Towards a new synergy between X and γ-ray astronomies

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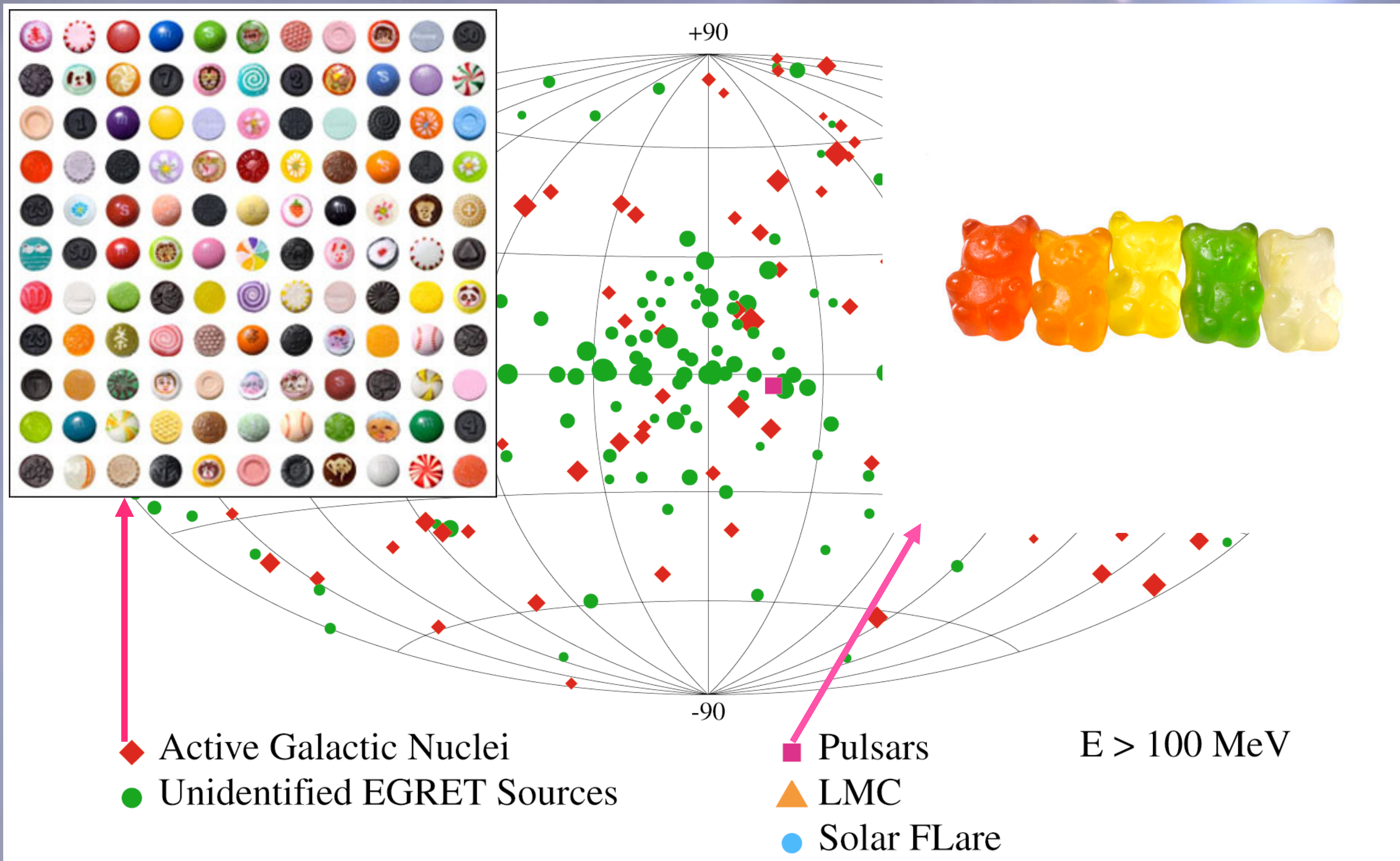
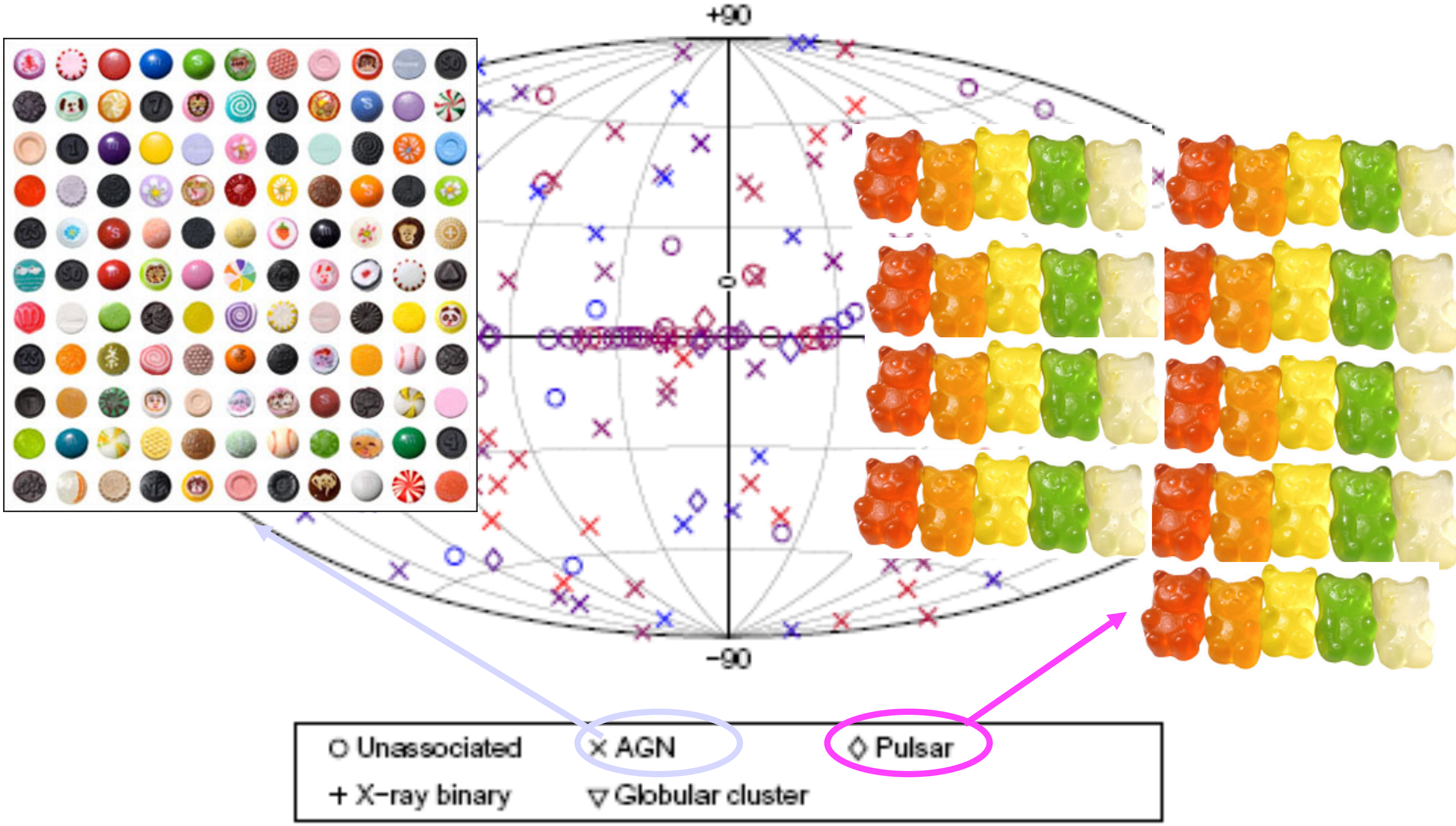
In collab. with A. DeLuca, M.Marelli, G.Bignami

γ-ray astronomy: last century view

•271 sources 172 UGO



The current γ-ray view



A lot of new NS detections

- **Many radio pulsars- (expected)**
- **Many msec radio pulsars- (less expected)**
- **Many Geminga-like NSs (expected?)**

When it comes to discover pulsations,

can LAT do all by itself?

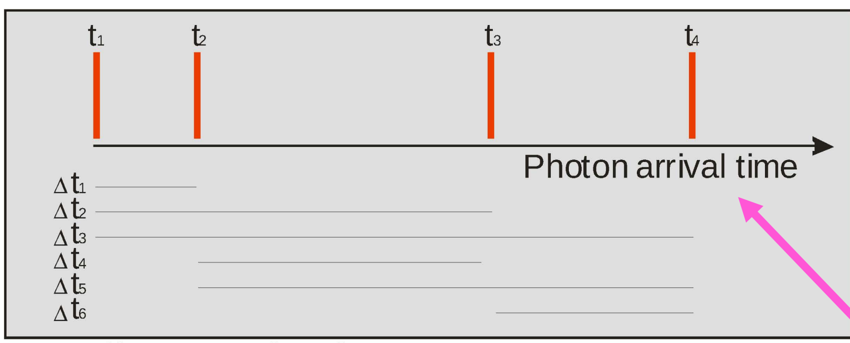
Are X-ray observations useless?

YES and NO

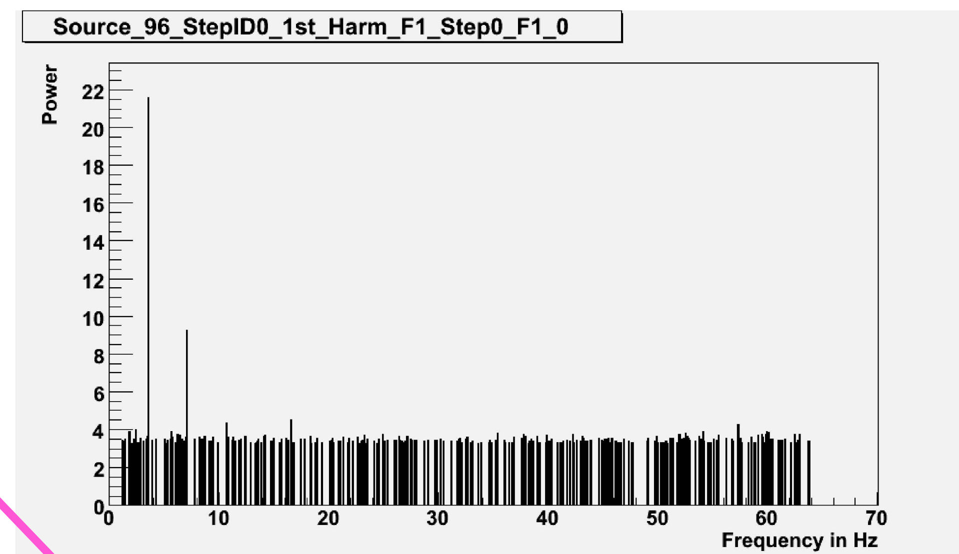
Time Differencing Technique

A Periodic signal will also show up in the differences of the arrival times => Calculate FT based on the time differences

Atwood et. al., **ApJ Lett., 652, 49 (2006)**
Ziegler et. al., **ApJ 680, 620 (2008)**



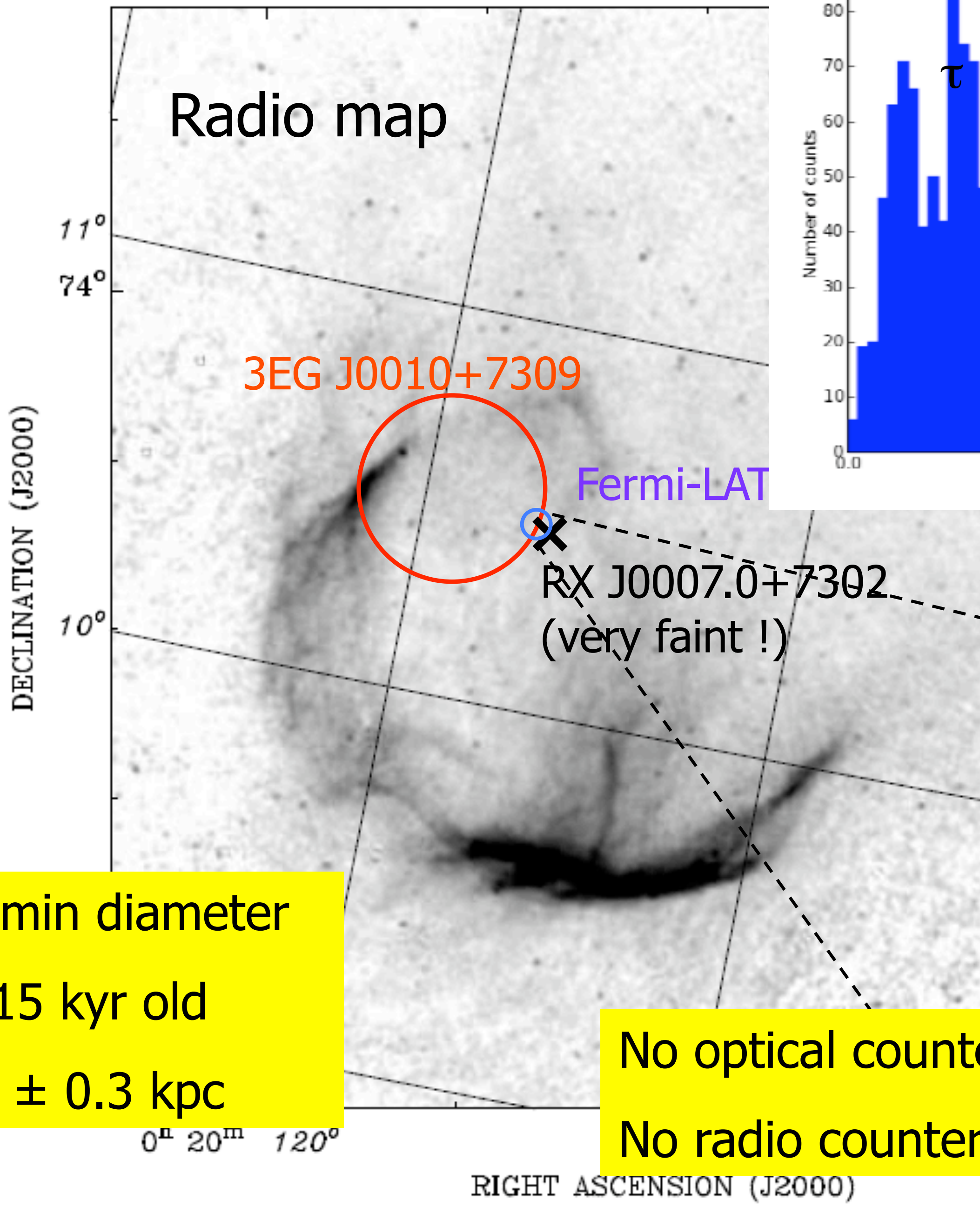
Credit: M. Ziegler

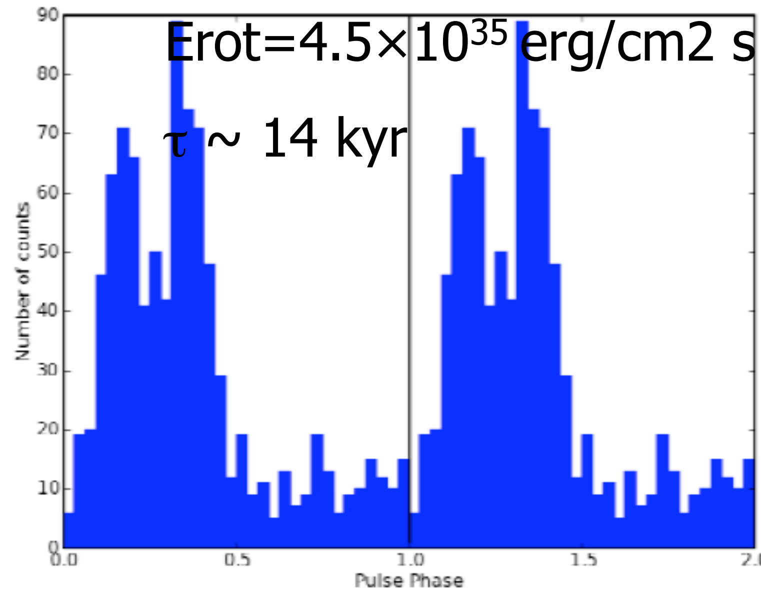


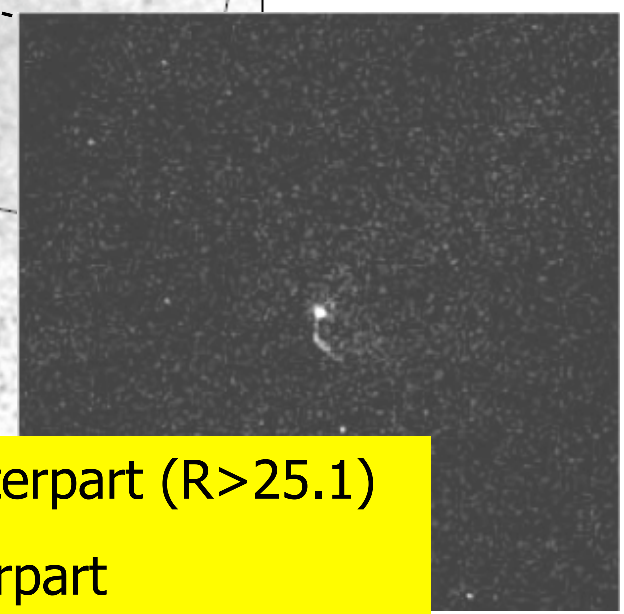
Source position

# of FFT bins = f * t_{max_diff} * 2
PC with 2GB can handle 33 x 10^6 bin FFT

The CTA-1 supernova remnant







90 arcmin diameter

5-15 kyr old

1.4 ± 0.3 kpc

No optical counterpart (R>25.1)

No radio counterpart

The role of X-ray astronomy

Source position

Swift/XRT observations of all unexplored fields

11 PSR observed

4 possible counterparts

Source physics

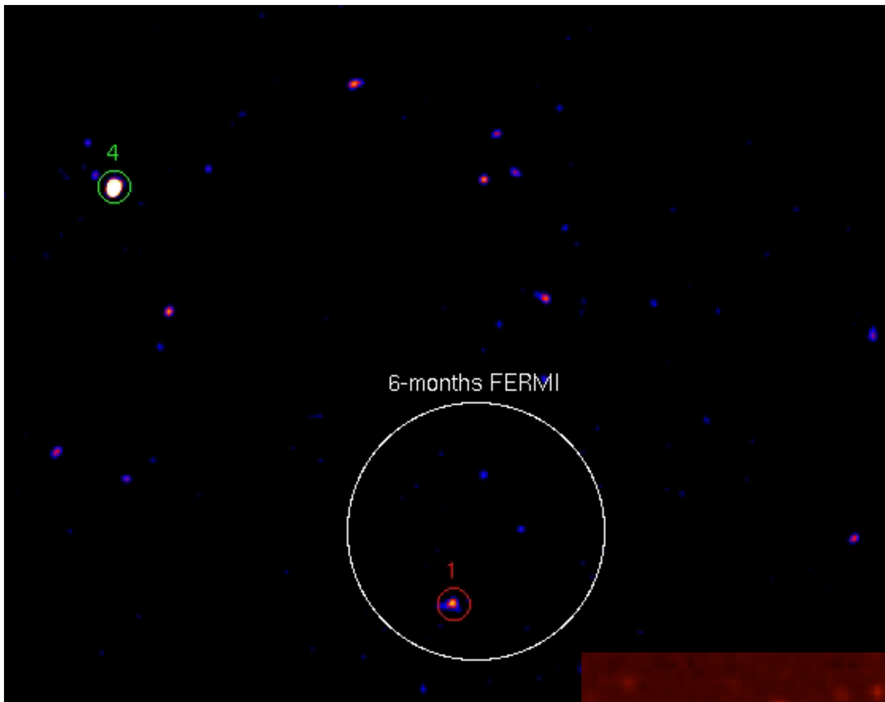
XMM-Newton / Chandra follow-up of most interesting PSRs

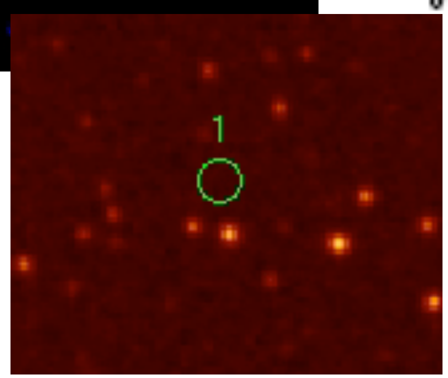
CTA1 PSR

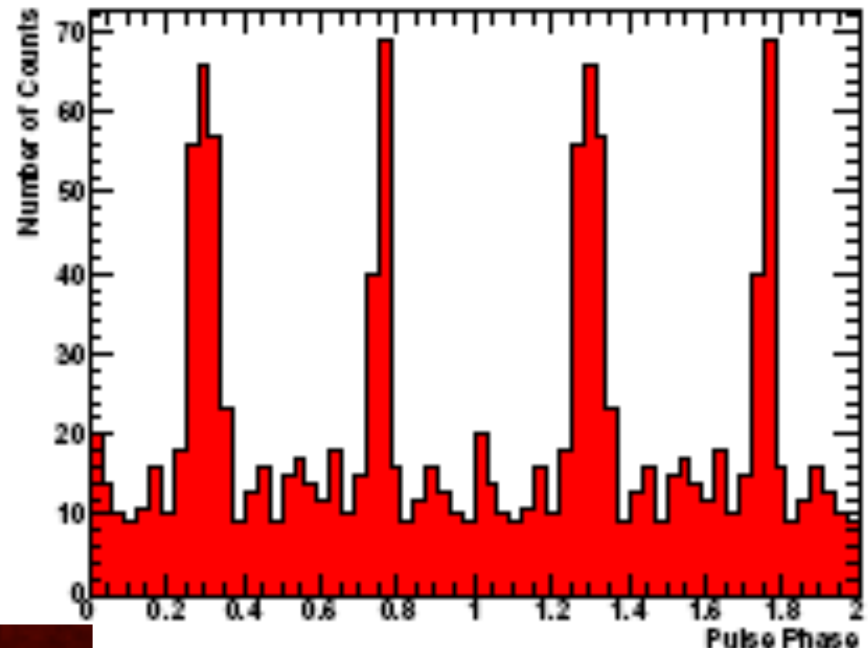
“Next Geminga”

XRT image of J0633

0633+0642R 98.4233 6.5708 .29739 77.7 0.0623 1.81 5.2E21 5.00E12 0.0531 3E-7 1.17







The role of X-ray astronomy

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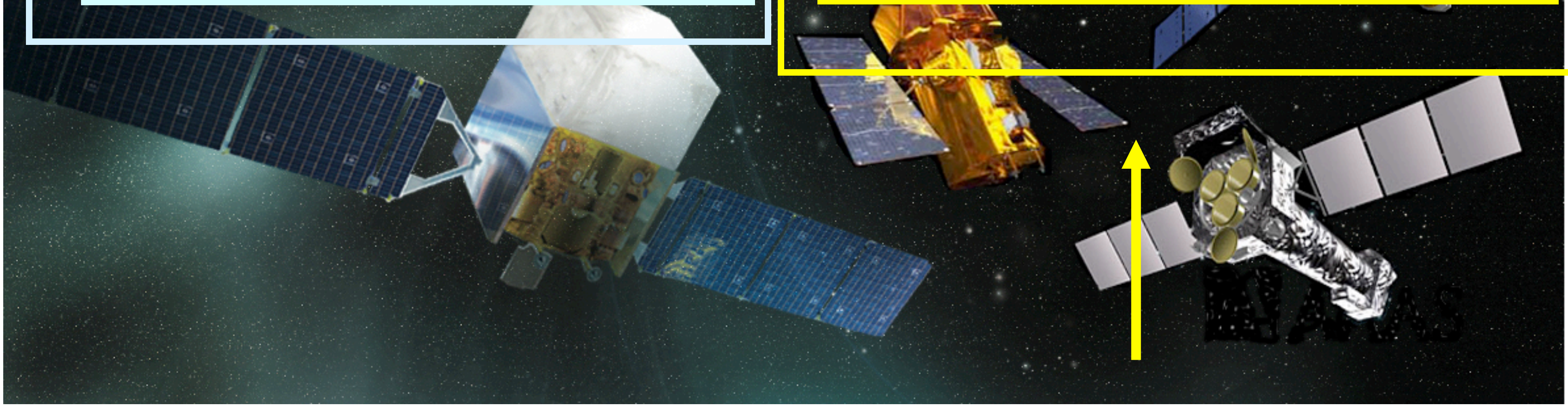
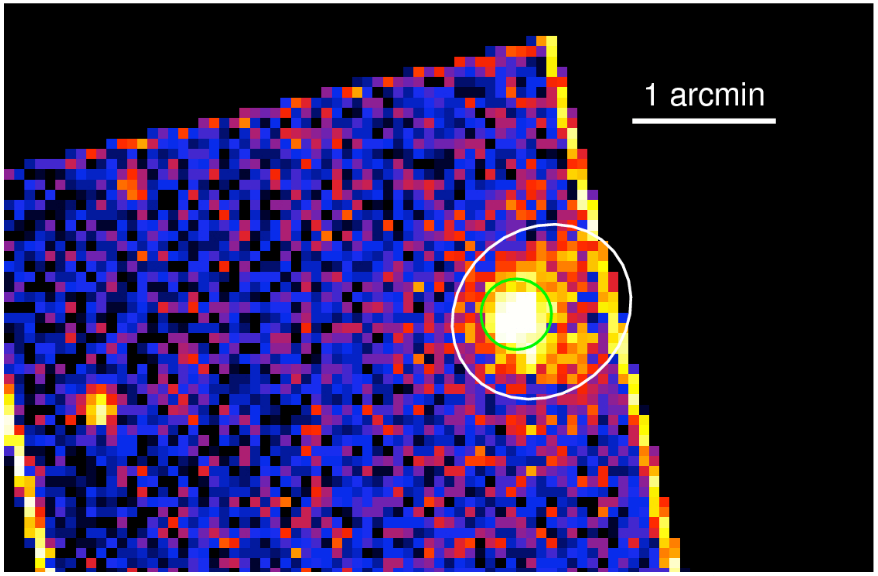
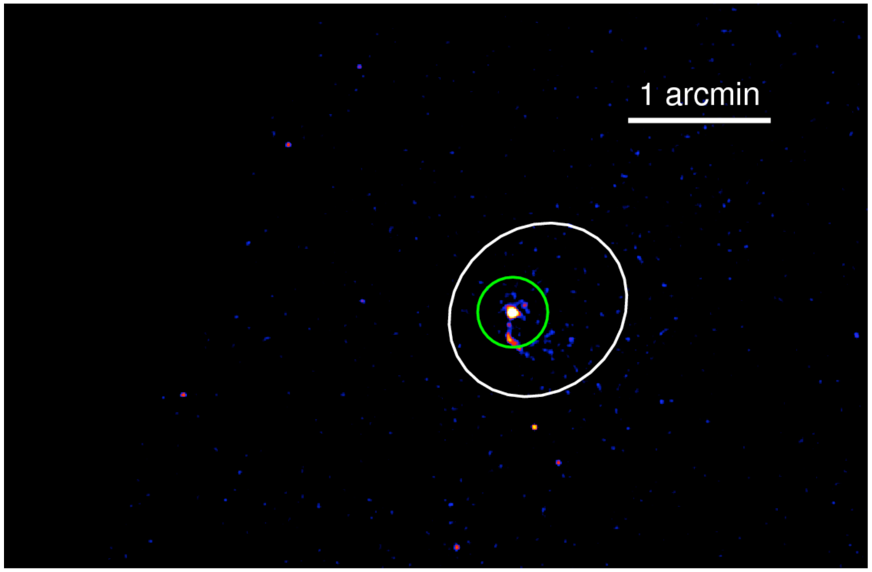


130 ks XMM-Newton observation

1)The PSR and the compact PWN





Discriminating PSR from PWN

Spatial-spectral deconvolution

Simultaneous spectral fit using different EEF coefficients for PSR and PWN

PSR (point-like) ~ EPIC PSF

PWN (diffuse) ~ Chandra map

PSR: BB+PL(?)

kT~0.1 keV, r~650 m

Γ ~1.3

Inner PWN: PL

Γ ~1.5

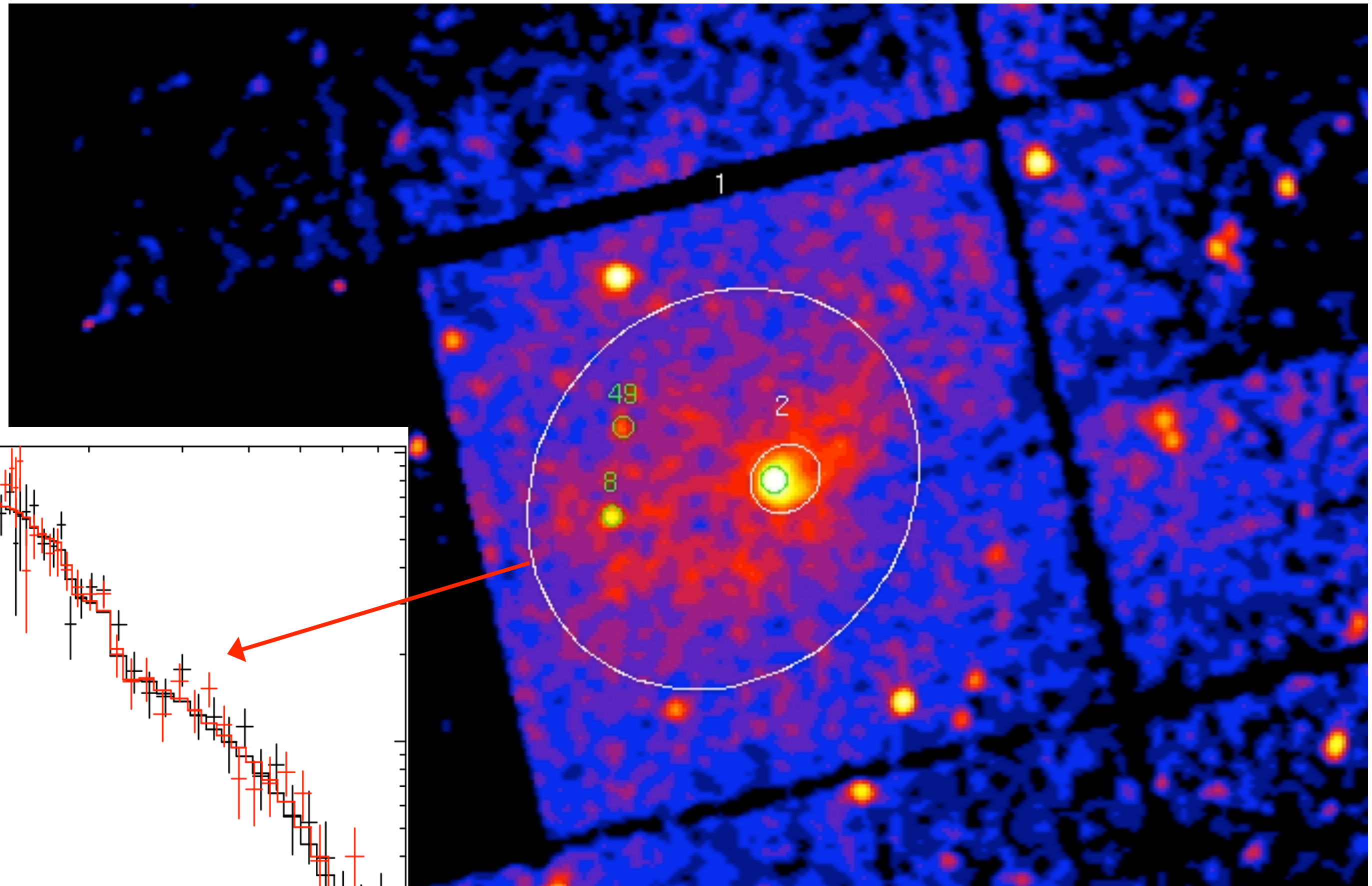
Obs.flux $1.3 \cdot 10^{-13}$ erg cm^{-2} s^{-1} (0.3-10 keV) 60% PSR, 40% PWN

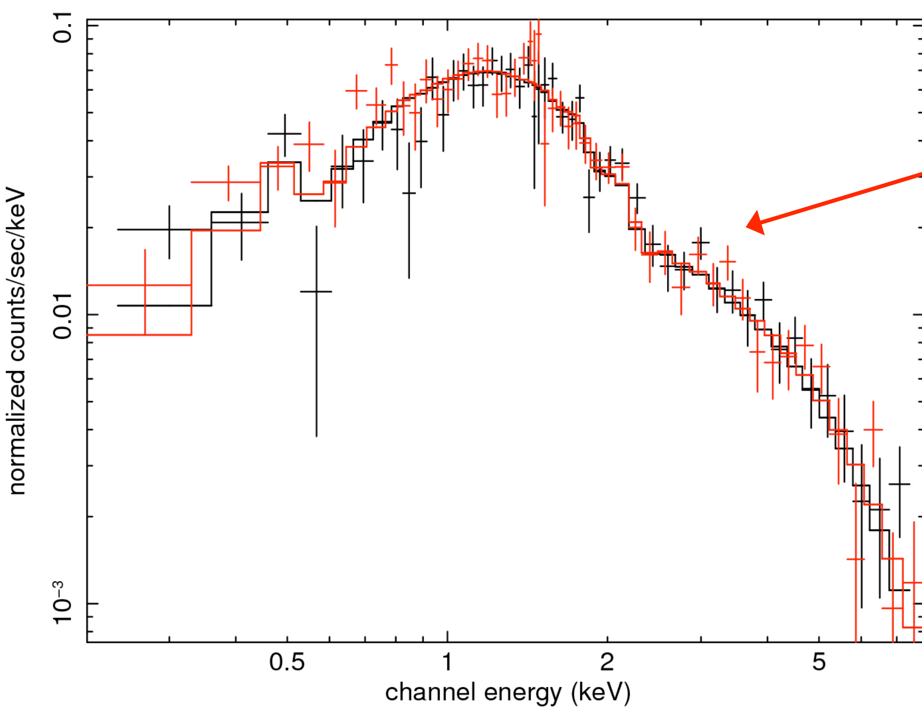
PSR: 20% th, 80% non-th

2) The extended plerion

Already seen by ROSAT & ASCA

(Seward et al.1995, Slane et al.1997)





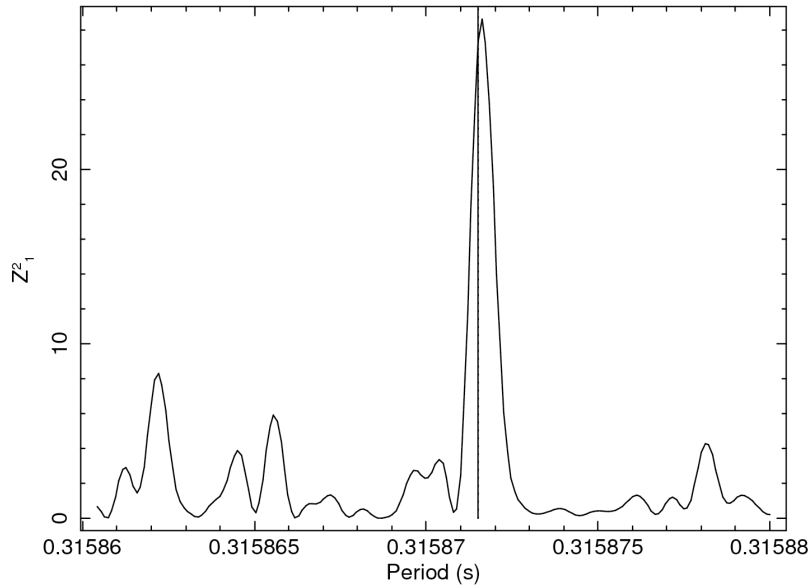
No significant thermal component within EPIC FOV

Spectrum steepens with radius

3) Pulsations in X-rays

Search at LAT period yields significant detection

130 ks XMM not enough to detect pulsation in blind search!

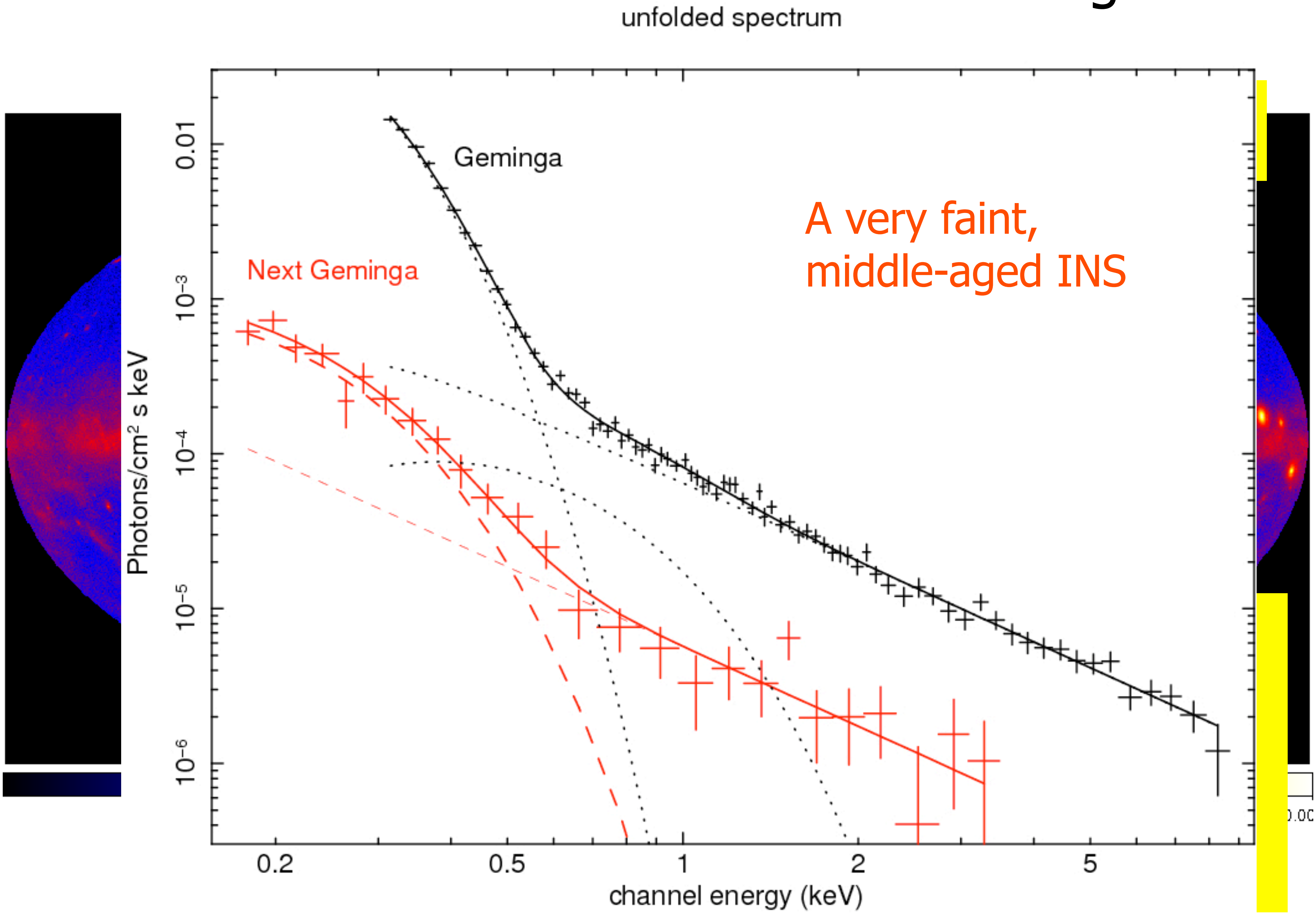


Folding with LAT ephemeris

~80% pulsation below 0.7 keV

No evidence for modulation at E > 2 keV

3EG J1835+5918 a.k.a. "Next Geminga"



A very faint,
middle-aged INS

The new role of gamma-ray astronomy

- Single out interesting NSs

The NEW role of X-ray Astronomy

- **Position, position, position**
  → to secure detection

- **Deeper observations**
  → to probe the emission mechanisms