Recent Research Achievements of Magnetars

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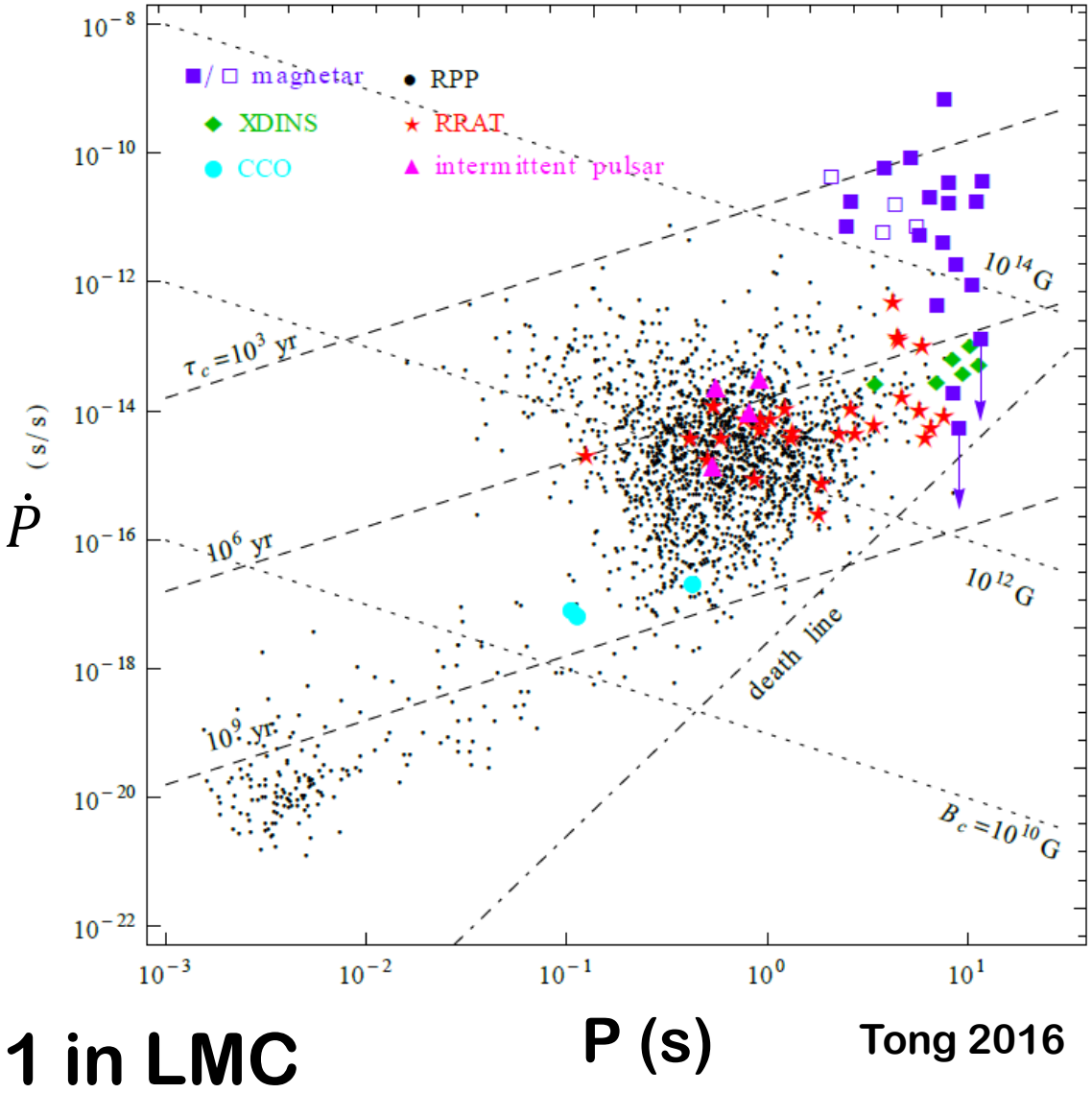
Magnetars

- **Soft Gamma Repeater (SGR)**
  Anomalous X-ray Pulsar (AXP)
- $L_X \sim 10^{33} - 10^{36}\ \mathrm{erg \cdot s^{-1}}$
- $P = 2 \sim 12\ \mathrm{s}$
  $\dot{P} = 10^{-10} \sim 10^{-13}\ \mathrm{s \cdot s^{-1}}$
  $B \sim 10^{14} - 10^{15}\ \mathrm{G}$
- **23 magnetars + 5 candidates**
- **Galactic sources + 1 in SMC + 1 in LMC**



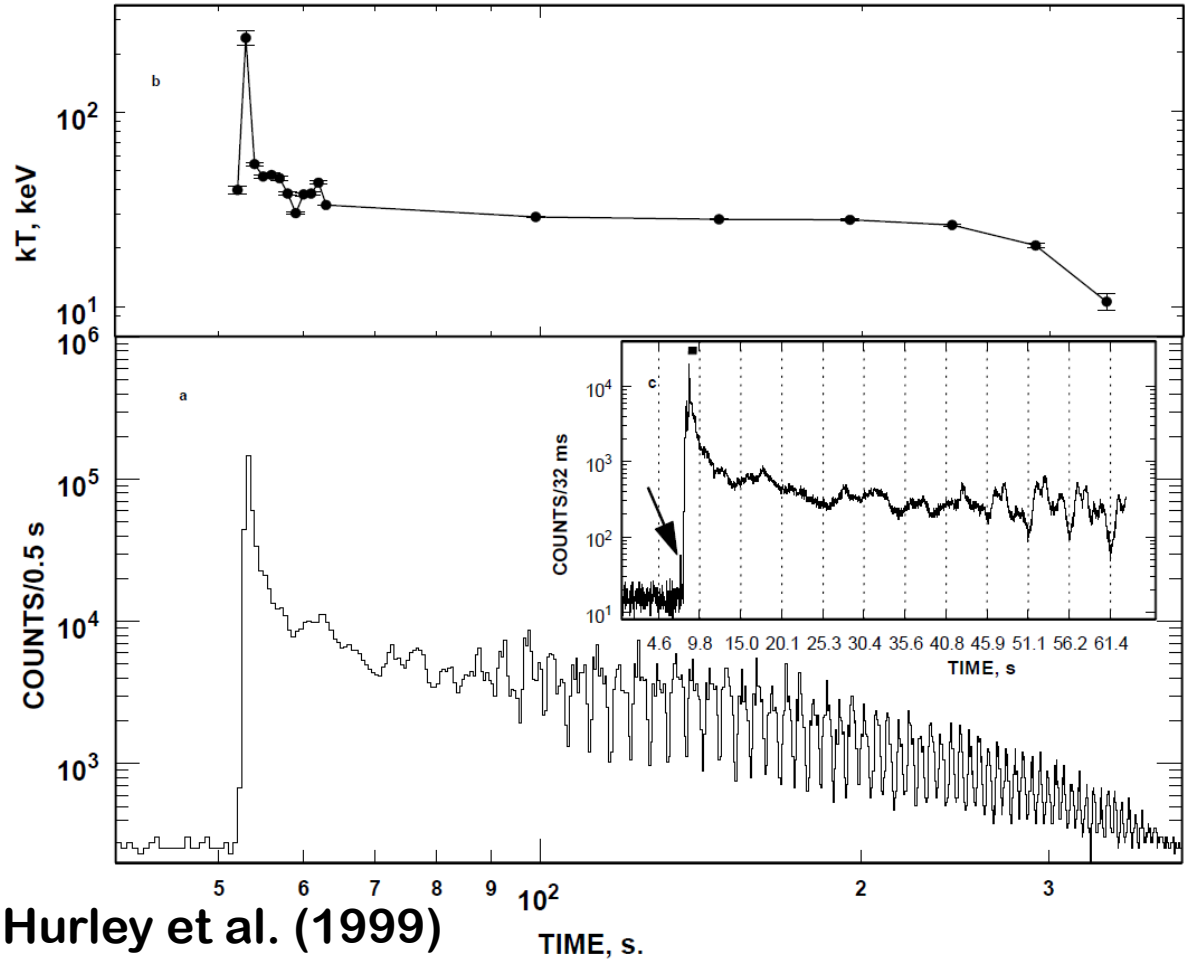
Tong 2016

Isolated Pulsars with Extremely High B field

Magnetar Bursts

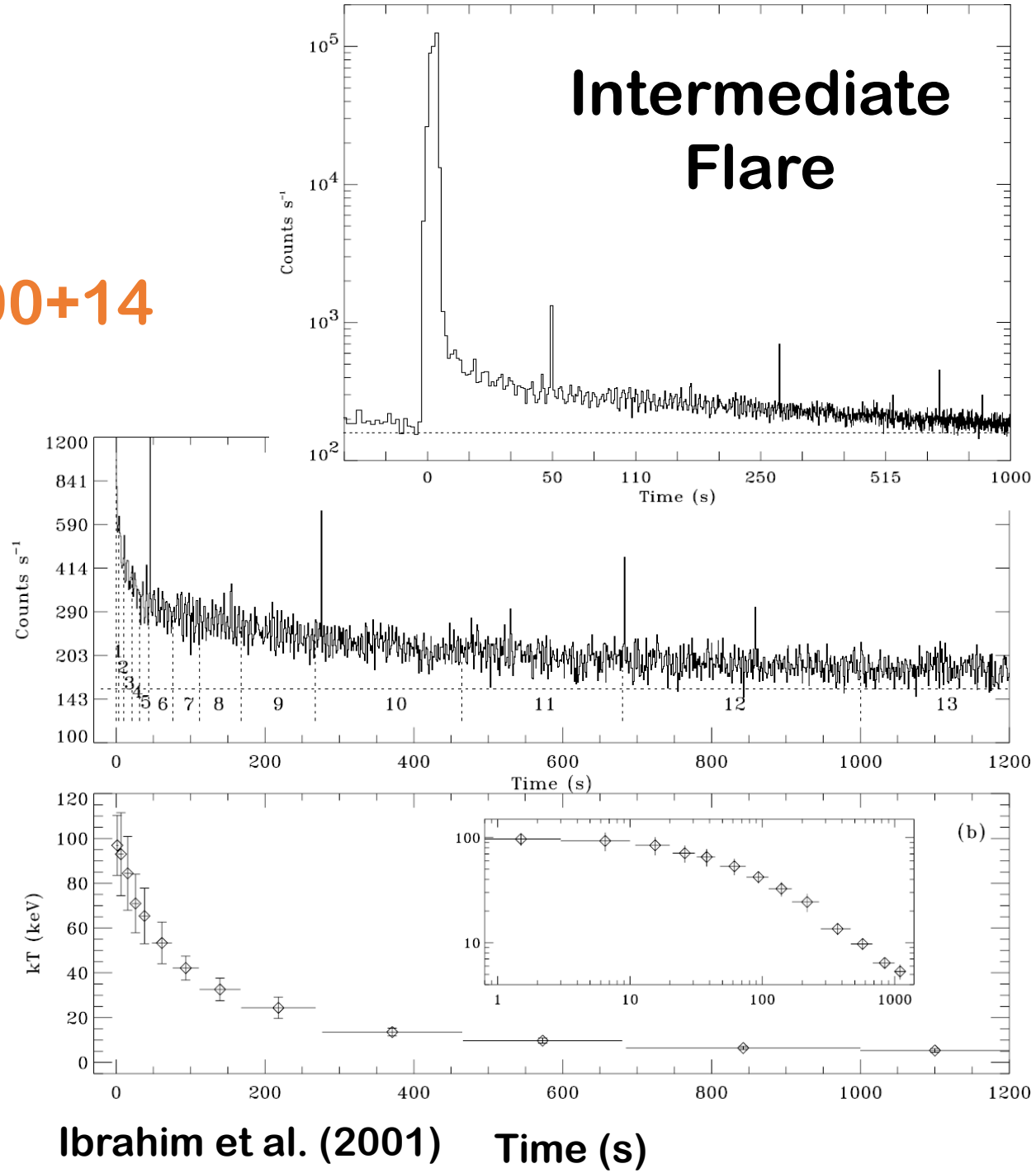
Giant Flare

SGR 1900+14



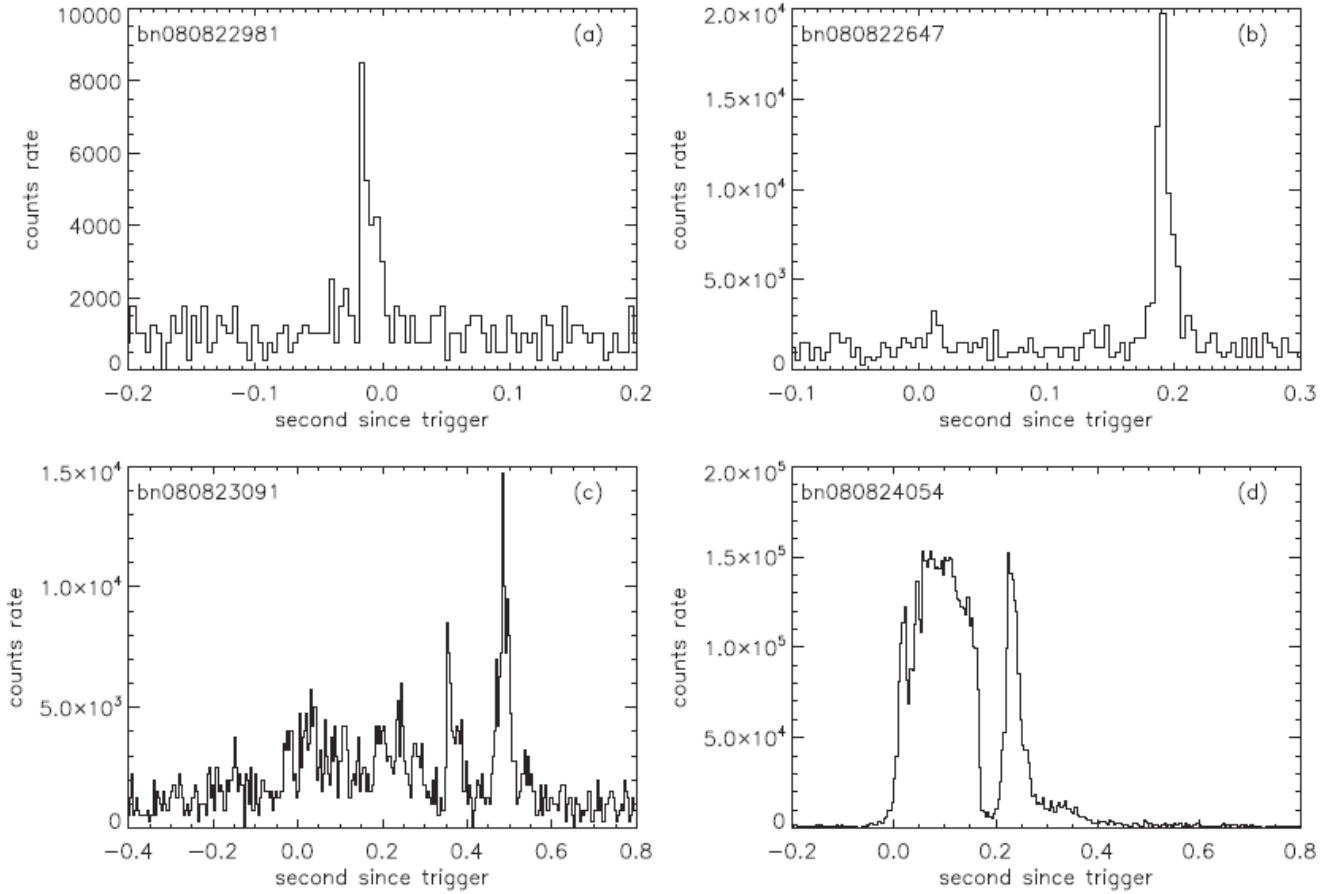
Hurley et al. (1999)

Intermediate Flare



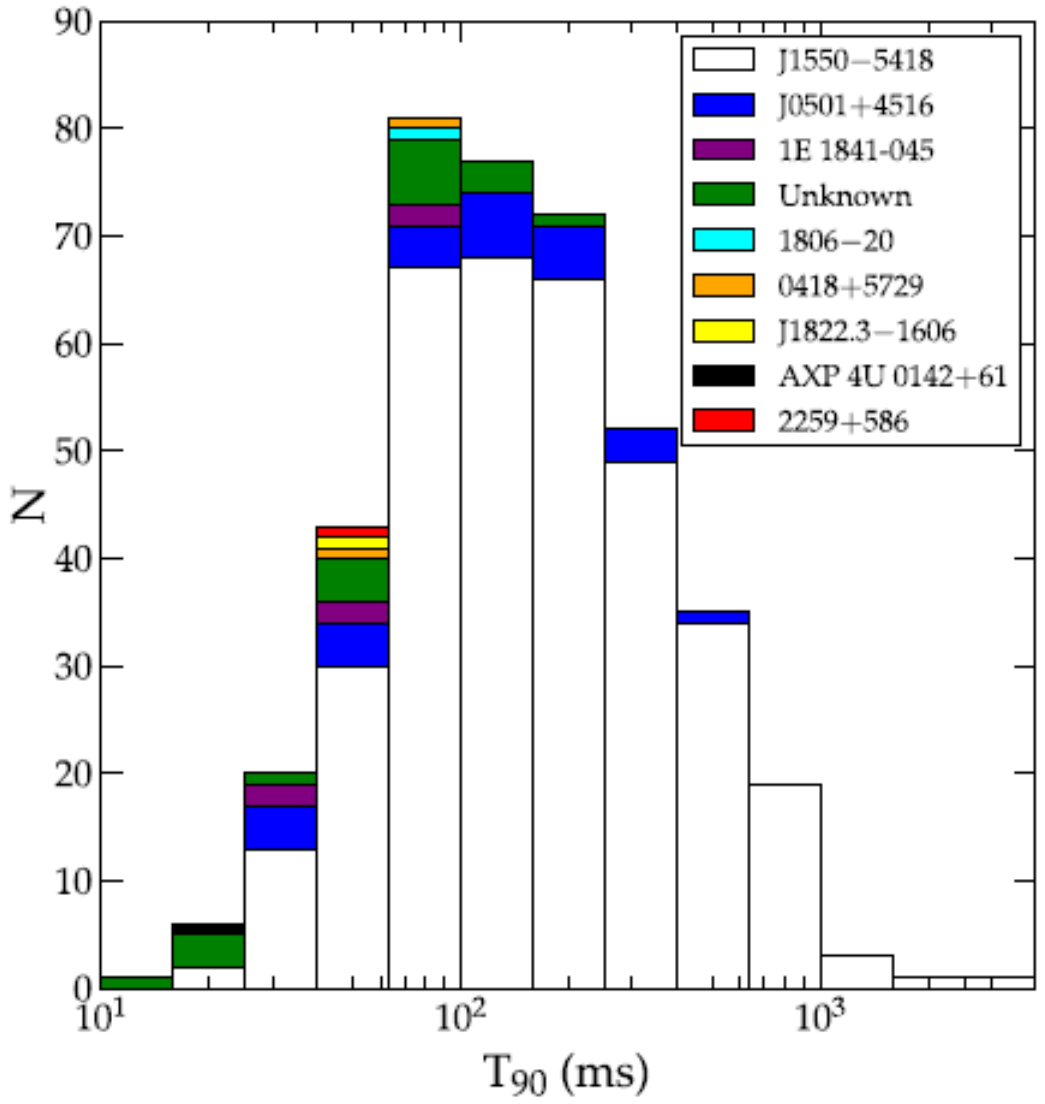
Ibrahim et al. (2001)

Magnetar Bursts



Lin et al. (2011)

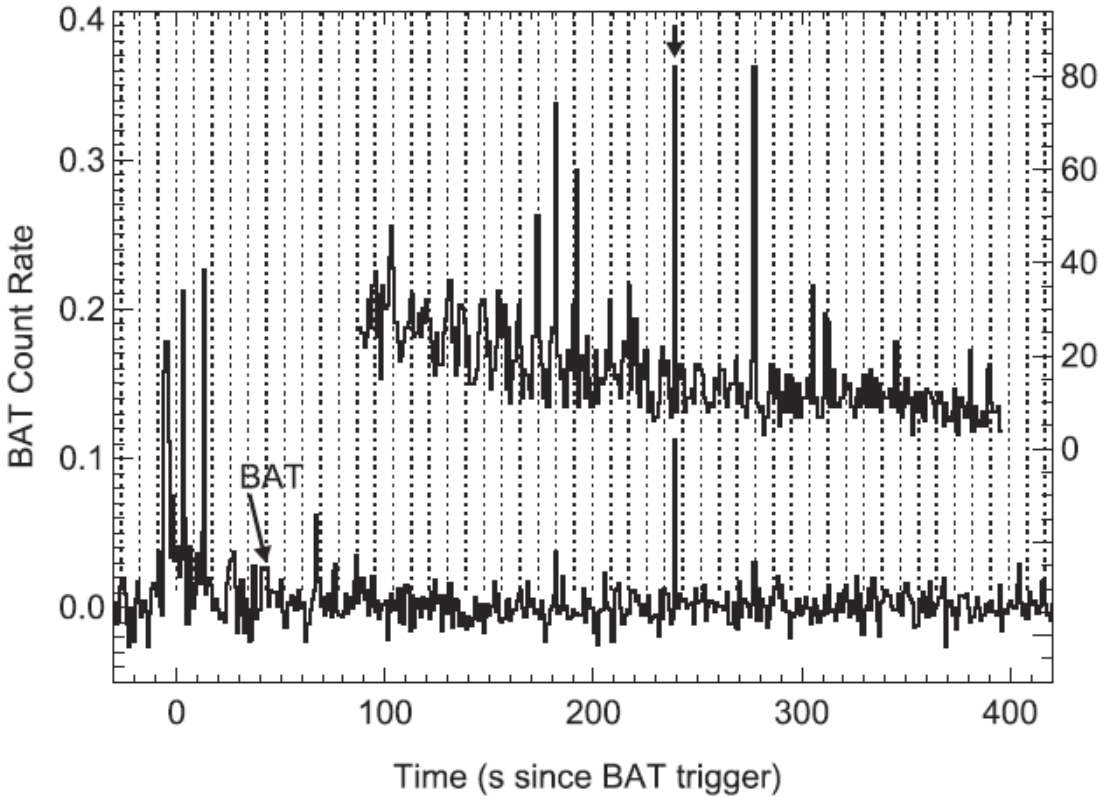
SGR 0501+4516

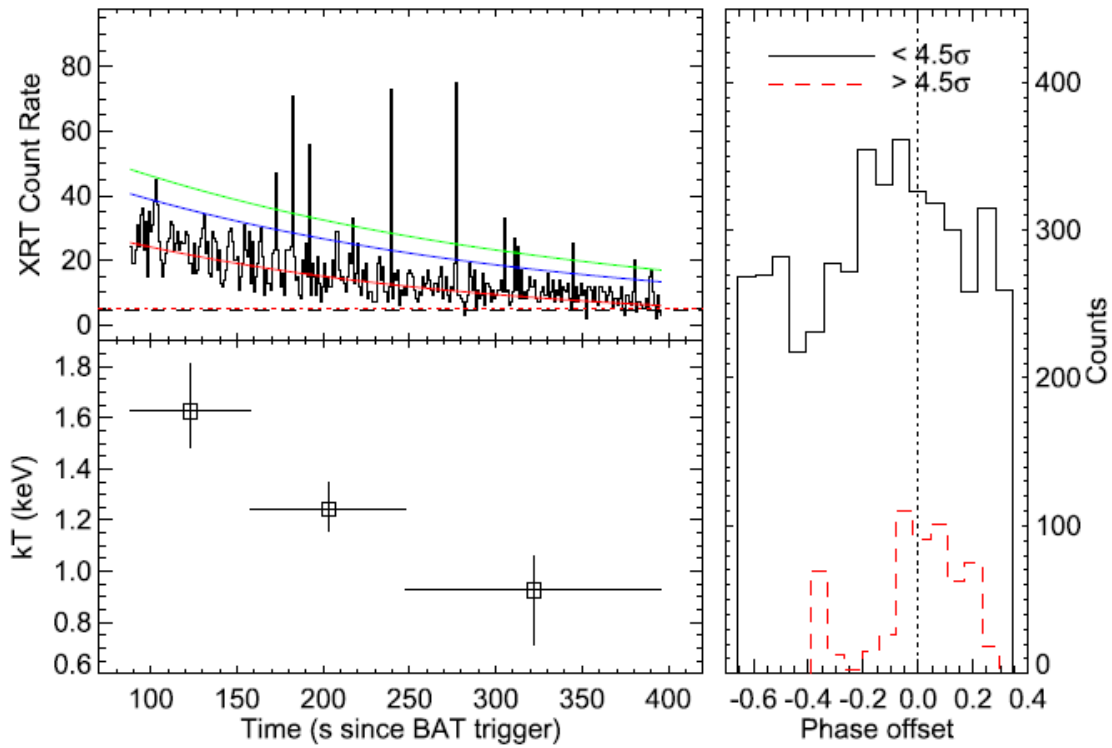


Collazzi et al. (2015)

Burst: Tail – also found in short bursts

4U 0142+61 bursts on 2015 Feb. 28 observed with Swift

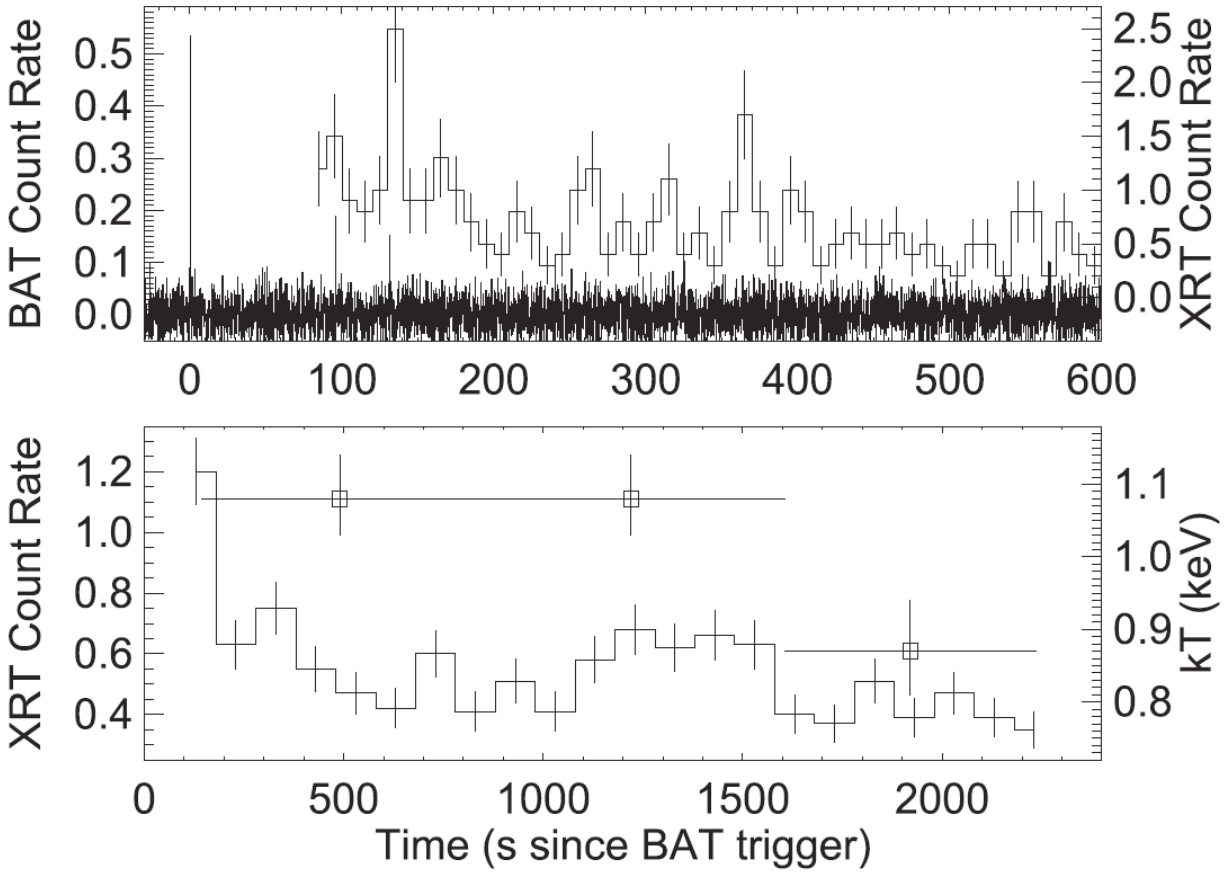




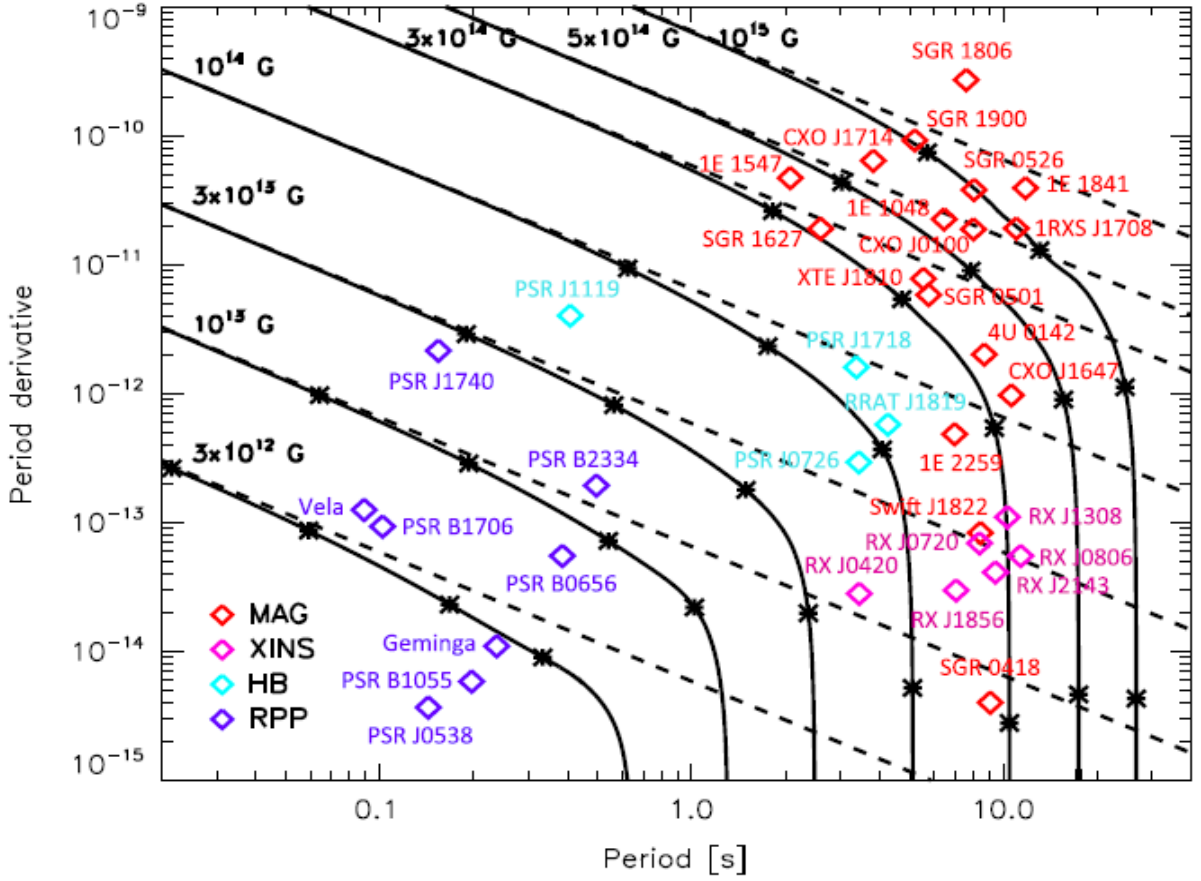
- Evolutions through the tail: kT ↓ , BB area → , pulse fraction ↑
- X-ray bursts' phases basically aliened with the peak of the pulse profile from the continues emission.

Gogus, Lin et al. 2017

Bursts & Cooling Tail from PSR J1119-6127



Gogus, Lin et al. 2016



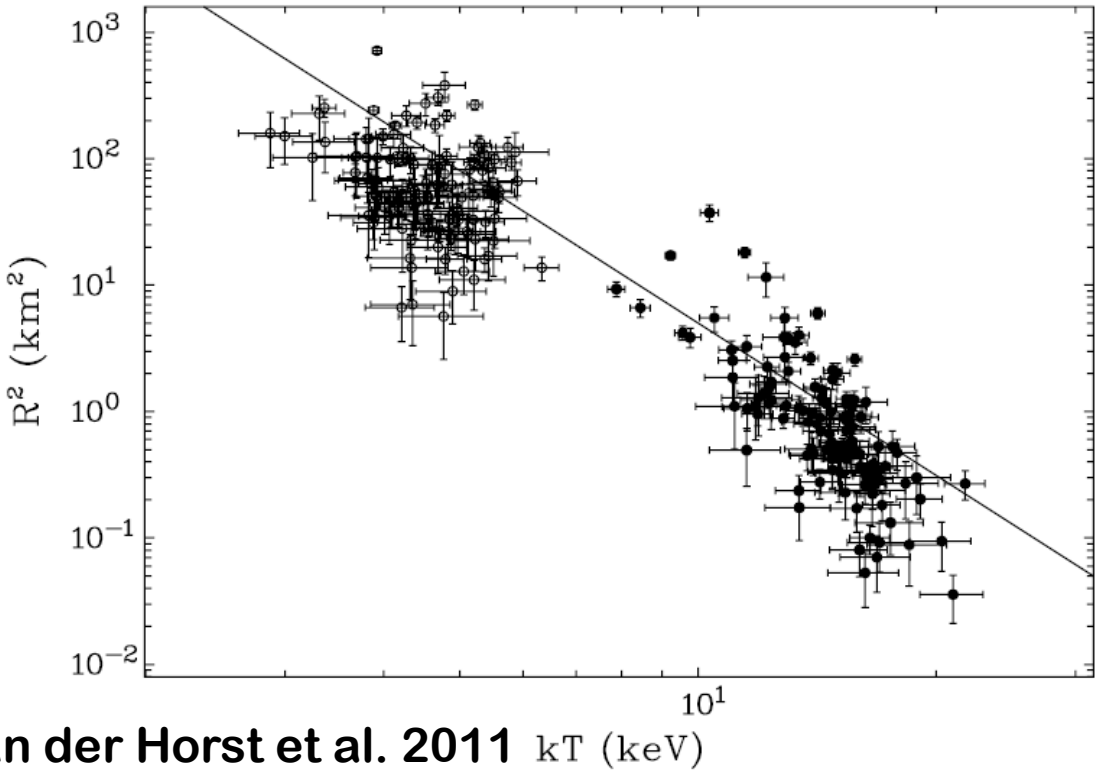
Viganò et al. 2013

Magnetar-like behavior from high B field radio pulsars

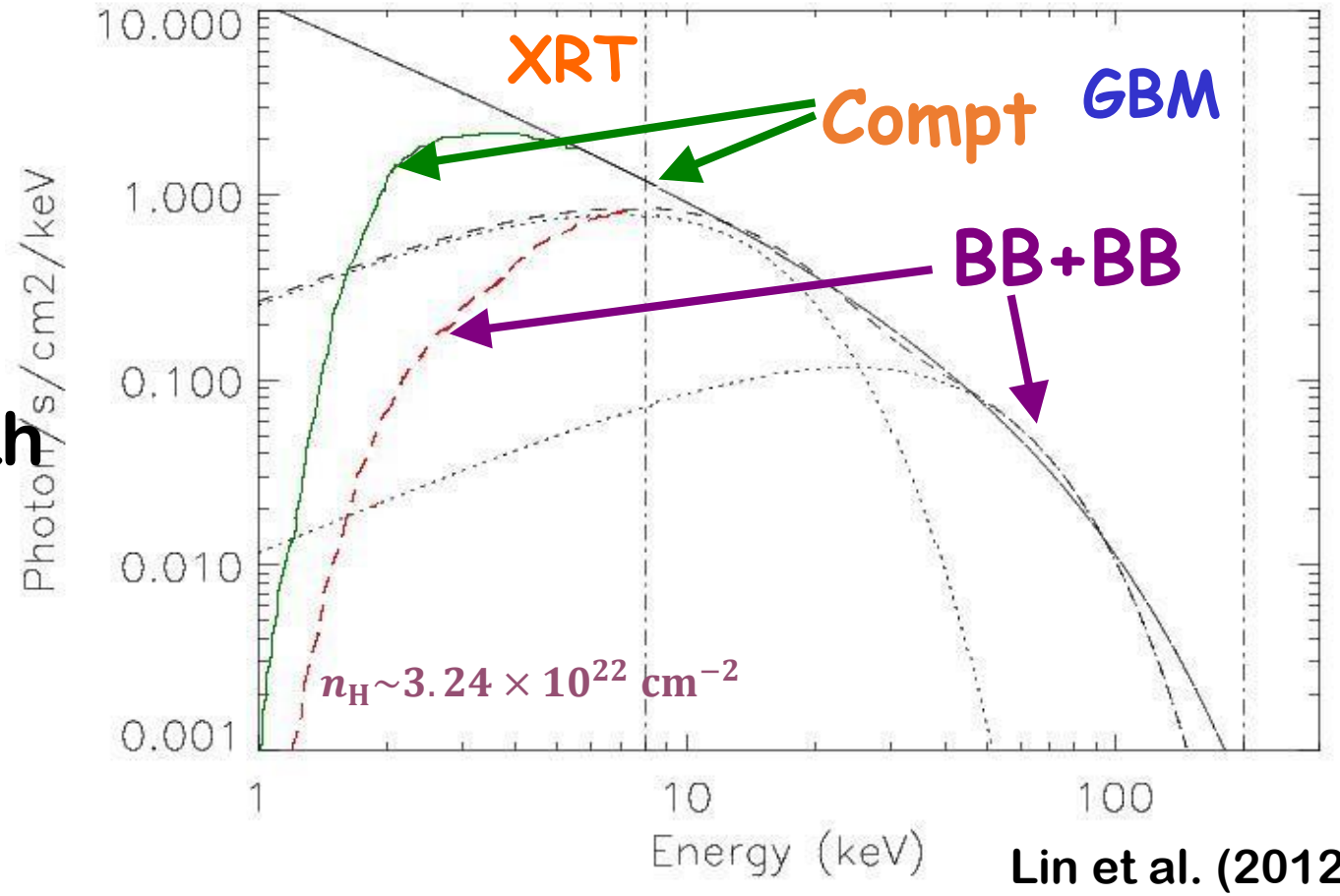
Burst: Spectrum

Model survived:

- **Thermal : BB+BB**
- **Non-thermal : a power law with exponential cutoff (COMPT)**



van der Horst et al. 2011



Lin et al. (2012

The X-ray band (<10 keV) is critical.

BB+BB

low kT : 3~6 keV , $\langle kT \rangle \sim 4.5$ keV

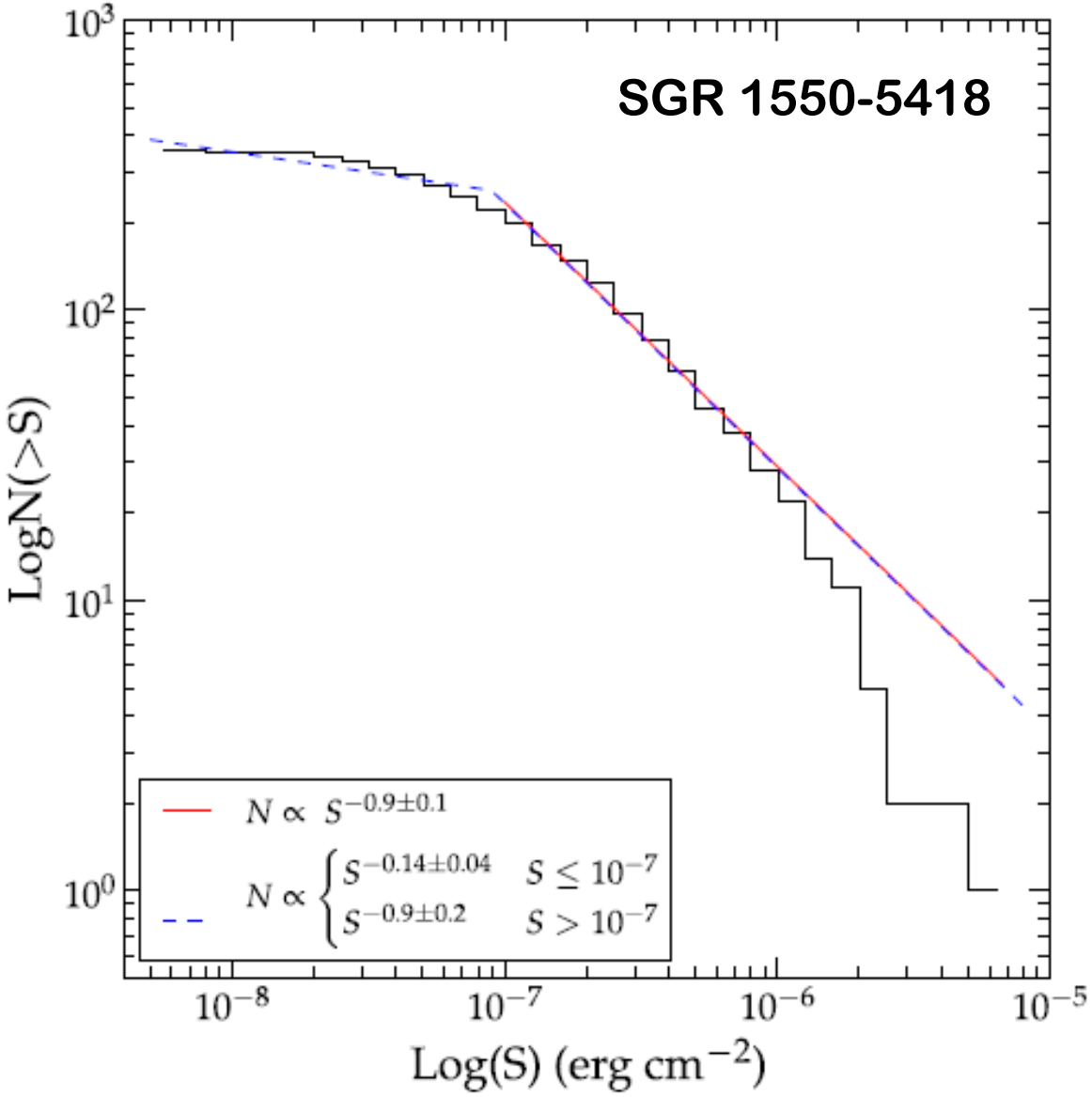
high kT : 10~20 keV , $\langle kT \rangle \sim 15$ keV

Burst: Energetic

SGR 1550-5418 for example:

- **Energy from one burst**
  $10^{37} \sim > 10^{40}$ erg **(~5 kpc)**
- **Total energy emitted in bursts**
  $> 6.6 \times 10^{41}$ erg

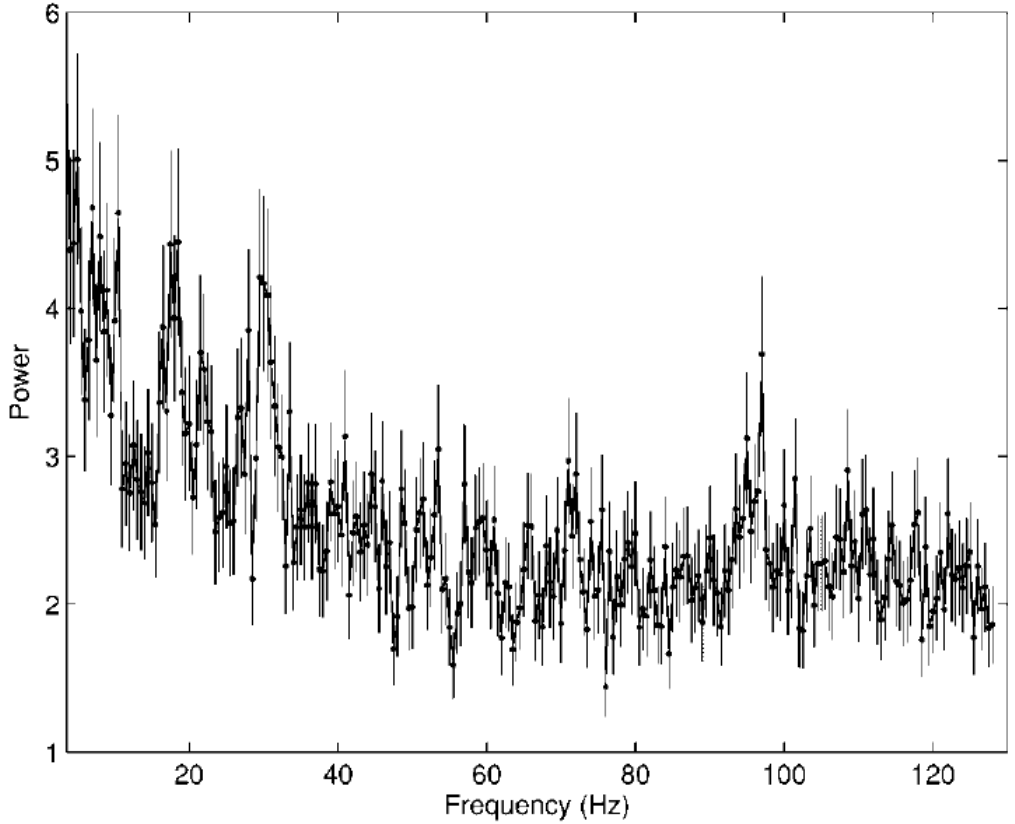
- **logN~logS**
  a single power law （ -0.4~-1 ）



Collazzi et al. (2015)

QPOs

Tail followed the giant flare of SGR 1806-20



Israel et al. 2005

- **QPO in GF tails:**
- **~20-150 Hz**
- **QPO in stacked short burst: in the same range of those in GF tails**
- **QPO from single short burst:**
- **260 Hz**
- **Trigger mechanism**

Huppenkothen et al 2014

Summary

Burst physics	Observations
Trigger mechanism	Burst statistical properties; QPO in a single burst
Emission Process	Burst cooling tail; Burst spectrum
Magnetar interior	QPOs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