X-ray Observations of New Gamma-ray Pulsars Discovered by Fermi LAT

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On behalf of
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Motivation

- Fermi LAT detected 55 pulsars including 24 new ones

- X-ray observations are essential for those newcomers

  (1) X-ray counterparts can give unique information of **precise positions** in the sky if the sources cannot be found in the radio survey

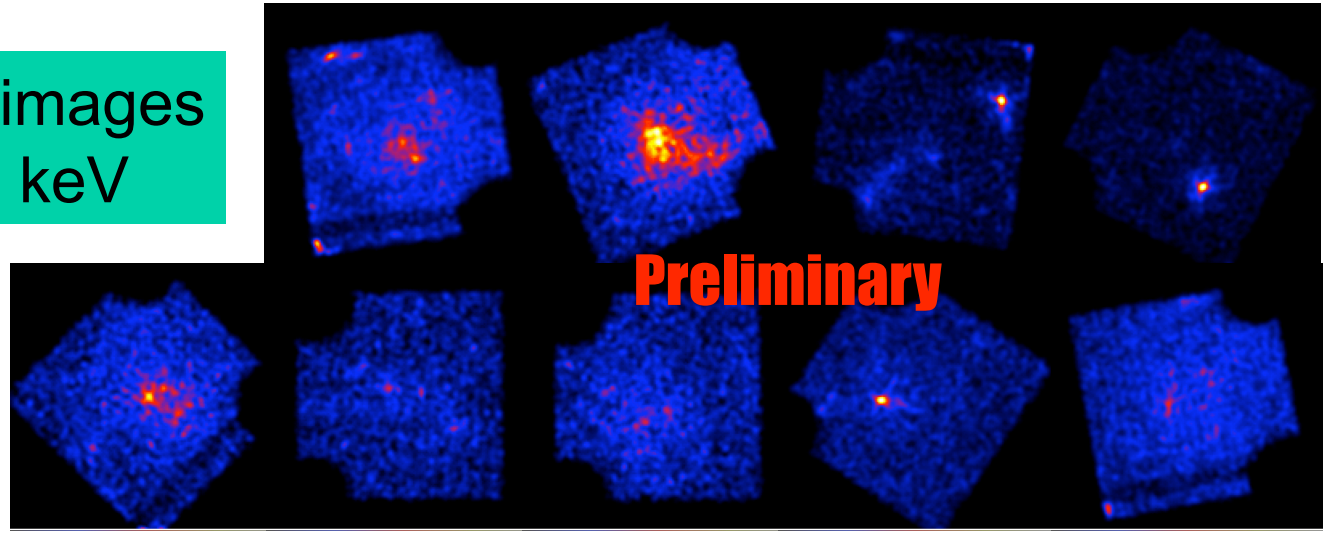
  (2) Gamma-ray studies cannot find any differences between radio-loud and radio-quiet pulsars but **how about X-ray properties?**

Suzaku Observations

- 12 pulsars, 280 ks in total for AO4
- XIS nominal position
- No window/burst/timing option
- Detecting pulsation is NOT aimed

- **9 pulsars observed as of today**

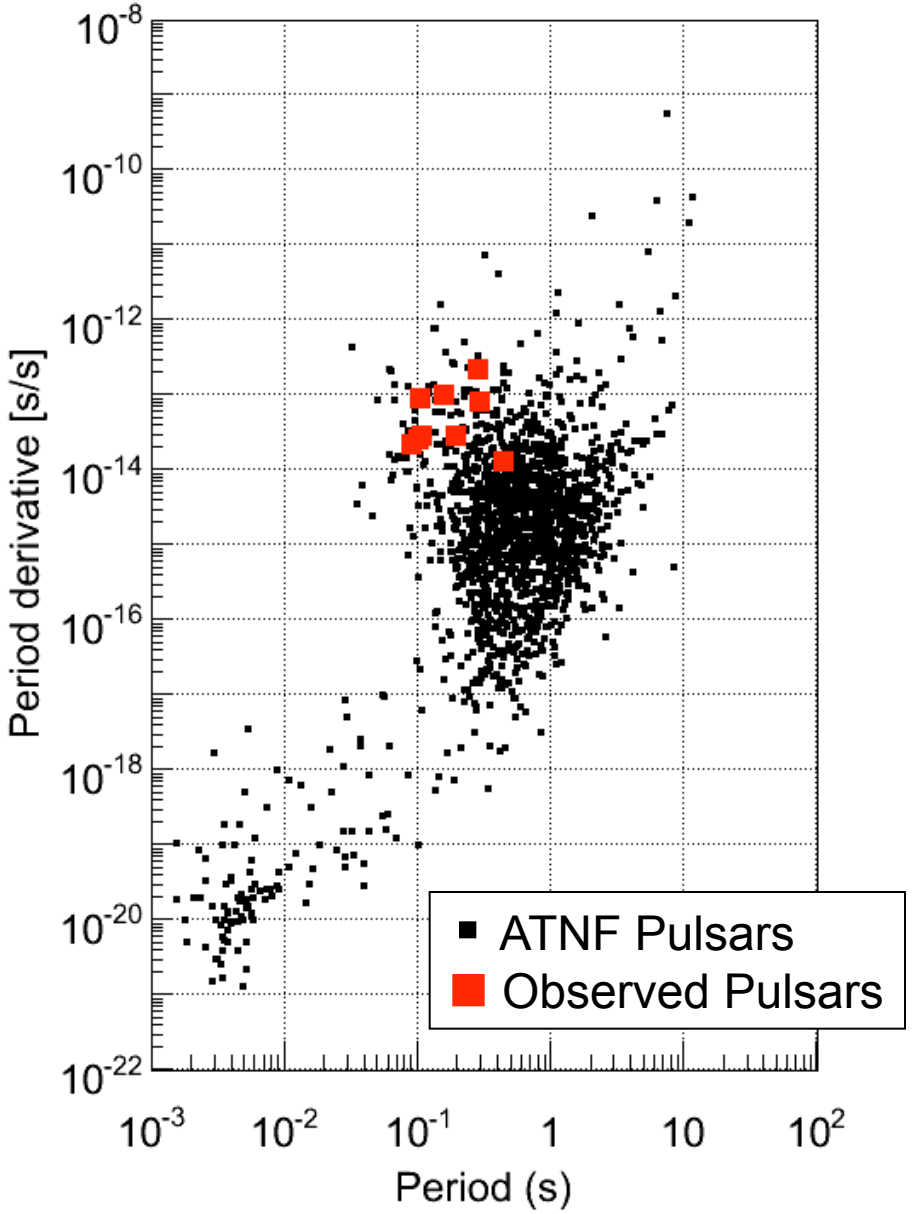
XIS0+3 images
0.5 – 10 keV



Observed Pulsars

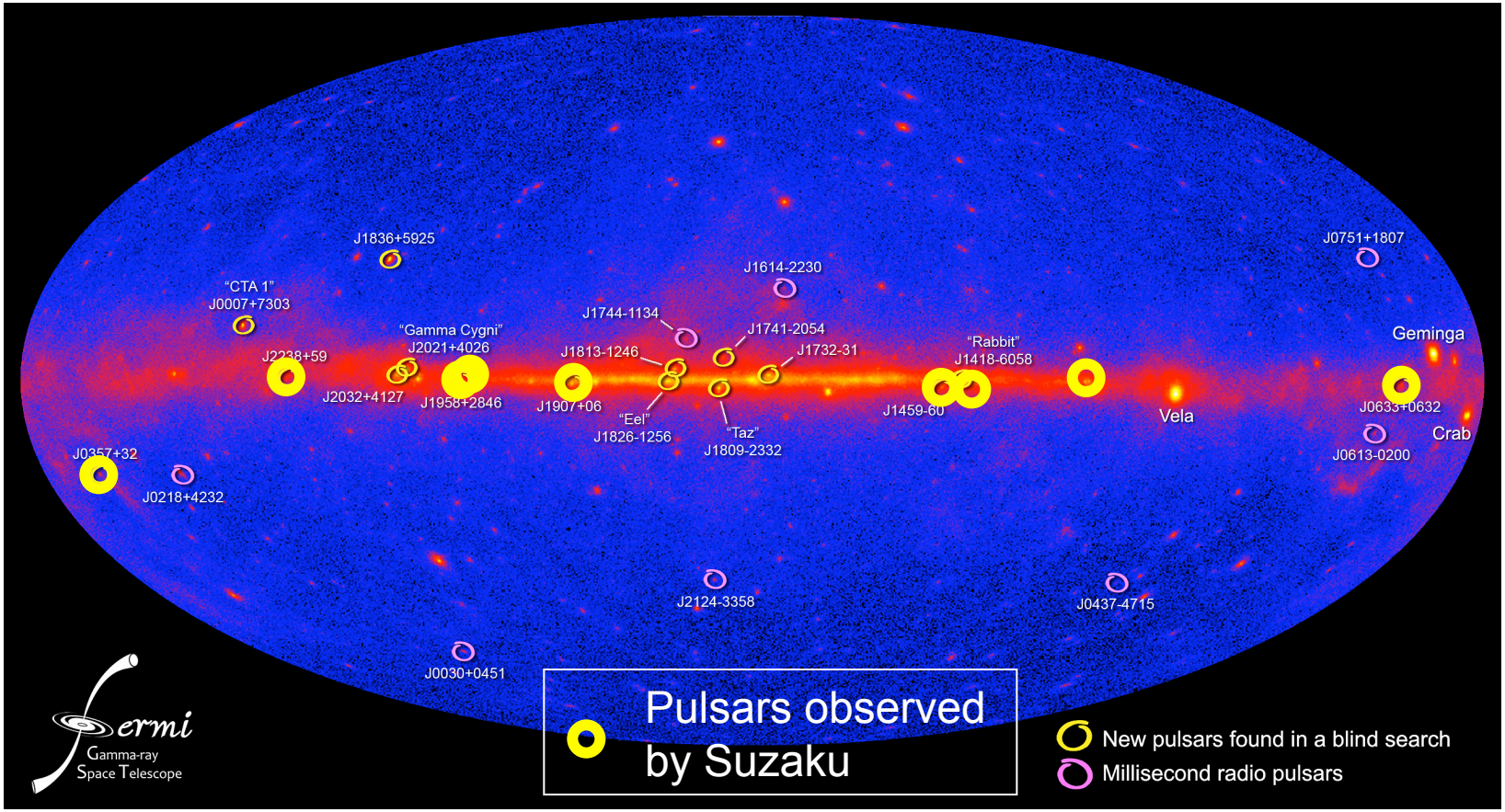
J0357+32 J1907+06
J0633+0632 J1954+2836
J1413-6205 J1958+2846
J1459-60 J2238+59
and
J1028-5819
…discovered in radio but no X-ray observations

- Right: Position in the $P - \dot{P}$ plot
- $\dot{E} = 5.8 \times 10^{33} - 2.8 \times 10^{36}$ erg/s
- $\tau_c = 20 - 547$ kyr



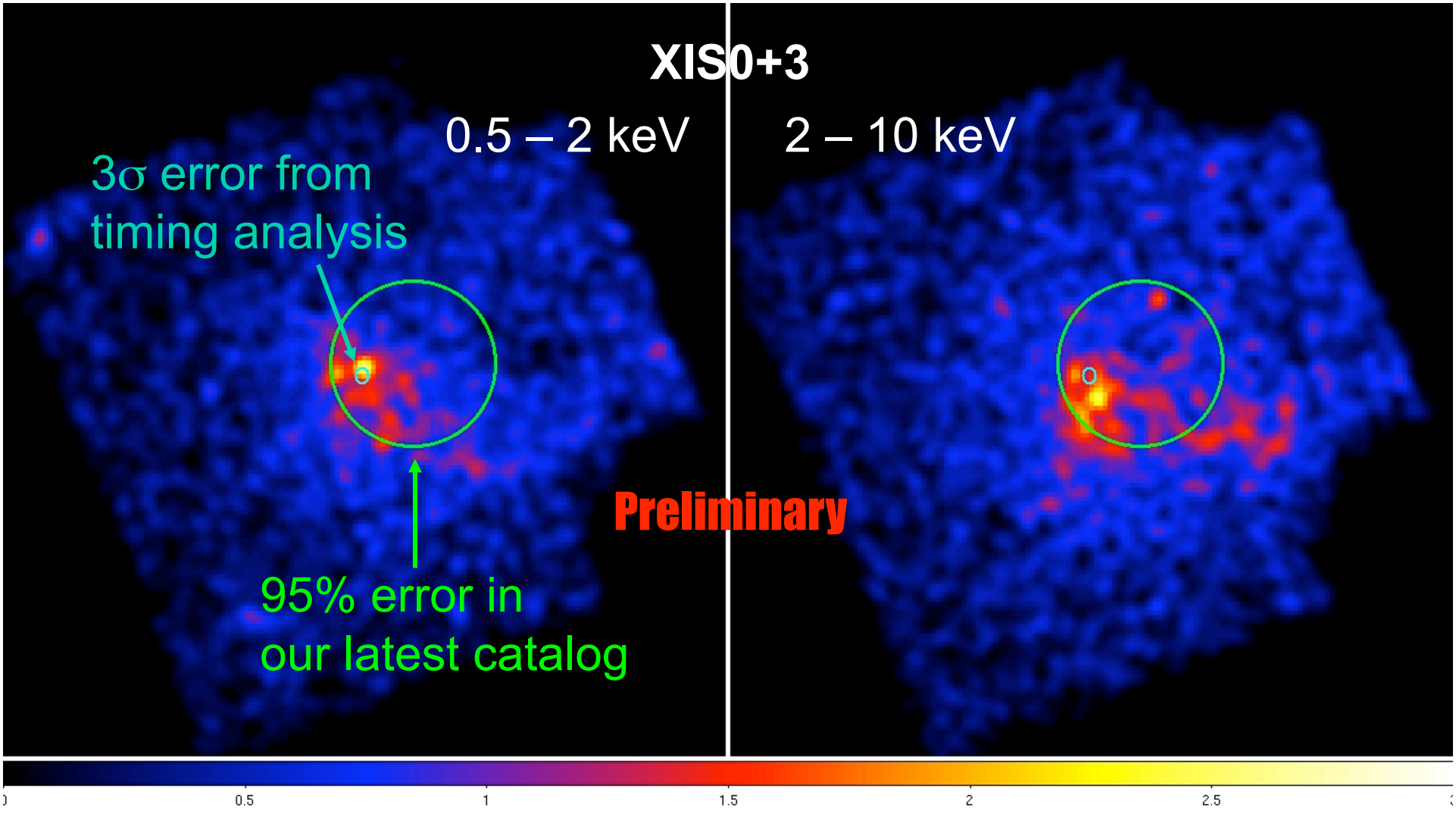
Observed Pulsars

- Position in the all-sky map



PSR J0633+0632 - Images

- τ_c = 59 kyr, $\dot{E}$ = 1.2 x 10^{35} erg s^{-1}
- 24 ks exposure
- Soft point source + Extended emission



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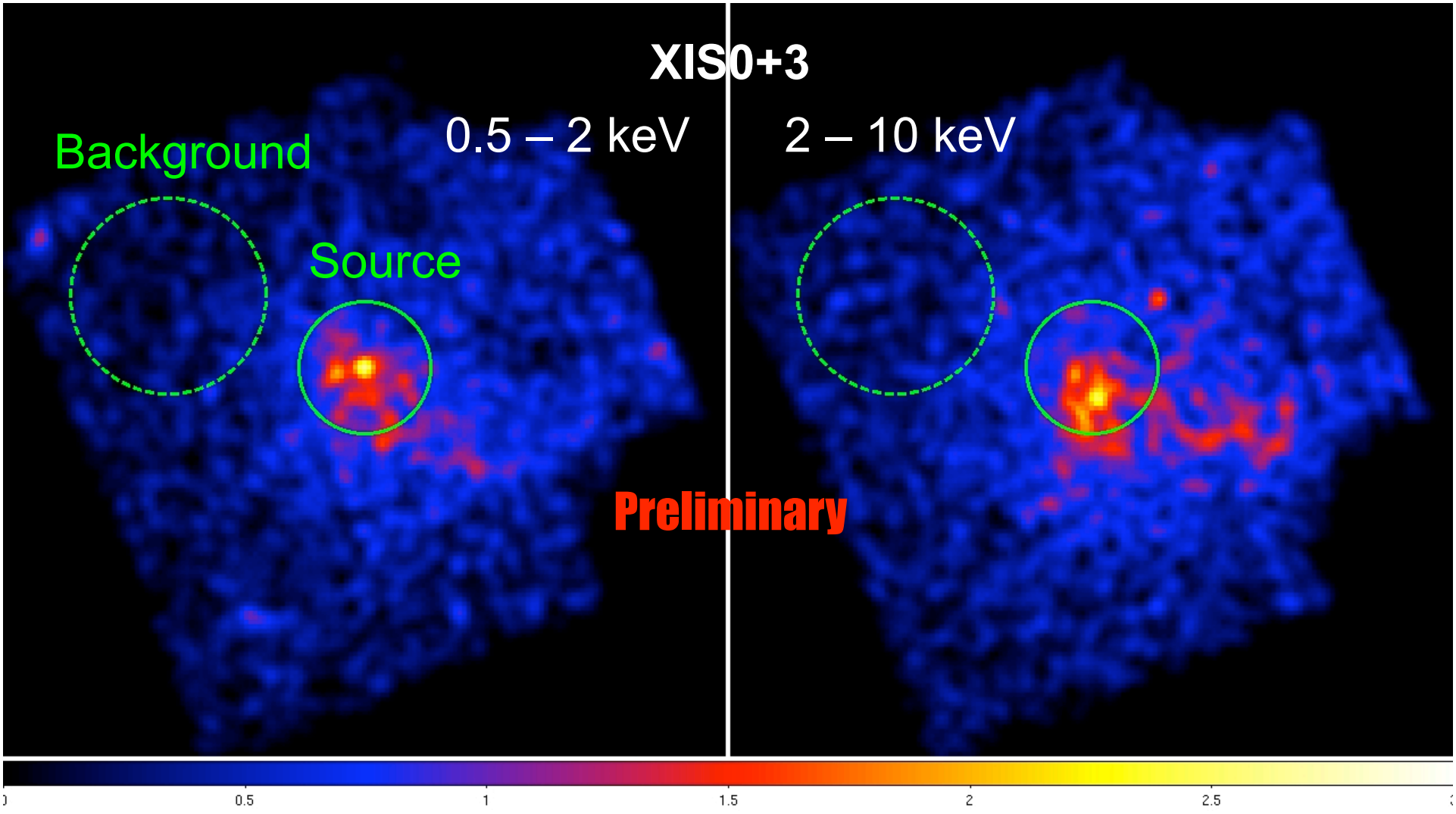
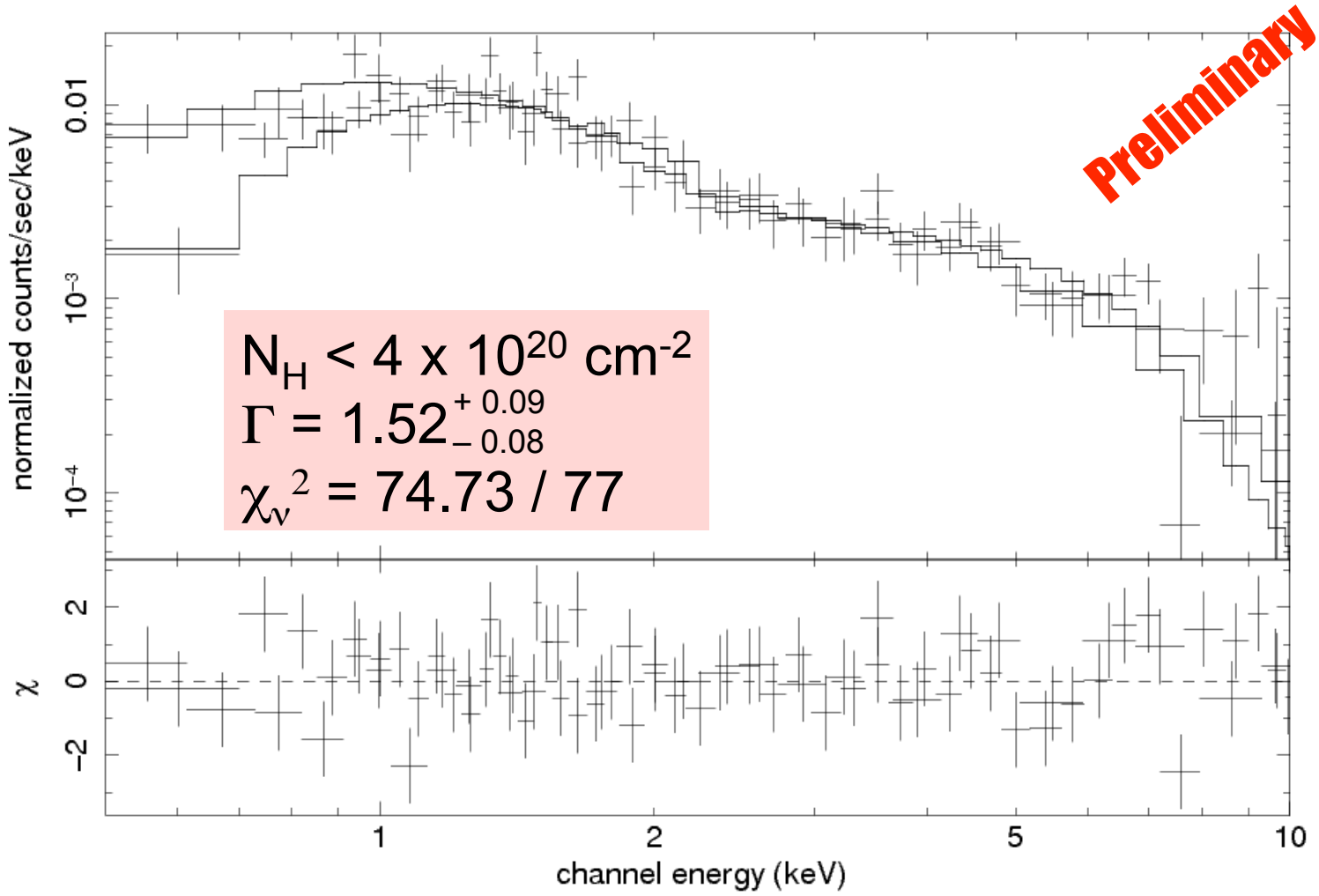


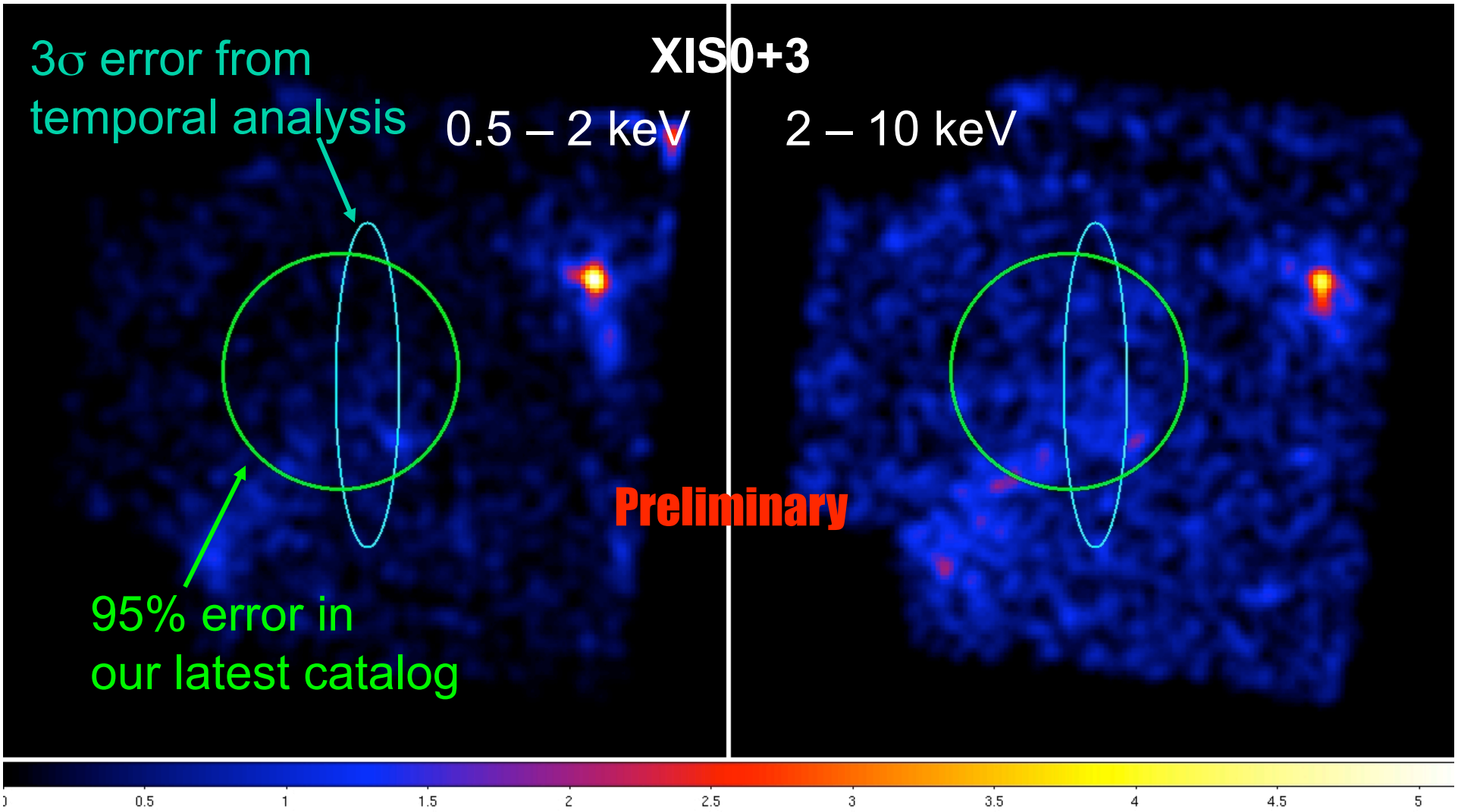
PSR J0633+0632– Spectrum

- Absorbed power-law model is the best



PSR J0357+32 - Images

- τ_c = 547 kyr, $\dot{E}$ = 5.8 x 10^{33} erg s^{-1}
- 21 ks exposure
- Point source + Extended emission?



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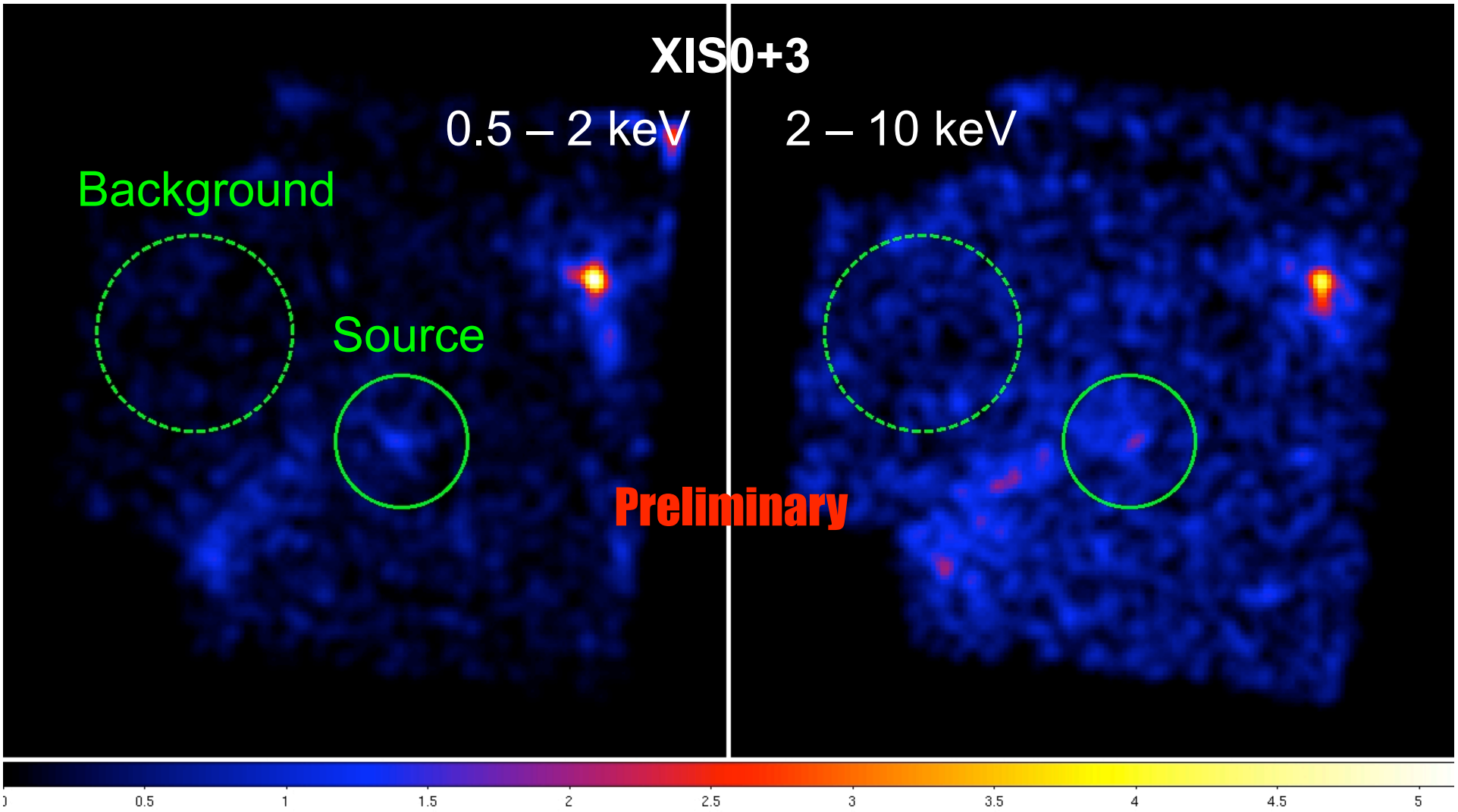

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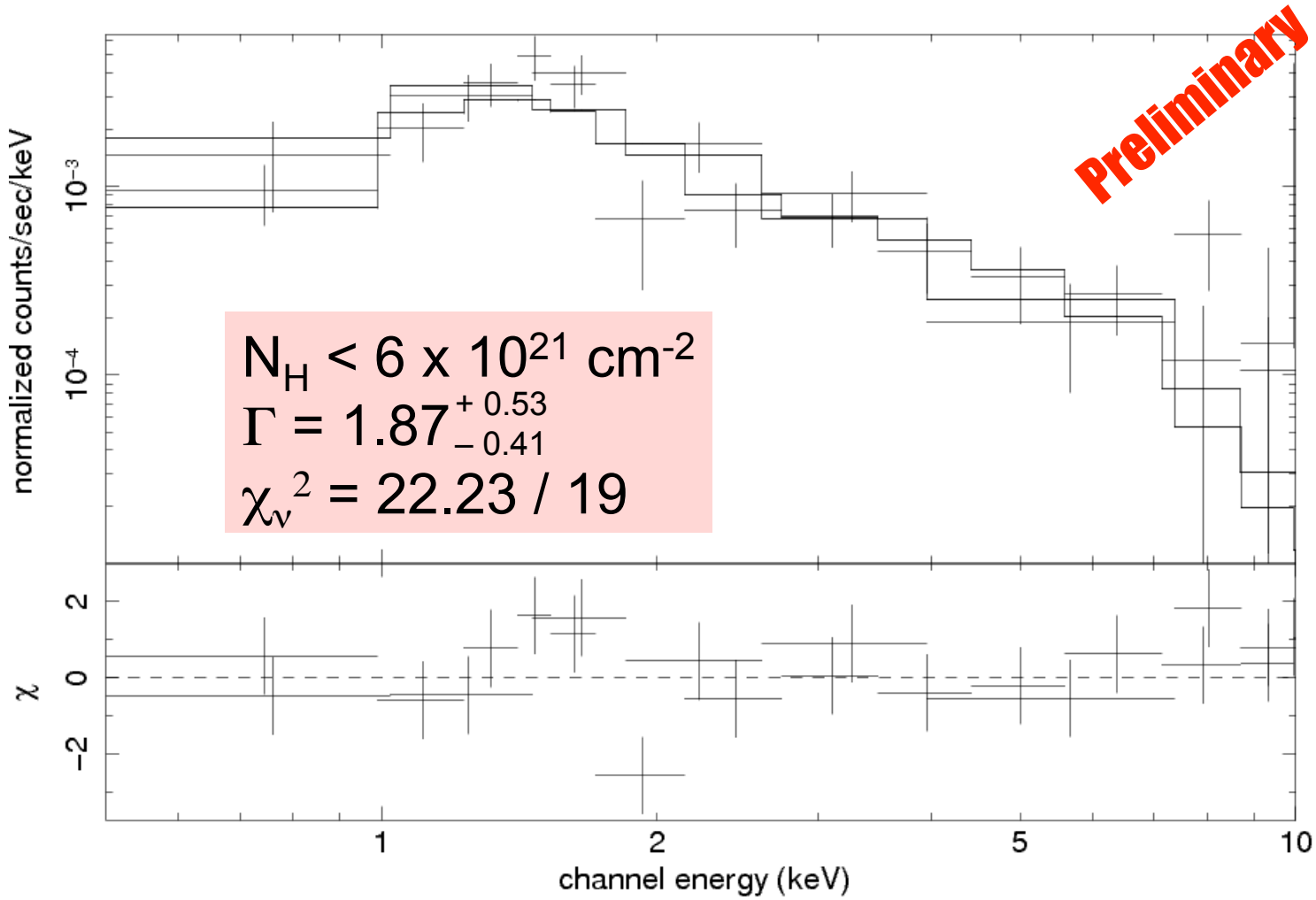
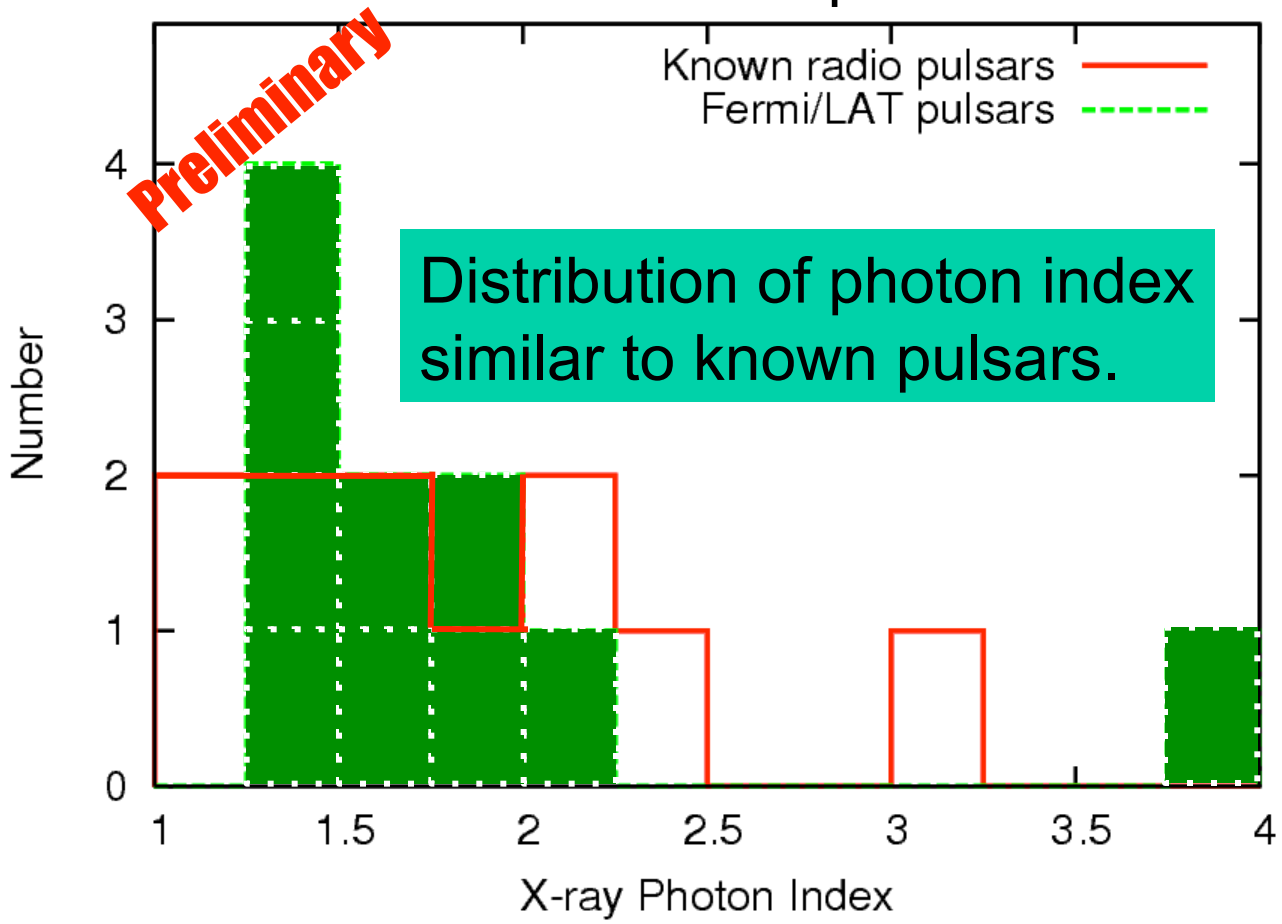


Results Overview

- X-ray counterparts are found for most of the targets
- Only one target lacks obvious counterpart...
  Nearby source is analyzed
- PL or PL + BB model is preferred

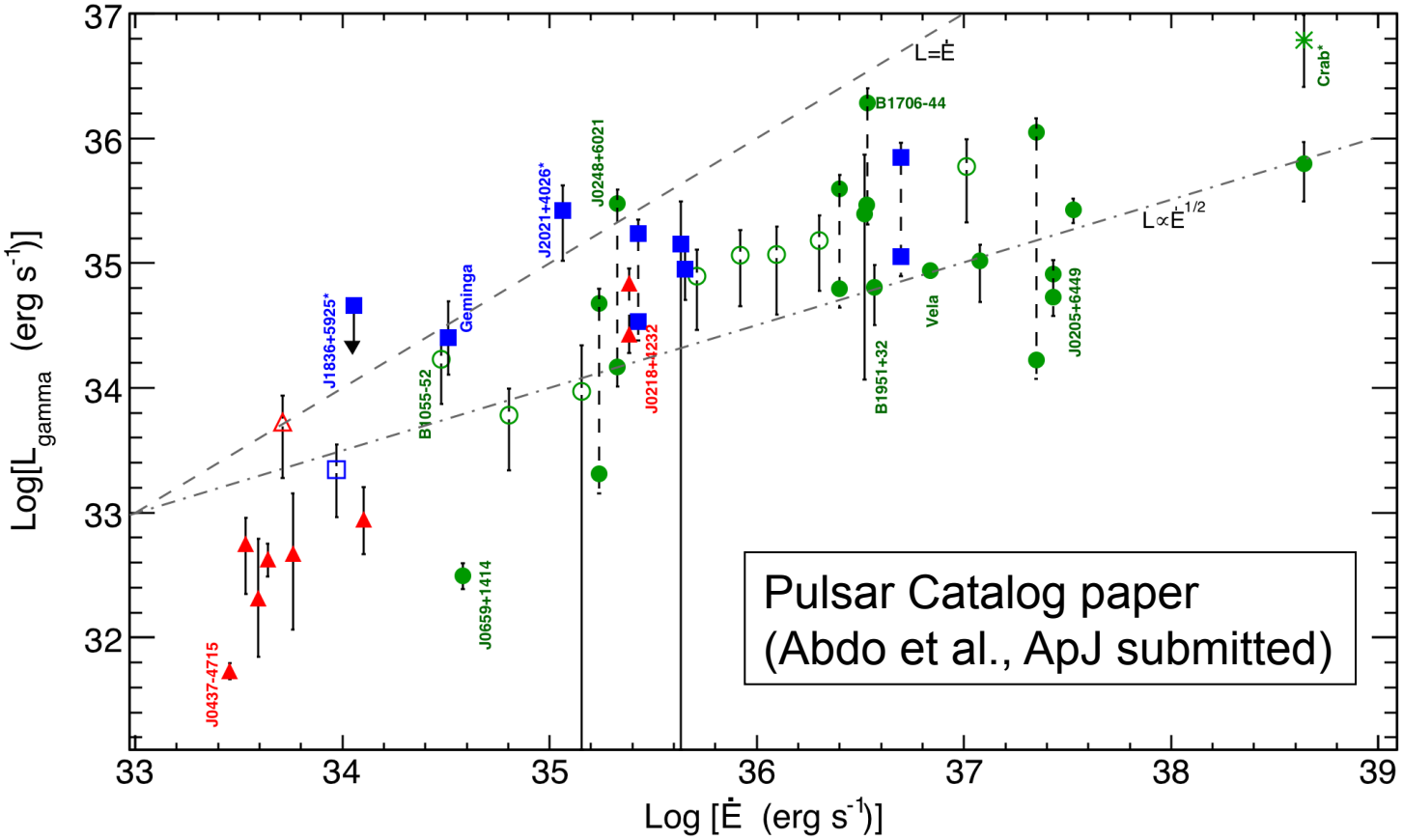


"Known radio pulsars" are radio pulsars
- Detected by Fermi LAT
and
- Studied in X-ray band.
Including 5 EGRET PSRs

"Fermi LAT pulsars" include pulsars Suzaku observed, Geminga and the new pulsar in CTA 1 (meaning no radio detection or radio quiet)

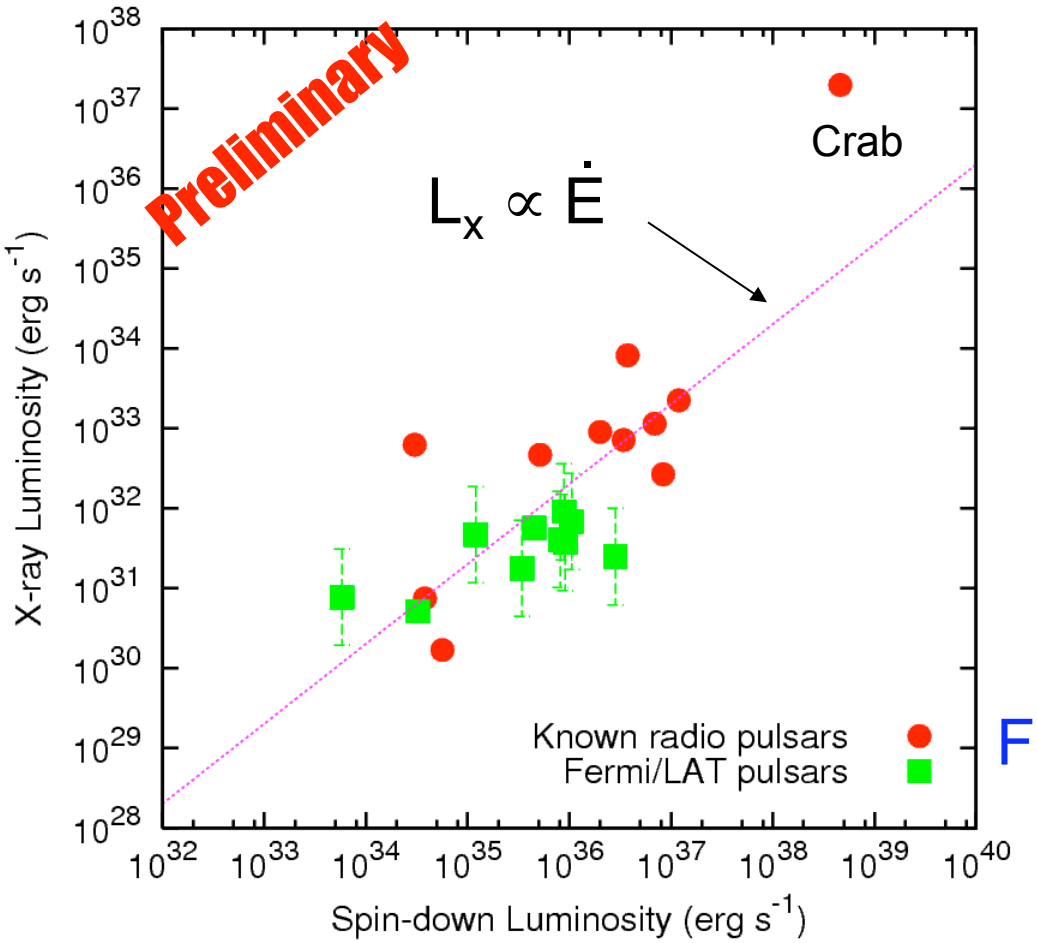
Distance Estimation to Calculate X-ray Luminosity

- Distance can be estimated with L_γ and F_γ for new pulsars
- Assuming a relation $L_\gamma \propto \dot{E}^{0.5}$

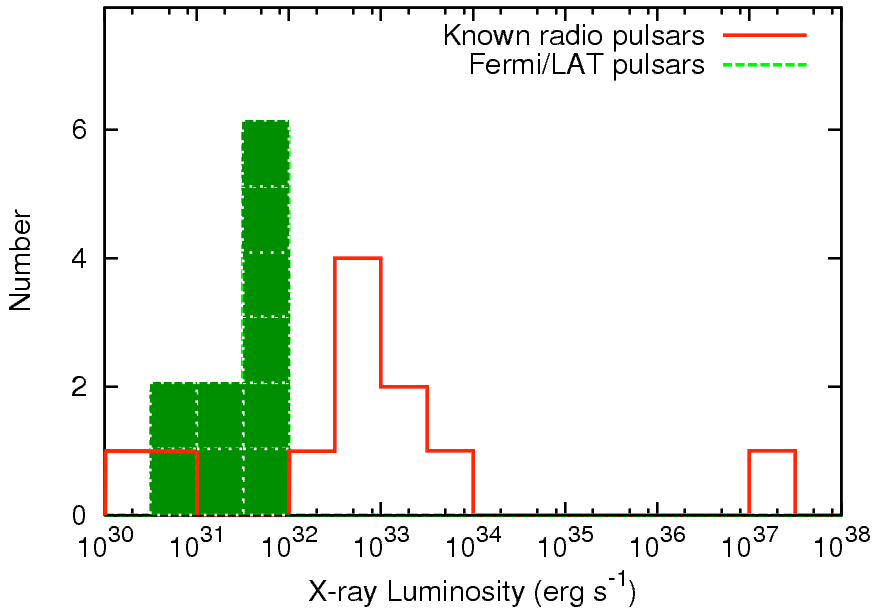


Spin-down Luminosity vs X-ray Luminosity

- New pulsars follow the relation $L_x \propto \dot{E}$, too (Ögelman 1995, Kawai et al. 1997)
- **No differences were found in this study**



L_x distribution



Fermi LAT can find fainter PSRs

More complete population studies

Summary

- We are observing Fermi LAT pulsars with Suzaku

- Faint X-ray counterparts are found for most of targets

- Power-law component found for all sources

- Properties similar to those of gamma-ray pulsars with radio emission

Further X-ray observations are ongoing
with Chandra and XMM-Newton


ermi
Gamma-ray
Space Telescope