Fast Radio Bursts and Commensal Science at the VLA

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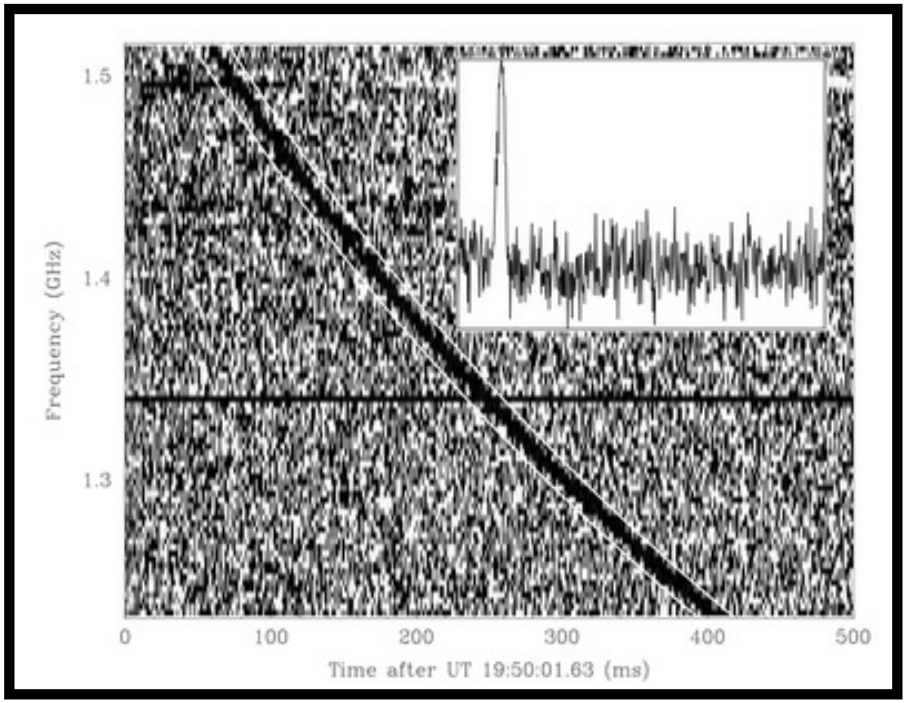
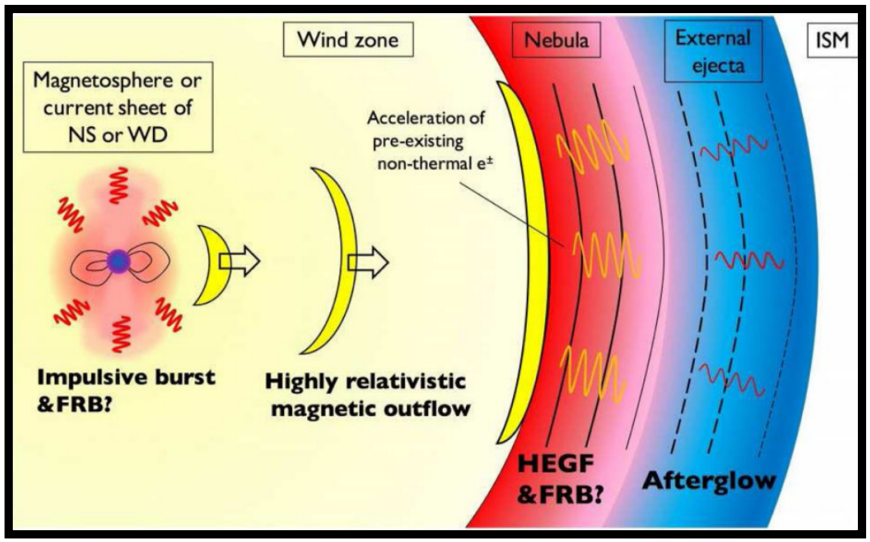
A NEW PHENOMENON

- Discovery by Parkes Observatory (Lorimer et al 2007)
- Millisecond duration radio transient with second-scale dispersive sweep
- Really bright (like, too bright)

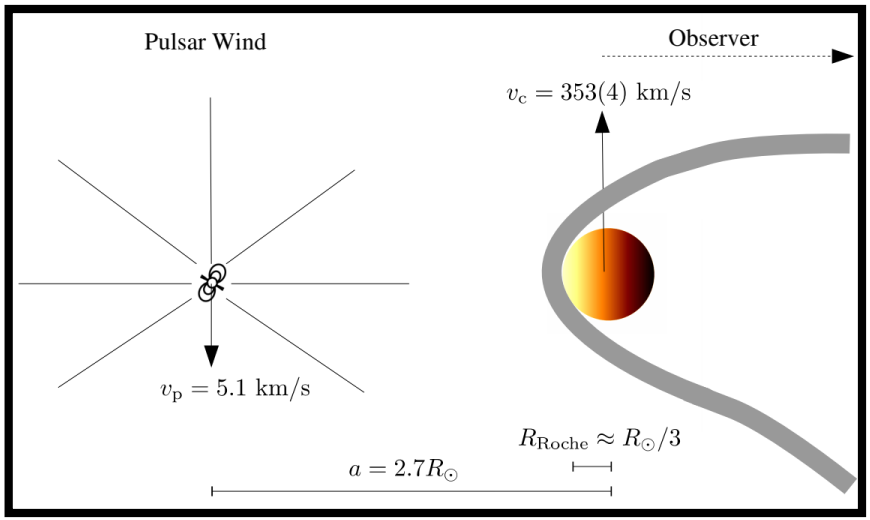


WHAT ARE THEY?

- DM => z ~ 0.1–1.
- Tb ~ 10^{35} K, E_r ~ 10^{40} erg (apparent)
- Models:
  - Young magnetars (Lyutikov et al, Murase et al, Katz et al, Metzger et al)
  - Compact object binaries (Dai et al, Kashiyama et al, Zhang)
  - Lensed pulsars (Cordes et al)



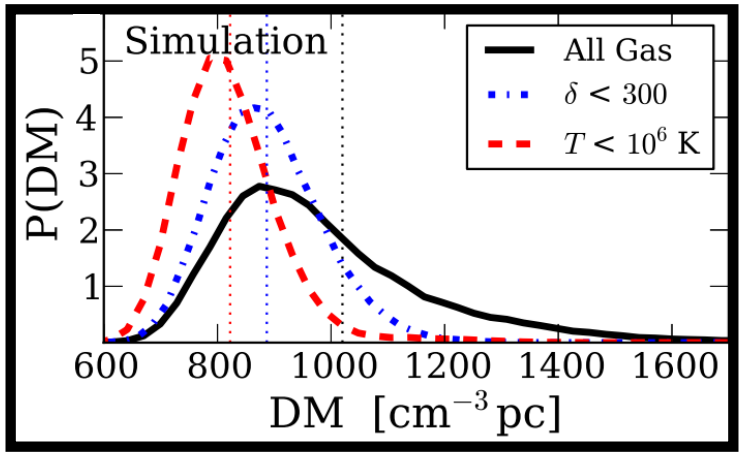
ms-magnetar (Murase et al 2016)



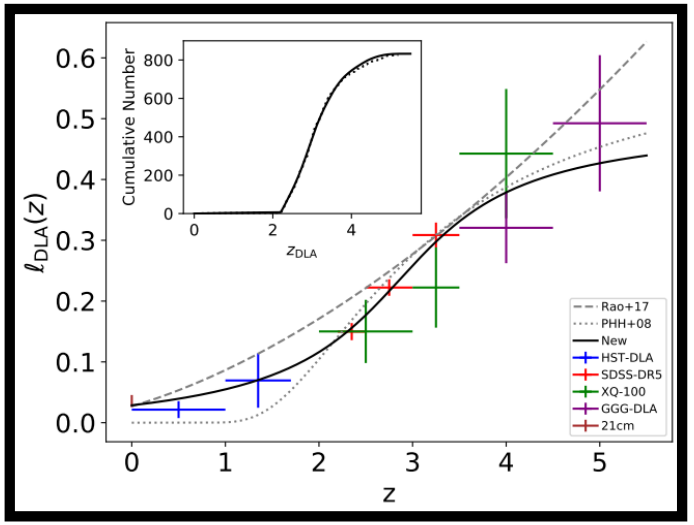
Lensed black widow pulsar (Main et al 2018)

HOW CAN WE USE THEM?

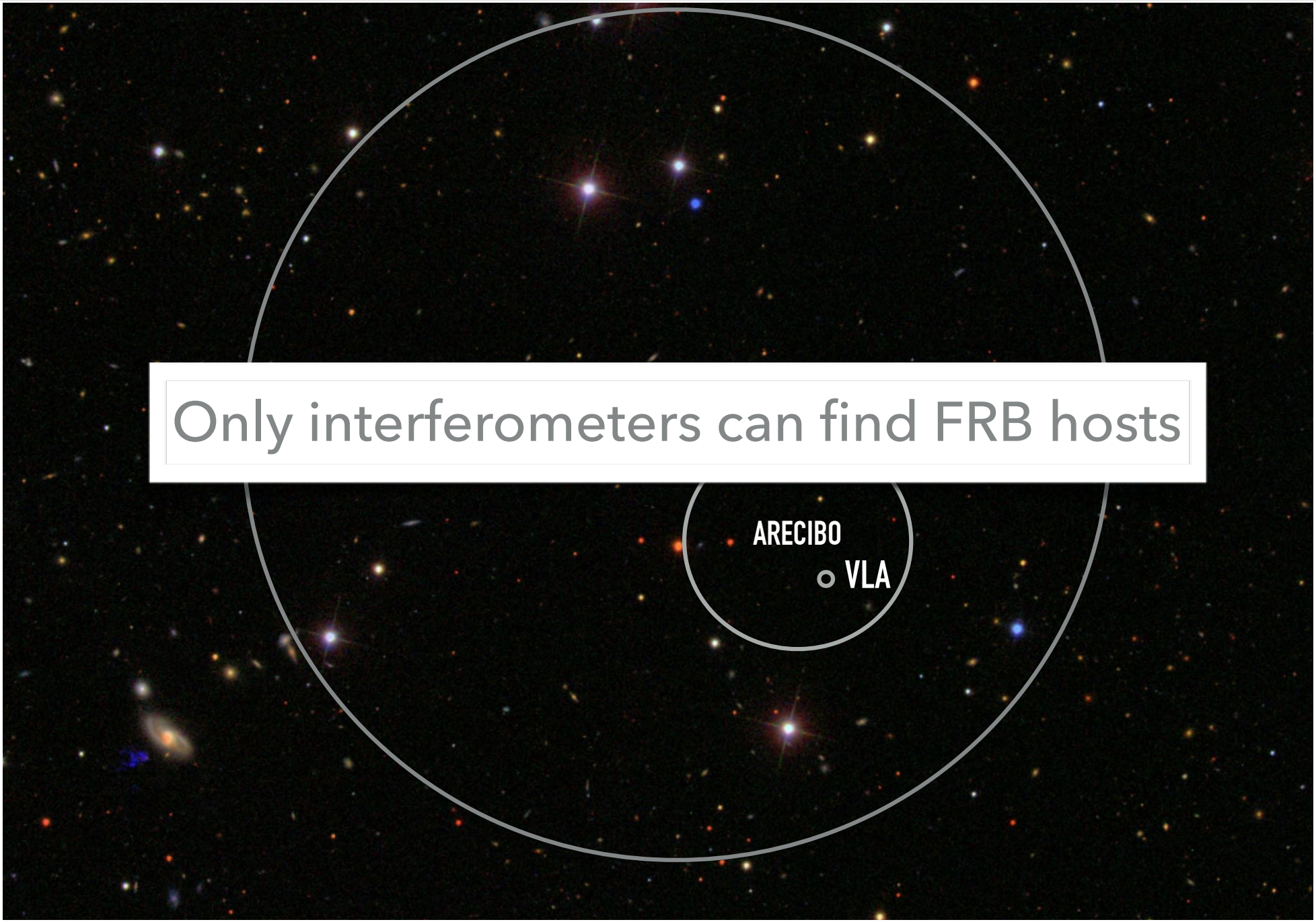
- DM ~ D*n_e
- n_e ~ Ω_b
- Relevant systems:
  - "Hidden" baryons
  - Damped Lyα
  - IGM magnetic field



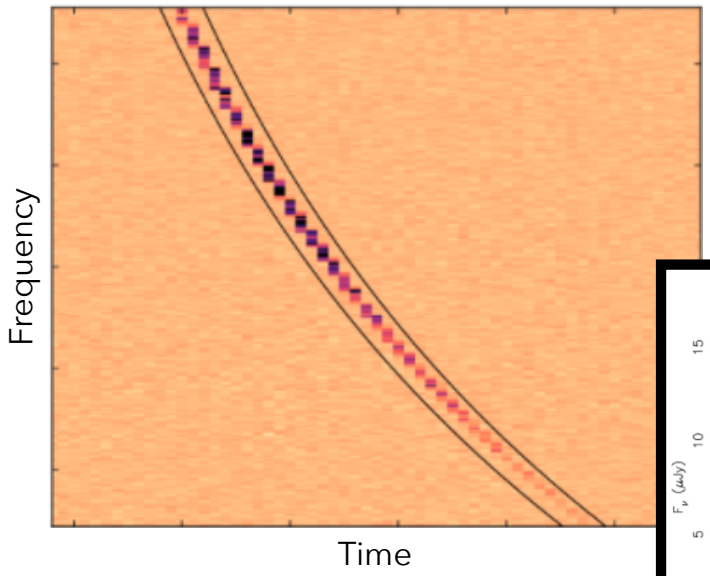
Galaxy halo DM by McQuinn et al (2014)

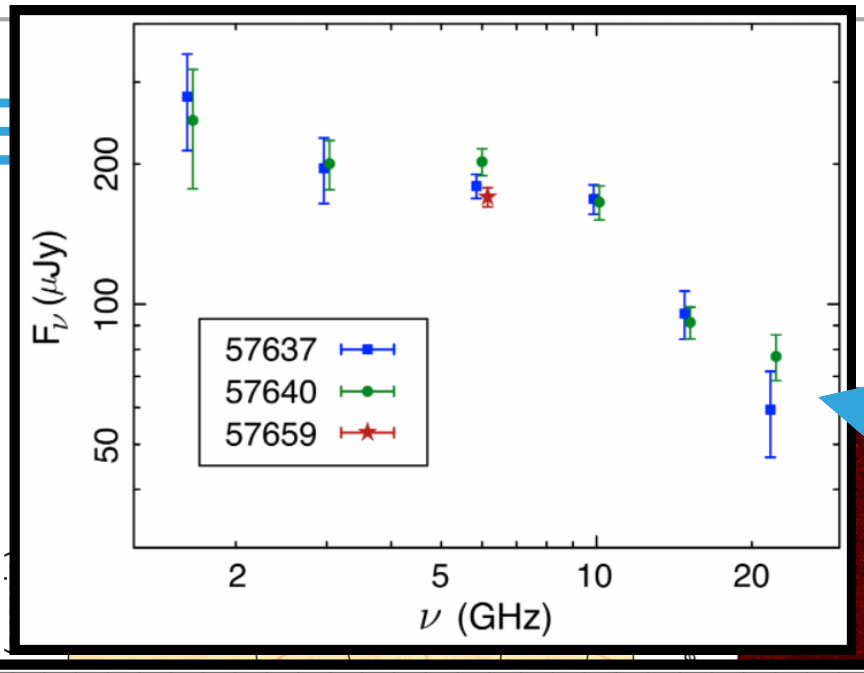


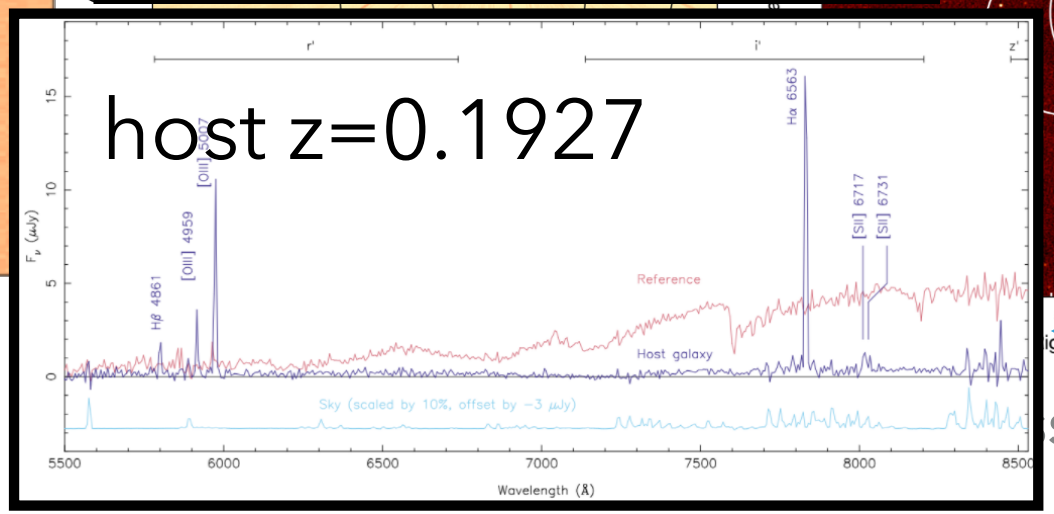
Damped Lyα Prochaska & Neeleman (2017)

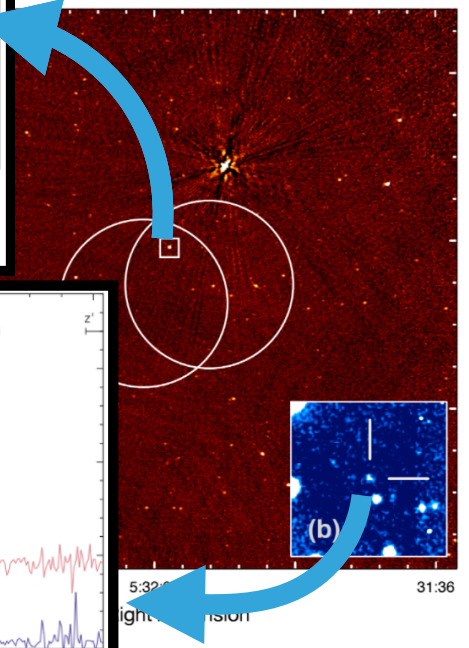

Only interferometers can find FRB hosts
ARECIBO
VLA

POWER OF INTERFEROME









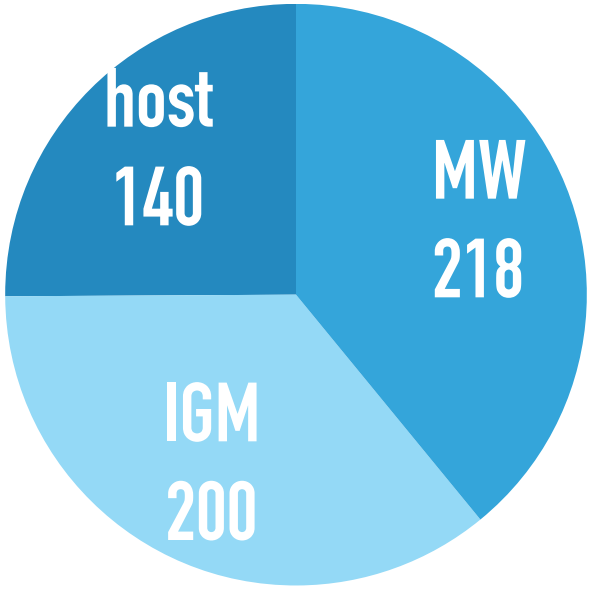
Search

sociate

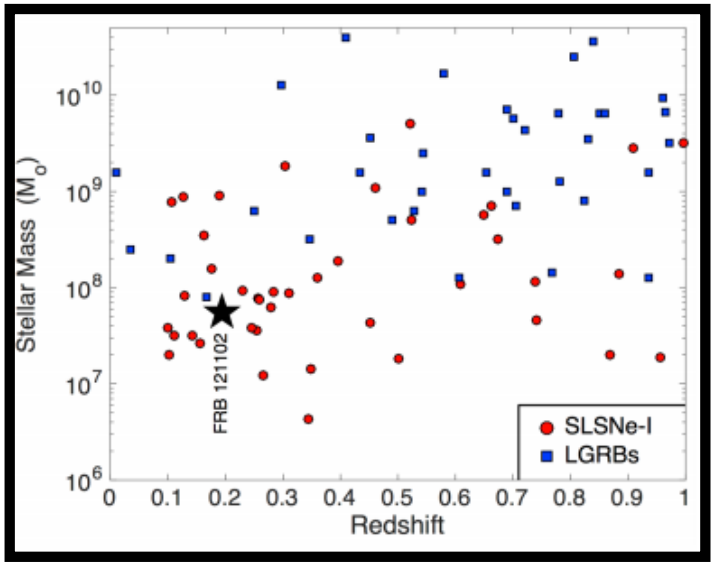
FRB 121102 papers in 2017:
Chatterjee+, Tendulkar+, Marcote+, Bassa+, Scholz+, Law+

WHAT HAVE WE LEARNED?

- FRB resides in dwarf galaxy in kpc-scale star-forming region offset from galaxy center
- DM distribution along line of sight
- FRB coincident with pc-scale radio source
- First FRB volumetric rate
- Potential connections to SLSN-I and magnetar unification models (Metzger et al, Murase et al, Kashiyama et al)

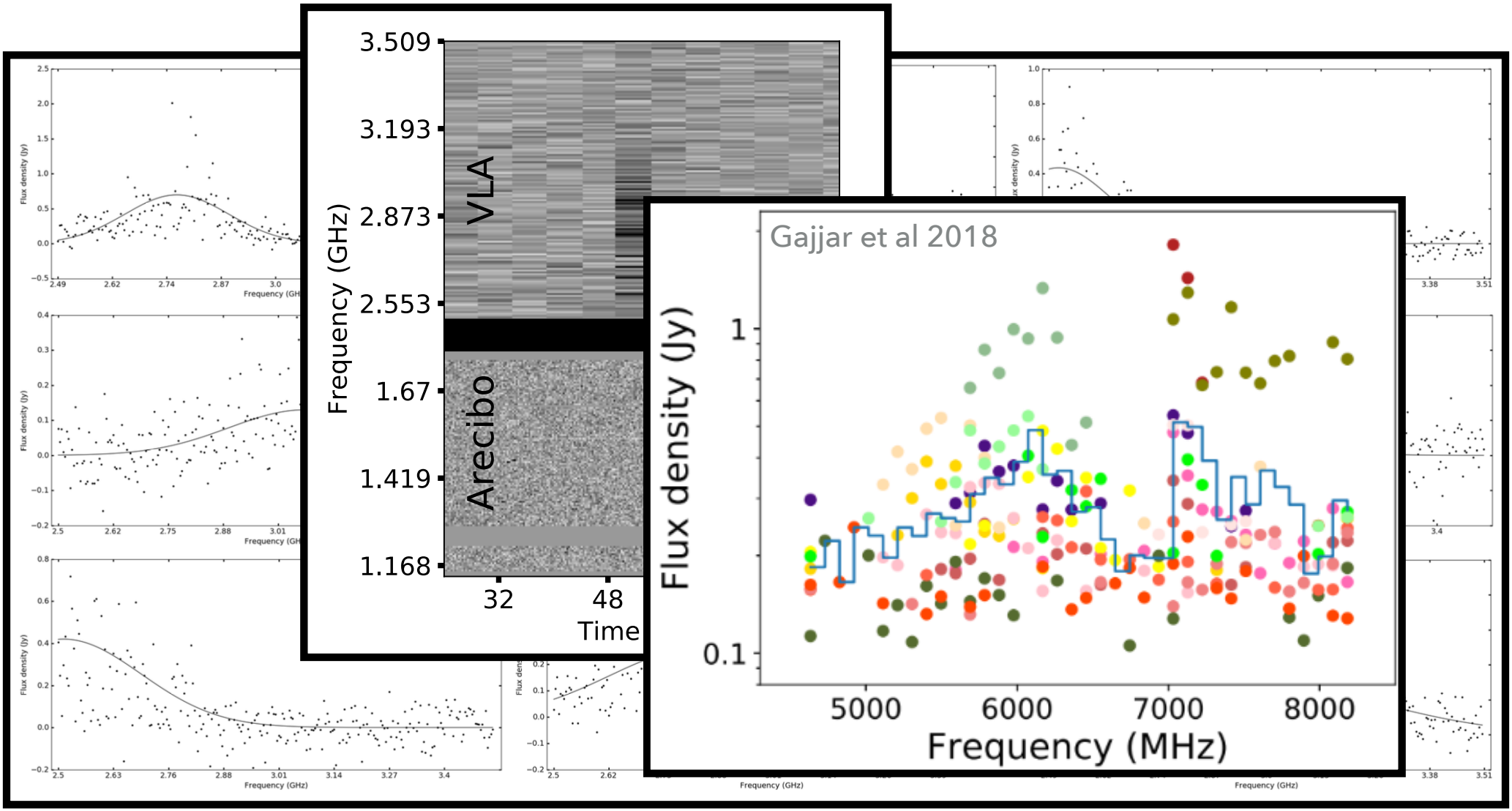


Where are the electrons? (DM in pc/cm3)



Host connection to SLSN-I (Metzger et al)

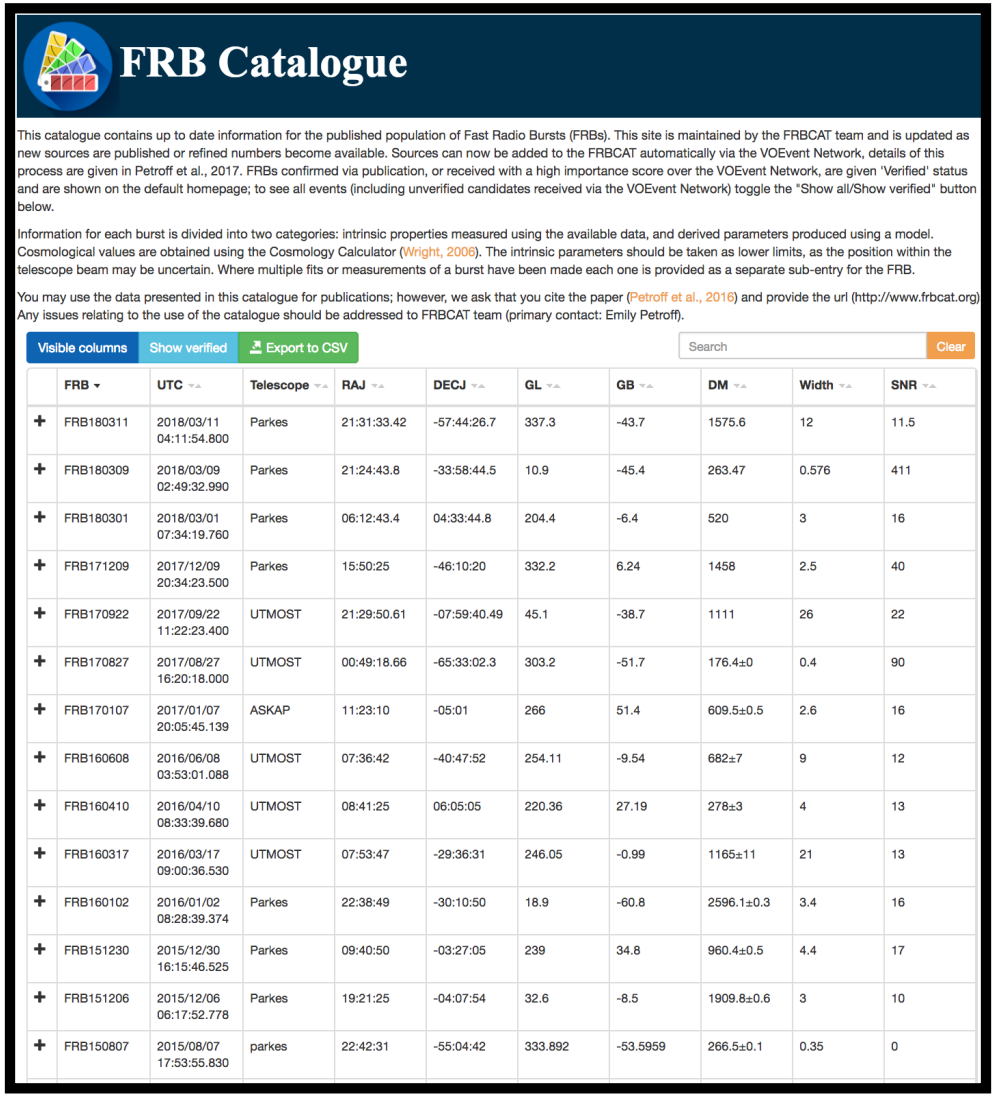
SPECTRAL DIVERSITY



Nine 3 GHz burst spectra for FRB 121102 (Law et al 2017)

A BRIEF HISTORY OF FRBS

- 2007: Lorimer burst published
- 2011: An FRB sample (Thornton et al) and "that thing with the microwave oven" (Burke-Spolaor et al)
- 2014: First non-Parkes FRB (Spitler et al)
- 2015: FRB polarimetry (Masui et al, Petroff et al)
- 2016: A repeating FRB (Spitler et al)
- 2017: FRBs with interferometers (Caleb et al, Chatterjee et al)
- Today:
  - 34 (public) detections by Parkes, GBT, Arecibo, Molonglo, ASKAP, VLA, EVN, Effelsberg.
  - ~1 new FRB/month
  - One FRB host identified



FRB Catalogue

This catalogue contains up to date information for the published population of Fast Radio Bursts (FRBs). This site is maintained by the FRBCAT team and is updated as new sources are published or refined numbers become available. Sources can now be added to the FRBCAT automatically via the VOEvent Network, details of this process are given in Petroff et al., 2017. FRBs confirmed via publication, or received with a high importance score over the VOEvent Network, are given 'Verified' status and are shown on the default homepage; to see all events (including unverified candidates received via the VOEvent Network) toggle the "Show all/Show verified" button below.

Information for each burst is divided into two categories: intrinsic properties measured using the available data, and derived parameters produced using a model. Cosmological values are obtained using the Cosmology Calculator (Wright, 2006). The intrinsic parameters should be taken as lower limits, as the position within the telescope beam may be uncertain. Where multiple fits or measurements of a burst have been made each one is provided as a separate sub-entry for the FRB.

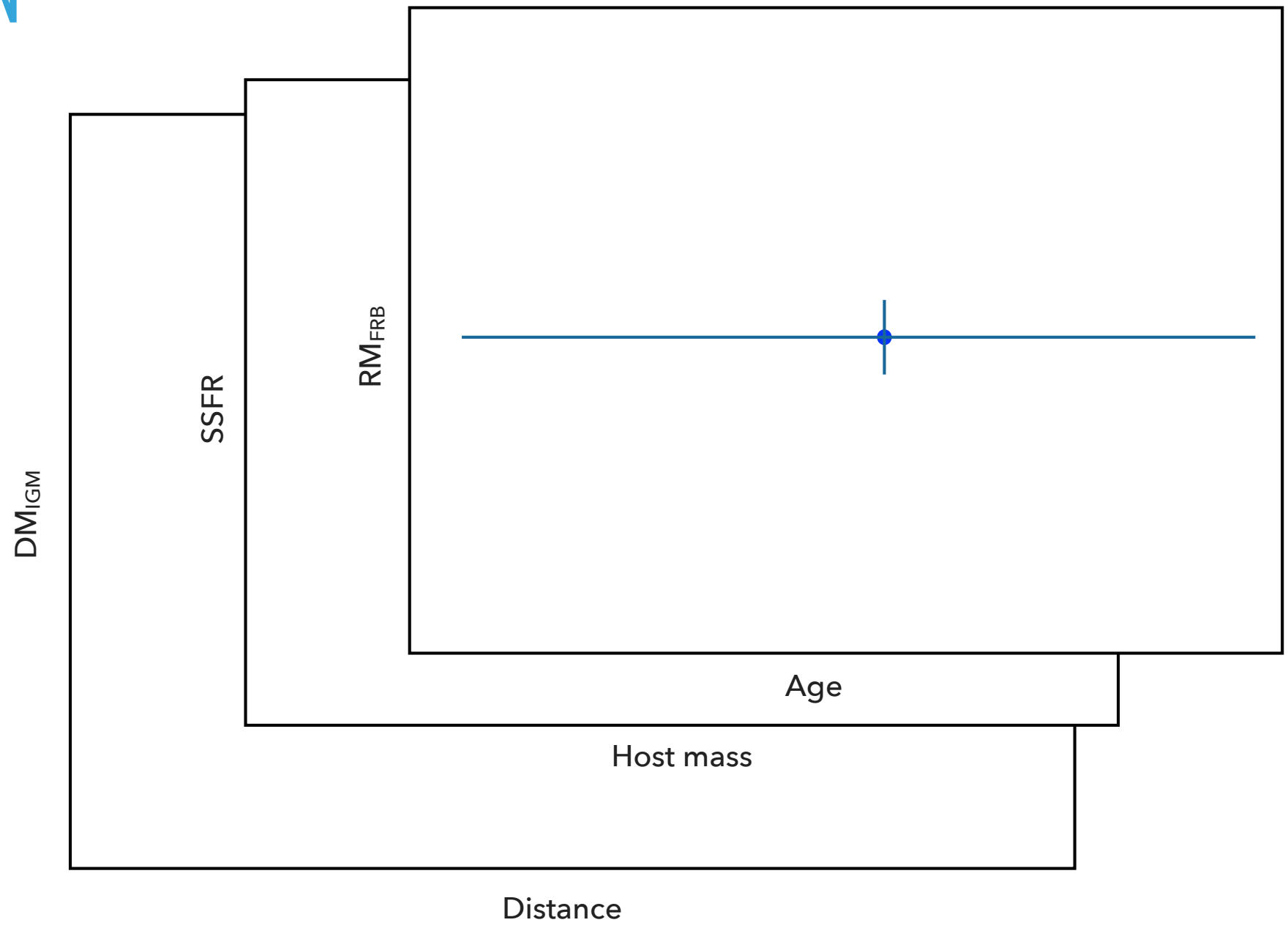
You may use the data presented in this catalogue for publications; however, we ask that you cite the paper (Petroff et al., 2016) and provide the url (http://www.frbcat.org) Any issues relating to the use of the catalogue should be addressed to FRBCAT team (primary contact: Emily Petroff).

Visible columns | Show verified | Export to CSV | Search | Clear

	FRB	UTC	Telescope	RAJ	DECJ	GL	GB	DM	Width	SNR
+	FRB180311	2018/03/11 04:11:54.800	Parkes	21:31:33.42	-57:44:26.7	337.3	-43.7	1575.6	12	11.5
+	FRB180309	2018/03/09 02:49:32.990	Parkes	21:24:43.8	-33:58:44.5	10.9	-45.4	263.47	0.576	411
+	FRB180301	2018/03/01 07:34:19.760	Parkes	06:12:43.4	04:33:44.8	204.4	-6.4	520	3	16
+	FRB171209	2017/12/09 20:34:23.500	Parkes	15:50:25	-46:10:20	332.2	6.24	1458	2.5	40
+	FRB170922	2017/09/22 11:22:23.400	UTMOST	21:29:50.61	-07:59:40.49	45.1	-38.7	1111	26	22
+	FRB170827	2017/08/27 16:20:18.000	UTMOST	00:49:18.66	-65:33:02.3	303.2	-51.7	176.4±0	0.4	90
+	FRB170107	2017/01/07 20:05:45.139	ASKAP	11:23:10	-05:01	266	51.4	609.5±0.5	2.6	16
+	FRB160608	2016/06/08 03:53:01.088	UTMOST	07:36:42	-40:47:52	254.11	-9.54	682±7	9	12
+	FRB160410	2016/04/10 08:33:39.680	UTMOST	08:41:25	06:05:05	220.36	27.19	278±3	4	13
+	FRB160317	2016/03/17 09:00:36.530	UTMOST	07:53:47	-29:36:31	246.05	-0.99	1165±11	21	13
+	FRB160102	2016/01/02 08:28:39.374	Parkes	22:38:49	-30:10:50	18.9	-60.8	2596.1±0.3	3.4	16
+	FRB151230	2015/12/30 16:15:46.525	Parkes	09:40:50	-03:27:05	239	34.8	960.4±0.5	4.4	17
+	FRB151206	2015/12/06 06:17:52.778	Parkes	19:21:25	-04:07:54	32.6	-8.5	1909.8±0.6	3	10
+	FRB150807	2015/08/07 17:53:55.830	parkes	22:42:31	-55:04:42	333.892	-53.5959	266.5±0.1	0.35	0

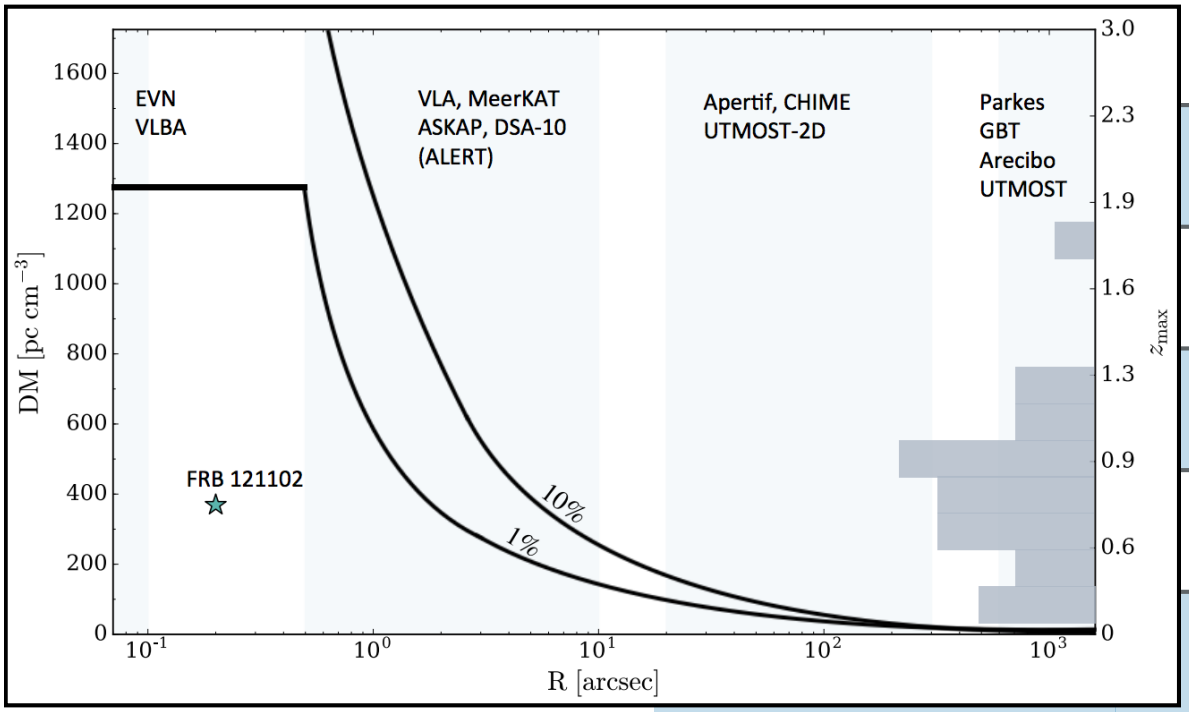
See http://frbcat.org by Petroff et al (2016)

VISION



BUILDING BOOM

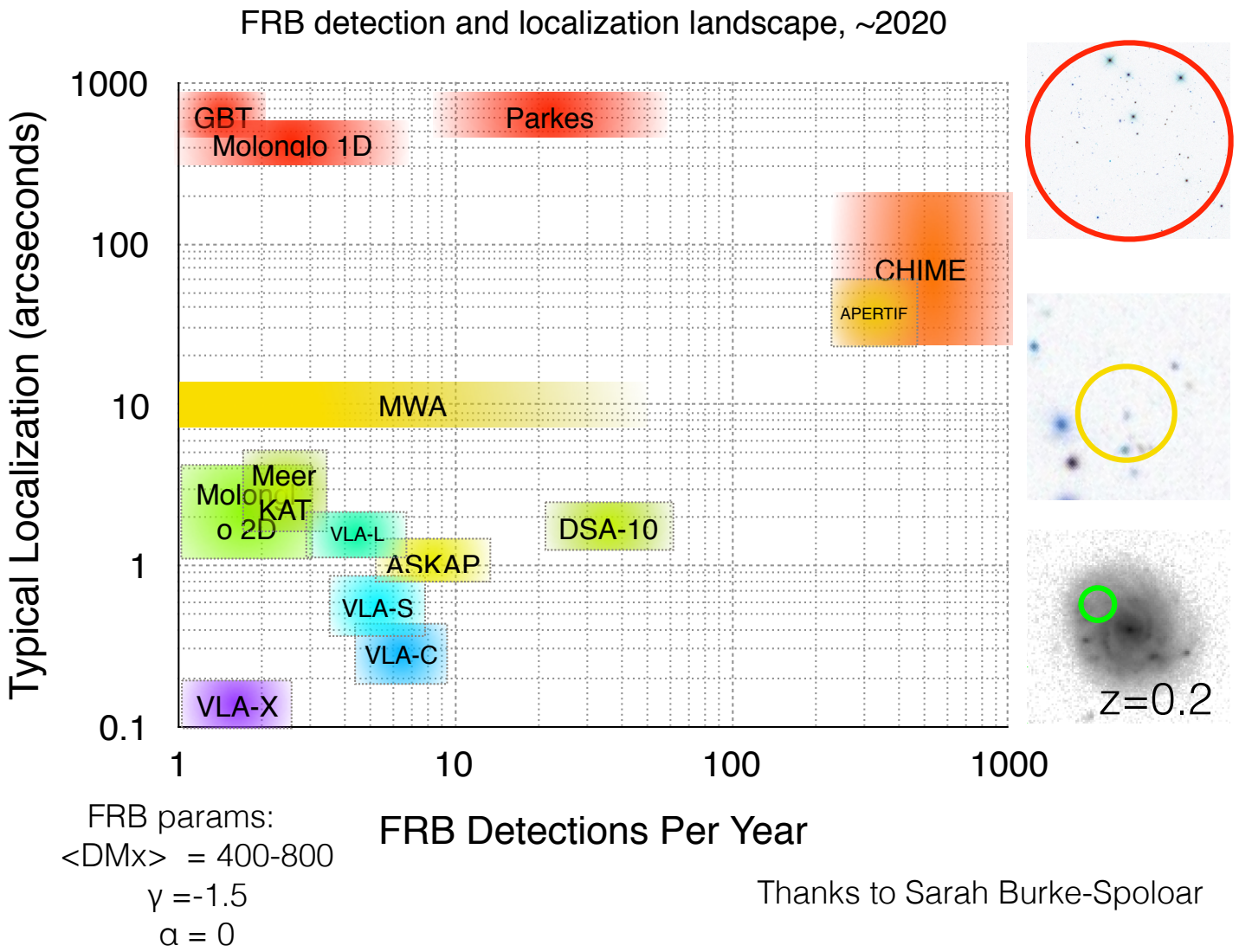
Telescope	FoV	Θ_b	Search
VLA	5-30′	0.1-40″	Imaging
CHIME	2x90°	0.4°	BF
		1′x2°	BF
		40″	Imaging
		10″	BF
		15″x30′	BF
		5″	BF
		1′	BF



Required resolution for host identification (Eftekhari et al 2017)

INDUSTRIALIZING FRB LOCALIZATION

- Hundreds of hours needed for ~Jy-ms sensitivity
- Localizations require data at ~TB/hour and ~PB/FRB
- Real-time analysis and commensality help

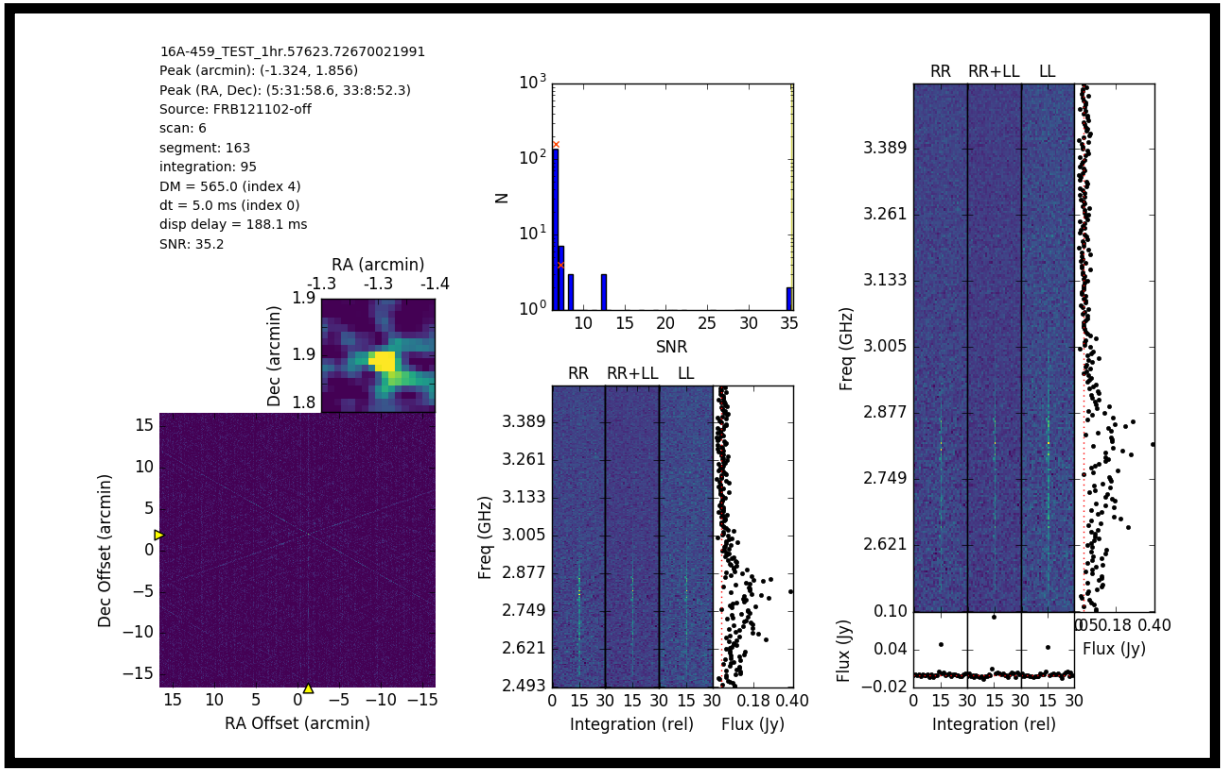


FRB params:
<DMx> = 400-800
γ =-1.5
α = 0

Thanks to Sarah Burke-Spoloar

REALFAST

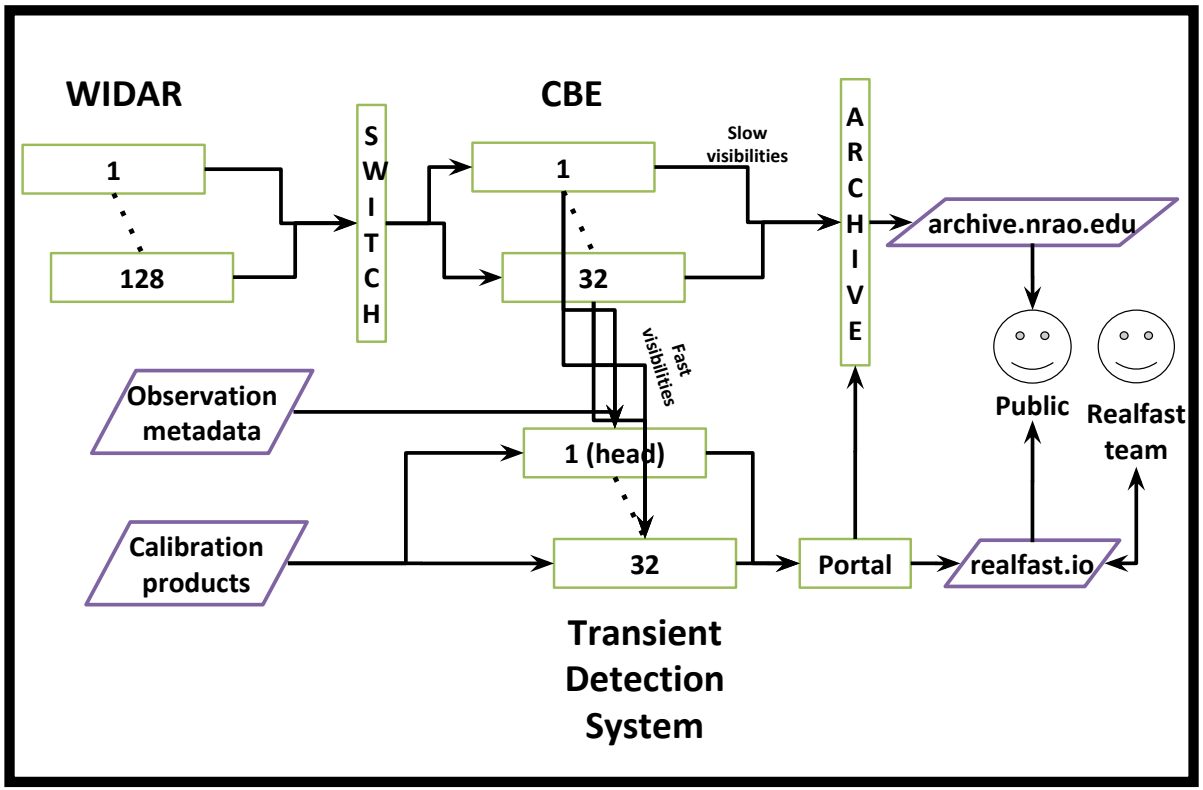
- VLA commensal fast transient survey system
  - Fast sampled visibilities
  - Dedicated computing
  - Triggered data recording
- NSF-funded for 3 years
- More info at https://arxiv.org/abs/1802.03084 http://realfast.io



Prototype realfast localization of FRB 121102

IMPLEMENTING COMMENSAL

- realfast chooses:
  - internal correlator integration time
  - Deploy correlator mode for general use
- Primary choses:
  - Frequencies somewhere between 1 and 50 GHz
- Fast sampled visibilities are a "new", public data product



CONCLUSIONS

- FRBs field moving from ***discovery*** to ***characterization*** and ***exploitation***.
- Expect many FRBs, few localizations.
- Testable models (e.g., magnetar unification) in place.
- ***Radio discovery*** limits progress.
- Commensal and purpose-built telescopes will lead the way.