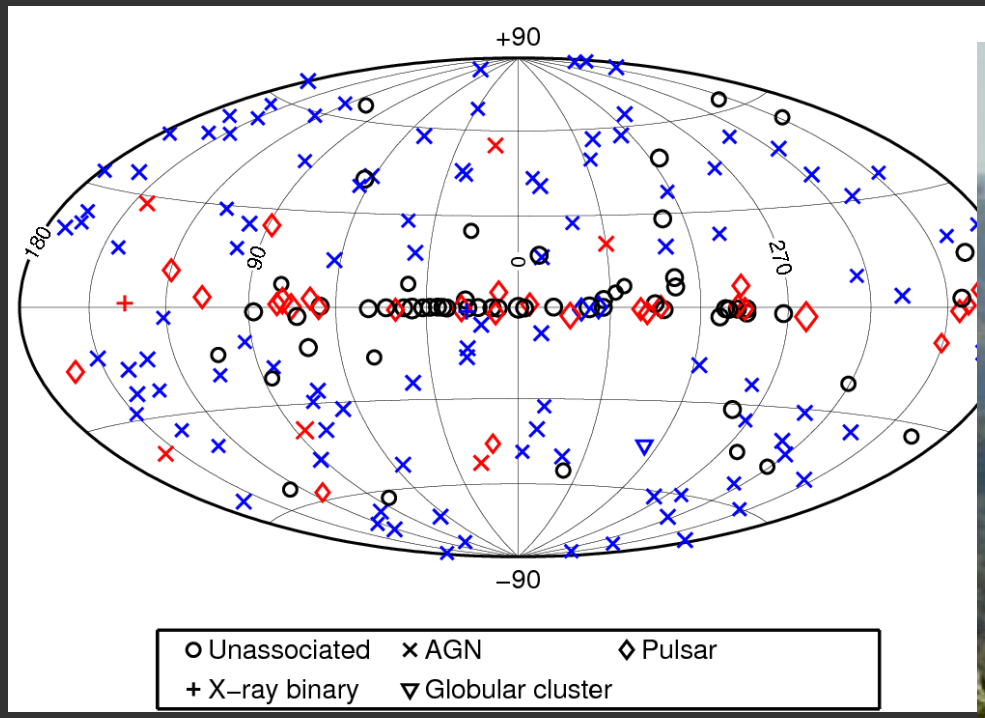
Searching for Radio Pulsars in Unidentified Fermi-LAT Bright Sources



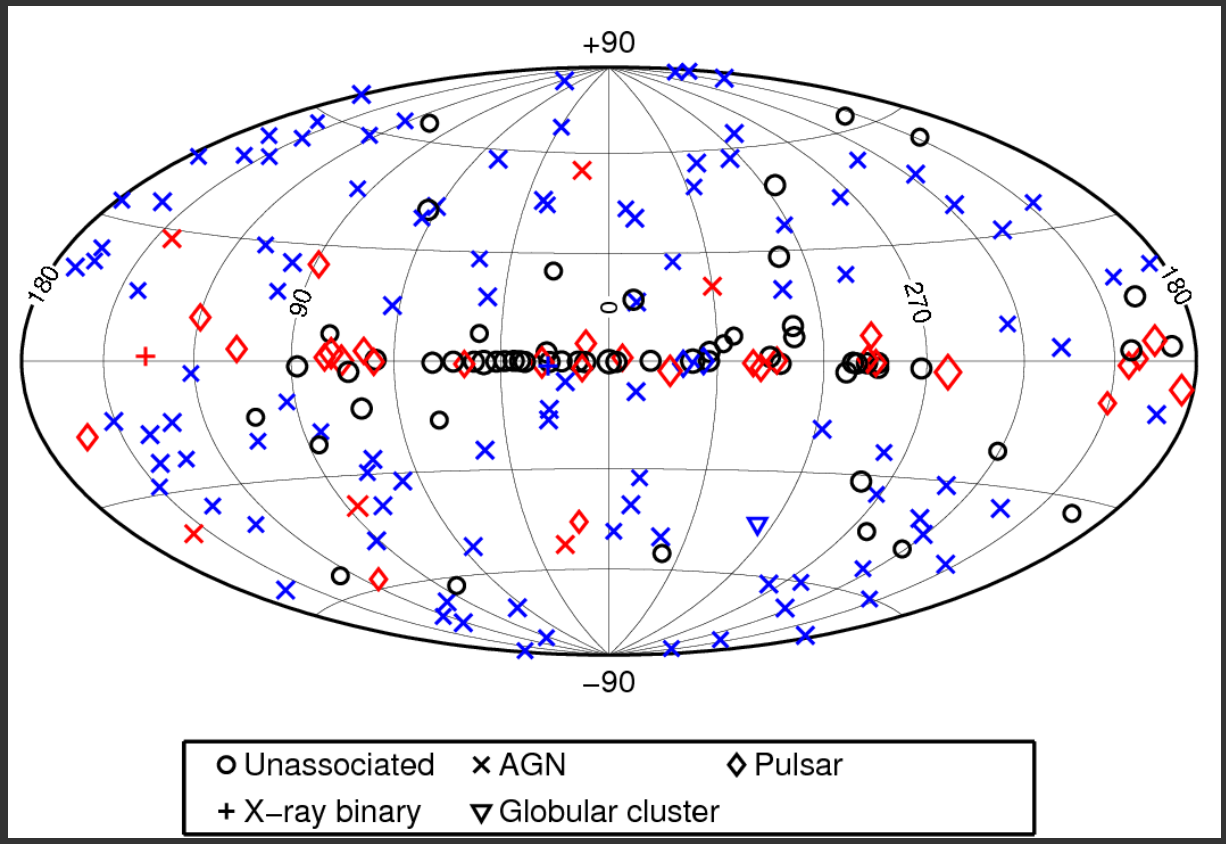
Scott Ransom (NRAO)

For the Fermi Pulsar Search Consortium (PSC)

Fermi Bright Source List

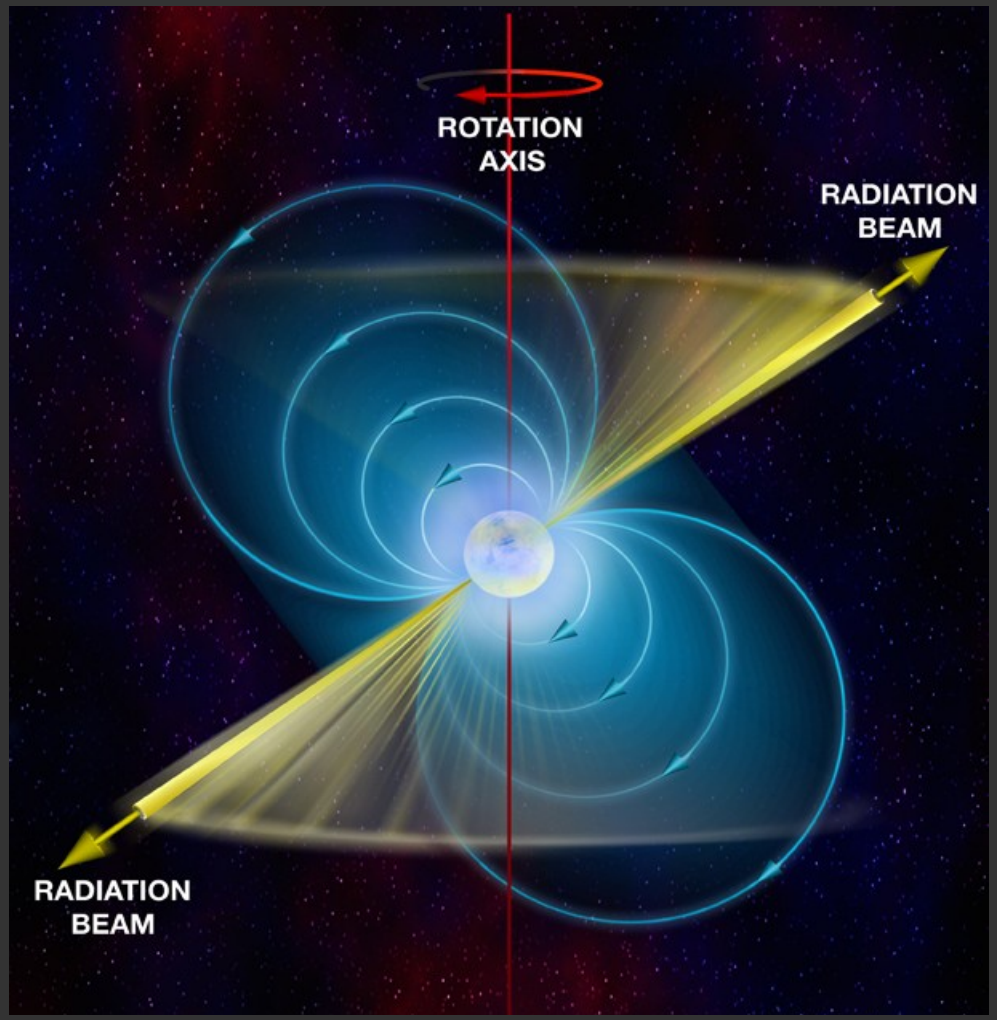
- 205 sources after 3 months at >10σ
- Many with associations
- Many new pulsars
- Many without associations might be new pulsars
- Blind searching in γ-rays is getting much harder...

Abdo et al, 2009, ApJS, 183, 46



Why search for pulsars?

- Radio and γ-rays come from different parts of magnetosphere
  - Constrain emission
  - See work by Romani, Harding, Gonthier, etc
- Dispersion Measure gives a distance
- Radio timing typically much more accurate
- Some pulsars we can't find in γ-rays



Searches for γ-ray PSRs in EGRET srcs were not very successful. Exceptions:
PSR J2229+6114 (Halpern et al 2001)
PSR J2021+3651 (Roberts et al 2002)

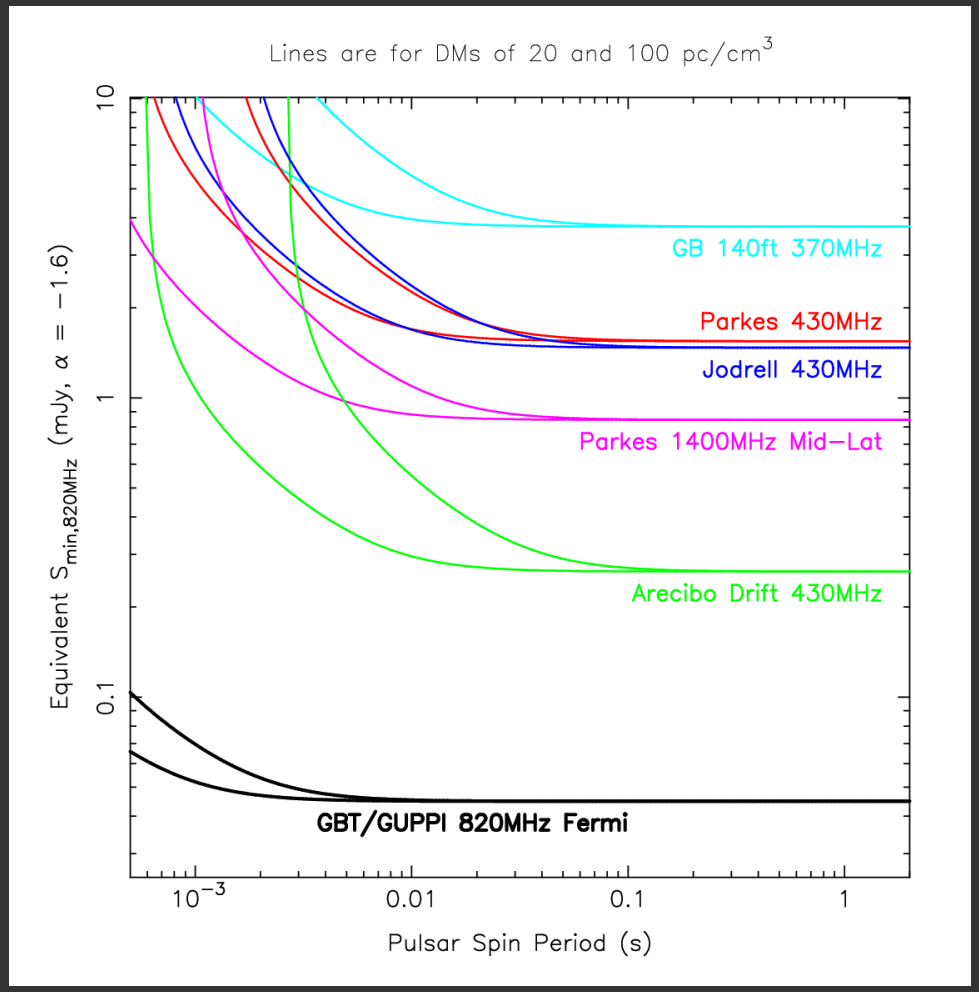
Which BSL Sources?

- Chose 27 sources:
  - No associations
  - Not flagged as variable
  - Not already deeply searched in radio
  - Dec > -40deg
  - 8 sources at high galactic latitude
- 30 hrs of GBT time
  - Used 9-month posns
  - Obs finished 2 wks ago

95% conf. regions well-matched to 820MHz GBT beam, 15' in diameter

Observations and Data Analysis

- Each src obs ~1 hour
  - GBT+GUPPI @ 820MHz
  - 2048 freq channels
  - 61μs sampling
  - 200MHz of bandwidth
  - ~110 GB / src
  - ~3 TB total
- Compute Intensive
  - Search over Dispersion Measure, frequency, and potential orbital (linear) acceleration
  - Requires ~2 days on 50 CPUs per source



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  - 0FGL J1311.9-3419 had nothing
  - 0FGLs J2214.8+3002, J1231.5-1410, and J0614.3-3330 each have bright binary millisecond pulsars!

0FGL J2214.8+3002 is PSR J2214+30

3.12 ms spin

10 hr orbit

13 Mjup min companion

~1.5 kpc (DM)

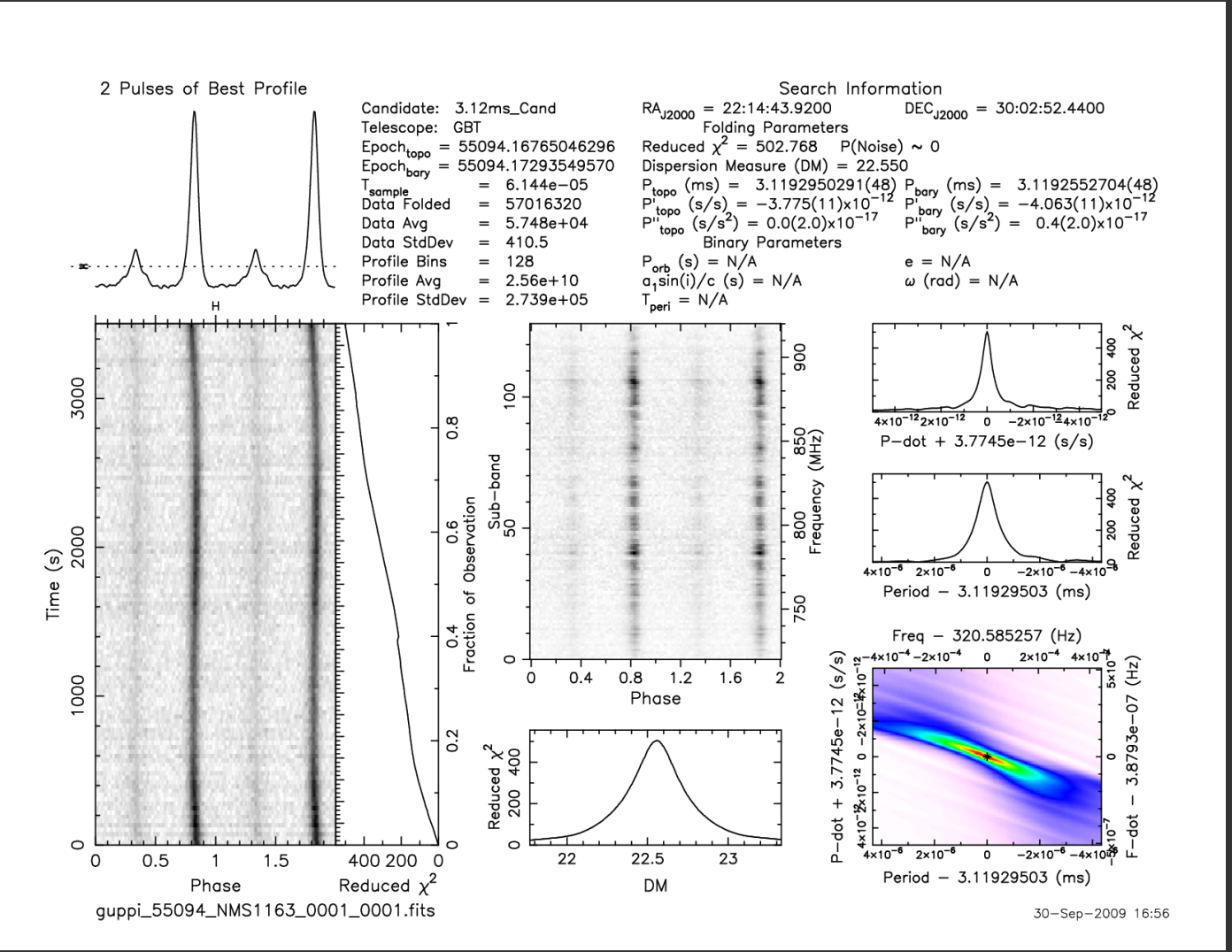
X-ray point sources...

Very bright

Scintillation

Arecibo visible!

"Black-Widow", NANOGrav MSP?



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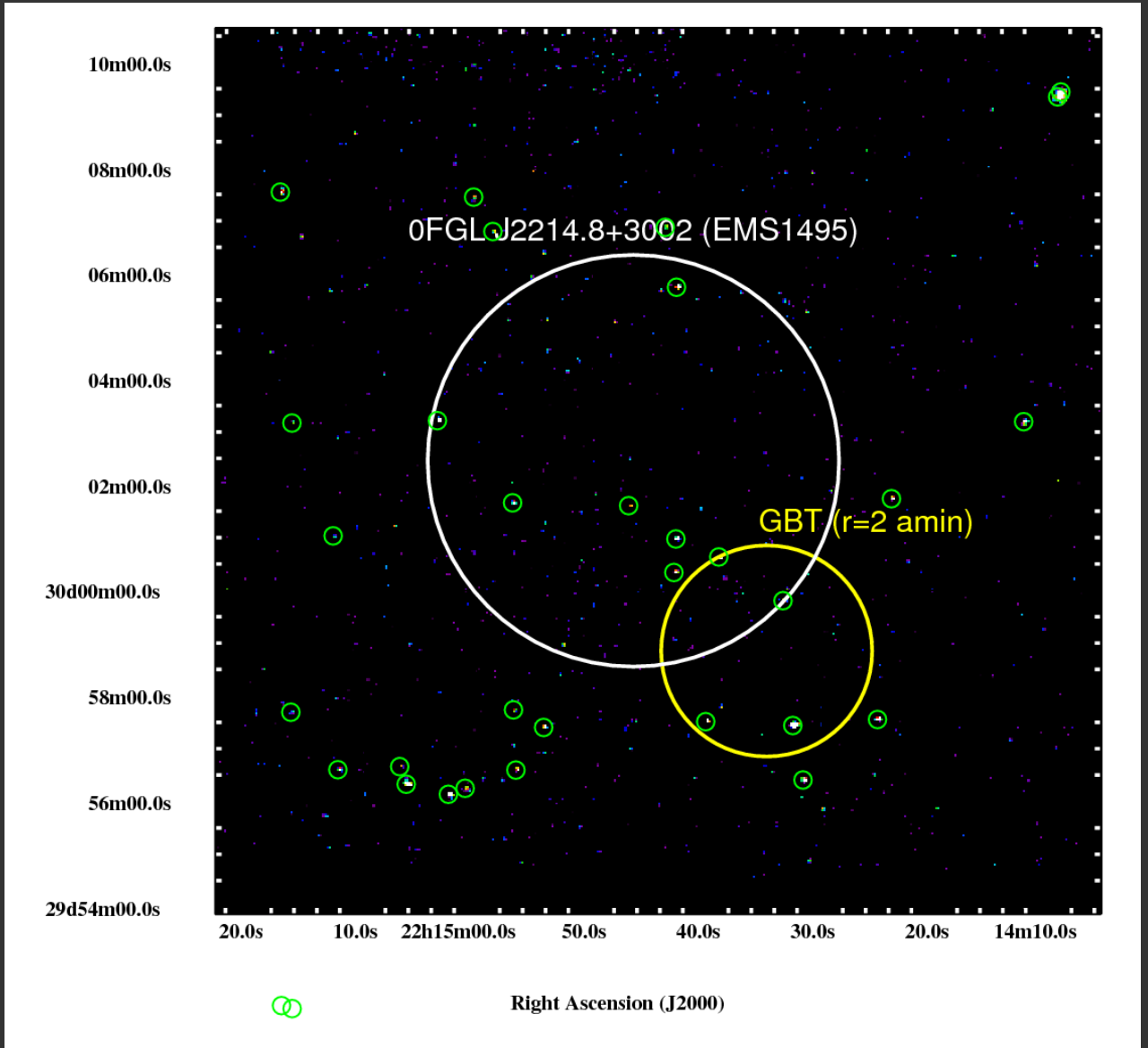
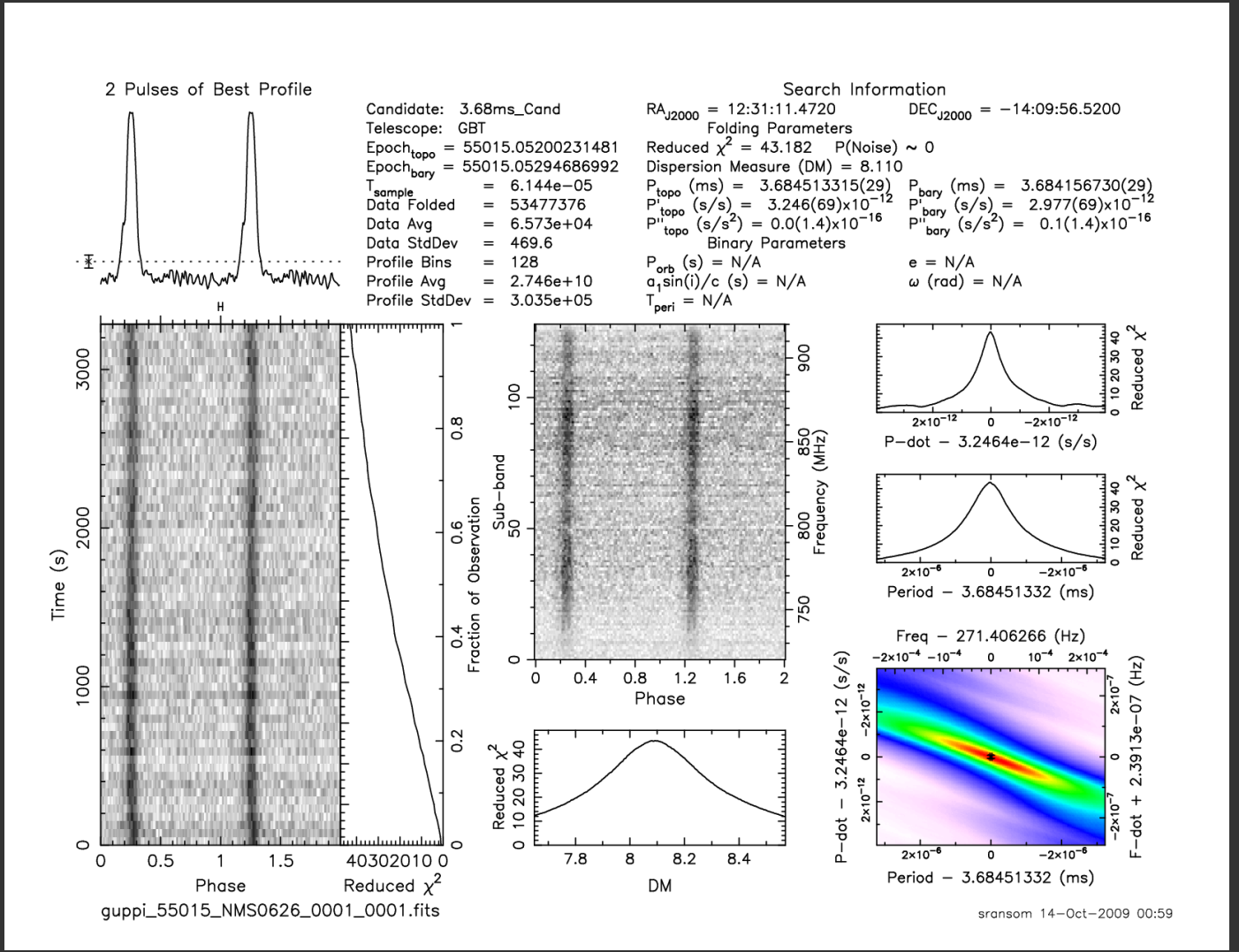


Chandra ACIS

0FGL J1231.5-1410 is PSR J1231-14

"Normal" Binary MSP (and close)

- 3.68 ms spin
- 1.86 day orbit
- 0.2 Msun min companion
- ~400 pc (DM)
- Good X-ray point source... (thanks to Michael Wolff)



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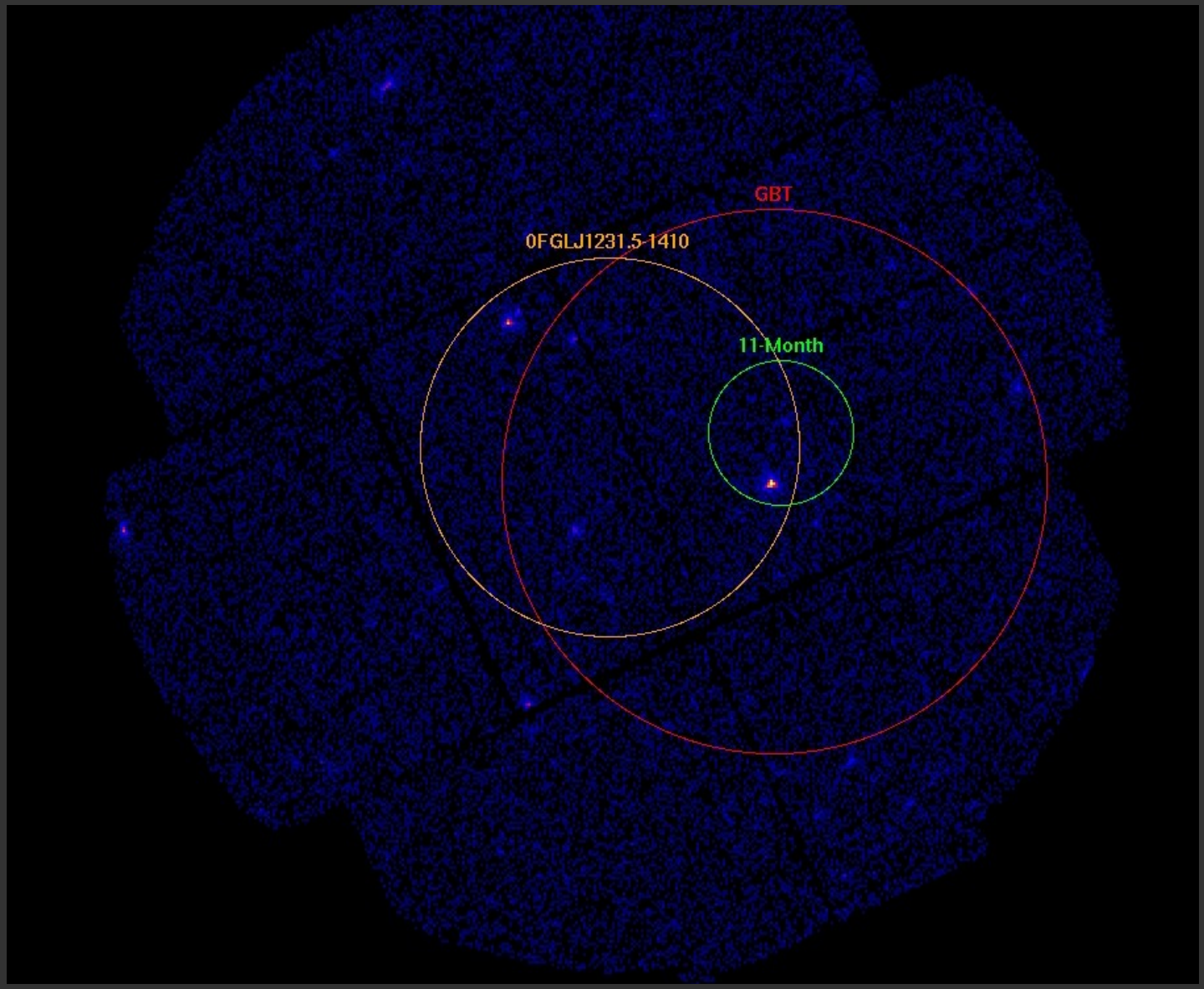


XMM-Newton (MOS)

0FGL J0614.3-3330 is PSR J0614-33

3.15 ms spin

unknown orbit

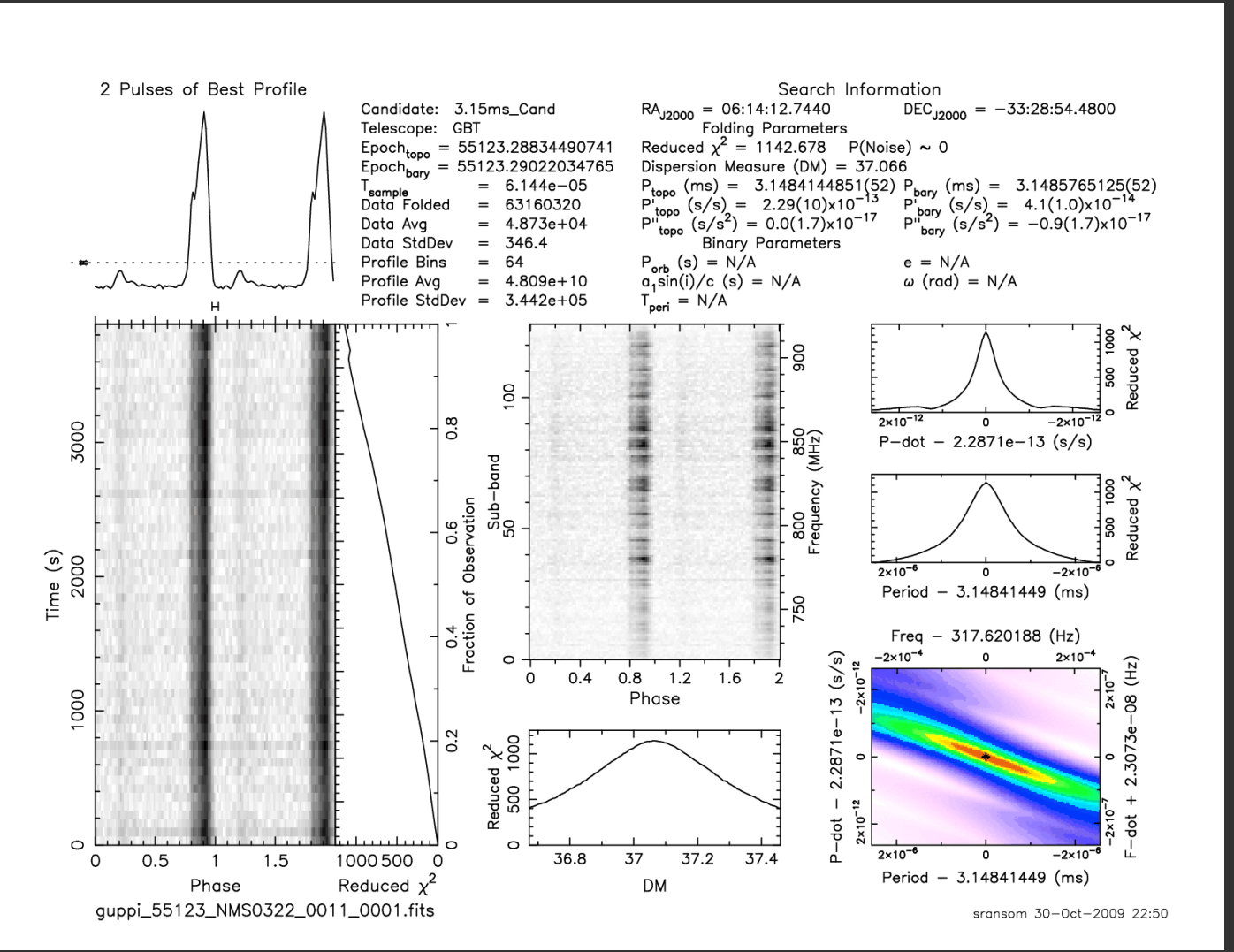
~2 kpc (DM)

X-ray point sources...

Very bright

Scintillation

Unknown Binary MSP



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unknown orbit

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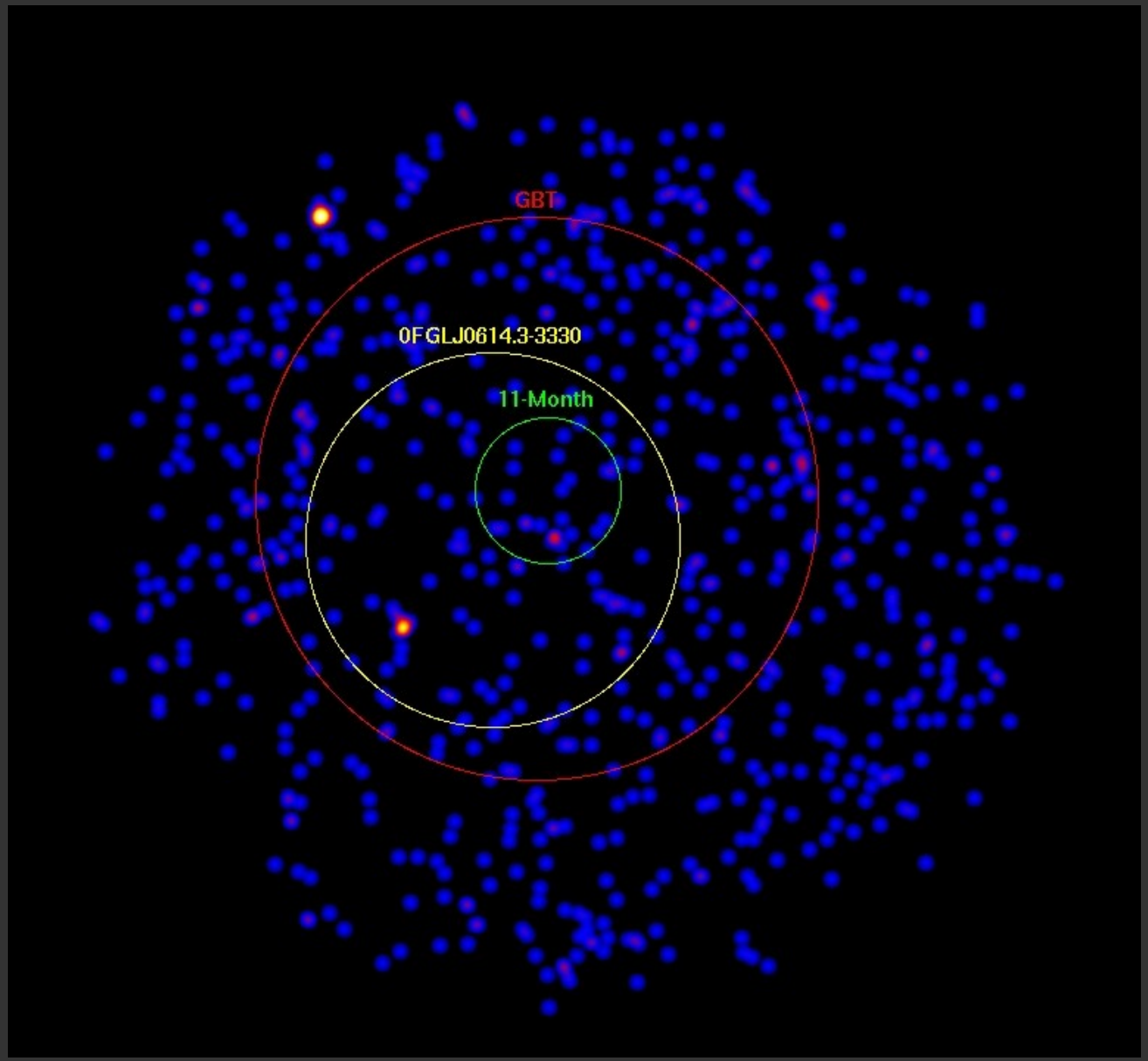
Very bright

Scintillation



Swift XRT

Conclusions

- 3 out of 4 high-Galactic latitude sources searched so far have bright radio MSPs!
- No γ-ray pulsations yet...(timing required)
- A new way to find such valuable systems:
  - Basic physics tests (e.g. NS EoS)
  - Gravitational wave detection (e.g. *NANOGrav*)
- Still 18 more sources to search (4 high-lat)
- Many more in Mallory Robert's 350MHz survey and other searches at Parkes, Arecibo and Effelsberg
- γ-ray and radio luminosities of MSPs uncorrelated(?)
- γ-ray and radio both likely have wide fan-beams