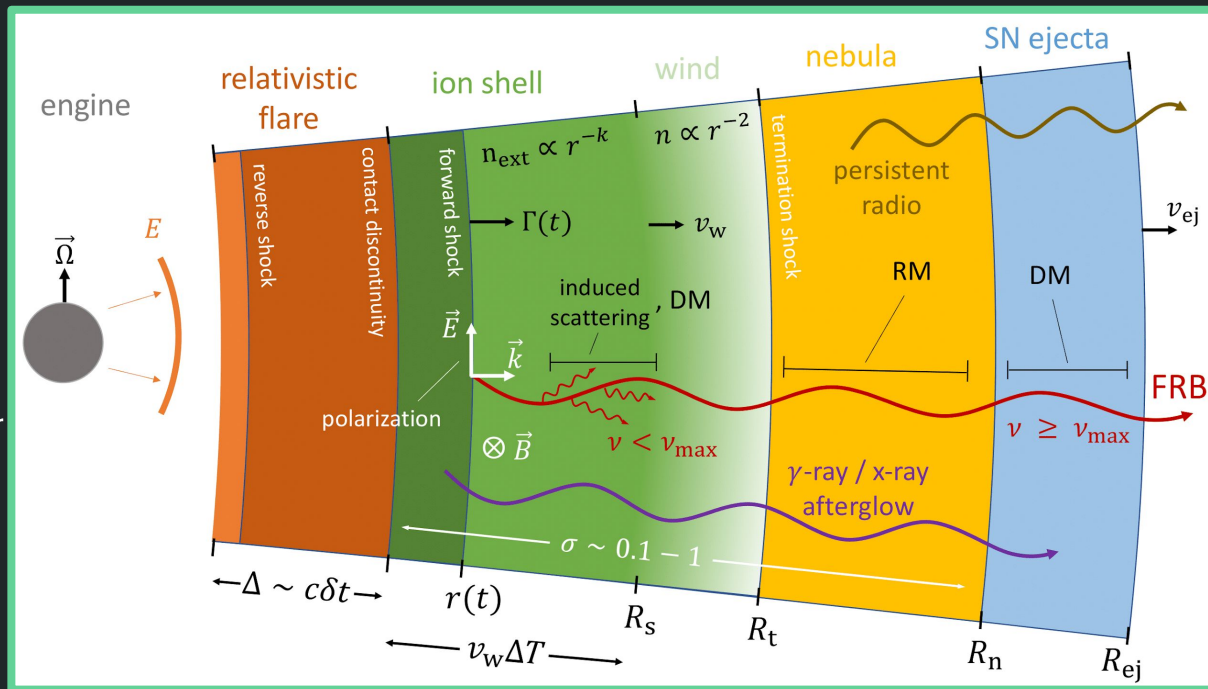
- ★ AGN jets
- ★ Nearby NS

## ◆ SN & SNR

- ★ Young magnetar
- ★ Persistent radio source
- ★ Emission
  - ★ Synchrotron maser
  - ★ Magnetospheric

## ◆ SLSNe/LGRBs

- ★ Similar hosts
- ★ Let's observe!

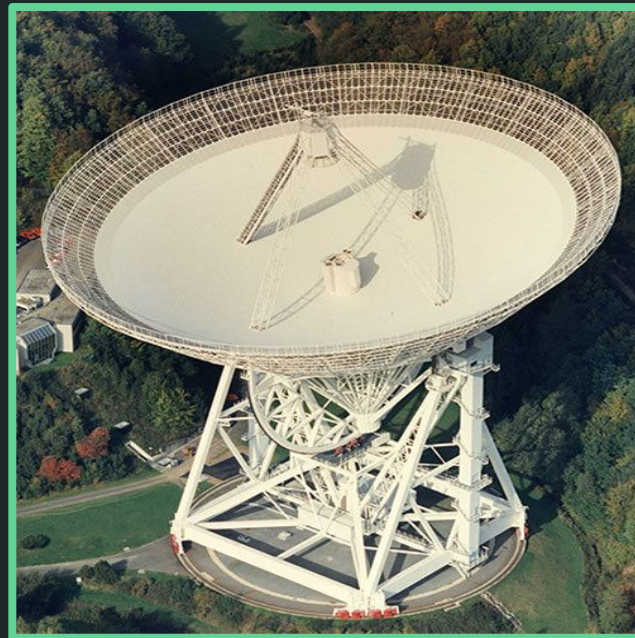


Metzger+2019

DOI: 10.1093/mnras/stz700

# C+ survey

- ◆ Observe 10 SLSNe/LGRBs
- ◆ Effelsberg
  - ★ C+ receiver
  - ★ 5-9 GHz
  - ★ 48 hours
- ◆ No detections
- ◆ Similar surveys
  - ★ No detections



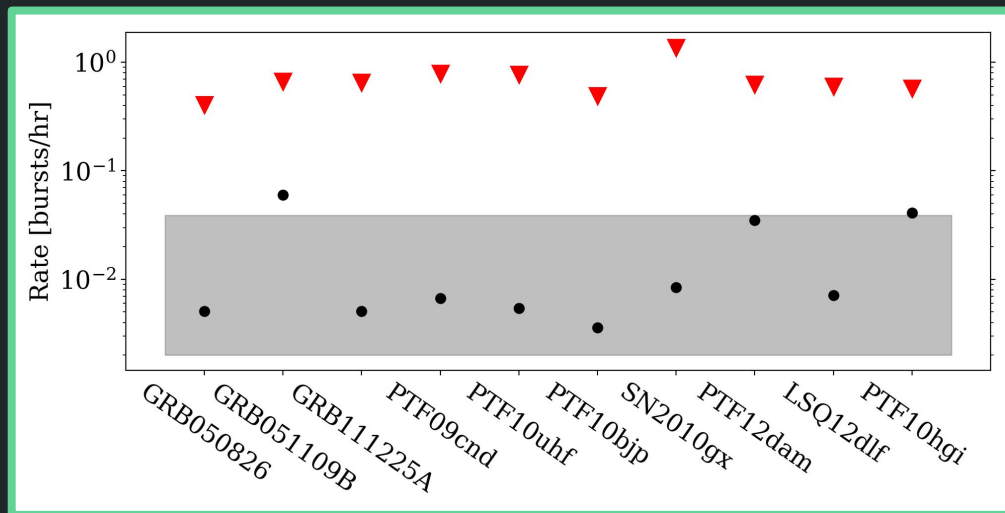
Effelsberg  
mpg.de

# C+ survey results

- ◆ Use C+ rate of FRB121102
  - ★ Bi-weekly observations
  - ★ Same obs setup
  - ★ > 100 hours
  - ★ 0.012 bursts/hr
- ◆ Scale FRB121102 rate to targets

$$R = R_0 \left( \frac{1+z_0}{1+z} \right)^\gamma \left( \frac{D_L}{D_{L,0}} \right)^{2\gamma}$$

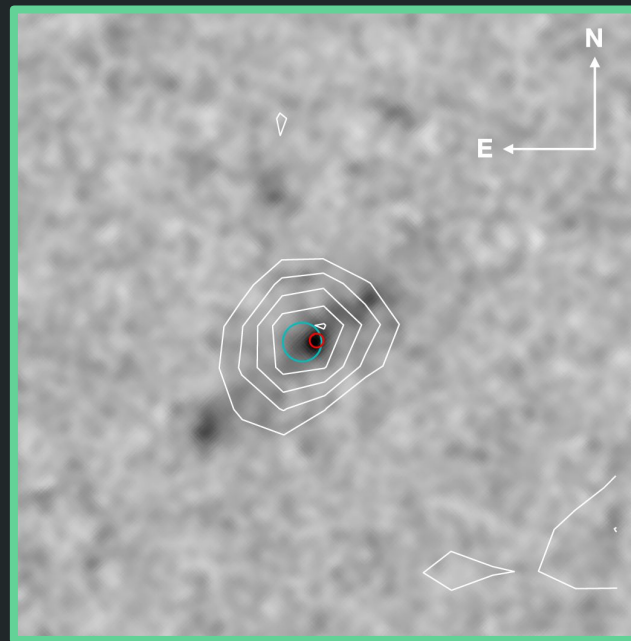
- ◆ Expect on average < 1 burst from each target



Hilmarsson+2020  
Submitted to MNRAS

# PTF10hgi

- ◆ SLSN
- ◆ Detection of a persistent radio source
- ◆ Analog to FRB121102?
- ◆ Follow-up
  - ★ PAF (1.2-1.5 GHz)
    - ★ 13 hours
  - ★ UWL (0.7-4 GHz)
    - ★ 2.3 hours
- ◆ No detections



Eftekhari+2019  
DOI:10.3847/2041-8213/ab18a5

# PTF10hgi results

## ◆ Use 1.4 GHz rate of FRB121102

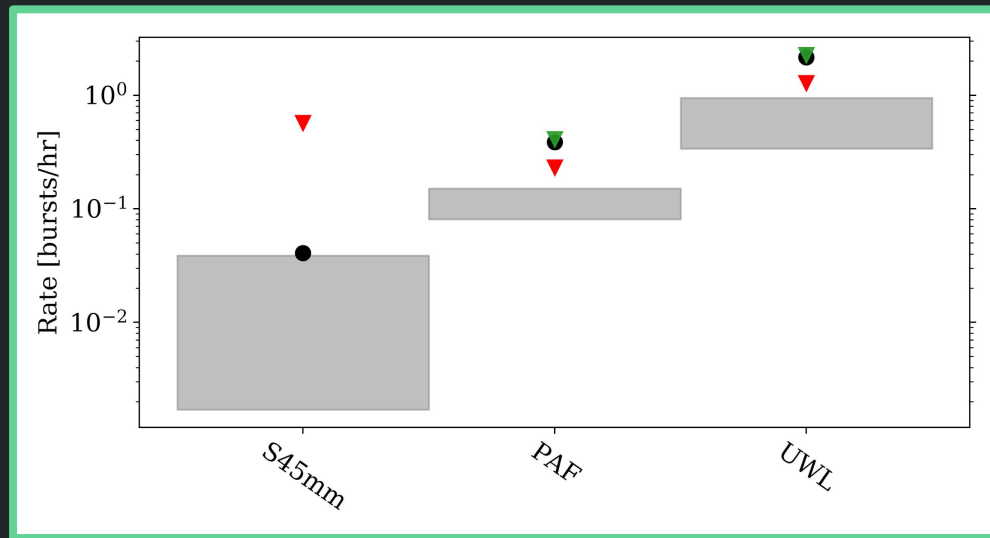
- ★ Effelsberg
- ★ > 110 hours
- ★ 0.24 bursts/hr

## ◆ Scale FRB121102 rate

- ★ Receiver
- ★ PTF10hgi

$$R = R_0 \left( \frac{\text{SEFD}}{\text{SEFD}_0} \right)^\gamma \left( \frac{\Delta\nu}{\Delta\nu_0} \right)^{\gamma/2} \left( \frac{1+z_0}{1+z} \right)^\gamma \left( \frac{D_L}{D_{L,0}} \right)^{2\gamma}$$

## ◆ Expect on average 5 bursts from each receiver



Hilmarsson+2020  
Submitted to MNRAS

# PTF10hgi - Why no detections?

*i) No FRB121102-like source in PTF10hgi*

*ii) No FRBs from magnetars in SNRs*

*iii) Bursts beamed away from line of sight*

*iv) SNR still opaque at observed frequencies*

*v) Quiescent state of bursting source*

# Non-Poissonian burst distribution

## ◆ Weibull distribution

- ★ Rate
- ★ Shape parameter
  - ★  $k < 1$

## ◆ FRB121102 1.4 GHz survey

- ★ 0.3 bursts/hr
- ★  $k = 0.4$

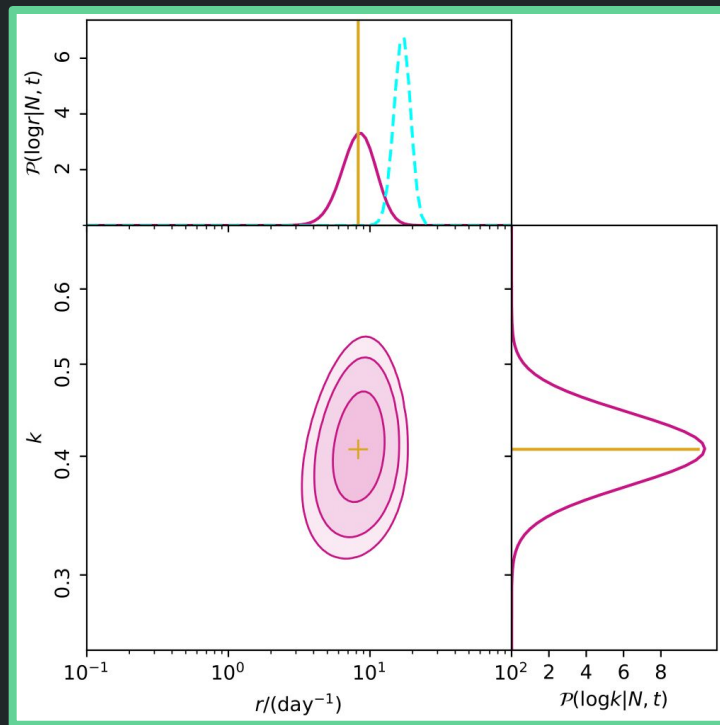
## ◆ Non-detection probability, single obs

$$P(N = 0 | k, r) = \frac{\Gamma(1/k) \Gamma_i \left( 1/k, (\Delta_{\text{obs}} r \Gamma(1+1/k))^k \right)}{k \Gamma(1+1/k)}$$

- ★ Multiply probabilities for many obs

## ◆ PTF10hgi non-detection probability

- ★ PAF: 14%
- ★ UWL: 16%

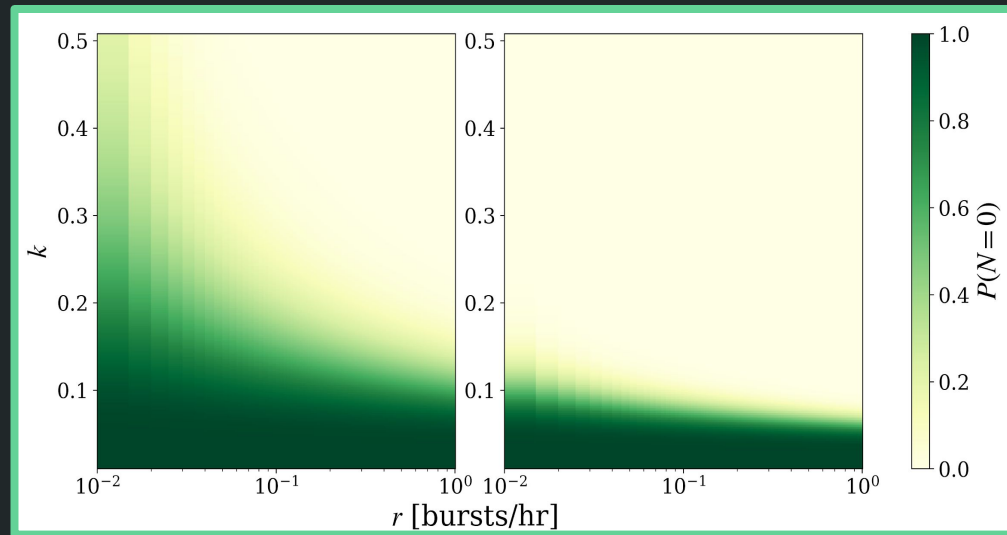


Cruces+2020

In prep

# Non-Poissonian burst distribution - cont.

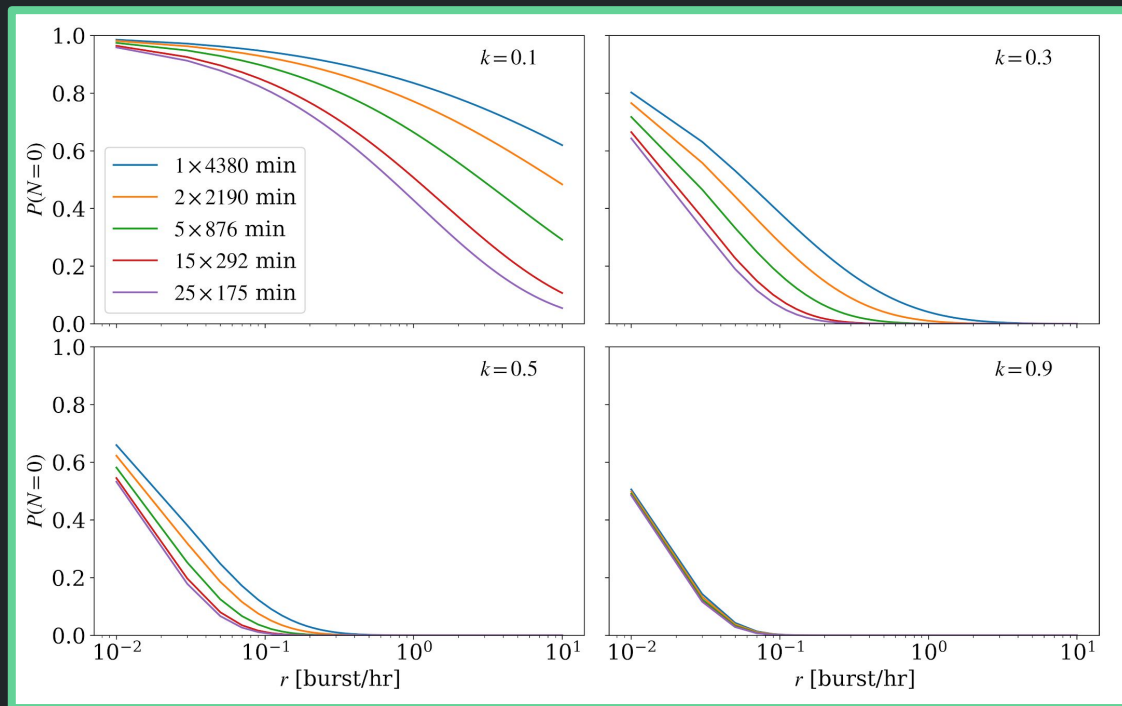
- ◆ No Weibull burst analysis at 6 GHz
- ◆ PTF10hgi non-detection probability with C+
  - ★ Ranges of rate and shape factor
  - ★ Exclude 1.4 GHz parameters
  - ★ Different distribution parameters for high vs low frequencies



Hilmarsson+2020  
Submitted to MNRAS

# Follow-up strategy

- ◆ Recent localisations
  - ★ Repeating/non-repeating
  - ★ Various galaxies
- ◆ Follow-up strategy
  - ★ Non-Poissonian
    - ★ Many short obs
  - ★ Beaming
    - ★ Multiple targets
  - ★ Include other host types



Hilmarsson+2020  
Submitted to MNRAS

# Conclusions

*SLSNe/LGRBs fit progenitor theories and share similarities with host of FRB121102*

*Observe 10 SLSNe/LGRBs at 5-9 GHz for ~50 hours*

*No detections*

*Follow up detection of persistent radio source at PTF10hgi for ~15 hours*

*No detections*

*Despite non-detections, still possibility of SLSNe/LGRBs being FRB progenitors*  
*Recently localised FRB180916, low RM, fits within SNR framework if system is old*

thanks

---