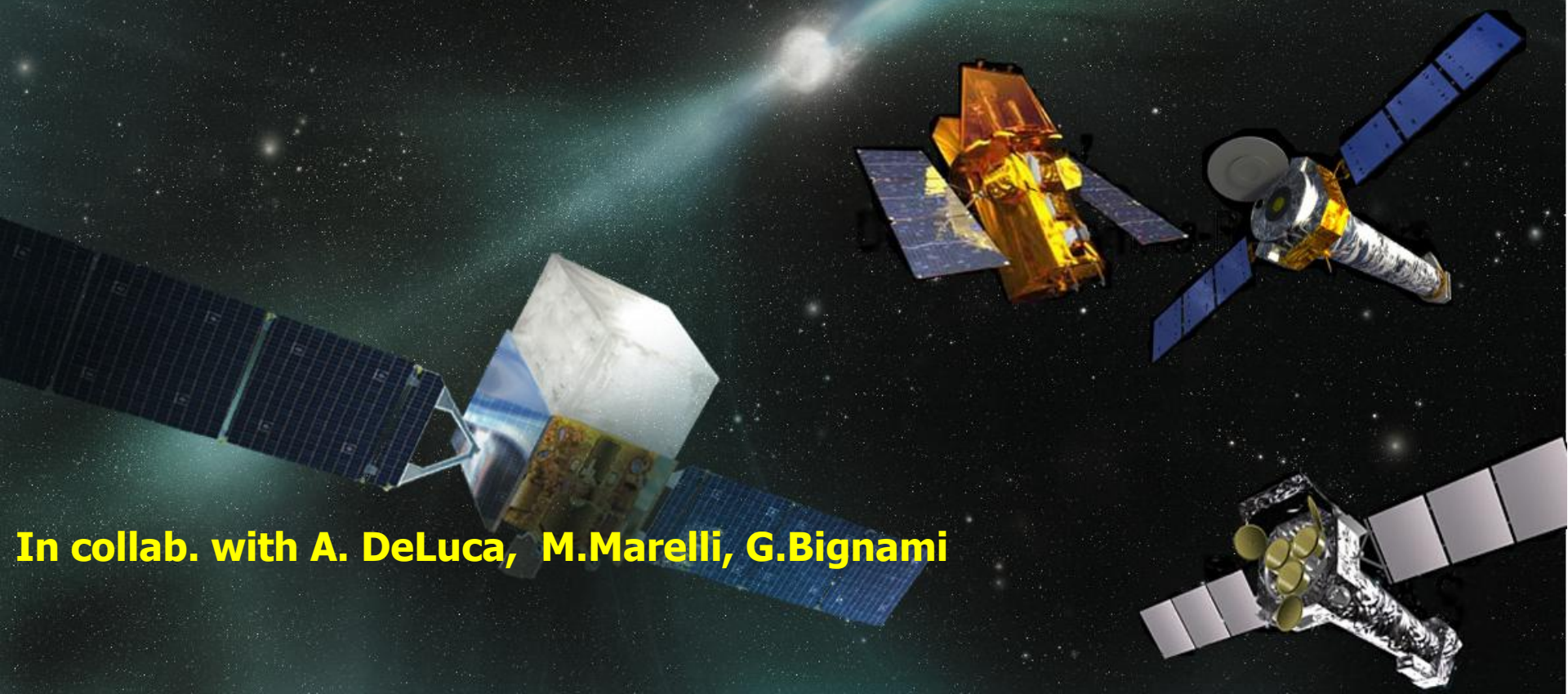
Towards a new sinergie between X and γ-ray astronomies

Patrizia Caraveo

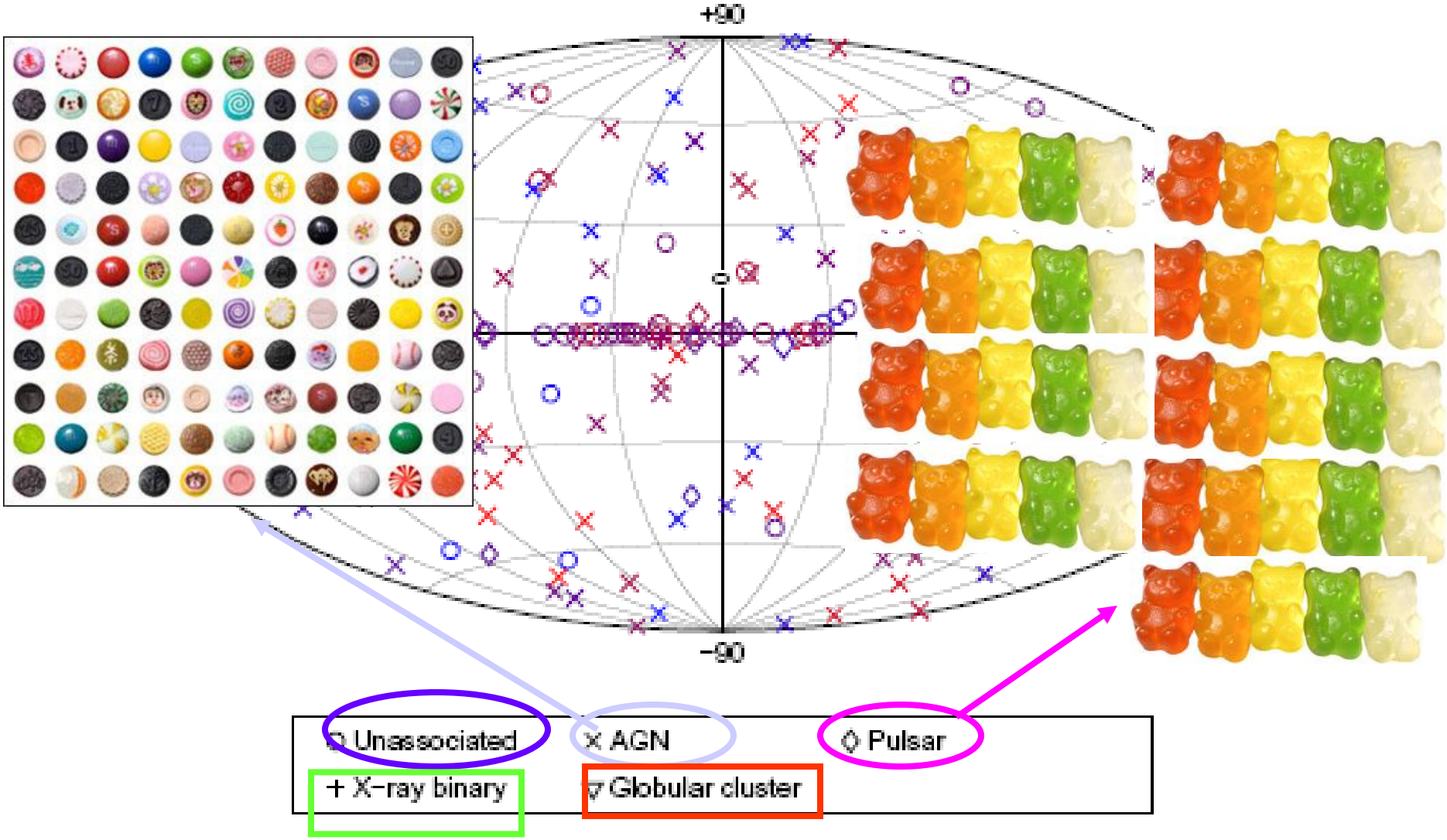


In collab. with A. DeLuca, M.Marelli, G.Bignami

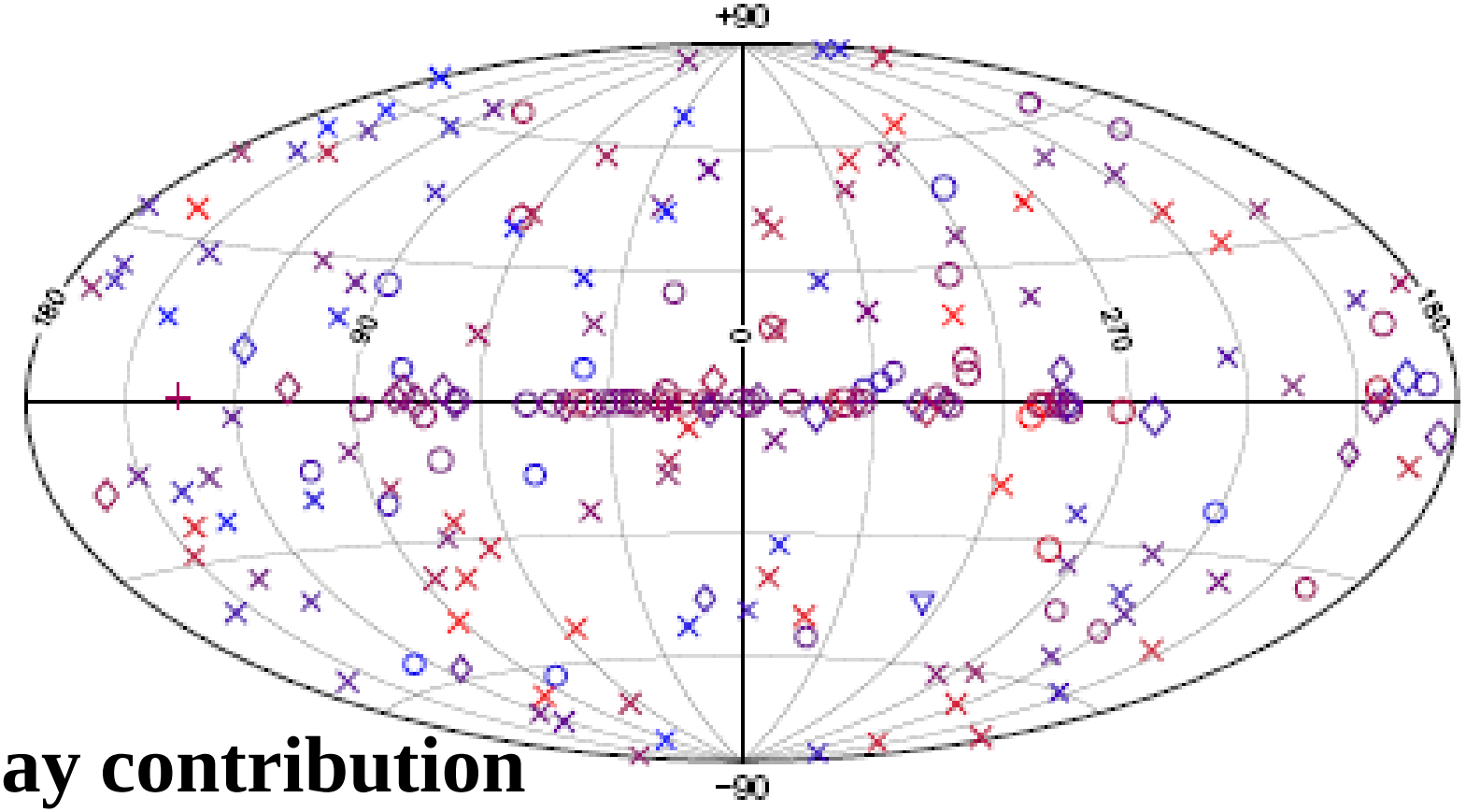
γ-ray astronomy: last century view

•271 sources 172 UGO

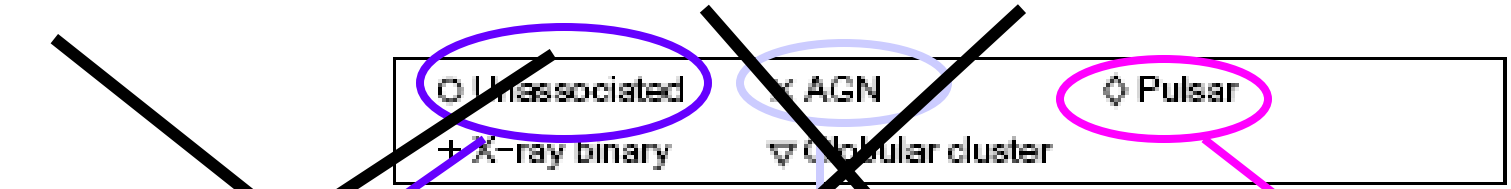
The current γ-ray view



The current γ-ray view



X-ray contribution

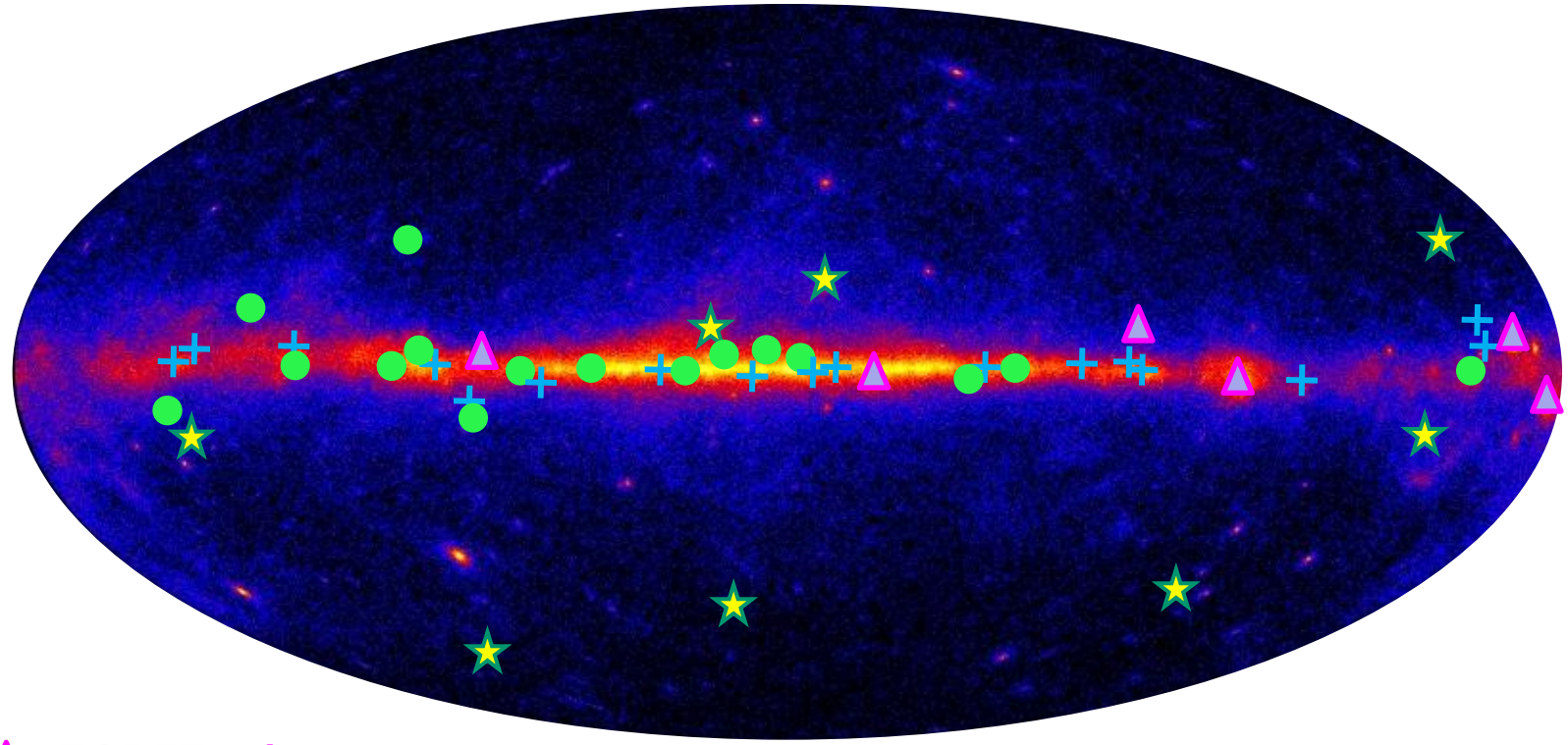


Searching for counterparts

Correlated variability

Positions and more

Fermi Pulsars



△ EGRET pulsars

\+ young pulsars discovered using radio ephemeris

● pulsars discovered in blind search

☆ millisecond pulsars discovered using radio ephemeris

A lot of new NS detections

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

The new role of gamma-ray astronomy

- **Single out interesting NSs**

When it comes to discover pulsations,

can LAT do all by itself?

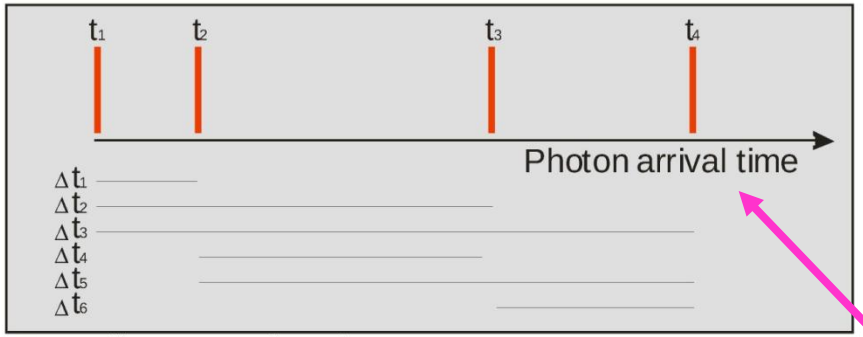
Are X-ray observations useless?

YES and NO

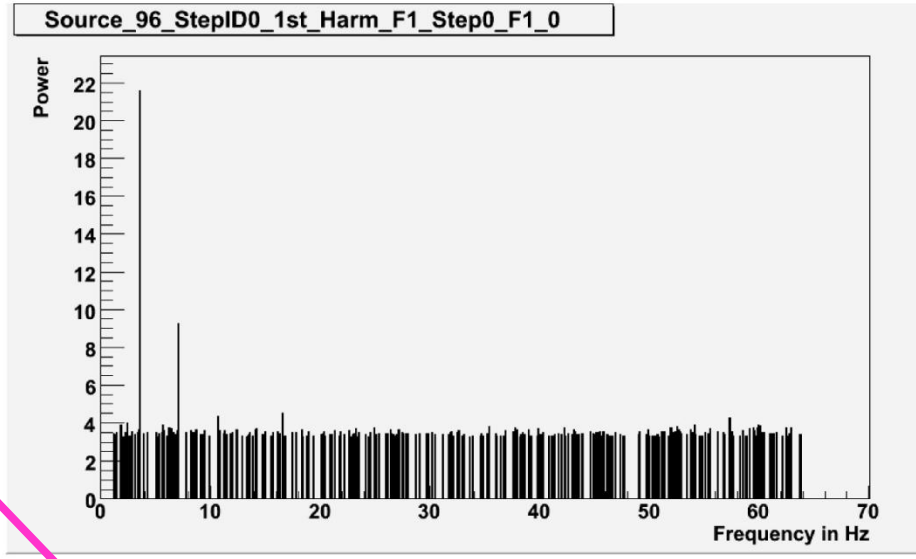
Time Differencing Technique

A Periodic signal will also show up in the differences of the arriv 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

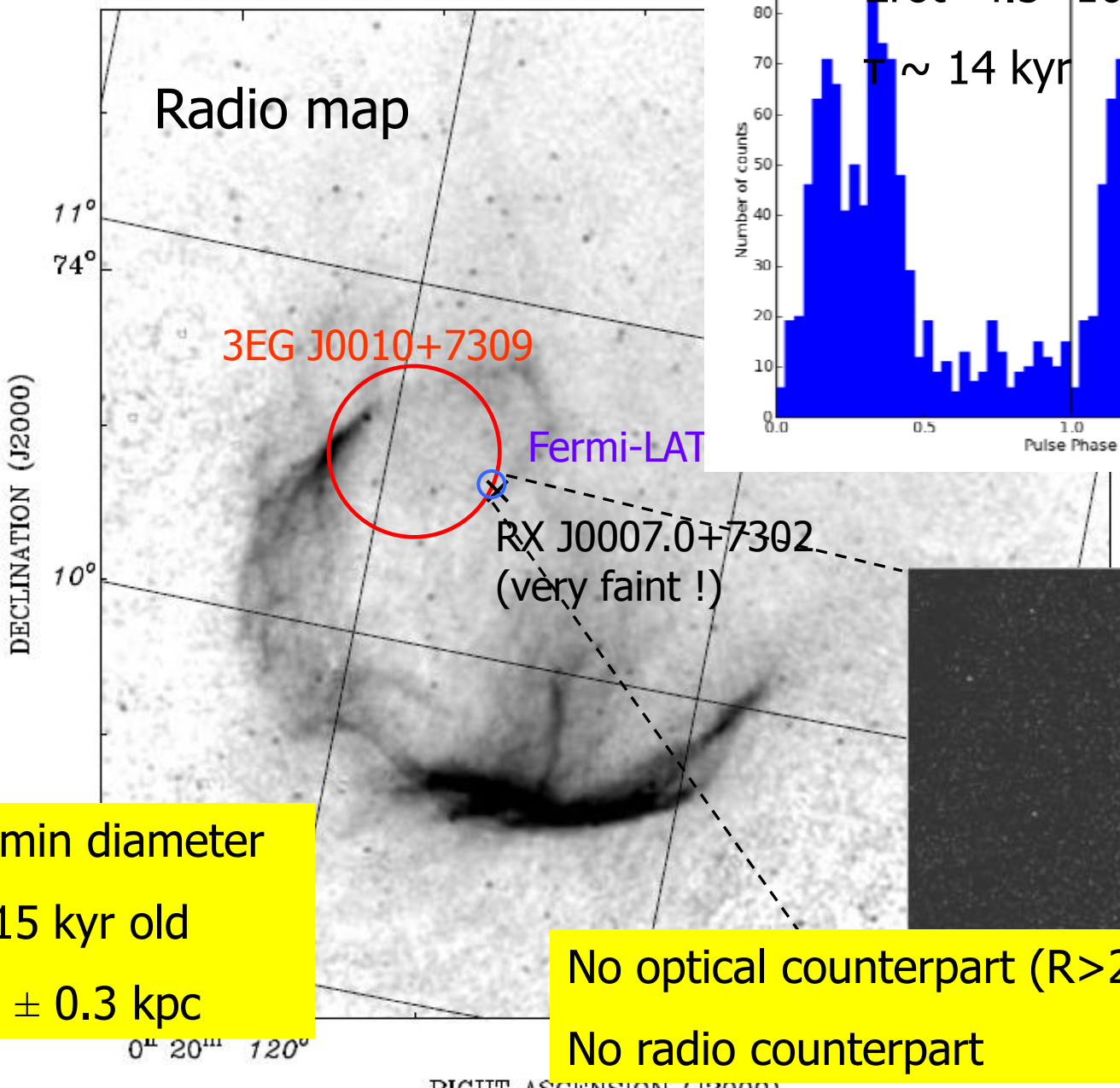


# of FFT bins = f * t_{max_diff} * 2

PC with 2GB can handle 33 x 10^6 bin FFT

Source position

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

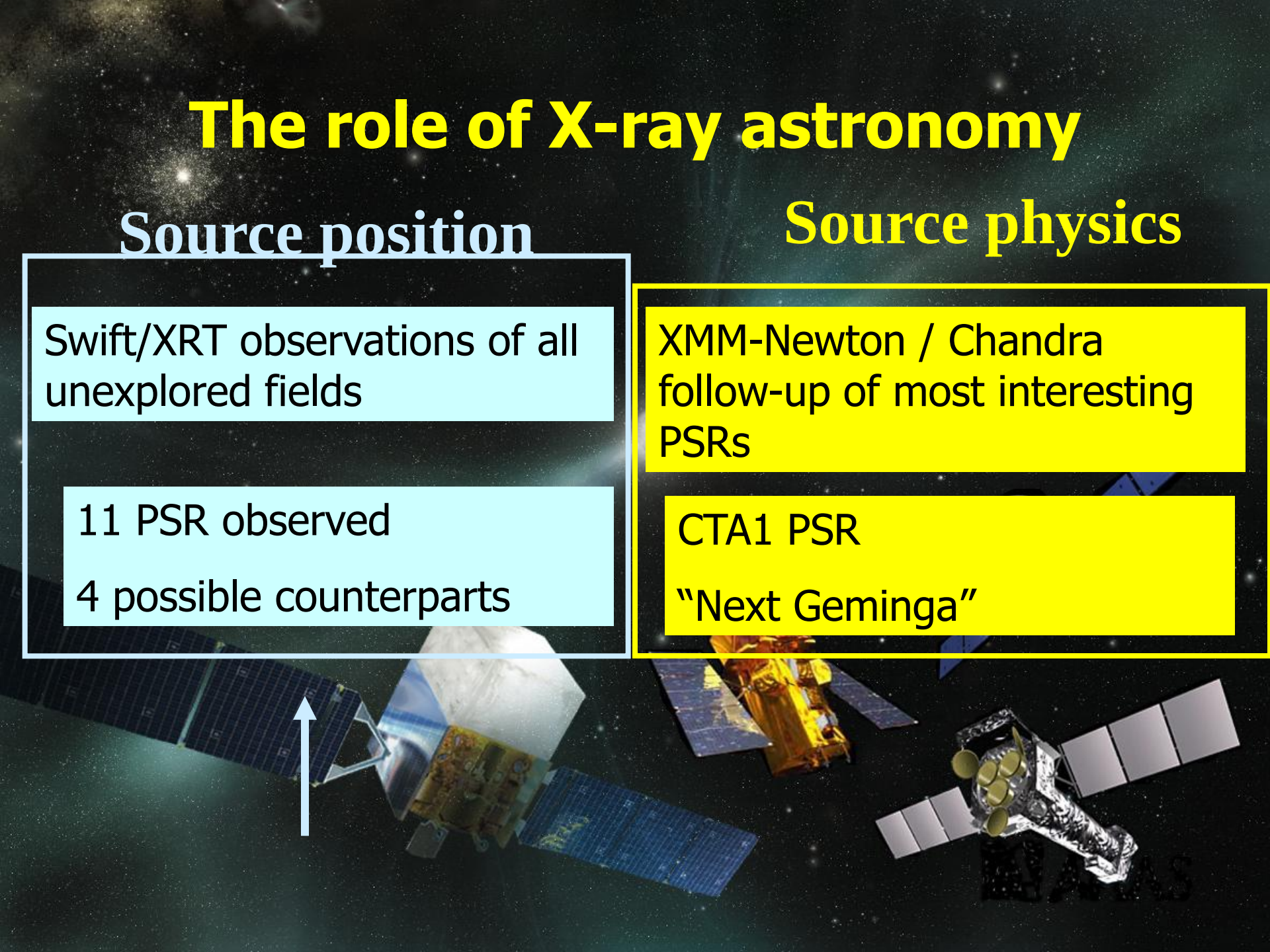
4 possible counterparts

Source physics

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

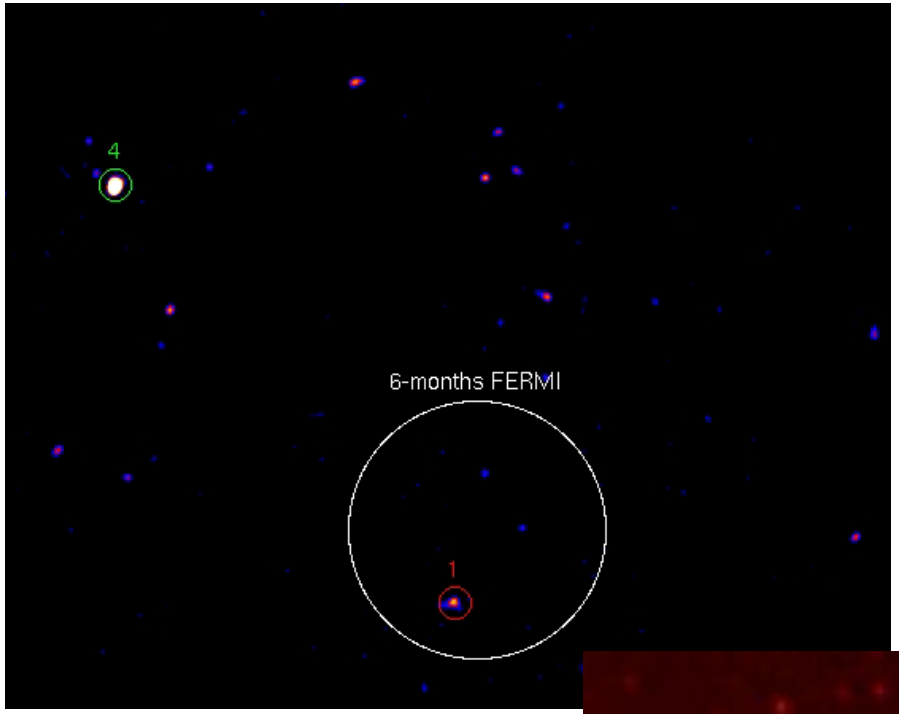
CTA1 PSR

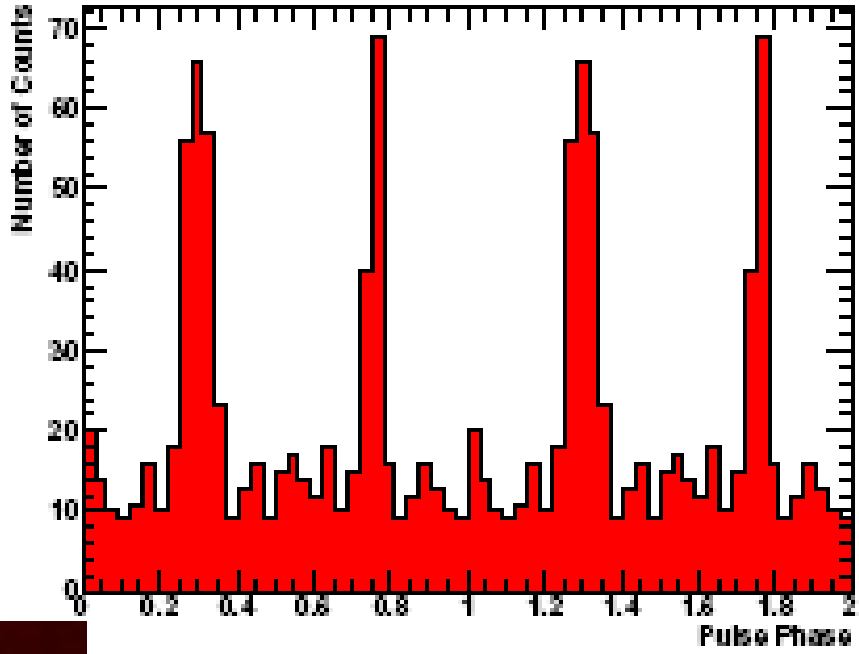
"Next Geminga"



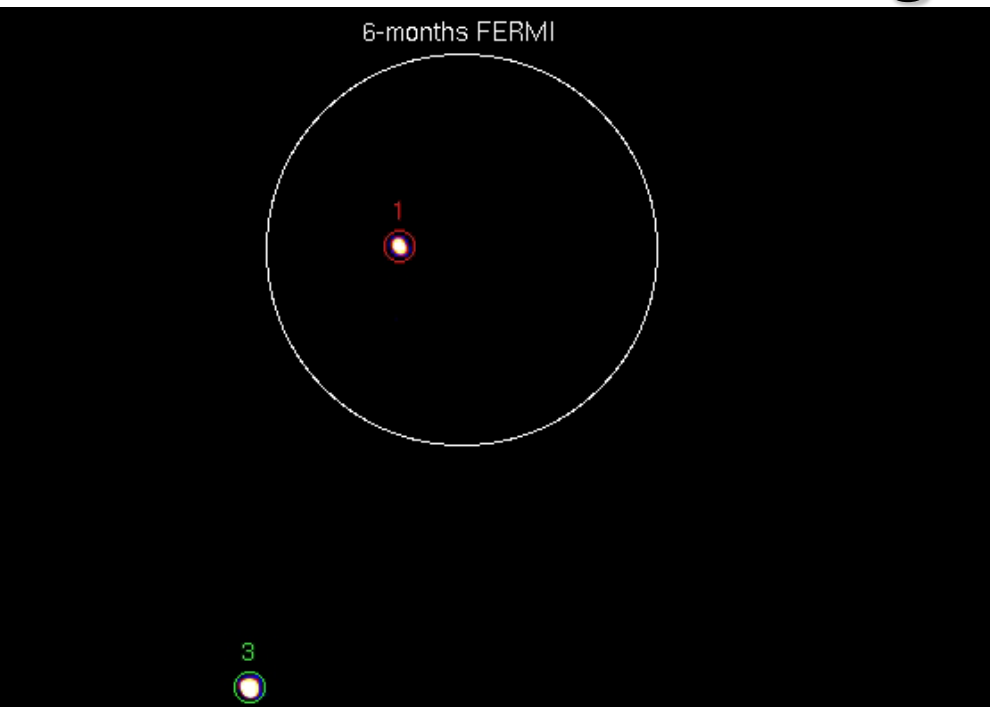
XRT image of J0633

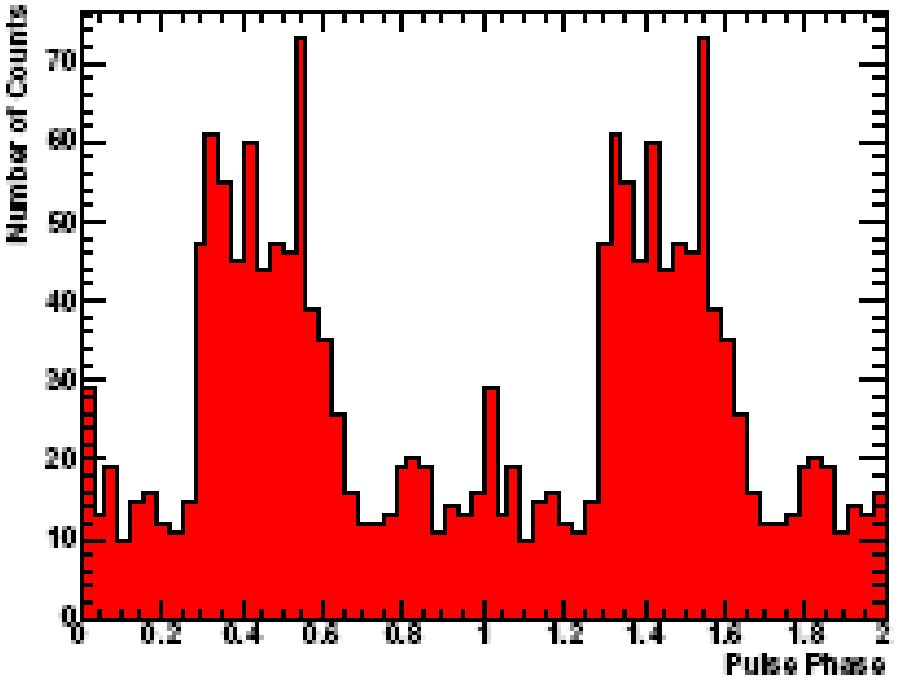
0633+0642R 98.4233 6.5708 .29739 77.7 0.0623 1.81 5.2E21 5.00E12 0.0531 3E-7 1.17



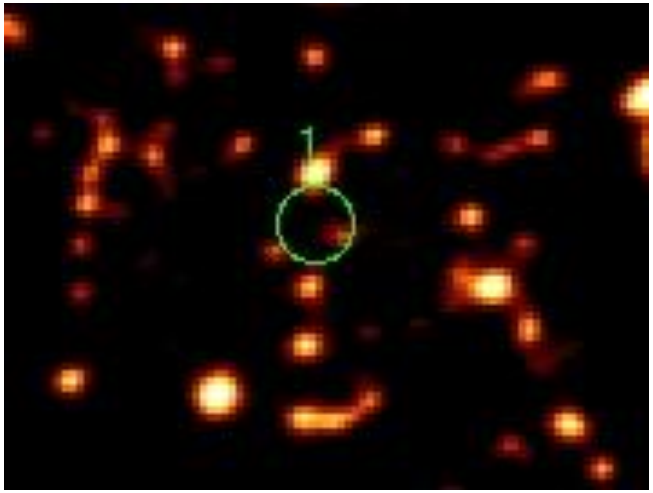


XRT image of J1741





1741-2050 265.4656 -20.9041 .413699 12.9 0.522 ? 2.8E21 2.40E12 0.0715 3E-7 0.0719



The role of X-ray astronomy

Source position

Swift/XRT observations of all unexplored fields

11 PSR observed

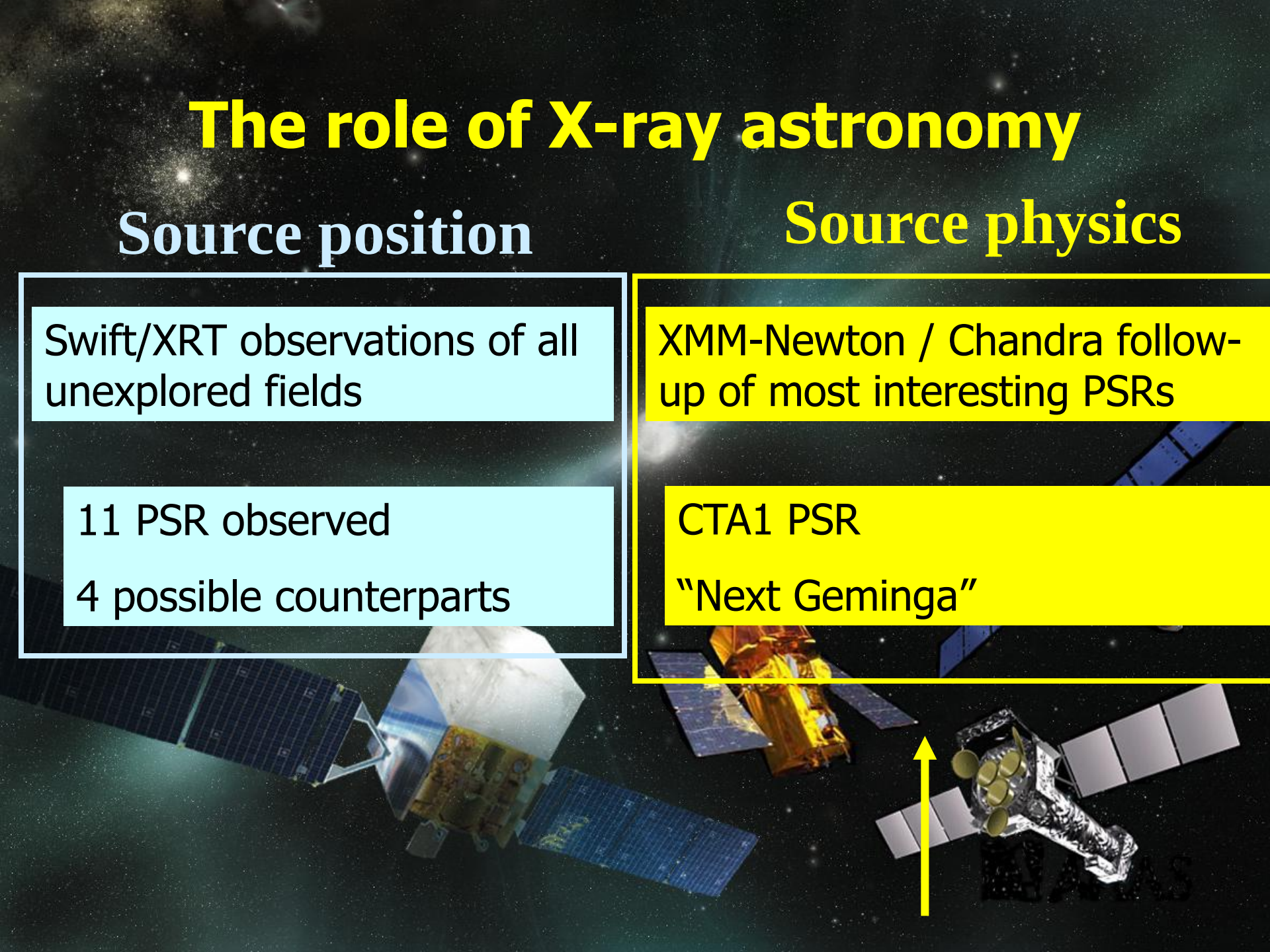
4 possible counterparts

Source physics

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

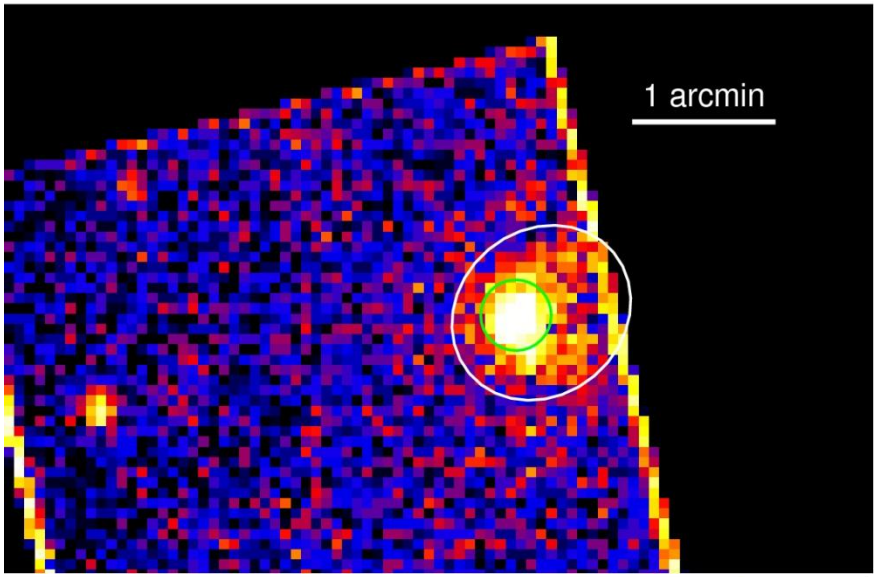
CTA1 PSR

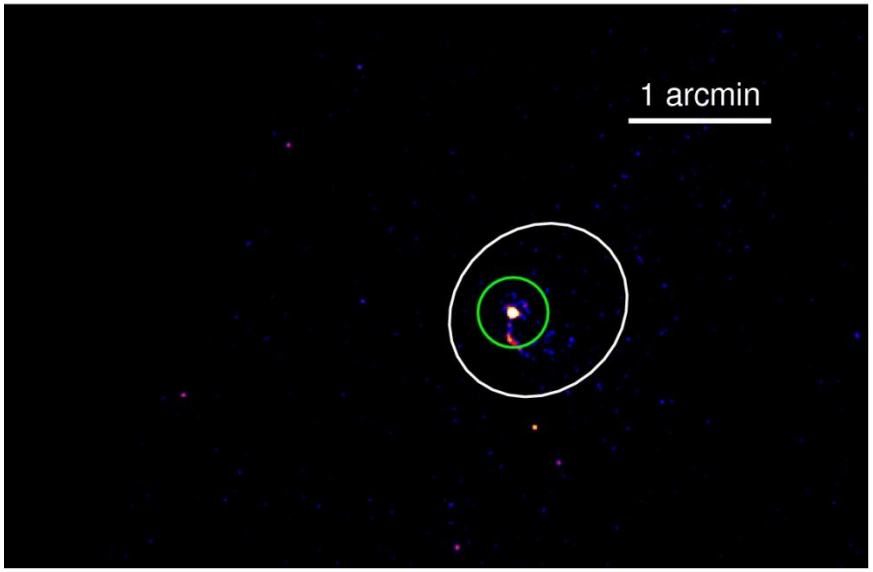
“Next Geminga”



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

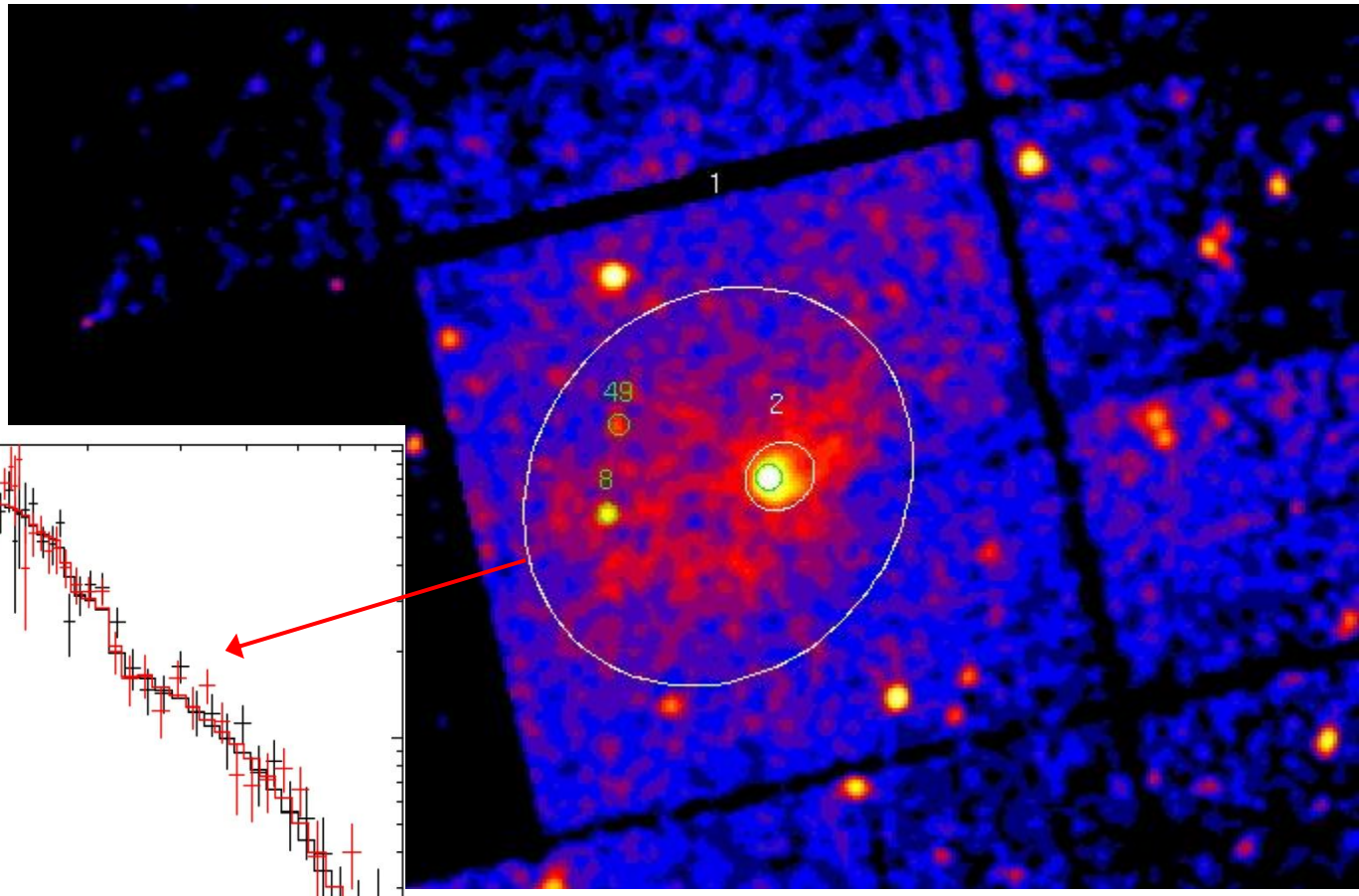
Obs.flux $1.3 \cdot 10^{-13}$ erg cm^{-2} s^{-1} (0.3-10 keV) 60% PSR, 40% PWN

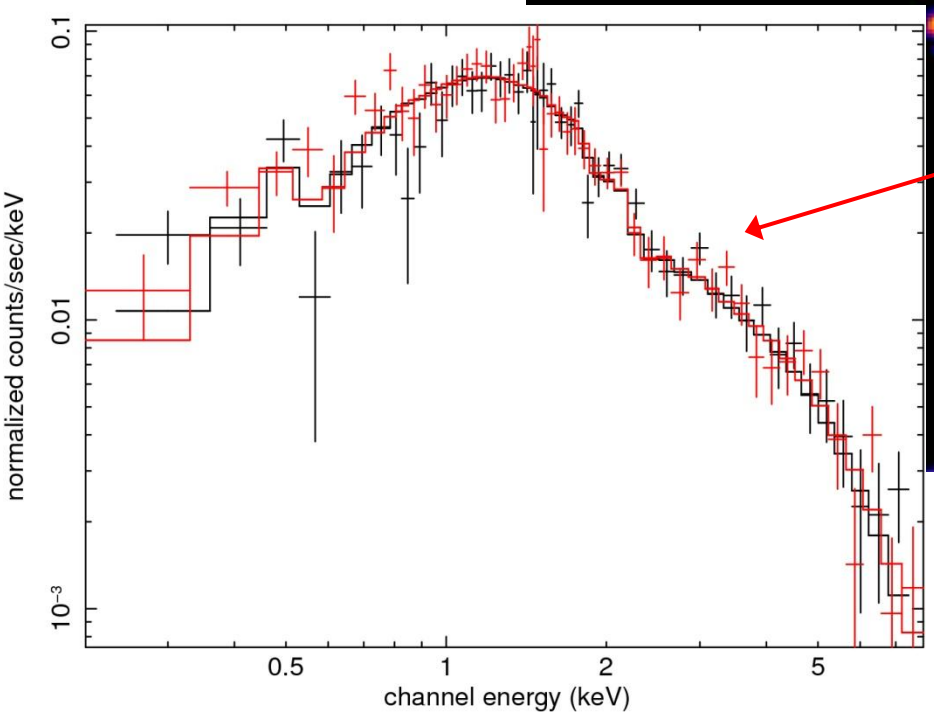
PSR: 20% th, 80% non-th

2) The extended plerion

Already seen by ROSAT & ASCA

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

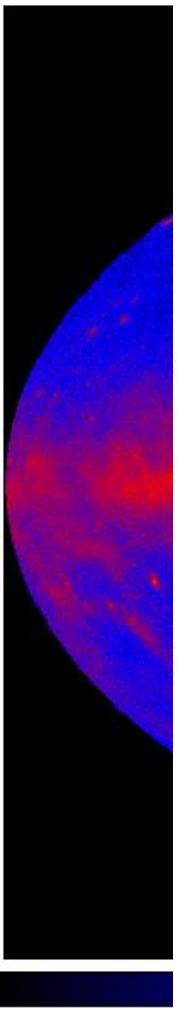


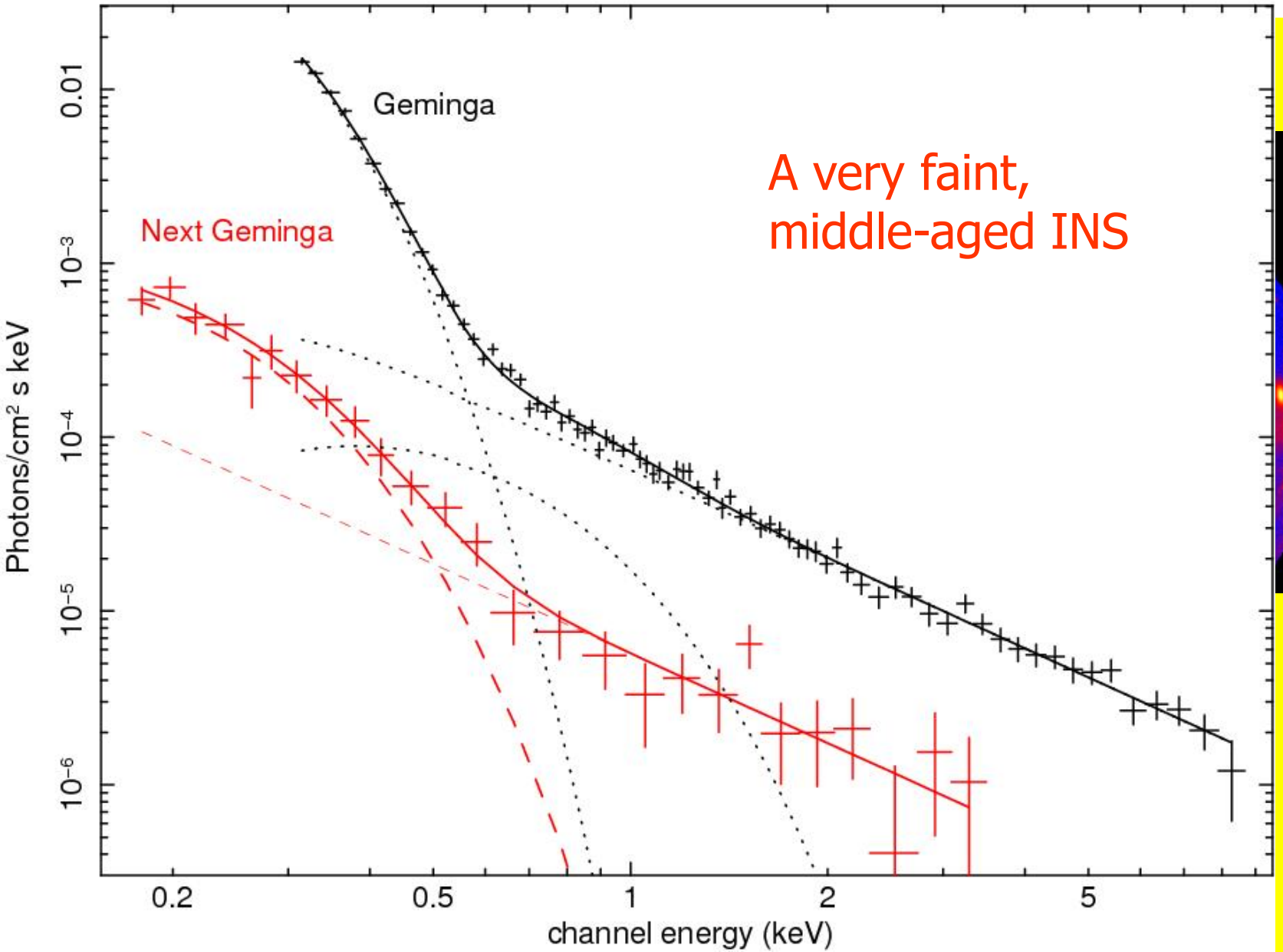


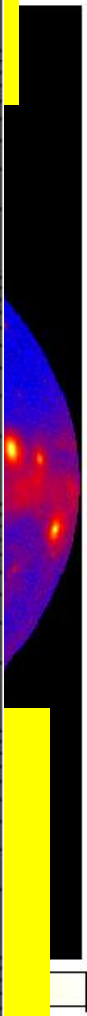
No significant thermal component within EPIC FOV

Spectrum steepens with radius

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







X-ray view of gamma-ray only PSRs

- **LAT PSR J0007+7303 in CTA1 as seen with XMM: indeed, a Vela-like, radio-silent pulsar**
- **LAT PSR J1836+5925 as seen with XMM: really Geminga-like**
- **New Chandra/XMM data are needed to address X-ray emission properties of rotation-powered PSRs and their dependence on "geometry"**

The NEW role of X-ray Astronomy

- **Position, position position**

  → to secure detection

- **Deeper observations**

  → to probe the emission mechanisms