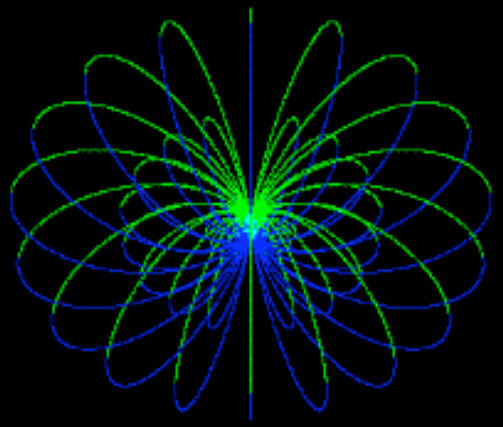
1RXS J1708 - 4009 X-ray and IR monitoring: a possible tool to foresee magnetars' activity



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1RXS J1708-4009: a bit of history…

- first observed with Rosat (Voges et al. 1996) and Asca (Suguzaki et al. 1997)

- early data: fairly stable rotator ~ 11s (Israel et al 1999), but recently two glitches in the last 5 yrs, with different recoveries (Kaspi et al. 2000/2003, Dall'Osso et al 2003)

- no obvious SNR association (Gaensler et al. 2001)

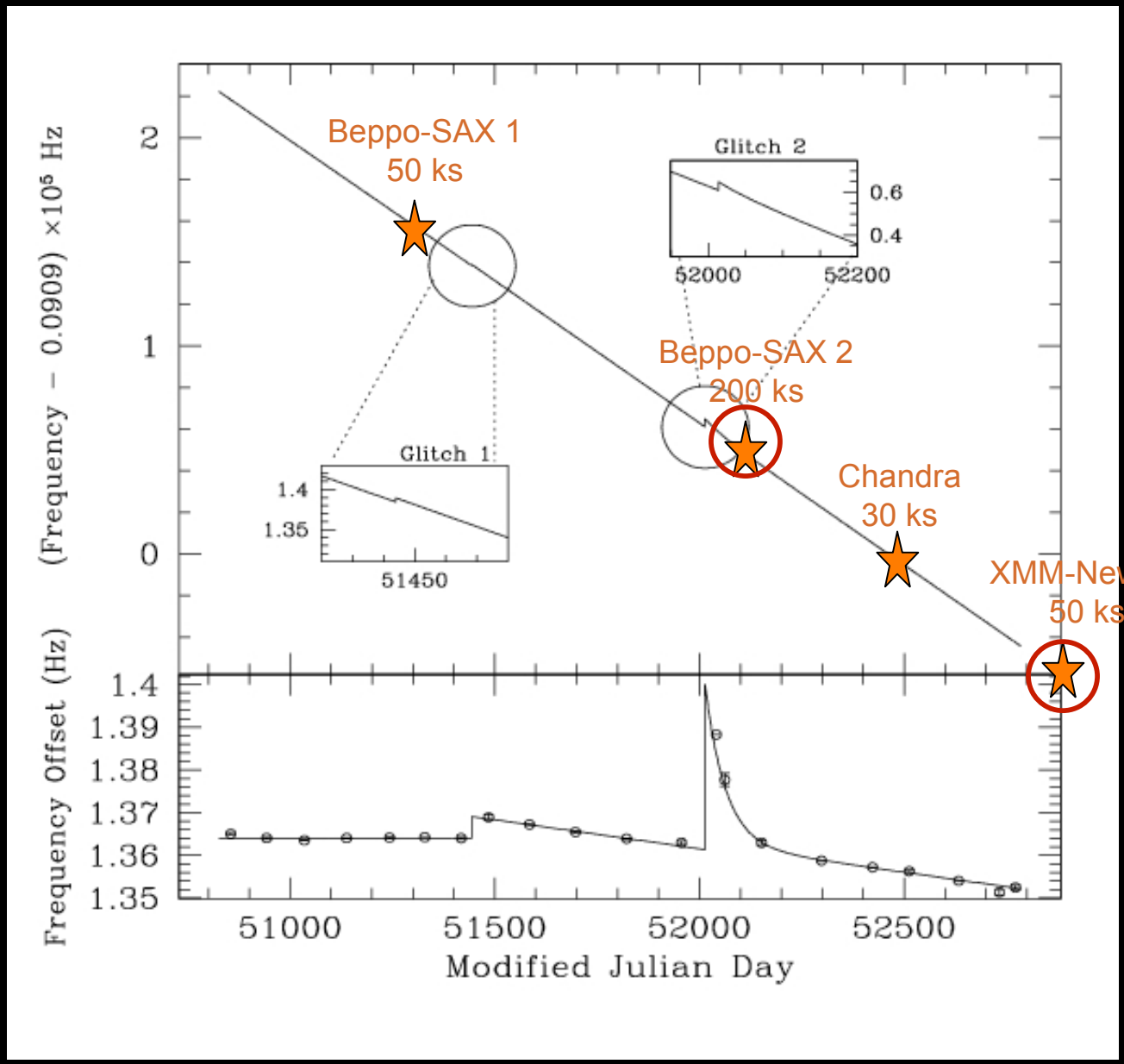
- radio continuum upper limit of 0.3 mJy (Rea et al. in prep.) and radio pulsations upper limit of 0.1 mJy (see Burgay's poster)

- pulse phase spectroscopy of two BeppoSax obs (Israel et al. 2001; Rea et al. 2003):
  1) large spectral variability with spin phase
  2) strong energy dependence of pulse profile shape

- evidence for an absorption line at ~8keV in the phase resolved spectrum while the source was not totally recovered from the second glitch (Rea et al. 2003)

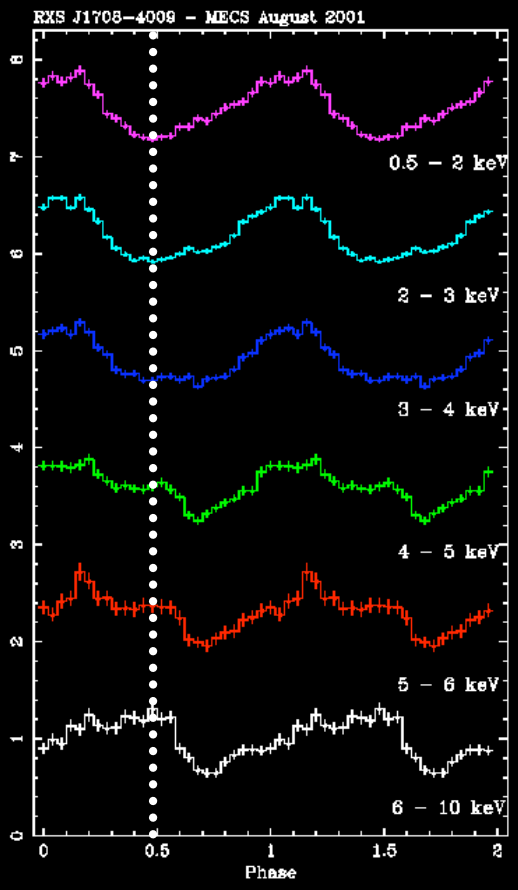
- debated IR counterpart (Israel et al. 2003; Safi-Harb & West 2005)

- high energy tail extending over ~100 keV (Kuiper et al. 2006)

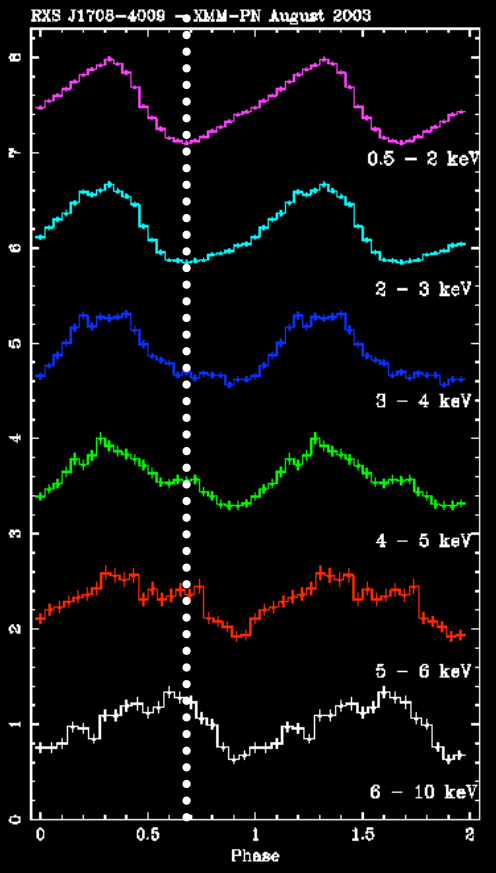


(from Kaspi et al. 2003)

Energy dependent pulse profile and pulsed fraction

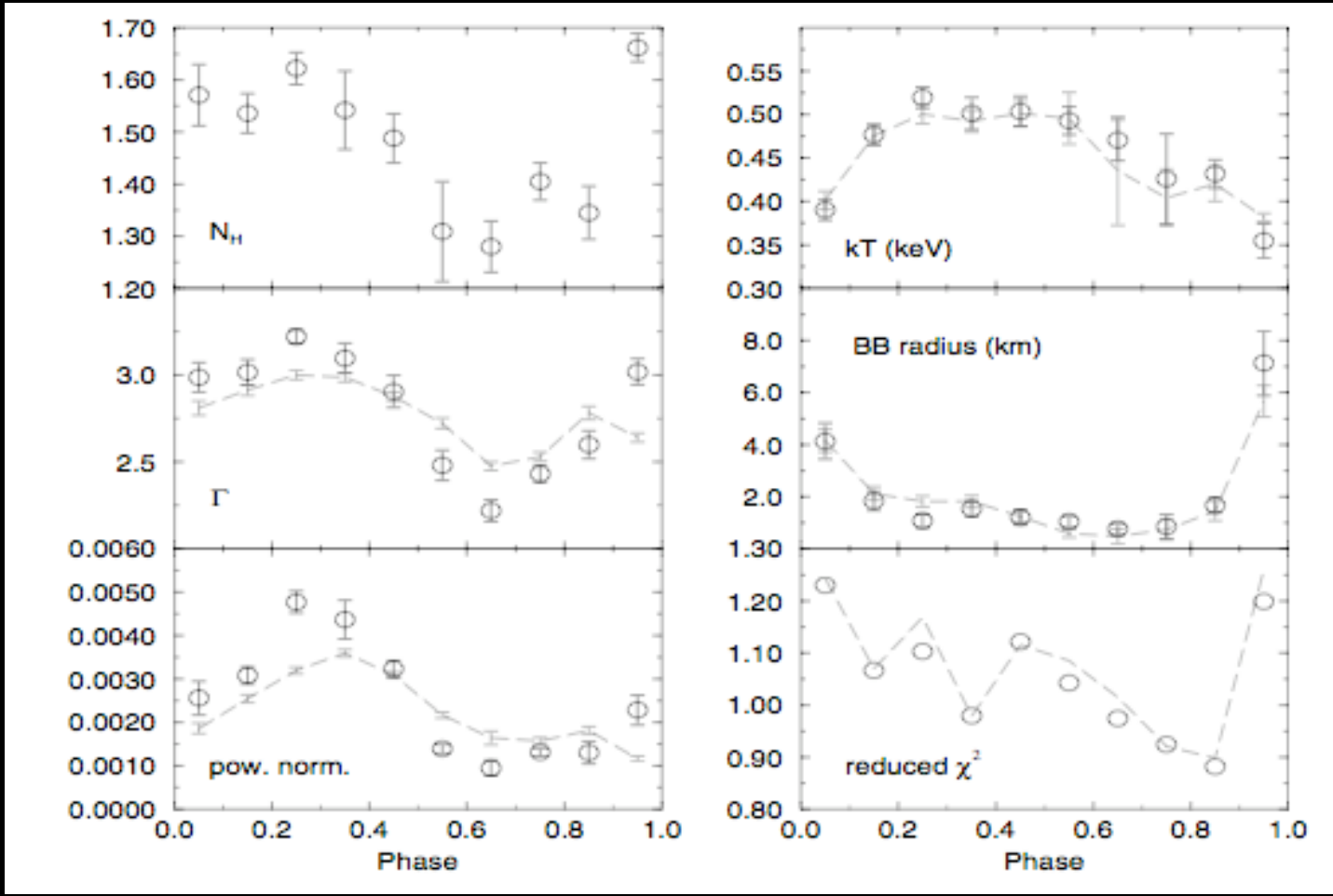


BeppoSAX 2
(source not totally recovered from the glitch; Rea et al. 2003)
30% PF in 0.1-2 keV
17% PF in 6-10 keV

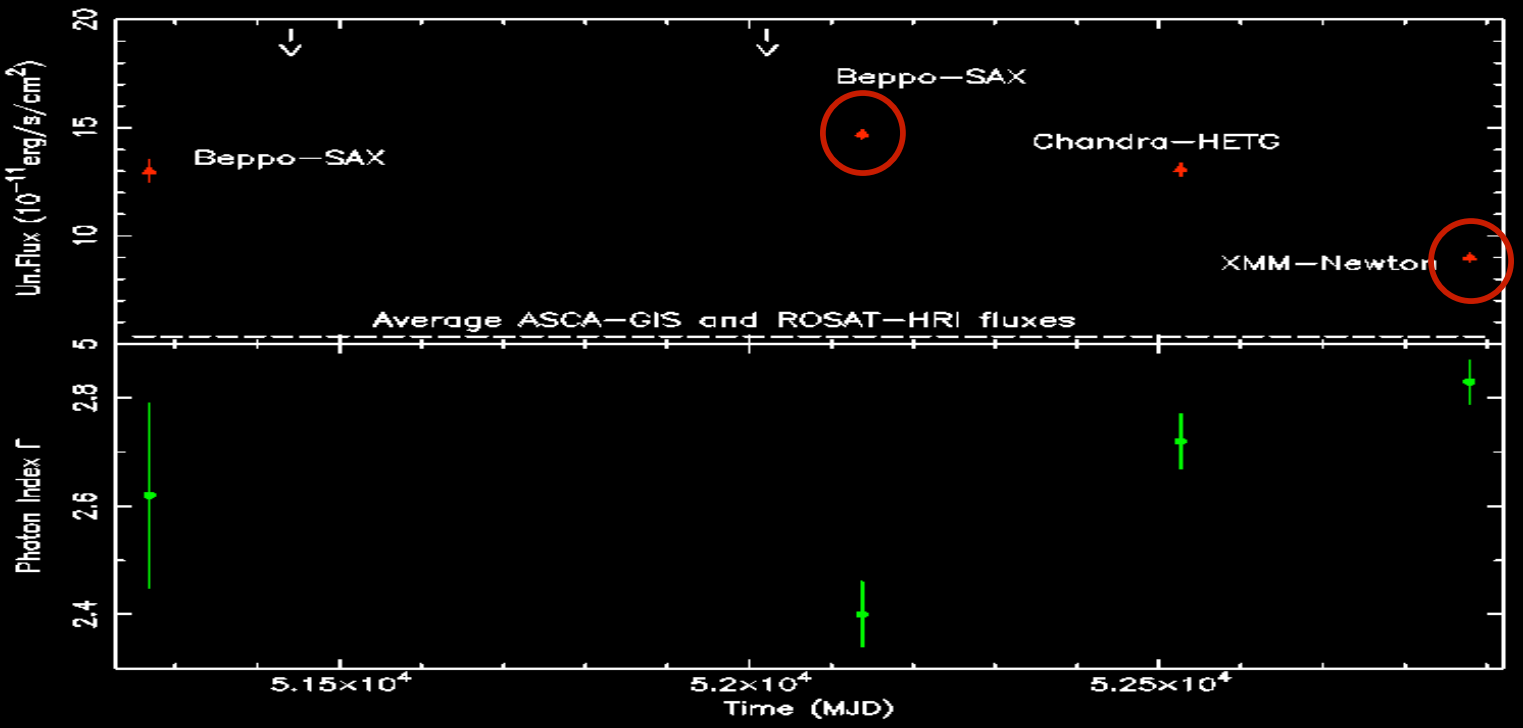


XMM-Newton
(Post glitch; Rea et al. 2005)
39% PF in 0.5-2 keV
29% PF in 6-10 keV

Pulse Phase Spectroscopy



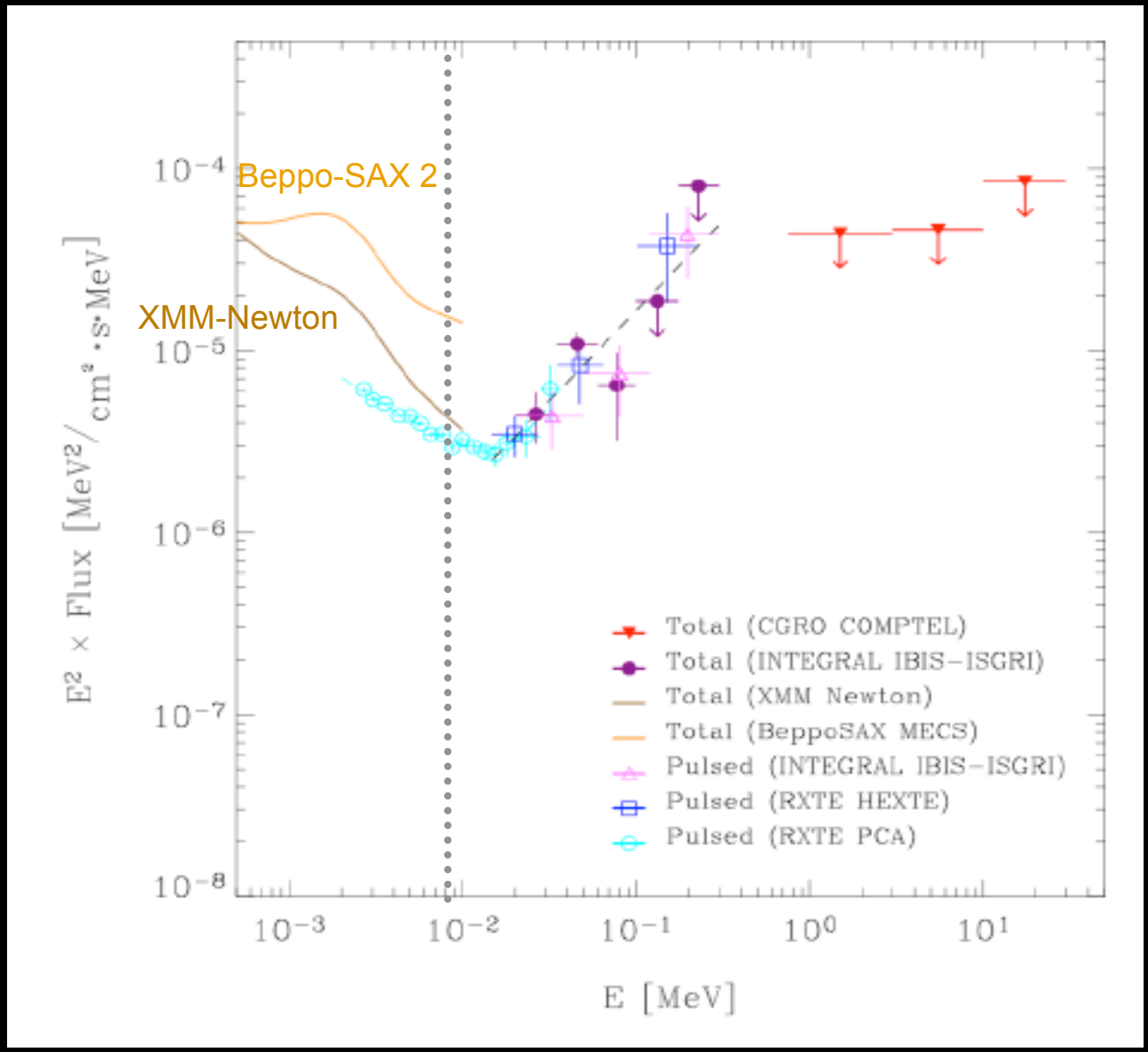
Long term evolution: flux-hardening correlation



Γ - L correlation:

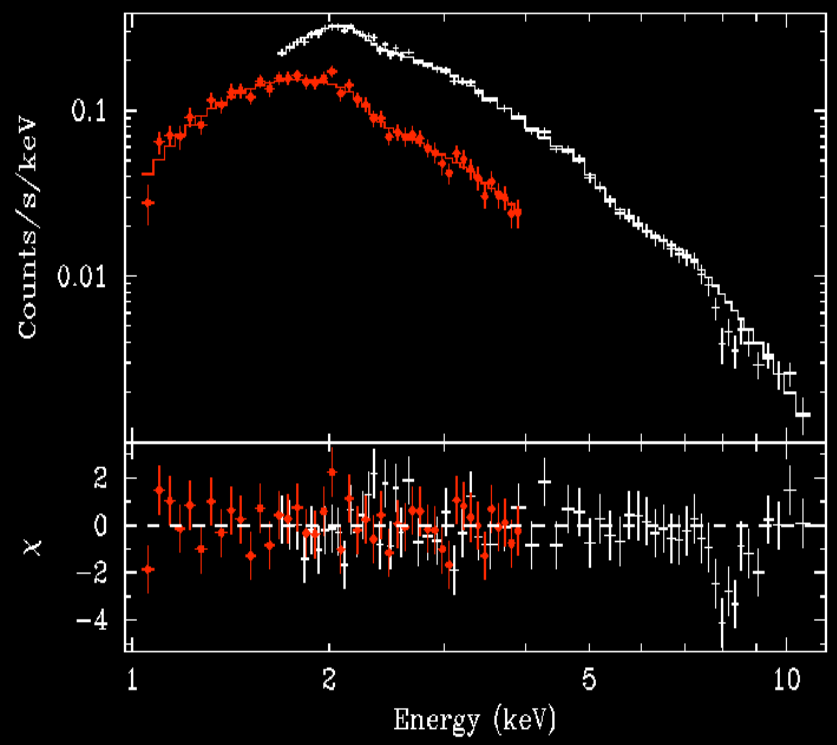
The spectrum became harder as the flux rose in correspondence of the two glitches and then softened as the luminosity dropped, following the glitch recovery

(Rea et al. 2005)

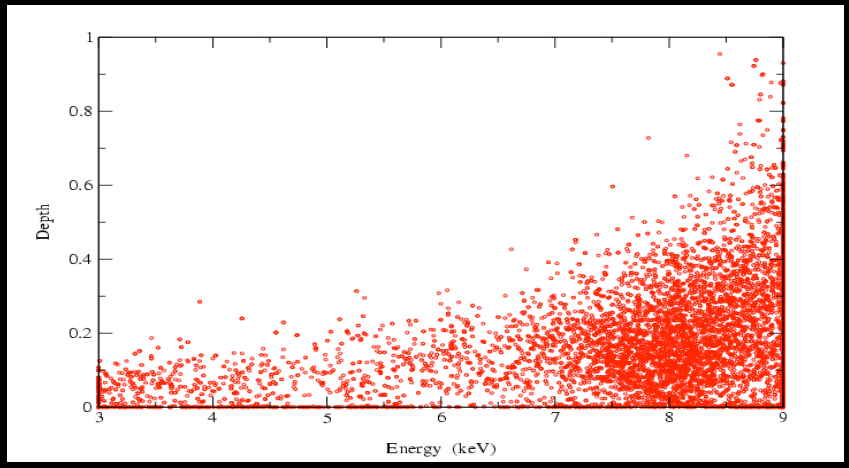


(from Kuiper et al. 2006)

Re-analysis of the line detection



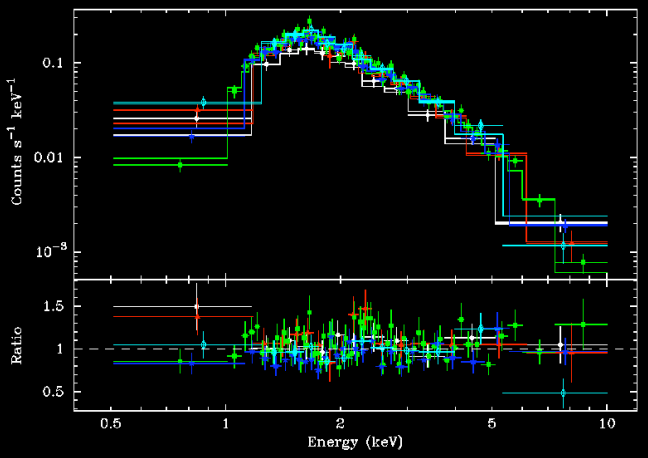
- Line significance not affected by background subtraction or extraction region
- F-test CL 4σ



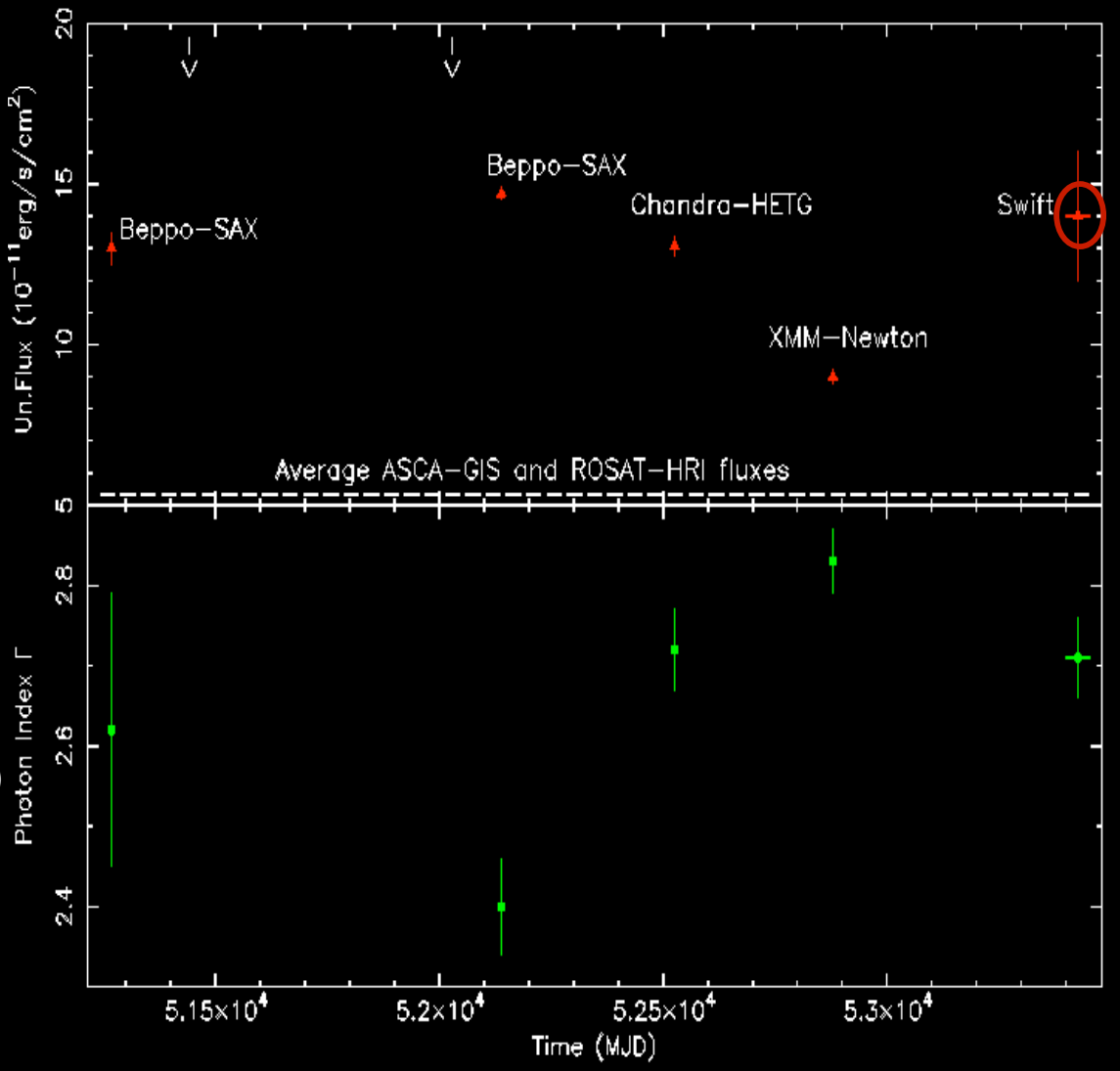
- Monte Carlo simulation of 10^4 spectra
- Continuum model and same number of photons as in BeppoSax spectrum.
- 32 spectra with depth >0.8 in 10000
- Prob line being a fluctuation <0.32 %
- Detection confirmed at 99.68% CL

(Rea et al. 2003, 2005)

New Swift observations confirm the flux-hardness correlation



- Observed many times being a calibrator source
- We used 5 observations in PC and WT data (5-10 ks each: 54ks)
- P = 11.0027(3) s; PF ~ 35+/-7 %
- Flux enhancement, mainly due to the BB, and spectral hardening with respect to XMM



(Campana et al. 2006, submitted)

Twisted magnetosphere?

A key feature of twisted magnetospheres is that they support current flows, and the presence of charged particles (e- and ions) produces both a large resonant scattering depth and an extra heating of the star surface (by returning currents;).

Both scattering depth and released luminosity increase with the twist angle : since spectral hardness increase with depth this implies a positive Γ - L correlation (as observed) !

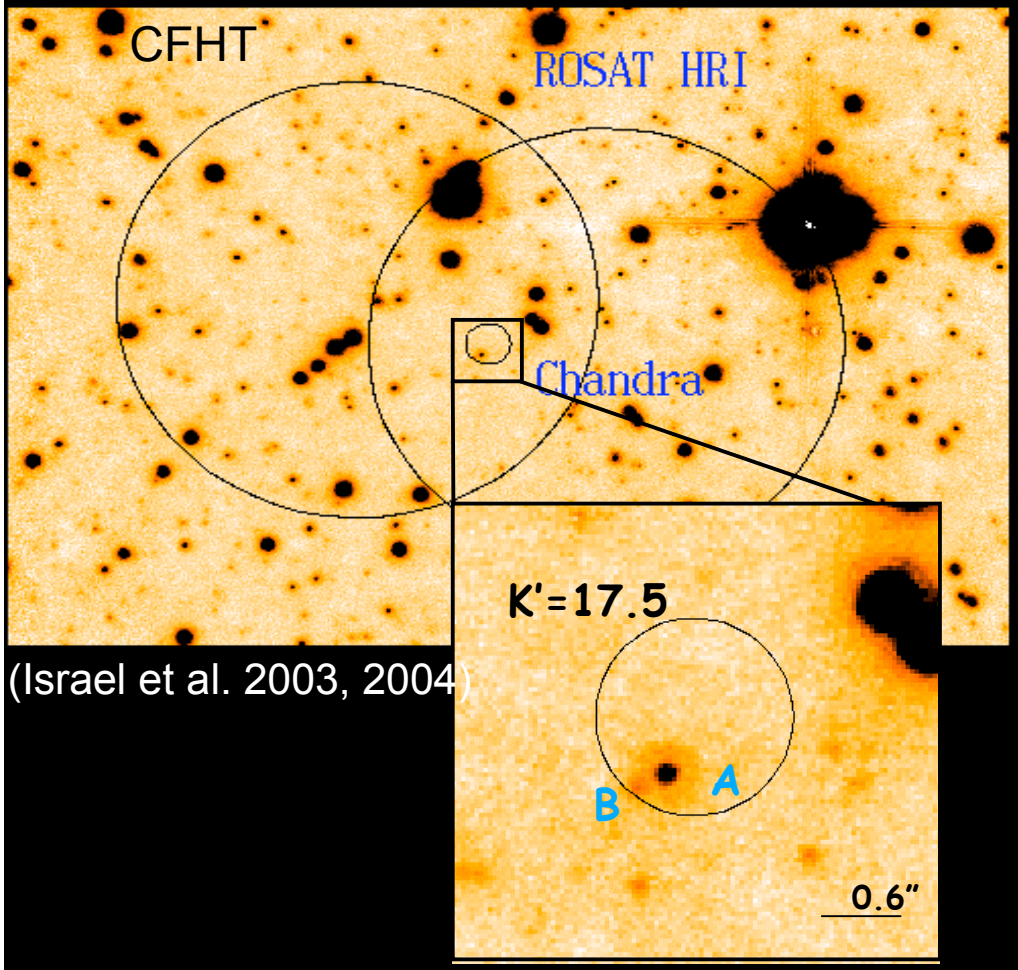
Glitches might occur when the crust cannot bear the stress anymore

transient appearence of a cyclotron line have two condintion

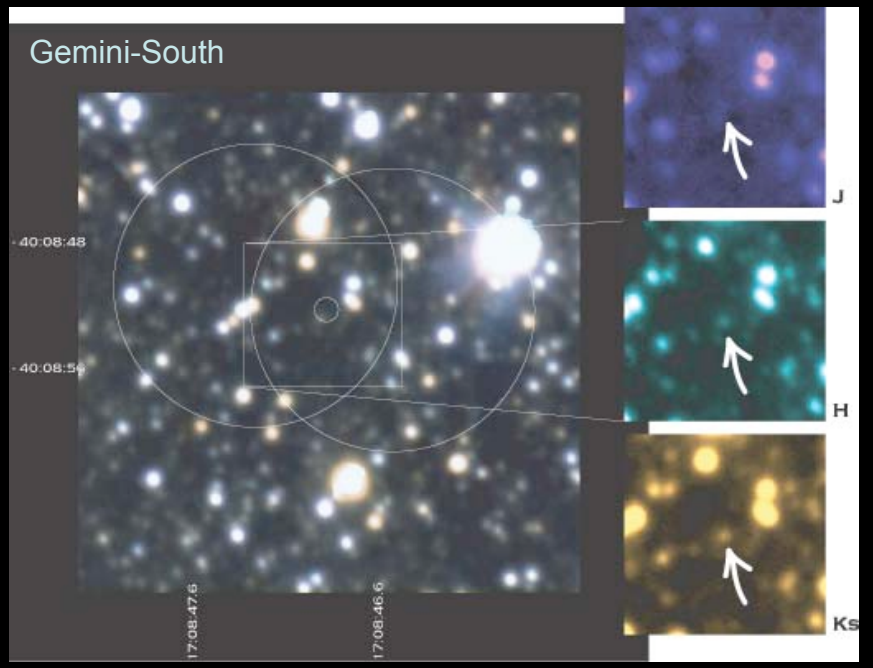
1) Large Twist angle
2) $L(\omega_i) > L^{rc}_x \sim 10^{35}$ erg/s

(Thompson, Lyutikov & Kulkarni 2002)

On the debated IR counterpart



(Israel et al. 2003, 2004)

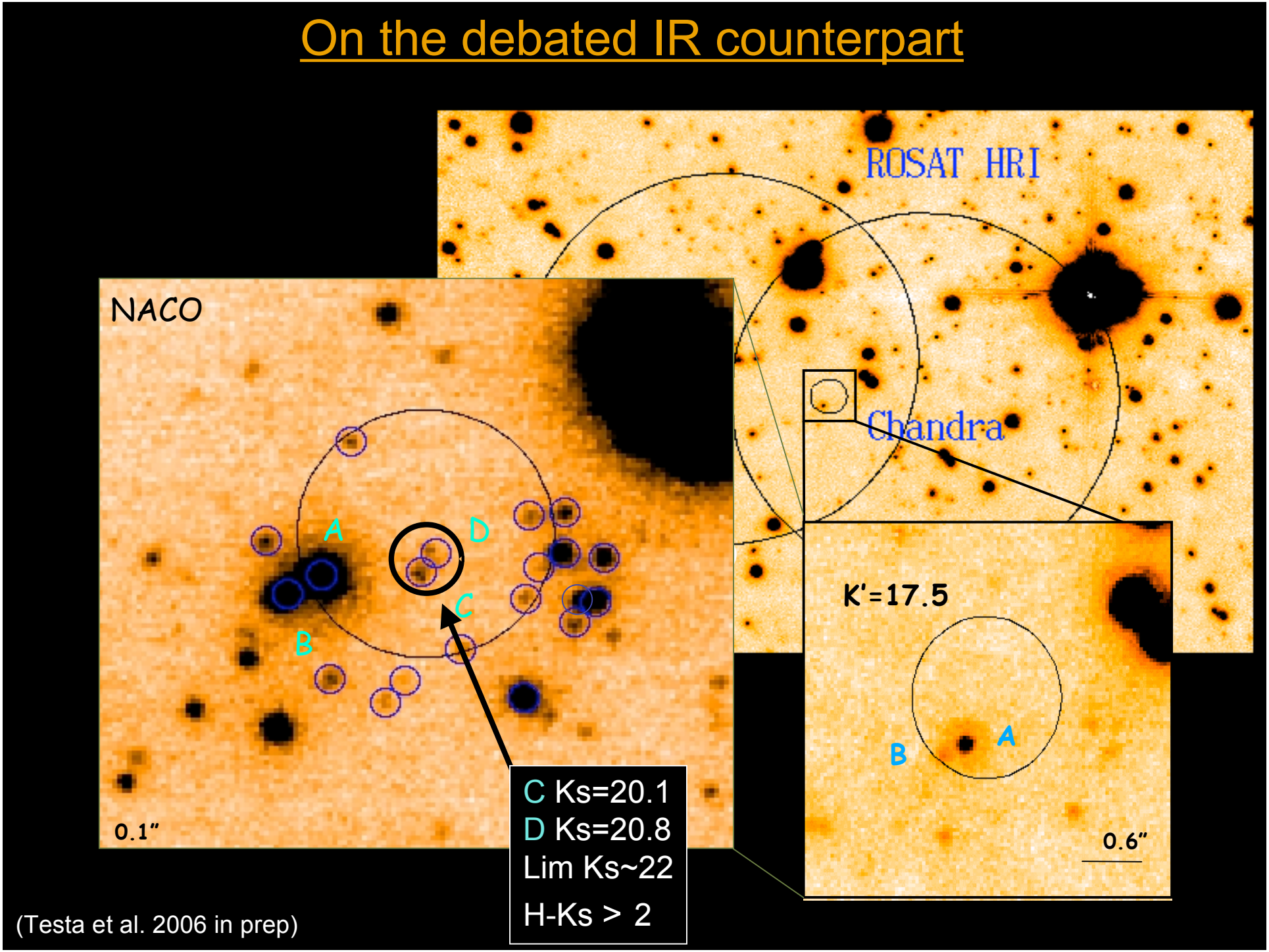


(Safi-Harb & West 2005)

- Two sources detected at the Chandra position with K'=17.5 (A) and K'=20.0 (B)
- A has unusual colors -> proposed counterpart

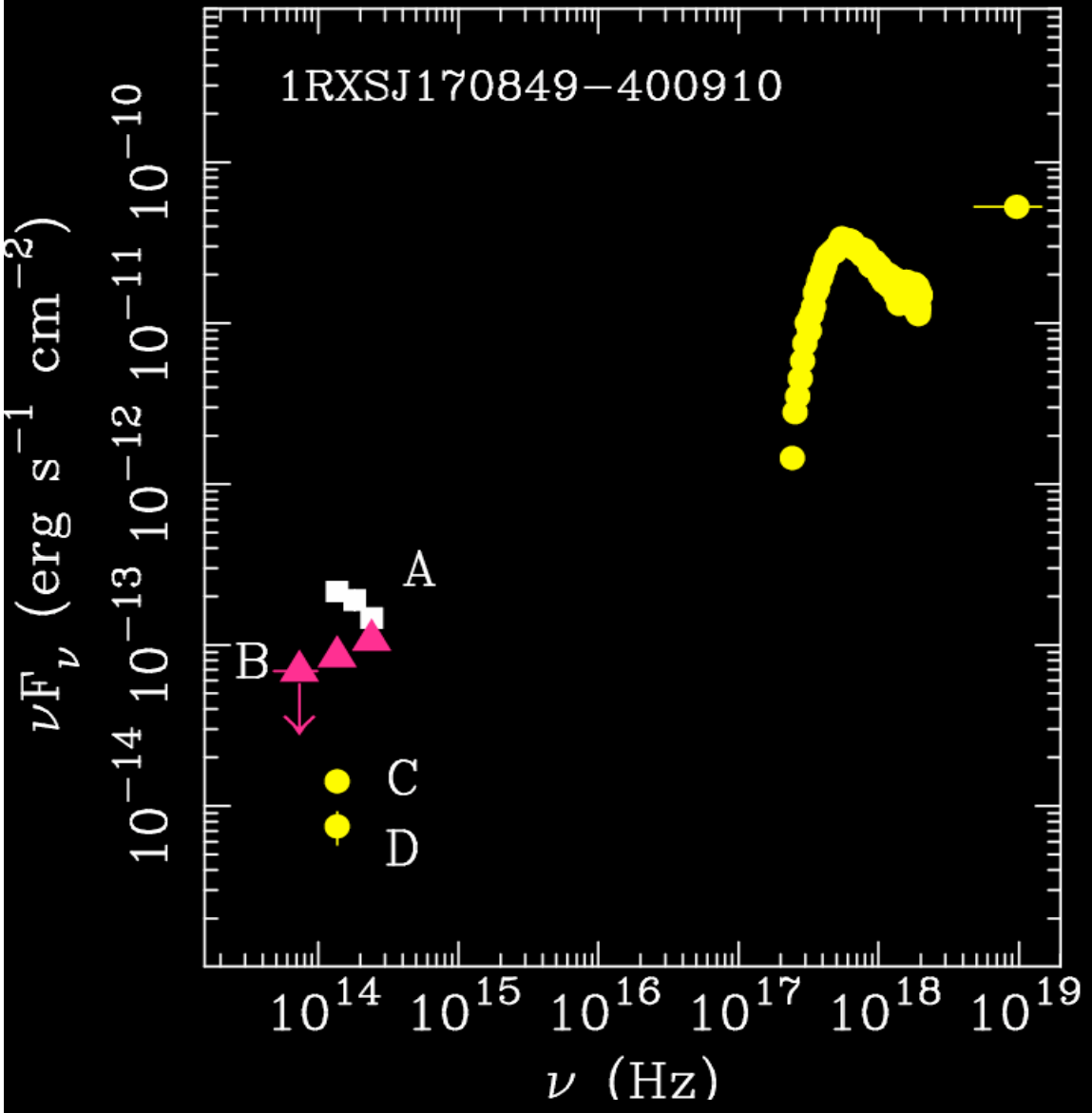
- No IR variability
- B is most likely to be the counterpart (more plausible F_X/F_{IR} ratio >1000)

On the debated IR counterpart

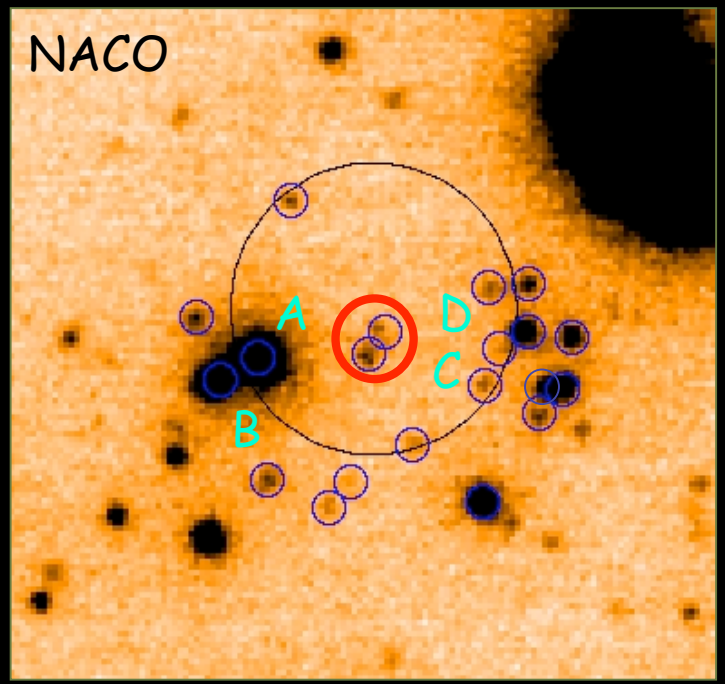


(Testa et al. 2006 in prep)

On the debated IR counterpart



Ks of objects C and D are more in agreement than object A with the usual F_X/F_{IR} of AXPs



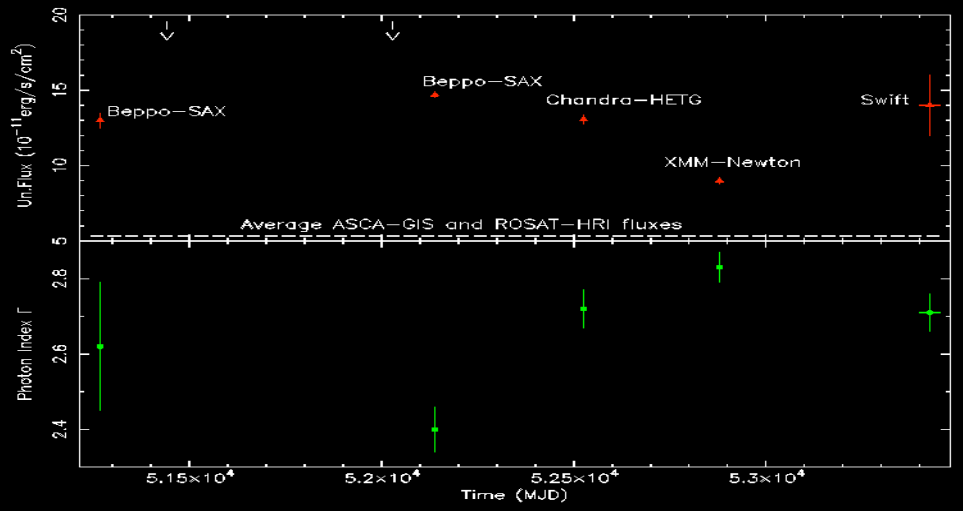
(Testa et al. 2006, in prep)

Conclusions 1/2

1) Thanks to the intensity-hardness correlation with a yearly monitoring might be possible to foresee next glitching activity of this source (others?).

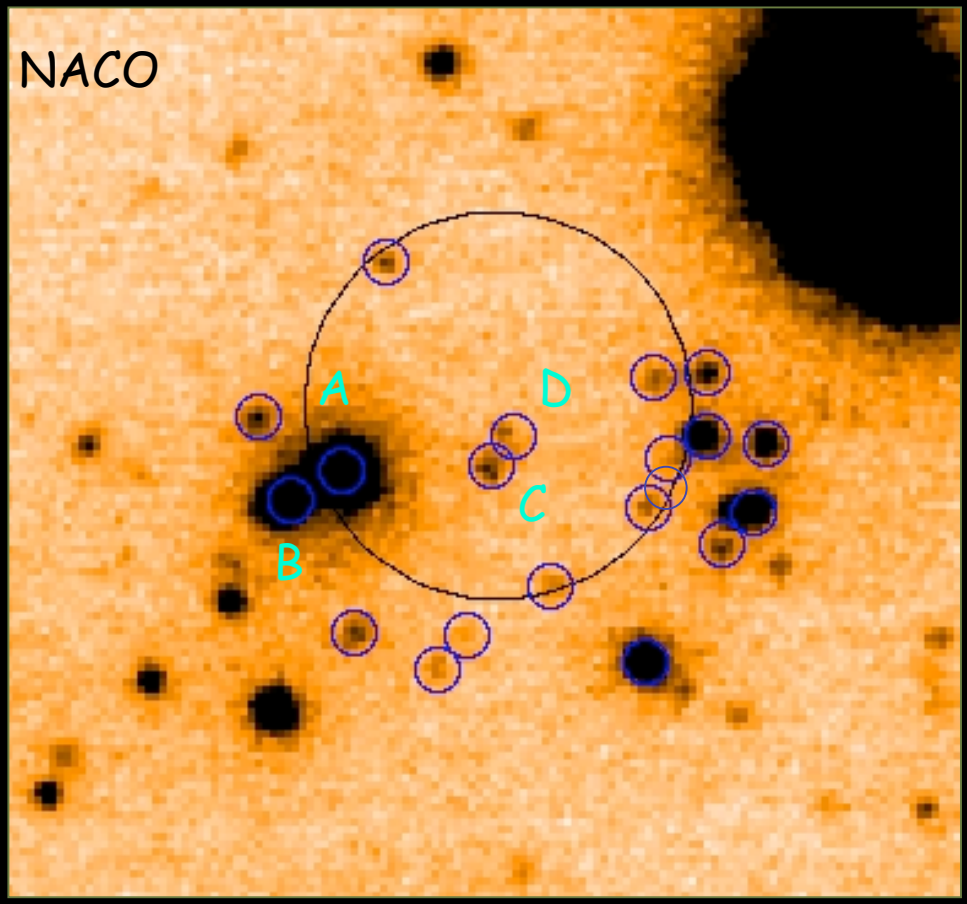
2) The fact that a similar behavior has occurred connected with the bursting and glitch of 1E 2259, make us believe that 1RXS J1708 experienced a similar bursting activity which went unseen because of the sparse monitoring.

3) The glitching activity, the possible transient appearance of the absorption line while the second big glitch was not recovered yet, and the Γ - L correlation, might be explained within the twist scenario, although a detailed study in this sense is still under way.



Conclusions 2/2

3) The IR counterpart of 1RXS J1708-4009 seems neither ‘A’ or ‘B’ candidates. Many faint objects are present within the Chandra error circle, preventing an unambiguous identification of the correct IR counterpart



Commercials…

Posters:

Marta Burgay -
Searching for radio pulsations in AXPs

Nanda Rea -
Our distorted view of magnetars: applications of the Resonant Cyclotron Scattering model to AXPs and SGRs

http://www.icra.it/MG/mg11/

Extreme properties of neutron stars: Theory and Observations

Session: APT3

Deadline: May 15th

SOC:
Mariano Mendez & Nanda Rea