Bursts before Burst:

A Comparative Study on FRB 200428-associated X-ray Burst and other FRB-absent X-ray Bursts from SGR J1935+2154

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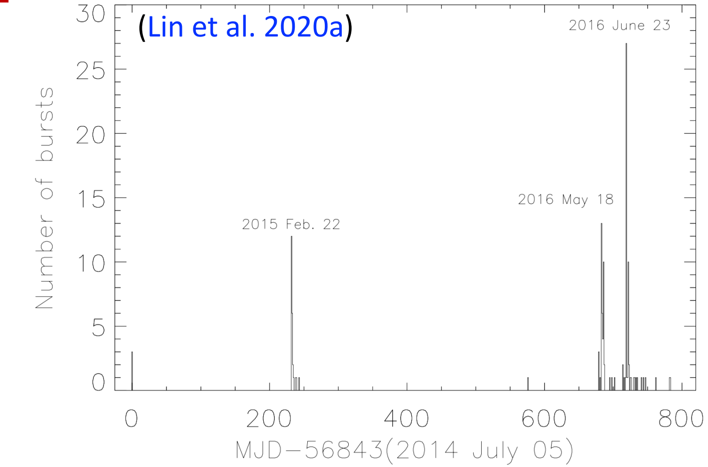
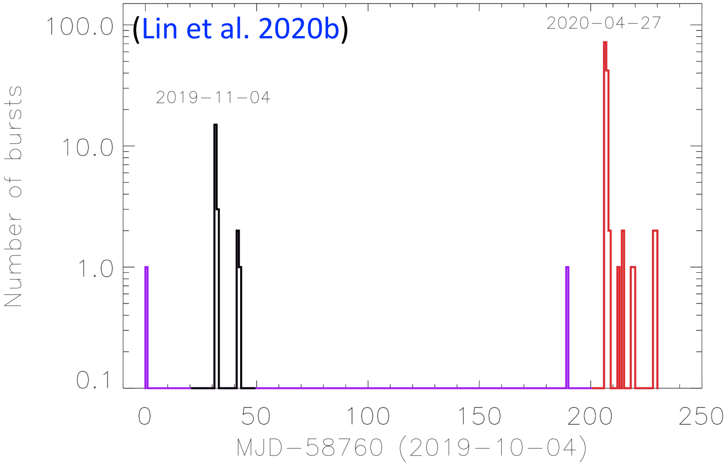
SGR J1935+2154



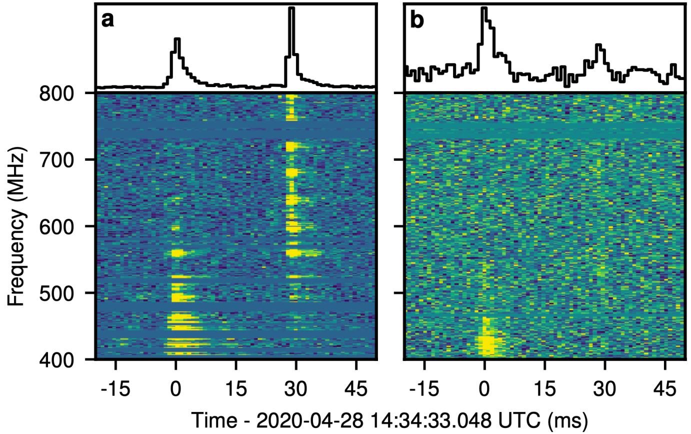


- **Magnetar nature** (Israel et al. 2016)
  - P = 3.24 s
  - $\dot{P} = 1.43\times10^{11}\ s\ s^{-1}$
  - B ~ 2.2 $\times$ 10^{14} G

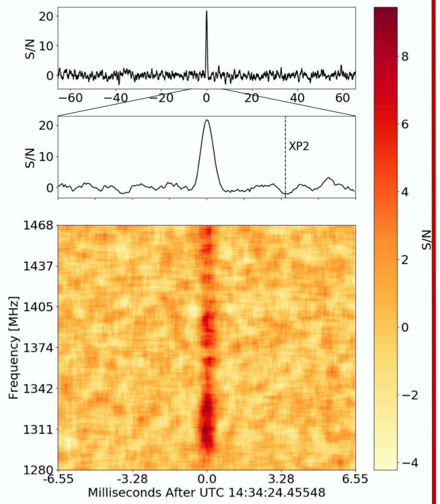
- **Distance**
  - A bright expanding dust-scattering X-ray ring observed by the XRT: ~ (2 – 7) kpc (Mereghetti et al. 2020).
  - Its associated SNR G57.2+0.8: 6.6 $\pm$ 0.7 kpc (Zhou et al. 2020).
  - By analyzing the contributions of the dispersion measure: 9.0 $\pm$ 2.5 kpc (Zhong et al. 2020).

SGR J1935+2154

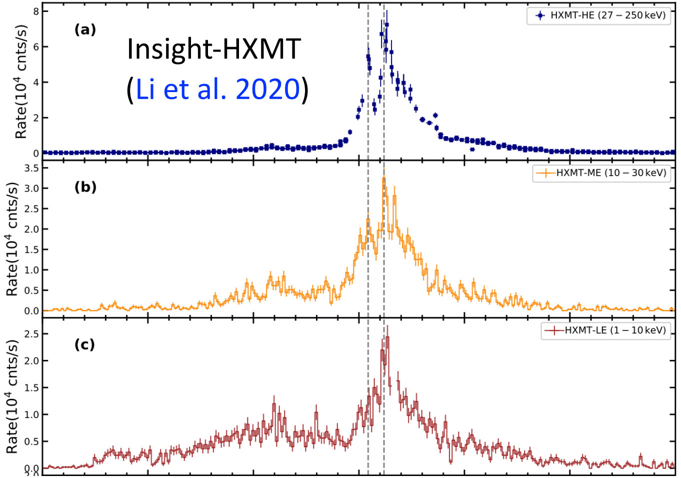
FRB 200428

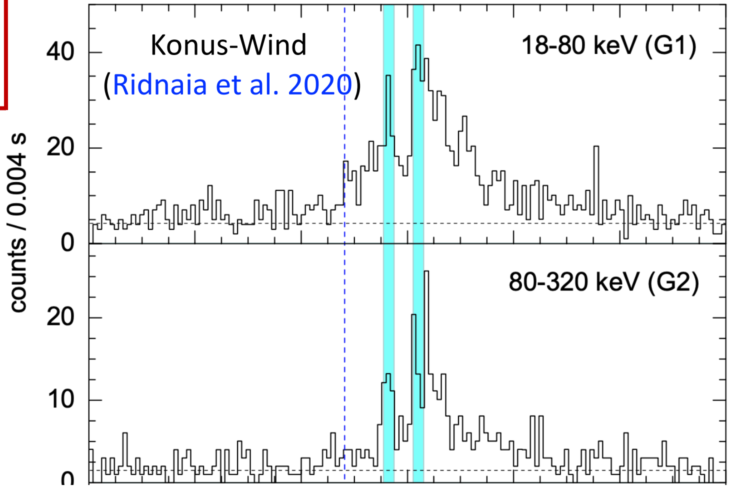


CHIME (CHIME/FRB Collaboration et al. 2020)

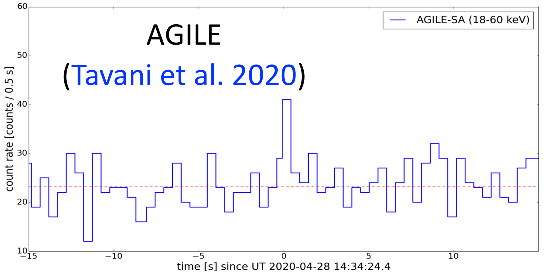


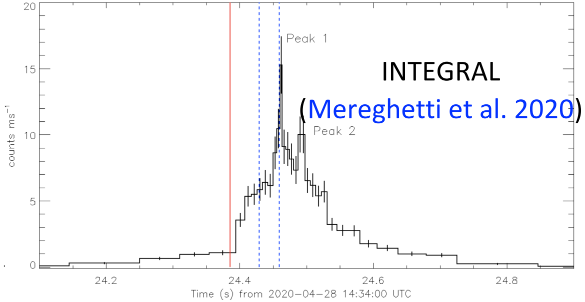
STARE2 (Bochenek et al. 2020)





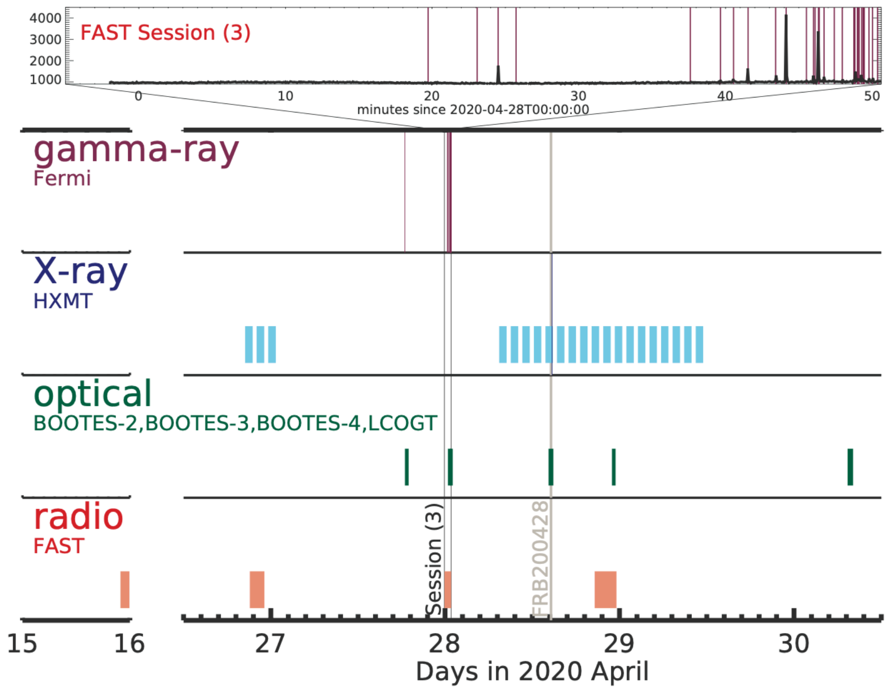
FRB 200428-associated XRB





SGR J1935+2154

- **FAST observations**
  - No pulsed radio emission during a bursting phase (Lin et al. 2020c).



ID	Burst time	Flux (erg cm^{-2} s^{-1})	Fluence (erg cm^{-2}
1	00:19:44.192	$1.22^{+0.18}_{-0.16} \times 10^{-6}$	$7.93^{+1.20}_{-1.05} \times 10^{-8}$
2	00:23:04.728	$3.26^{+0.73}_{-0.67} \times 10^{-7}$	$7.10^{+1.58}_{-1.47} \times 10^{-8}$
3	00:24:30.296	$2.37^{+0.05}_{-0.05} \times 10^{-5}$	$3.01^{+0.06}_{-0.07} \times 10^{-6}$
4	00:25:43.945	$1.99^{+0.70}_{-0.62} \times 10^{-7}$	$5.26^{+1.84}_{-1.64} \times 10^{-8}$
5	00:37:36.153	$2.73^{+0.58}_{-0.55} \times 10^{-7}$	$6.78^{+1.43}_{-1.35} \times 10^{-8}$
6	00:39:39.513	$8.96^{+1.09}_{-1.04} \times 10^{-7}$	$1.89^{+0.23}_{-0.22} \times 10^{-7}$
7	00:40:33.072	$1.20^{+0.11}_{-0.11} \times 10^{-6}$	$3.57^{+0.32}_{-0.33} \times 10^{-7}$
8	00:41:32.136	$4.69^{+0.16}_{-0.17} \times 10^{-6}$	$1.15^{+0.04}_{-0.04} \times 10^{-6}$
9	00:43:25.169	$2.23^{+0.14}_{-0.13} \times 10^{-6}$	$5.51^{+0.35}_{-0.33} \times 10^{-7}$
10	00:44:08.202	$3.93^{+0.08}_{-0.07} \times 10^{-5}$	$6.68^{+0.13}_{-0.13} \times 10^{-6}$
11	00:45:31.097	$8.44^{+1.32}_{-1.16} \times 10^{-7}$	$7.43^{+1.16}_{-1.02} \times 10^{-8}$
12	00:46:00.009	$7.83^{+0.66}_{-0.67} \times 10^{-7}$	$4.52^{+0.38}_{-0.39} \times 10^{-7}$
13	00:46:06.408	$4.11^{+0.64}_{-0.61} \times 10^{-7}$	$7.89^{+1.23}_{-1.17} \times 10^{-8}$
14	00:46:20.176	$2.32^{+0.06}_{-0.05} \times 10^{-5}$	$4.18^{+0.10}_{-0.09} \times 10^{-6}$
15	00:46:23.504	$3.17^{+0.46}_{-0.43} \times 10^{-7}$	$2.32^{+0.33}_{-0.31} \times 10^{-7}$
16	00:46:43.208	$9.81^{+0.75}_{-0.69} \times 10^{-7}$	$3.21^{+0.24}_{-0.23} \times 10^{-7}$
17	00:47:24.961	$1.66^{+0.43}_{-0.34} \times 10^{-7}$	$6.23^{+1.61}_{-1.29} \times 10^{-8}$
18	00:47:57.528	$1.16^{+0.12}_{-0.11} \times 10^{-6}$	$1.08^{+0.11}_{-0.10} \times 10^{-7}$
19	00:48:44.824	$3.96^{+0.46}_{-0.42} \times 10^{-7}$	$1.38^{+0.16}_{-0.15} \times 10^{-7}$
20	00:48:49.272	$3.05^{+0.17}_{-0.16} \times 10^{-6}$	$7.32^{+0.40}_{-0.38} \times 10^{-7}$
21	00:49:00.273	$7.80^{+1.14}_{-1.03} \times 10^{-7}$	$8.11^{+1.18}_{-1.07} \times 10^{-8}$
22	00:49:01.121	$8.36^{+0.96}_{-0.92} \times 10^{-7}$	$1.32^{+0.15}_{-0.14} \times 10^{-7}$
23	00:49:06.472	$9.66^{+4.00}_{-3.73} \times 10^{-8}$	$6.98^{+2.89}_{-2.69} \times 10^{-8}$
24	00:49:16.592	$1.78^{+0.16}_{-0.15} \times 10^{-7}$	$4.17^{+1.28}_{-1.24} \times 10^{-8}$
25	00:49:22.392	$7.72^{+1.10}_{-1.05} \times 10^{-7}$	$4.55^{+0.65}_{-0.62} \times 10^{-8}$
26	00:49:27.280	$3.58^{+1.32}_{-1.08} \times 10^{-7}$	$2.11^{+0.78}_{-0.64} \times 10^{-8}$
27	00:49:46.680	$3.87^{+0.39}_{-0.36} \times 10^{-7}$	$2.63^{+0.26}_{-0.24} \times 10^{-7}$
28	00:50:01.248	$7.83^{+0.66}_{-0.61} \times 10^{-7}$	$3.13^{+0.26}_{-0.25} \times 10^{-7}$
29	00:50:21.969	$1.32^{+0.55}_{-0.46} \times 10^{-7}$	$1.85^{+0.76}_{-0.65} \times 10^{-8}$

HOW SPECIAL IS THE FRB-ASSOCIATED BURST?

- Temporal analysis
- (Time-integrated, time-resolved) spectral analysis
- Event Rates

OBSERVATION AND DATA ANALYSIS

Bursts Identification

- A burst is defined that within its starting time (Tbb,1) and ending time (Tbb,2), all blocks are continuously above the background.

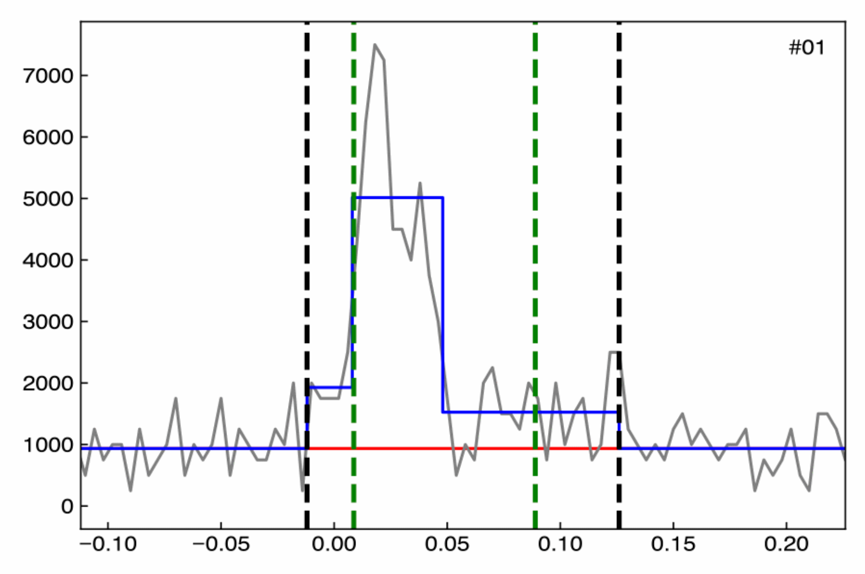
→ 34 bursts

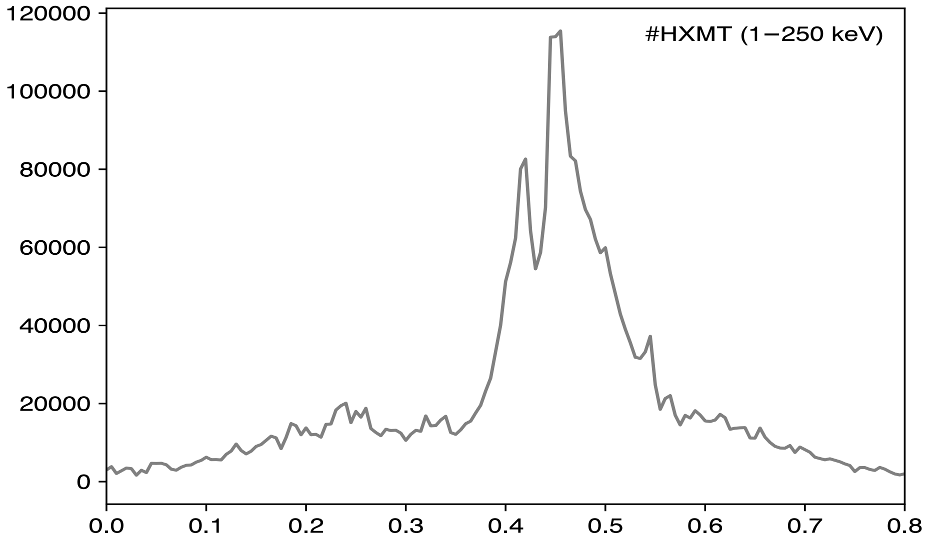
ID	Burst time (UTC 2020-04-28)	T_{bb} (s)	T_{90} (s)	MTV (s)
1	00:19:44.192	0.138	$0.080^{+0.016}_{-0.017}$	0.020
2	00:23:04.728	0.028	$0.021^{+0.053}_{-0.007}$	0.028
3	00:24:30.296	0.252	$0.122^{+0.002}_{-0.001}$	0.004
4	00:25:43.945	0.054	$0.076^{+0.085}_{-0.022}$	0.054
5	00:37:36.153	0.108	$0.095^{+0.085}_{-0.019}$	0.008
6	00:39:39.513	0.244	$0.194^{+0.062}_{-0.037}$	0.098
7	00:40:33.072	0.228	$0.190^{+0.005}_{-0.006}$	0.008
8	00:41:32.136	0.390	$0.222^{+0.008}_{-0.008}$	0.016
9	00:43:25.169	0.374	$0.174^{+0.004}_{-0.006}$	0.008
10	00:44:08.202	0.340	$0.154^{+0.001}_{-0.001}$	0.002
11	00:44:09.302	0.156	$0.112^{+0.003}_{-0.001}$	0.004
12	00:45:31.097	0.042	$0.030^{+0.004}_{-0.004}$	0.004
13	00:46:00.009	0.312	$0.208^{+0.021}_{-0.019}$	0.012
14	00:46:00.609	0.220	$0.126^{+0.007}_{-0.006}$	0.012
15	00:46:06.408	0.040	$0.019^{+0.009}_{-0.006}$	0.010
16	00:46:20.176	0.854	$0.166^{+0.005}_{-0.005}$	0.002
17	00:46:23.504	0.842	$0.742^{+0.017}_{-0.015}$	0.122
18	00:46:43.208	0.226	$0.128^{+0.018}_{-0.032}$	0.010
19	00:47:24.961	0.206	$0.152^{+0.024}_{-0.014}$	0.172
20	00:47:57.528	0.104	$0.084^{+0.005}_{-0.014}$	0.038
21	00:48:44.824	0.538	$0.382^{+0.020}_{-0.024}$	0.048
22	00:48:49.272	0.302	$0.112^{+0.018}_{-0.011}$	0.006
23	00:49:00.273	0.154	$0.120^{+0.030}_{-0.017}$	0.154
24	00:49:01.121	0.186	$0.151^{+0.010}_{-0.006}$	0.186
25	00:49:01.936	0.306	$0.181^{+0.045}_{-0.043}$	0.088
26	00:49:06.472	0.026	$0.022^{+0.026}_{-0.006}$	0.026
27	00:49:16.592	0.312	$0.234^{+0.003}_{-0.004}$	0.012
28	00:49:22.392	0.124	$0.078^{+0.013}_{-0.006}$	0.060
29	00:49:27.280	0.090	$0.082^{+0.073}_{-0.017}$	0.034
30	00:49:46.142	0.046	$0.036^{+0.034}_{-0.011}$	0.046
31	00:49:46.680	0.368	$0.150^{+0.022}_{-0.014}$	0.074
32	00:50:01.012	0.080	$0.047^{+0.025}_{-0.016}$	0.012
33	00:50:01.358	0.156	$0.095^{+0.006}_{-0.006}$	0.012
34	00:50:21.969	0.022	$0.019^{+0.026}_{-0.010}$	0.022

OBSERVATION AND DATA ANALYSIS

Temporal Analysis

- Light curves:

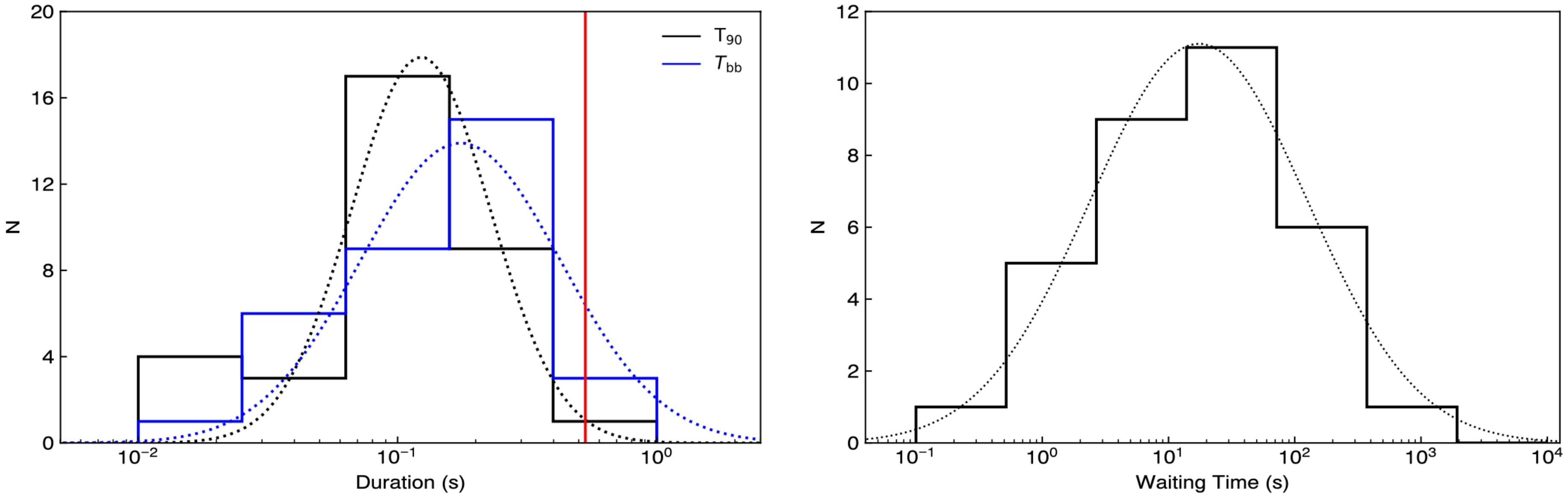




OBSERVATION AND DATA ANALYSIS

Temporal Analysis

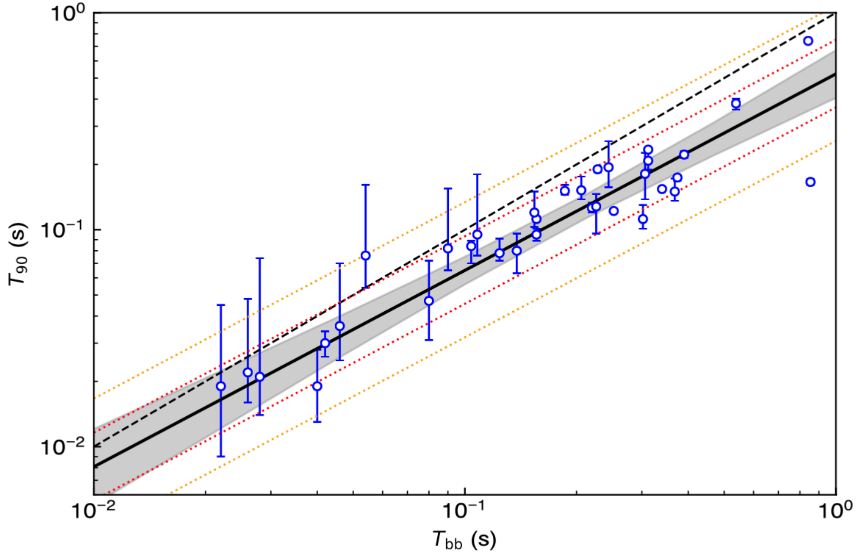
- Durations & Waiting times:
  - The distributions are Gaussian shapes in the logarithmic scale. The Tbb (T90) distribution peaks at 0.175 (0.118) s. The waiting time is peaking at 1.24 s.

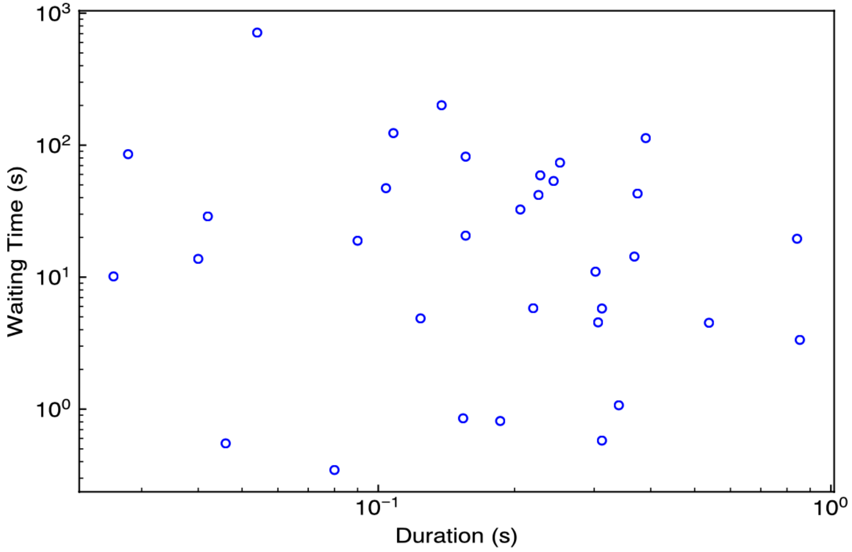


OBSERVATION AND DATA ANALYSIS

Temporal Analysis

- Durations & Waiting times:
  - The distributions are Gaussian shapes in the logarithmic scale. The Tbb (T90) distribution peaks at 0.175 (0.118) s. The waiting time is peaking at 1.24 s.
  - Correlations:

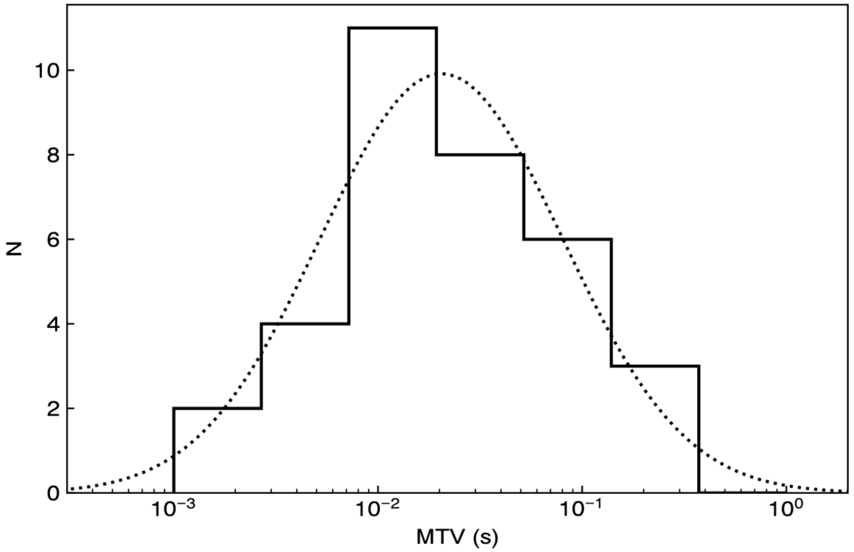


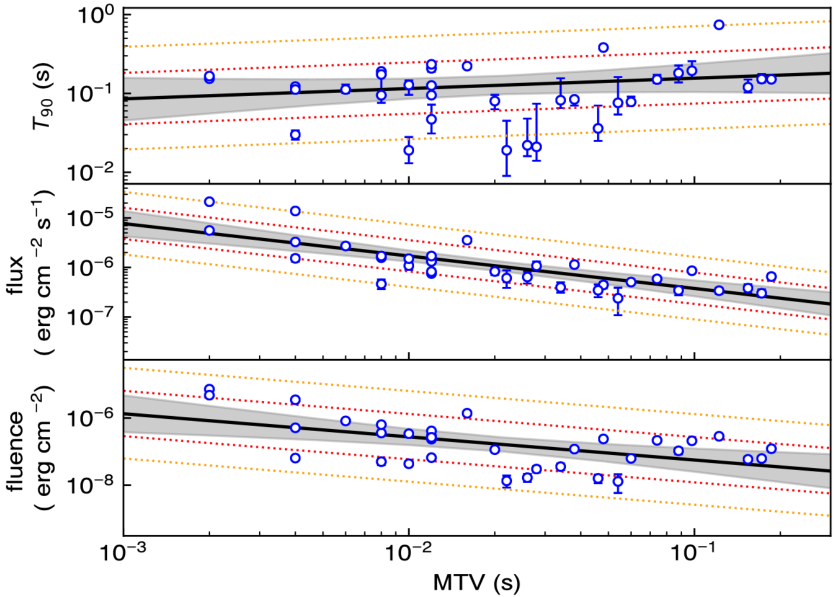


OBSERVATION AND DATA ANALYSIS

Temporal Analysis

- MTV:
  - The distributions is a Gaussian shape with a peak value ~ a few of ten milliseconds.





OBSERVATION AND DATA ANALYSIS

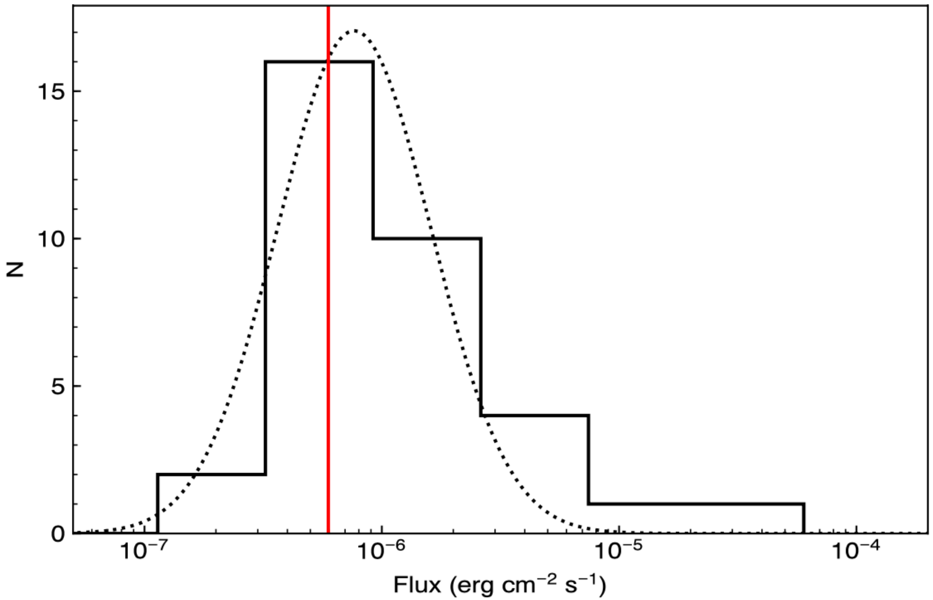
Time-Integrated Spectral Fitting

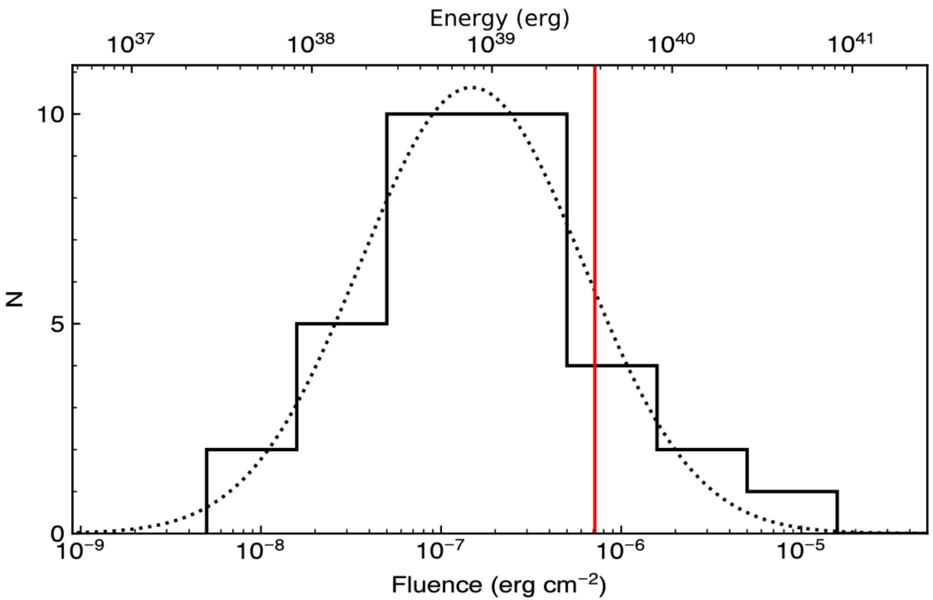
ID	BB			BB+BB				PL			CPL				BB+PL				Fluence
	kT (keV)	BIC	PGSTAT/dof	kT_1 (keV)	kT_2 (keV)	BIC	PGSTAT/dof	α	BIC	PGSTAT/dof	*alpha*	E_p (keV)	BIC	PGSTAT/dof	α	kT (keV)	BIC	PGSTAT/dof	$\left(\frac{10^{-8}}{\mathrm{erg\ cm^{-2}}}\right)$
1	**$6.41^{+0.51}_{-0.70}$** [a]	**124.6**	**114.5/152**	...	...	...	...	$-2.63^{+0.12}_{-0.13}$	139.1	129.1/152	**$-0.43^{+0.77}_{-0.55}$**	**$22.46^{+2.89}_{-3.43}$**	**122.8**	**107.7/151**	...	...	...	...	$11.42^{+2.00}_{-1.72}$
2	**$5.20^{+0.96}_{-0.61}$**	**53.4**	**43.4/153**	...	...	...	...	$-2.79^{+0.19}_{-0.30}$	63.2	53.1/153	$1.26^{+1.74}_{-1.51}$	$20.35^{+3.19}_{-3.53}$	58.5	43.4/152	...	...	...	...	$3.01^{+0.66}_{-0.61}$
3	...	...	...	$6.09^{+0.46}_{-0.46}$	$10.57^{+0.57}_{-0.47}$	182.8	162.7/151	...	...	...	**$0.71^{+0.10}_{-0.09}$**	**$32.94^{+0.24}_{-0.35}$**	**179.7**	**164.6/152**	...	...	...	...	**$348.79^{+6.89}_{-7.21}$** [b]
4	**$3.63^{+3.87}_{-0.67}$**	**86.7**	**76.6/153**	...	...	...	...	**$-3.27^{+0.53}_{-1.27}$**	**88.1**	**78.0/153**	$0.86^{+2.75}_{-1.64}$	$13.27^{+10.89}_{-3.27}$	91.7	76.6/152	...	...	...	...	$1.29^{+0.81}_{-0.70}$
5	**$6.68^{+0.91}_{-1.27}$**	**91.9**	**81.9/152**	...	...	...	...	$-2.84^{+0.17}_{-0.27}$	96.2	86.1/152	**$-0.84^{+1.30}_{-0.40}$**	**$20.59^{+6.29}_{-4.91}$**	**92.2**	**77.1/151**	...	...	...	...	$5.00^{+1.14}_{-1.06}$
6	$4.83^{+0.53}_{-0.30}$	145.6	135.6/152	$3.61^{+0.42}_{-0.39}$	$10.51^{+2.18}_{-1.62}$	126.5	106.4/150	$-2.66^{+0.09}_{-0.11}$	133.5	123.4/152	**$-1.40^{+0.49}_{-0.24}$**	**$14.18^{+4.46}_{-3.60}$**	**123.3**	**108.2/151**	$-2.79^{+0.18}_{-0.34}$	$6.38^{+2.02}_{-0.95}$	132.0	111.8/150	$20.94^{+2.61}_{-2.13}$
7	$6.38^{+0.26}_{-0.24}$	164.2	154.1/152	**$4.48^{+0.45}_{-0.21}$**	**$11.58^{+2.12}_{-1.19}$**	**132.3**	**112.1/150**	...	...	...	$-0.42^{+0.28}_{-0.31}$	$23.47^{+1.22}_{-1.48}$	136.3	121.2/151	$-2.41^{+0.20}_{-0.18}$	$6.36^{+0.49}_{-0.45}$	146.4	126.3/150	$35.88^{+2.89}_{-2.83}$
8	...	...	...	$4.78^{+0.32}_{-0.17}$	$11.04^{+0.91}_{-0.42}$	141.5	121.4/150	...	...	...	**$-0.32^{+0.14}_{-0.12}$**	**$26.87^{+0.63}_{-0.65}$**	**138.7**	**123.5/151**	$-2.57^{+0.07}_{-0.10}$	$7.69^{+0.22}_{-0.17}$	159.8	139.7/150	$138.49^{+4.55}_{-4.48}$
9	...	...	...	**$4.57^{+0.34}_{-0.22}$**	**$10.17^{+1.82}_{-1.04}$**	**159.3**	**139.2/150**	...	...	...	$-0.02^{+0.28}_{-0.23}$	$21.93^{+0.80}_{-0.86}$	163.9	148.8/151	$-2.59^{+0.18}_{-0.24}$	$5.92^{+0.39}_{-0.16}$	178.3	158.1/150	$63.51^{+3.97}_{-3.59}$
10	...	...	...	**$7.22^{+0.28}_{-0.28}$**	**$13.96^{+0.40}_{-0.43}$**	**306.2**	**286.1/150**	...	...	...	$0.40^{+0.06}_{-0.05}$	$40.13^{+0.26}_{-0.25}$	308.8	293.8/149	...	...	...	...	**$723.51^{+12.49}_{-11.81}$**
11	$7.32^{+0.17}_{-0.19}$	163.9	153.8/152	$4.53^{+0.54}_{-0.57}$	$9.84^{+1.03}_{-0.87}$	134.3	114.1/150	...	...	...	**$-0.08^{+0.26}_{-0.20}$**	**$27.12^{+0.93}_{-0.99}$**	**129.2**	**114.1/151**	$-2.92^{+0.17}_{-0.29}$	$7.87^{+0.25}_{-0.26}$	143.0	122.9/150	$51.07^{+2.92}_{-2.70}$
12	**$6.51^{+0.52}_{-0.54}$**	**87.1**	**77.1/153**	...	...	...	...	$-2.58^{+0.11}_{-0.16}$	113.6	103.5/153	$0.66^{+0.92}_{-0.71}$	$24.53^{+2.10}_{-2.40}$	91.5	76.3/152	...	...	...	...	$6.41^{+0.98}_{-0.91}$
13	$5.95^{+0.39}_{-0.34}$	137.1	127.0/152	$4.17^{+1.09}_{-0.33}$	$9.88^{+9.90}_{-1.06}$	129.4	109.2/150	$-2.46^{+0.07}_{-0.08}$	151.7	141.6/152	**$-0.59^{+0.45}_{-0.42}$**	**$22.13^{+1.73}_{-2.25}$**	**124.5**	**109.3/151**	$-2.42^{+0.16}_{-0.43}$	$6.15^{+0.93}_{-0.42}$	129.7	109.6/150	$23.54^{+2.87}_{-2.33}$
14	$6.33^{+0.27}_{-0.28}$	133.4	123.3/152	**$4.76^{+0.44}_{-0.45}$**	**$11.31^{+1.99}_{-1.73}$**	**119.4**	**99.2/150**	...	...	...	**$-0.25^{+0.38}_{-0.32}$**	**$23.95^{+1.28}_{-1.44}$**	**117.6**	**102.5/151**	...	...	...	...	$29.30^{+2.68}_{-2.30}$
15	**$6.07^{+0.68}_{-0.79}$**	**82.2**	**72.2/152**	...	...	...	...	$-2.72^{+0.17}_{-0.21}$	89.2	79.1/152	**$-0.42^{+1.30}_{-0.54}$**	**$21.02^{+3.87}_{-3.97}$**	**83.8**	**68.7/151**	...	...	...	...	$4.34^{+0.85}_{-0.75}$
16	...	...	...	$6.42^{+0.34}_{-0.23}$	$13.53^{+0.54}_{-0.36}$	200.1	179.9/151	...	...	...	**$0.19^{+0.07}_{-0.06}$**	**$38.83^{+0.34}_{-0.35}$**	**197.4**	**182.2/152**	...	...	...	...	**$478.40^{+8.67}_{-9.20}$**
17	**$4.72^{+0.31}_{-0.22}$**	**119.1**	**109.0/153**	**$4.18^{+0.49}_{-0.14}$**	**$12.44^{+5.07}_{-2.73}$**	**119.2**	**99.0/151**	$-2.57^{+0.08}_{-0.08}$	142.9	132.8/153	**$-0.27^{+0.86}_{-0.48}$**	**$18.36^{+1.22}_{-1.83}$**	**118.7**	**103.5/152**	...	...	...	...	$28.56^{+3.67}_{-3.76}$
18	$6.37^{+0.20}_{-0.23}$	157.4	147.3/153	$4.82^{+0.77}_{-0.28}$	$10.27^{+4.58}_{-1.27}$	149.4	129.2/151	...	...	...	**$0.14^{+0.36}_{-0.34}$**	**$23.99^{+1.16}_{-0.99}$**	**146.5**	**131.4/152**	$-2.52^{+0.21}_{-0.60}$	$6.58^{+0.32}_{-0.36}$	153.4	133.2/151	$34.03^{+2.56}_{-2.48}$
19	**$5.48^{+0.87}_{-0.55}$**	**101.4**	**91.3/153**	...	...	...	...	$-2.57^{+0.14}_{-0.21}$	109.5	99.4/153	$-0.32^{+1.45}_{-0.73}$	$21.24^{+3.39}_{-4.00}$	104.1	89.0/152	...	...	...	...	$6.20^{+1.20}_{-1.00}$
20	**$5.58^{+0.37}_{-0.33}$**	**101.8**	**91.8/152**	...	...	...	...	$-2.63^{+0.08}_{-0.11}$	147.1	137.0/152	$0.56^{+0.82}_{-0.59}$	$21.63^{+1.13}_{-1.80}$	105.0	89.9/151	...	...	...	...	$11.87^{+1.20}_{-1.11}$
21	$5.37^{+0.45}_{-0.31}$	125.5	115.4/153	$4.65^{+0.55}_{-0.25}$	$17.67^{+8.40}_{-4.20}$	120.7	100.5/151	$-2.43^{+0.08}_{-0.09}$	124.7	114.6/153	**$-0.95^{+0.63}_{-0.45}$**	**$19.79^{+2.65}_{-3.34}$**	**117.4**	**102.2/152**	**$-2.23^{+0.24}_{-0.34}$**	**$5.34^{+1.07}_{-0.41}$**	**117.2**	**97.1/151**	$23.82^{+4.10}_{-3.56}$
22	...	...	...	**$5.13^{+0.31}_{-0.18}$**	**$15.15^{+0.84}_{-0.83}$**	**160.3**	**140.2/150**	...	...	...	$-0.77^{+0.13}_{-0.14}$	$32.17^{+1.04}_{-1.29}$	168.5	153.4/151	...	...	...	...	$81.81^{+4.63}_{-3.91}$
23	**$4.68^{+1.62}_{-0.50}$**	**87.7**	**77.6/152**	...	...	...	...	**$-2.62^{+0.17}_{-0.30}$**	**86.8**	**76.8/152**	**$-1.24^{+1.48}_{-0.23}$**	**$17.46^{+7.53}_{-3.82}$**	**87.6**	**72.5/151**	...	...	...	...	$5.88^{+1.20}_{-1.23}$
24	$4.17^{+0.44}_{-0.29}$	145.8	135.7/152	$3.41^{+0.73}_{-0.30}$	$10.44^{+5.45}_{-2.35}$	146.3	126.1/150	**$-2.66^{+0.13}_{-0.17}$**	**141.6**	**131.5/152**	**$-1.62^{+1.06}_{-0.05}$**	**$9.64^{+7.69}_{-0.65}$**	**142.1**	**127.0/151**	...	...	...	...	$12.17^{+1.68}_{-1.53}$
25	$5.55^{+0.89}_{-0.53}$	98.1	88.0/153	...	...	...	...	$-2.40^{+0.12}_{-0.16}$	97.8	87.8/153	**$-1.11^{+0.77}_{-0.42}$**	**$23.14^{+4.65}_{-5.47}$**	**95.8**	**80.6/152**	$-2.37^{+0.22}_{-0.88}$	$6.47^{+2.76}_{-1.30}$	102.3	82.1/151	$10.54^{+2.37}_{-2.20}$
26	**$4.33^{+0.89}_{-0.63}$**	**41.9**	**31.8/152**	...	...	...	...	$-3.14^{+0.26}_{-0.52}$	46.1	36.0/152	$0.56^{+2.21}_{-1.27}$	$15.55^{+3.74}_{-3.60}$	46.7	31.6/151	...	...	...	...	$1.67^{+0.47}_{-0.44}$
27	$5.42^{+0.22}_{-0.18}$	149.8	139.7/152	**$4.73^{+0.25}_{-0.17}$**	**$15.51^{+2.59}_{-2.33}$**	**124.5**	**104.4/150**	...	...	...	$-0.16^{+0.37}_{-0.32}$	$20.78^{+0.89}_{-1.10}$	134.8	119.6/151	$-2.23^{+0.24}_{-0.17}$	$5.28^{+0.27}_{-0.25}$	130.1	109.9/150	$41.24^{+3.29}_{-2.76}$
28	**$4.26^{+0.39}_{-0.30}$**	**97.3**	**87.2/152**	...	...	...	...	$-2.80^{+0.14}_{-0.19}$	120.8	110.7/152	...	...	...	...	...	...	...	...	$6.28^{+0.83}_{-0.77}$
29	**$6.02^{+0.93}_{-0.91}$**	**99.5**	**89.4/152**	...	...	...	...	$-2.76^{+0.21}_{-0.35}$	102.9	92.8/152	$-0.70^{+1.90}_{-0.44}$	$19.00^{+6.74}_{-3.56}$	102.2	87.1/151	...	...	...	...	$3.56^{+0.92}_{-0.77}$
30	**$3.19^{+0.83}_{-0.45}$**	**71.6**	**61.5/152**	...	...	...	...	**$-3.29^{+0.34}_{-0.81}$**	**71.8**	**61.7/152**	$-0.52^{+3.21}_{-0.56}$	$9.34^{+5.95}_{-1.10}$	76.3	61.2/151	...	...	...	...	$1.59^{+0.49}_{-0.44}$
31	$4.60^{+0.31}_{-0.24}$	155.6	145.5/152	**$4.28^{+0.29}_{-0.25}$**	**$19.17^{+4.85}_{-4.30}$**	**149.1**	**129.0/150**	$-2.60^{+0.08}_{-0.10}$	153.4	143.3/152	**$-1.41^{+0.78}_{-0.20}$**	**$13.36^{+4.20}_{-2.62}$**	**147.6**	**132.5/151**	**$-2.56^{+0.26}_{-0.30}$**	**$4.97^{+0.98}_{-0.55}$**	**148.2**	**128.1/150**	$21.62^{+2.78}_{-3.14}$
32	**$5.65^{+0.49}_{-0.42}$**	**91.7**	**81.7/152**	...	...	...	...	$-2.56^{+0.12}_{-0.14}$	125.4	115.4/152	$2.31^{+1.02}_{-1.18}$	$21.72^{+2.05}_{-1.38}$	96.6	81.5/151	...	...	...	...	$6.59^{+0.97}_{-0.87}$
33	**$5.63^{+0.22}_{-0.23}$**	**101.1**	**91.0/152**	$4.82^{+0.84}_{-0.41}$	$9.46^{+8.42}_{-2.86}$	102.6	82.5/150	...	...	...	**$0.46^{+0.52}_{-0.34}$**	**$21.64^{+0.92}_{-0.99}$**	**99.8**	**84.7/151**	...	...	...	...	$26.51^{+1.94}_{-2.39}$
34	**$4.10^{+1.21}_{-0.63}$**	**55.2**	**45.2/152**	...	...	...	...	$-2.83^{+0.30}_{-0.76}$	58.7	48.7/152	...	...	...	...	...	...	...	...	$1.34^{+0.58}_{-0.49}$

OBSERVATION AND DATA ANALYSIS

Time-Integrated Spectral Fitting

- Flux, fluence & energy:
  - Distributions:

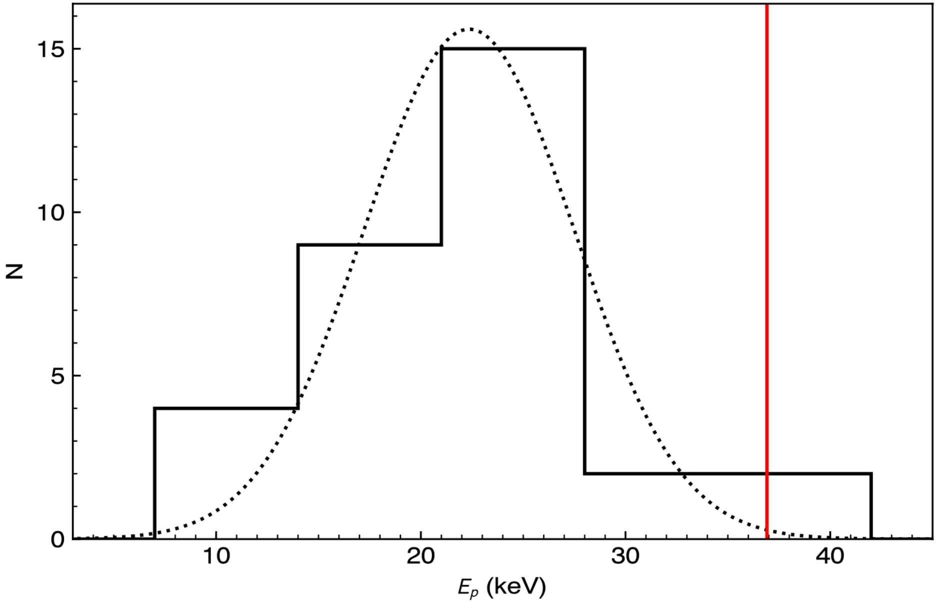


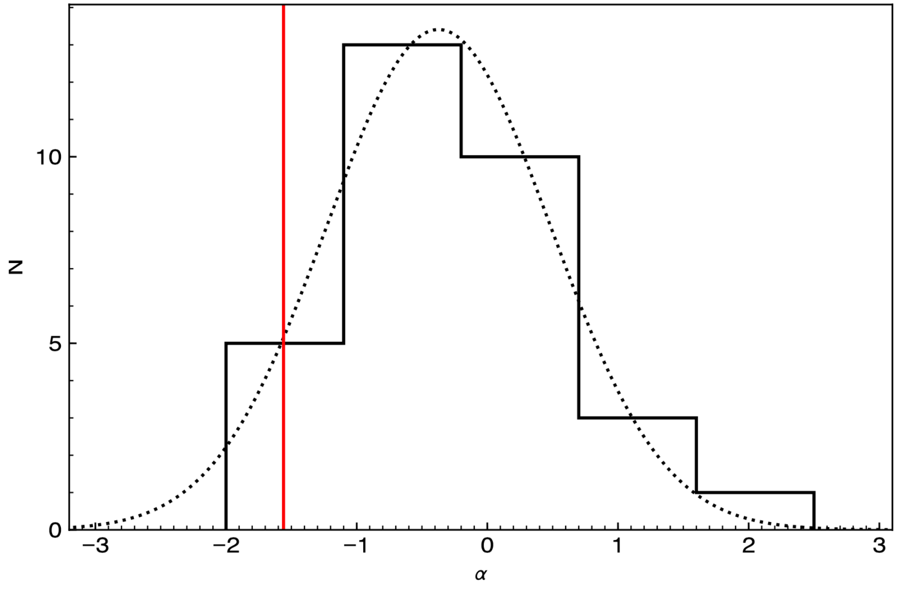


OBSERVATION AND DATA ANALYSIS

Time-Integrated Spectral Fitting

- CPL:
  - Parameter distributions:

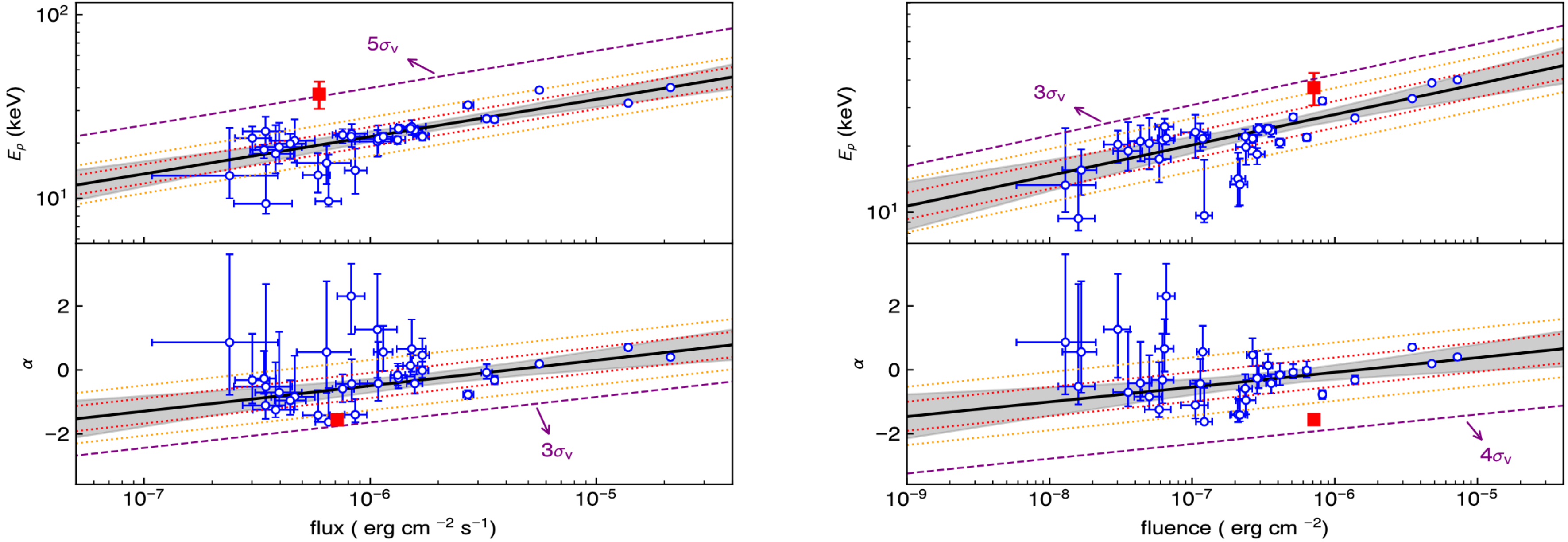




OBSERVATION AND DATA ANALYSIS

Time-Integrated Spectral Fitting

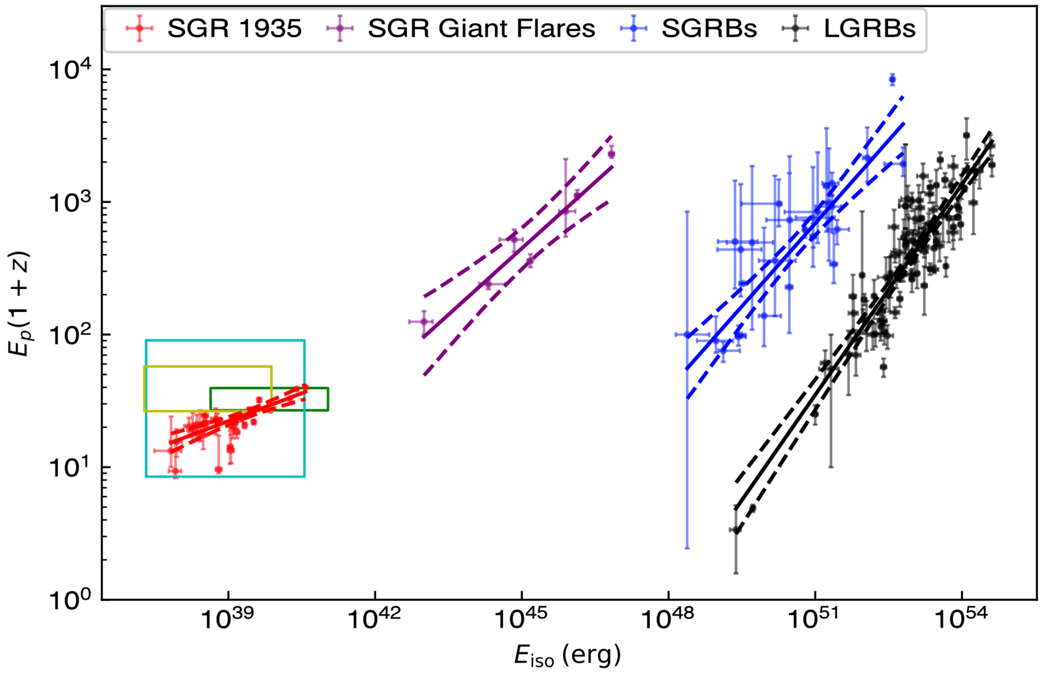
- CPL:
  - Parameter distributions
  - Correlations with flux/fluence:



OBSERVATION AND DATA ANALYSIS

Time-Integrated Spectral Fitting

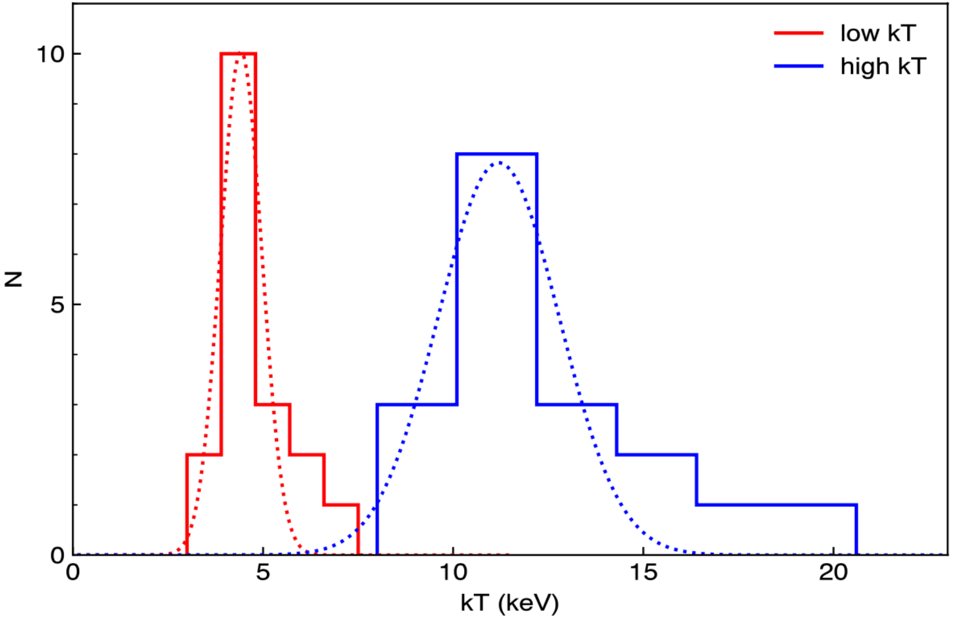
- CPL:
  - Parameter distributions
  - Correlations with flux/fluence
  - E_p-E_{iso}:

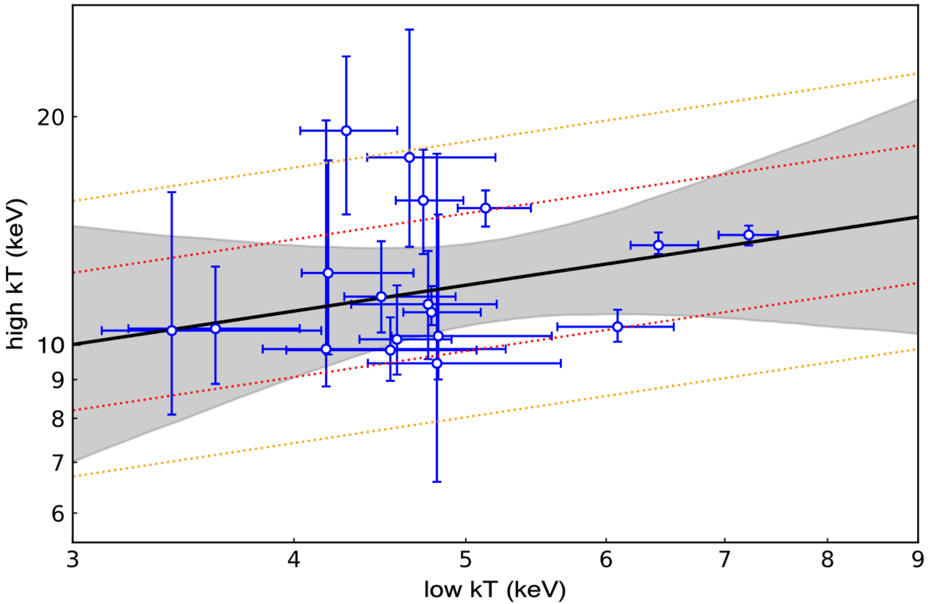


OBSERVATION AND DATA ANALYSIS

Time-Integrated Spectral Fitting

- BB+BB:
  - Parameter distributions and their correlation:

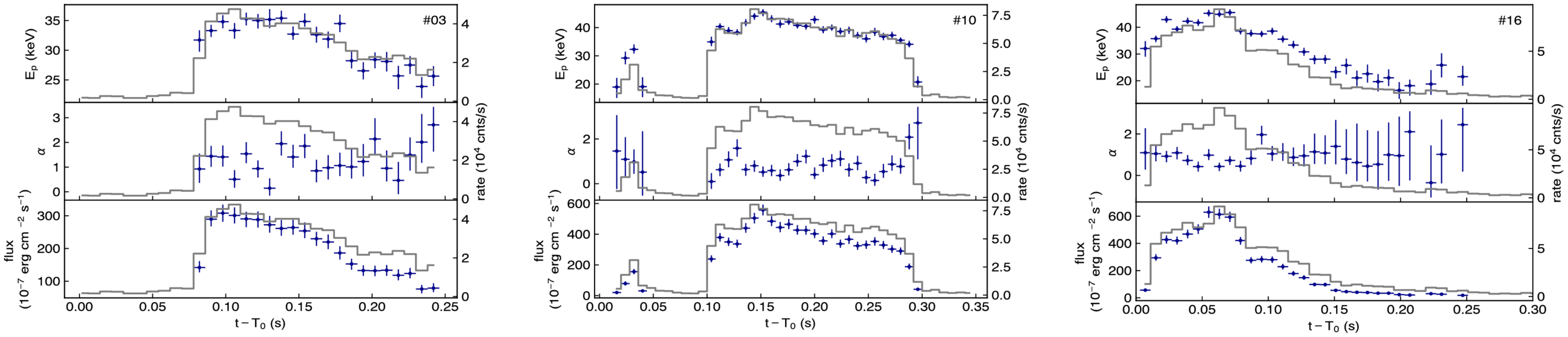




OBSERVATION AND DATA ANALYSIS

Time-Resolved Spectral Fitting

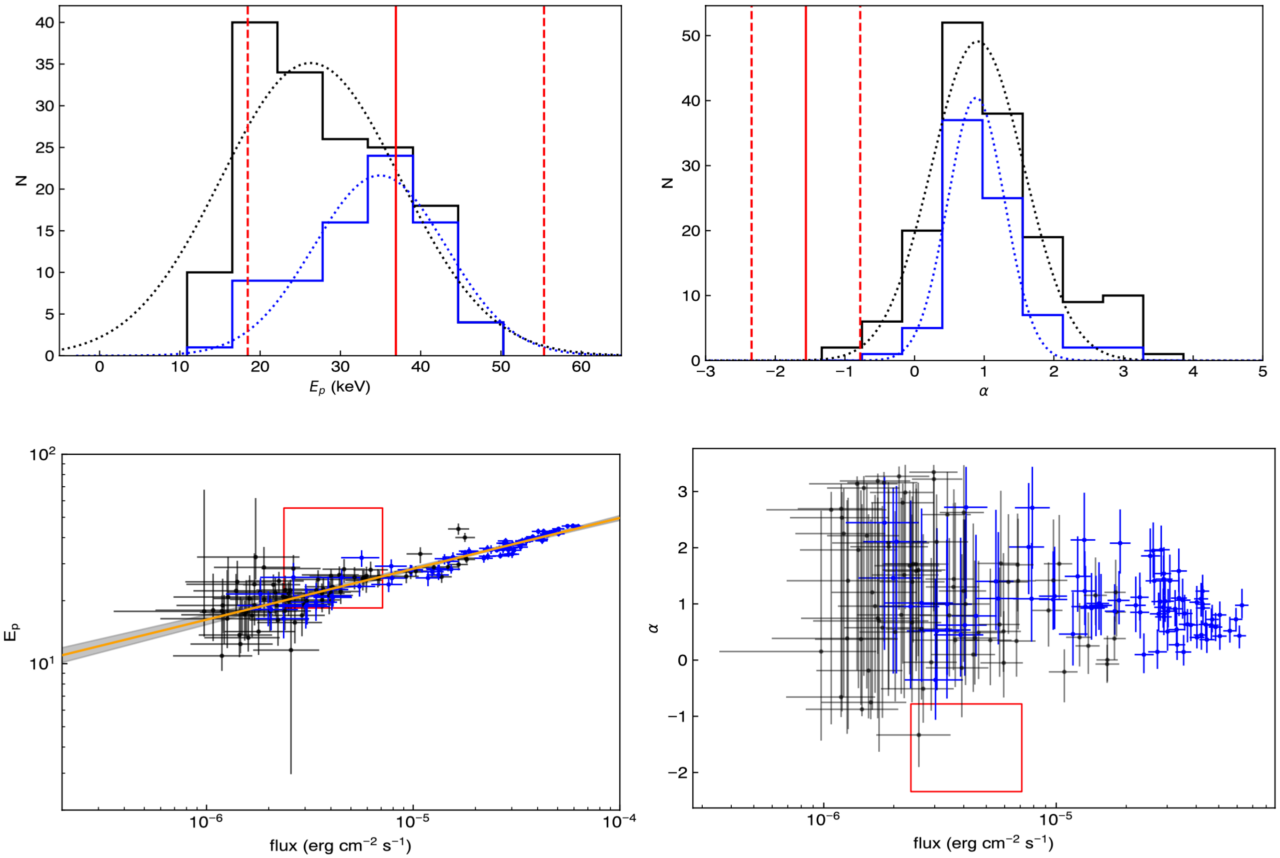
- CPL:
  - CPL parameters and flux/counts evolution for 3 bright SGRs:



OBSERVATION AND DATA ANALYSIS

Time-Resolved Spectral Fitting

- CPL:
  - CPL parameters and flux/counts evolution for 3 bright SGRs
  - Parameter distributions and correlations:



HOW SPECIAL IS THE FRB-ASSOCIATED BURST?

Not so special except for its soft alpha and high Ep

Properties	FRB-associated burst	Our sample	Special?
Duration	0.53 s (longer than 97% of the bursts in our sample)	Gaussian distribution peaks at 0.18 s.	√
Light curve profile	Multiple spikes, multiple episodes, and a large flux	Some bursts (namely, #1, #9, #11, etc.) exhibit similar features with FRB-associated burst.	×
Spectral properties	$\alpha = -1.56 \pm 0.06$, Ep = 36.9±6.2 keV →non-thermal	$\alpha \sim -0.37$, Ep ~ 22.4 →thermal-like	√
Energy	Flux ≈ 6×10^{-7} erg cm^{-2} s^{-1}, fluence ≈ 7×10^{-7} erg cm^{-2}	Flux ~ 8×10^{-7} erg cm^{-2} s^{-1}, fluence ~ 1.5×10^{-7} erg cm^{-2}	×
Spectra-Energy correlation	Off-track the correlations	A tight correlation between Ep and flux (fluence) with a slope of 0.20±0.02 (0.14 ± 0.02).	√
Time-resolved properties and correlation	Similar with time-integrated properties and correlation		√

HOW SPECIAL IS THE FRB-ASSOCIATED BURST?

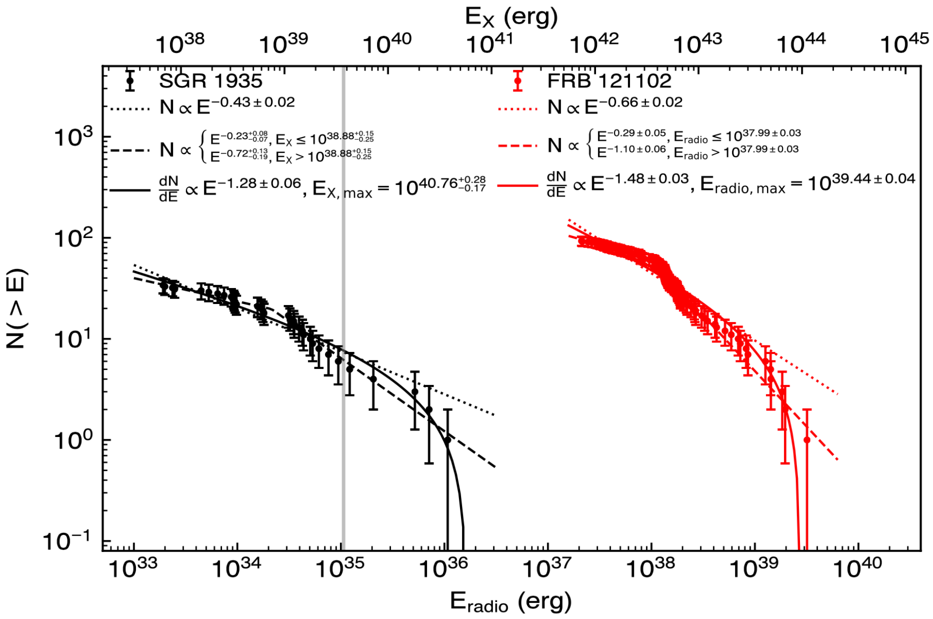
Physical explanation:

- Beaming effect
- Narrow spectra of FRB emission with most outside the GHz band
- The uniqueness of FRB-associated X-ray burst

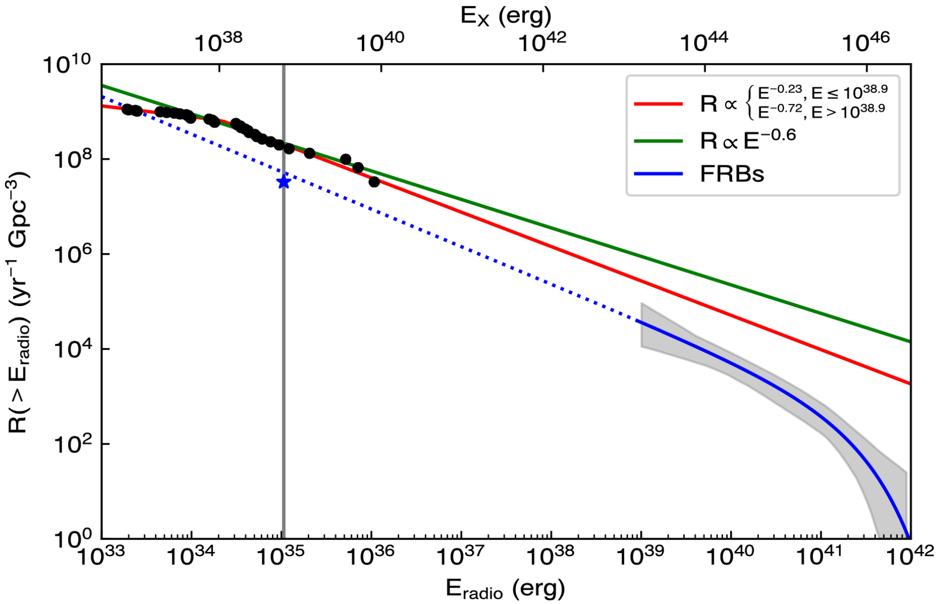
Future complete samples of FRB-associated and FRB-absent X-ray bursts from Galactic magnetars are needed to determine whether the FRB-associated bursts are truly atypical.

SGR BURST RATE AND COMPARISON WITH THE FRB BURST RATE

Cumulative energy distribution of SGR 1935 bursts and FRB 121102:



Energy-dependent event rate densities of magnetar XRBs and FRBs:

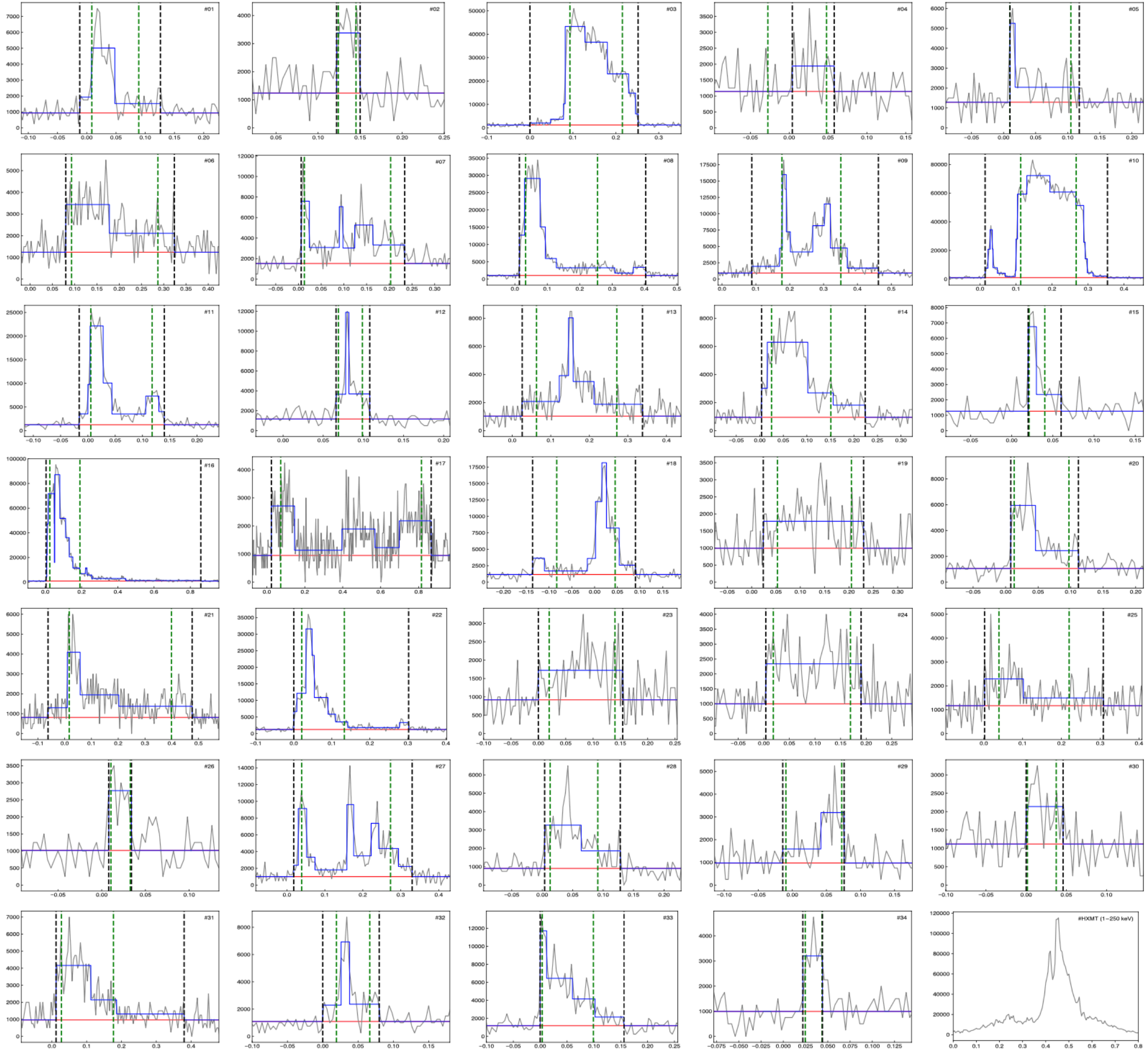


SUMMARY

- We systematically analyzed the FRB-absent bursts of SGR J1935+2154 just hours before the FRB 200428 event.
- The FRB-associated X-ray burst observed by HXMT only distinguishes itself in terms of its non-thermal α and spectral peak energy, but is otherwise consistent with the burst population.
- We compared the cumulative energy distribution of our burst sample with that of the FRB burst sample of FRB 121102.
- The event rate density of FRBs is lower than the event rate density of magnetar bursts by a factor of ~ 150, suggesting that only a small fraction of magnetar bursts can produce FRBs.

Thanks !

BACKUP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#HXMT (1–250 keV)