

# Monitoring an Expanding Population of Soft Gamma Repeaters with RXTE

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# **Astrophysics of Neutron Stars 2010**

## **ASTRONS 2010**

2 – 6 August 2010

Çeşme – Izmir

visit

**[www.astrons2010.org](http://www.astrons2010.org)**

# Magnetars: One Page Summary

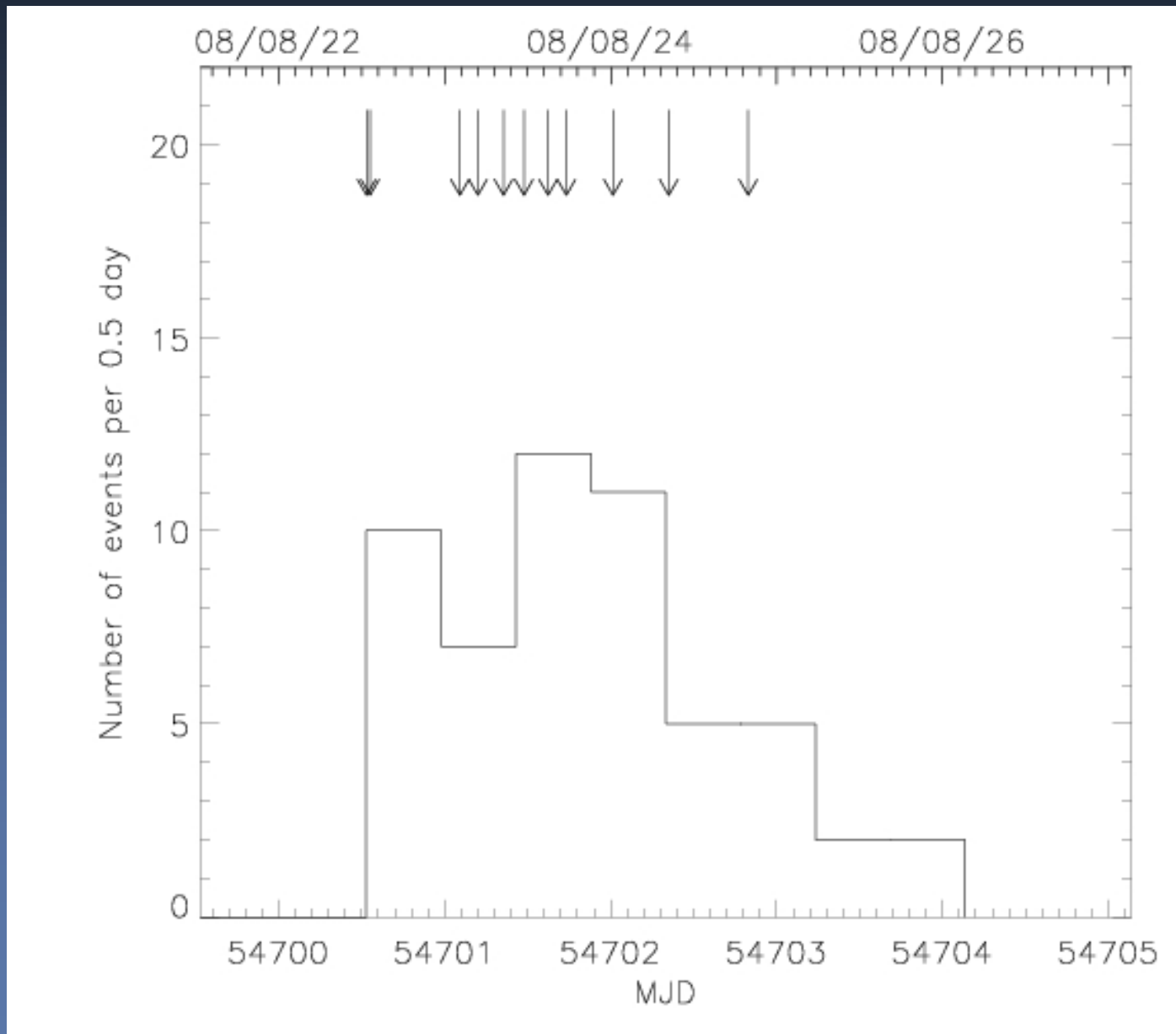
Magnetars are magnetically powered neutron stars

- ~16 are discovered to date – two in the last year (2008-2009) – Only 2 extragalactic sources
- Discovered in X/γ-rays: Short, soft repeated bursts. Radio, optical and IR counterparts exist for some
- $P = [2-11] \text{ s}$ ,  $\dot{P} \sim [10^{-11} - 10^{-13}] \text{ s/s}$
- $\tau_{\text{spindown}}(P/2\dot{P}) = 2-220 \text{ kyrs}$
- $B \sim [1-10] \times 10^{14} \text{ G}$  (mean surface dipole field:  $3.2 \times 10^{19} \sqrt{P\dot{P}}$ )
- Bright sources,  $L \sim 10^{33-36} \text{ erg/s}$ ,  $\gg$  rotational E-loss
- No evidence for binary nature so far (fallback disks?)
- SNe associations?

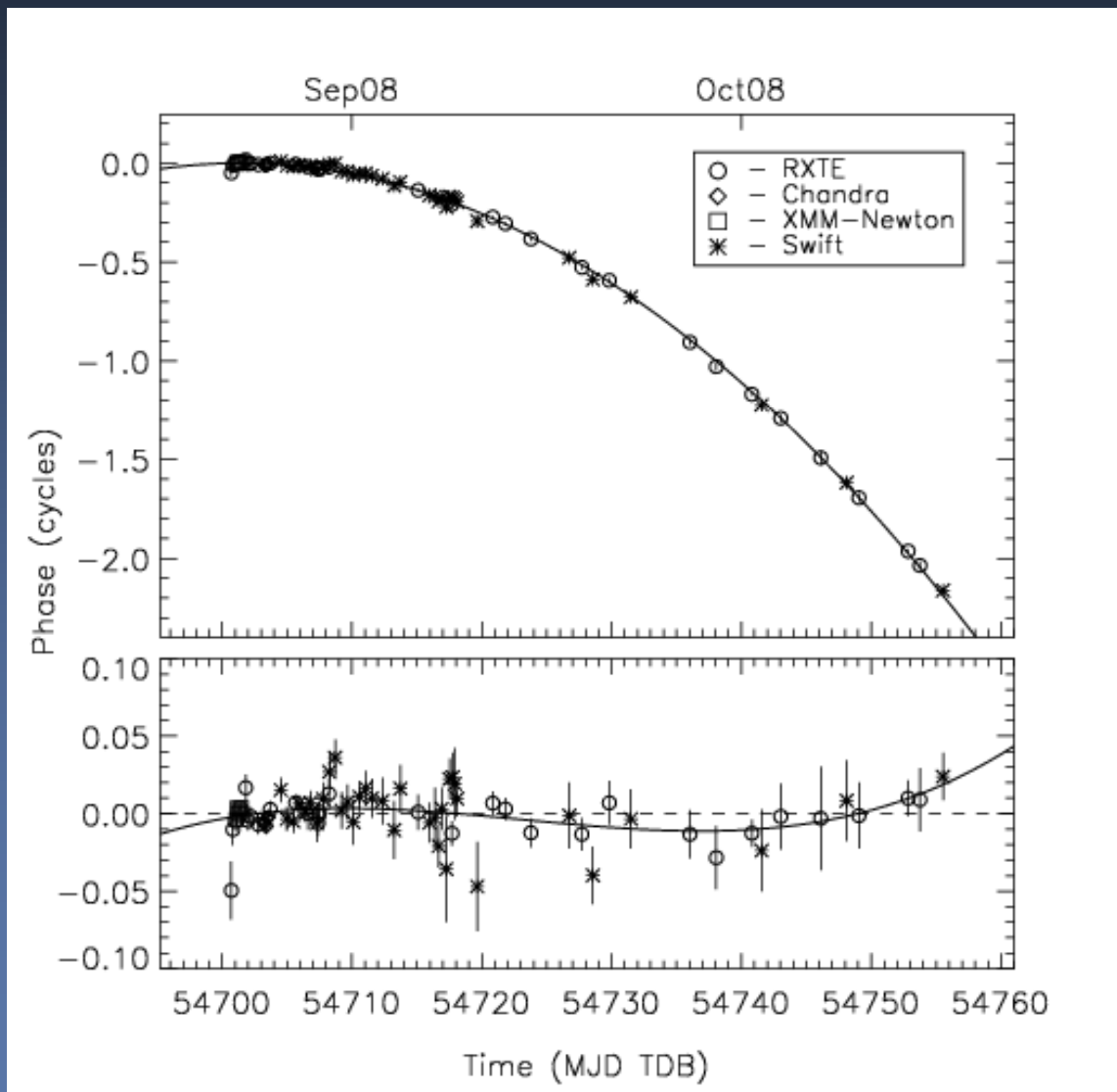
# SGR 0501+4516

- Swift triggered on 4 bursts on 22 August 2008
- RXTE ToO program triggered ~4 hours after the first Swift trigger
- $P = 5.769$  s was reported ~ 9 hours after the first Swift trigger!
- $P = 1.5 \times 10^{-11}$  s/s and  $B = 3 \times 10^{14}$  G
- CXO HRC location:
  - RA = 05h 01m 06.756s
  - Dec= +45d 16m 33.92s (with 0.10'' accuracy)
  - IR counterpart with UKIRT,  $K \sim 18.6$  (Tanvir and Varricatt 2008)
- 56 bursts detected from the source in about 3.5 days.

# Outburst of SGR 0501+4516



# Monitoring of SGR 0501+4516



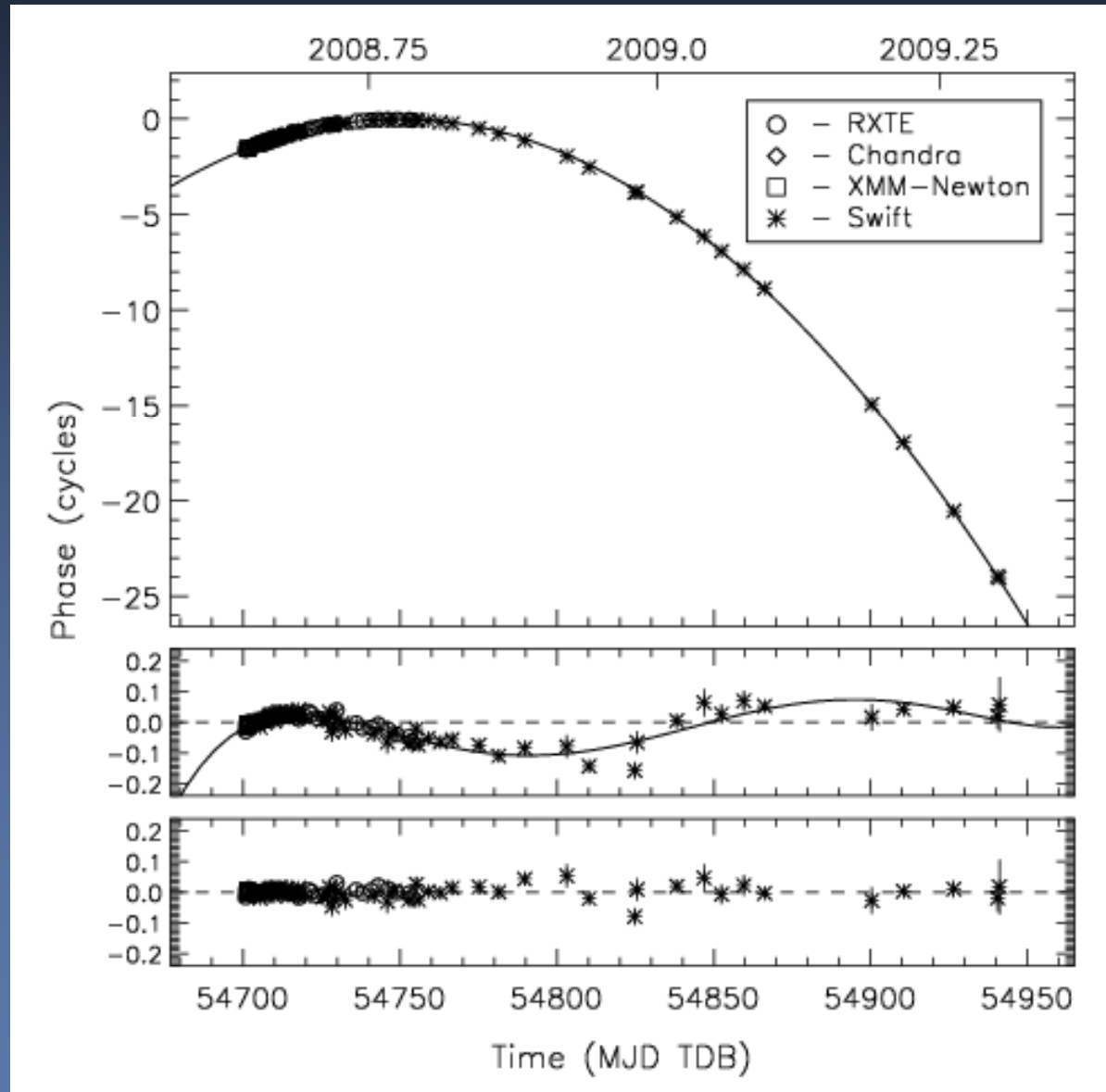
$$P = 5.7620689(1) \text{ s}$$

$$P = 7.5(2) \times 10^{-12} \text{ s/s}$$

$$B = 2.1 \times 10^{14} \text{ G}$$

*(Gogus et al. 2010)*

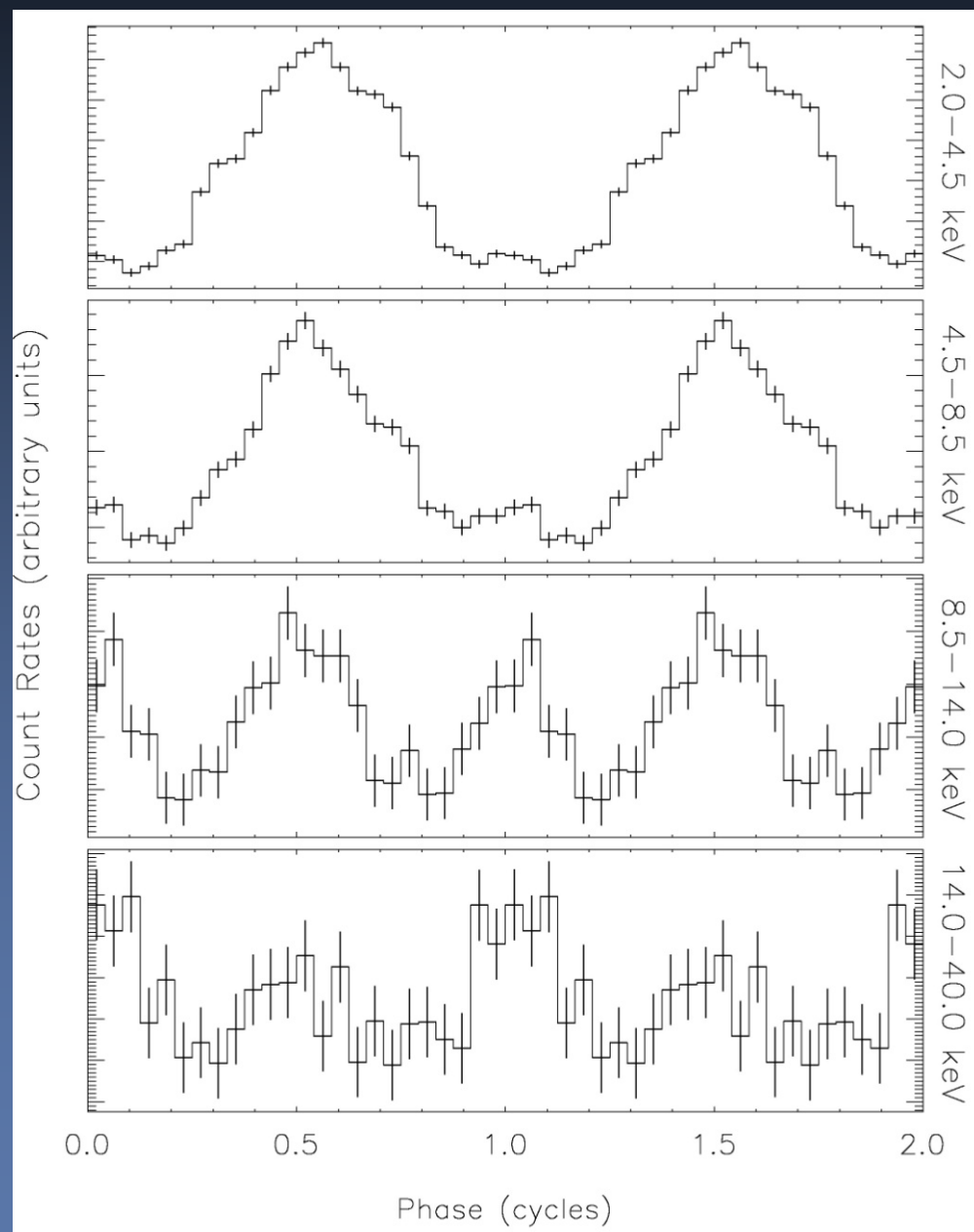
# Monitoring of SGR 0501+4516, continued



*(Gogus et al. 2010)*

# SGR 0501+4516: Energy Dependence of Pulse Profile:

**RXTE is crucial to  
link soft X-rays to  
hard X-rays**



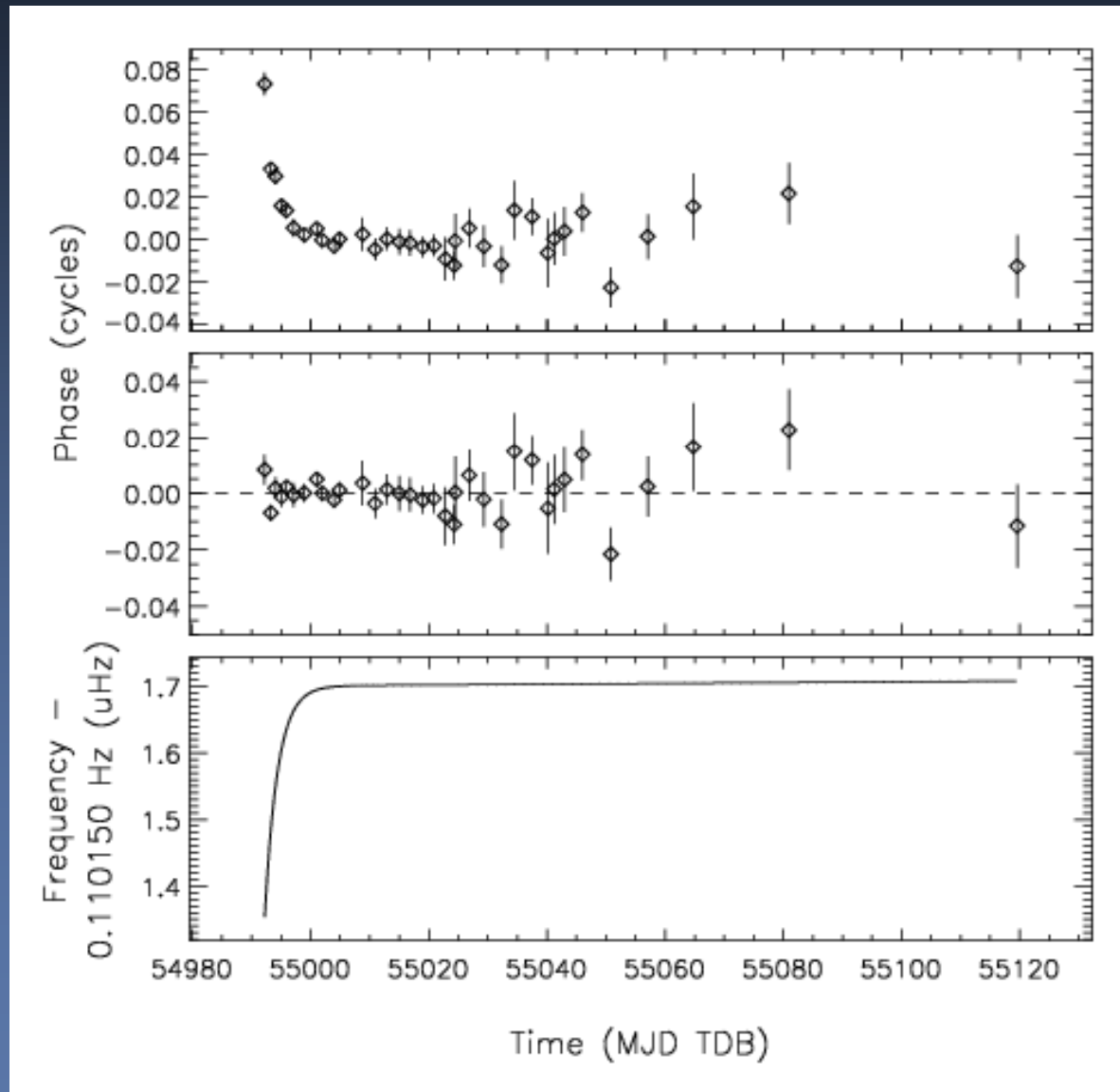
*(Gogus et al. 2010)*



# SGR 0418+5729

- 2 bursts on 5 June 2009 detected with the Fermi GBM
- $P_{\text{spin}} = 9.08 \text{ s}$  with RXTE within days
- CXO HRC location:
  - RA = 04h 18m 33.867s
  - Dec = +57d 32m 22.91s
- No IR ( $K_s > 21.3$ ; Wachter et al. 2009)  
No optical ( $r > 24$ ; Ratti, Steeghs & Jonker 2009)

# Apparent Glitch in SGR 0418+5729



$$\Delta\nu / \nu = 2 \times 10^{-5}$$

$$\dot{\nu} \sim 3.8 \times 10^{-15} \text{ Hz/s}$$

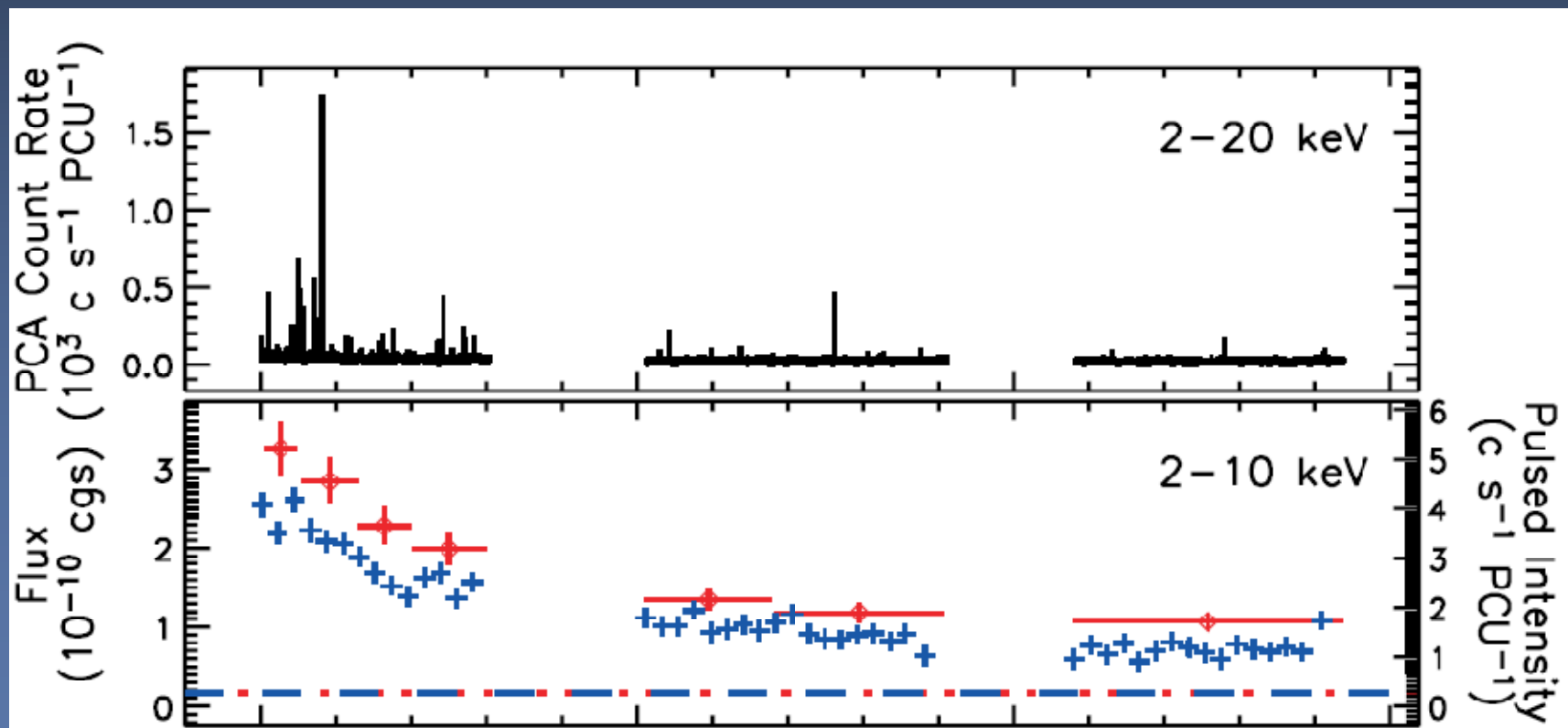
$$B \sim 5 \times 10^{13} \text{ G}$$

(Woods et al. 2010)

# Short Outburst of 1E 2259+586

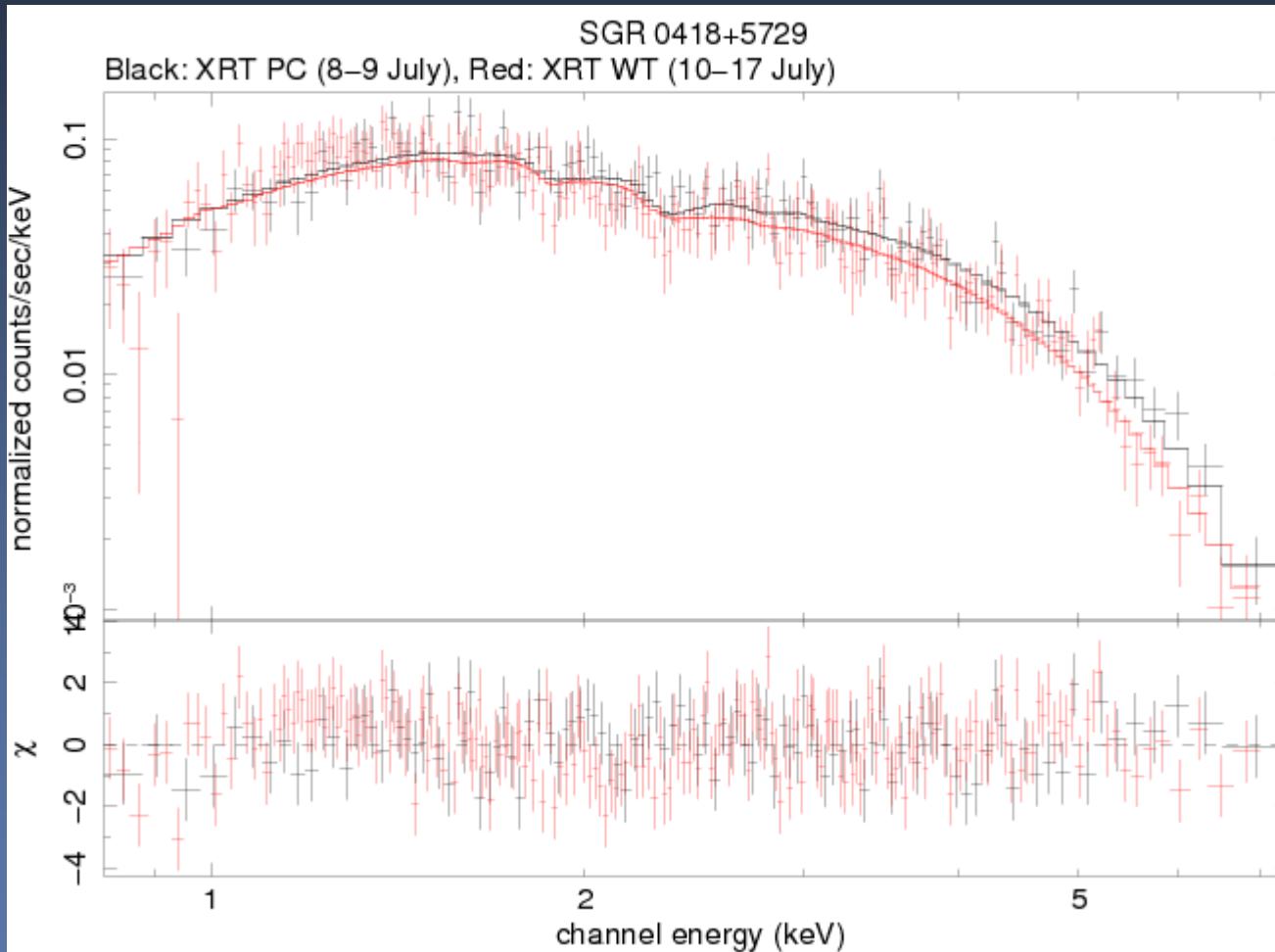
Bursts and flux increase are accompanied with a large glitch

$$B_d = 5.9 \times 10^{13} \text{ G}$$



(Kaspi et al. 2003)

# Spectrum of SGR 0418+5729



Pure Blackbody:

$$kT = 0.88 \text{ keV}$$

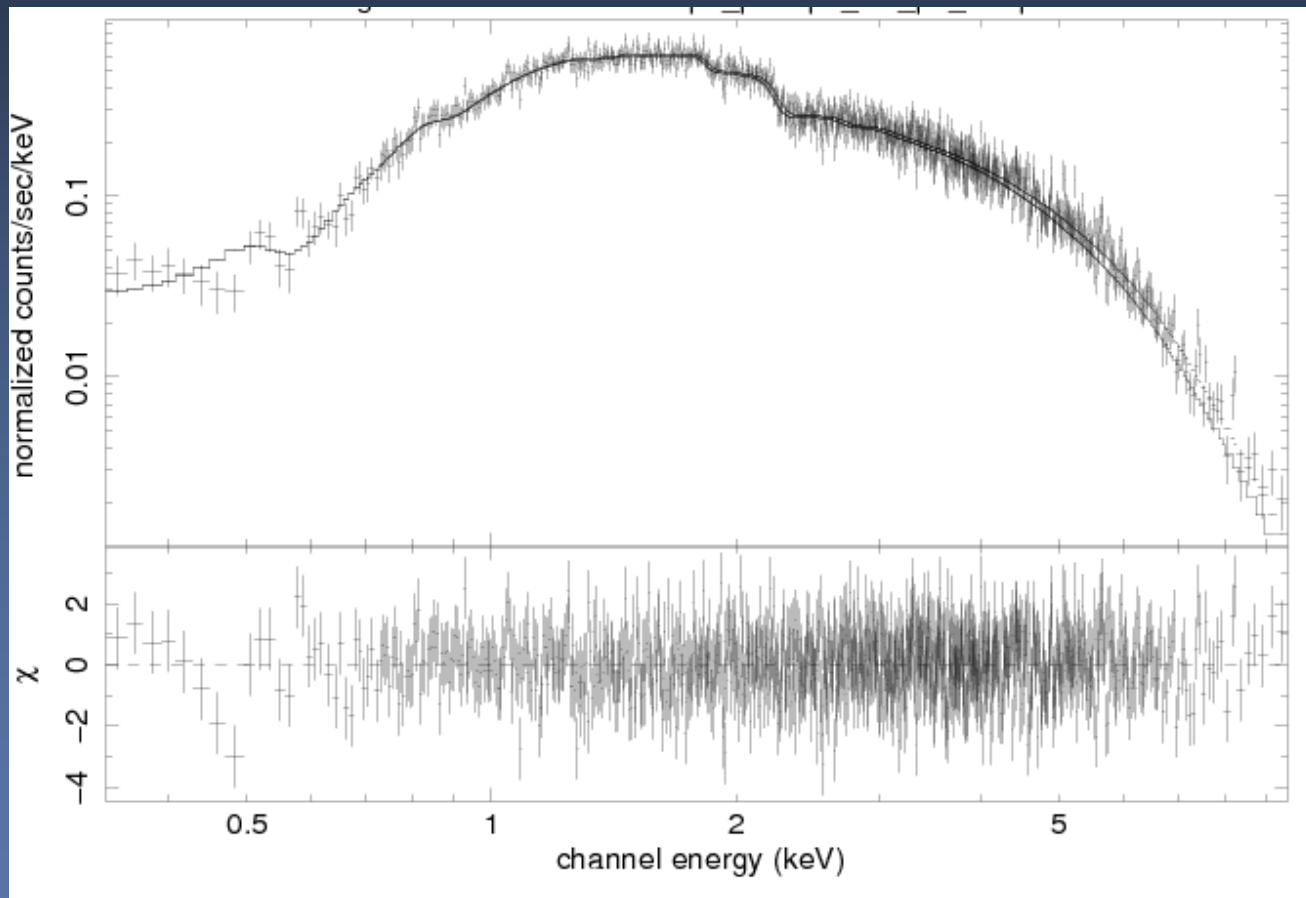
$$nH = 1.3 \times 10^{21} \text{ cm}^{-2}$$

Unabsorbed flux in the  
0.8 – 10 keV:

$$F = 1.1 \times 10^{-11} \text{ cgs}$$

*(Woods et al. 2010)*

# Spectrum of SGR 0418+5729



Blackbody + Power law

$$kT = 0.92 \text{ keV}$$

$$\Gamma = 3.02$$

$$nH = 7.7 \times 10^{21} \text{ cm}^{-2}$$

Unabsorbed flux:

$$F = 5.9 \times 10^{-12} \text{ cgs}$$

*(Woods et al. 2010)*

# Summary

XTE has been extremely important for SGRs  
(variable spin down, bursts, ...)

Synergy of RXTE, Fermi/GBM and Swift works  
perfectly for SGRs (2 new sources in 1 year)

Rapid response is really the key.

Thanks Jean, Evan, Divya, and many earlier  
members