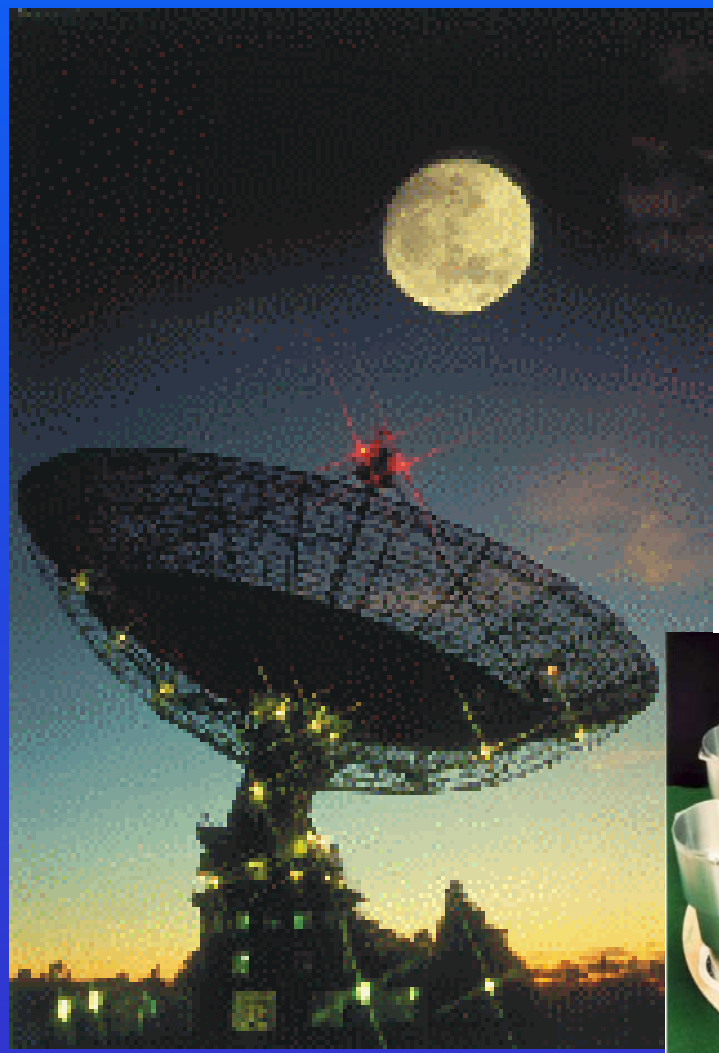
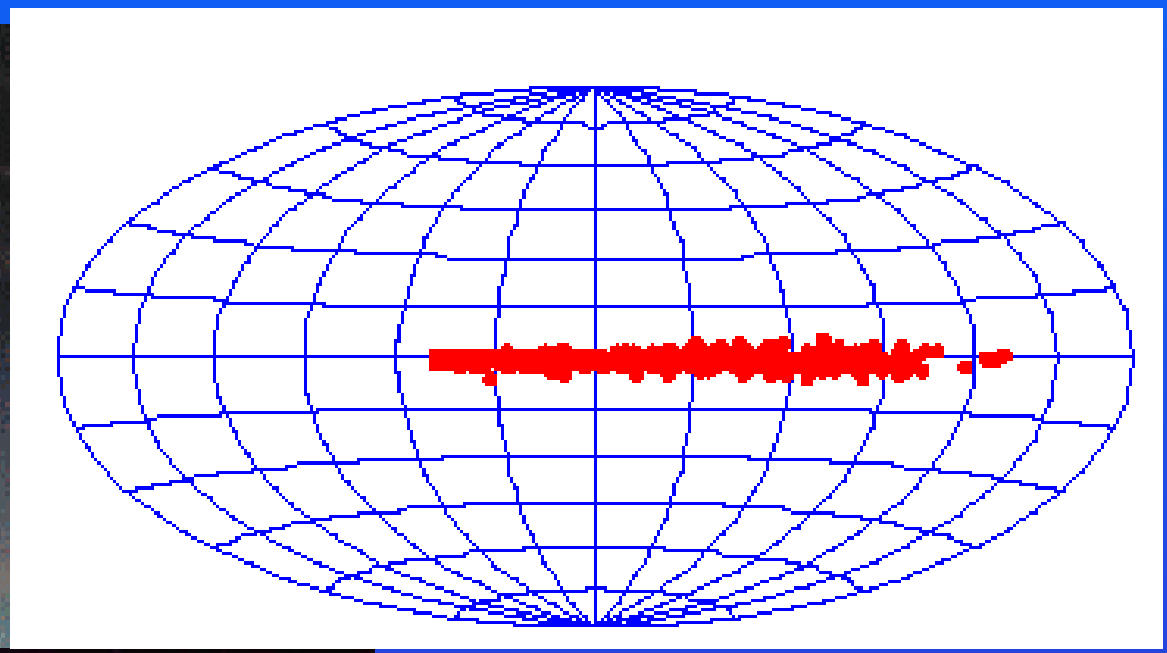
New Pulsars and EGRET UnID sources

Alice K. Harding
NASA Goddard Space Flight Center

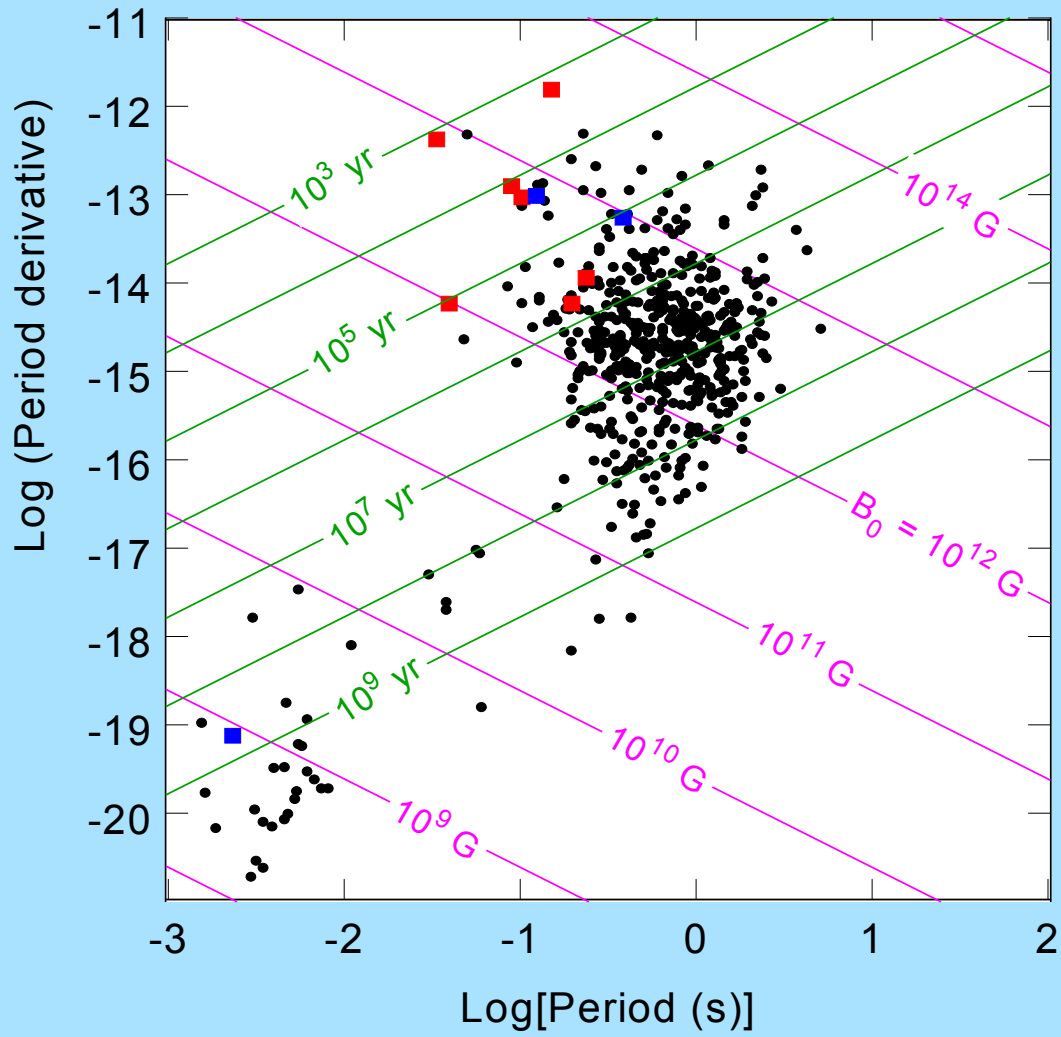
- **Post-CGRO radio pulsar detections**
  - Parkes multi-beam survey
  - Deep searches in EGRET error boxes
  - Deep searches in SNRs → young, faint pulsars
- **Upcoming radio surveys**
  - Arecibo multi-beam (2004)
  - Green Bank
  - Square-kilometer array (2015)

Parkes multi-beam survey: 775 new radio pulsars and counting...

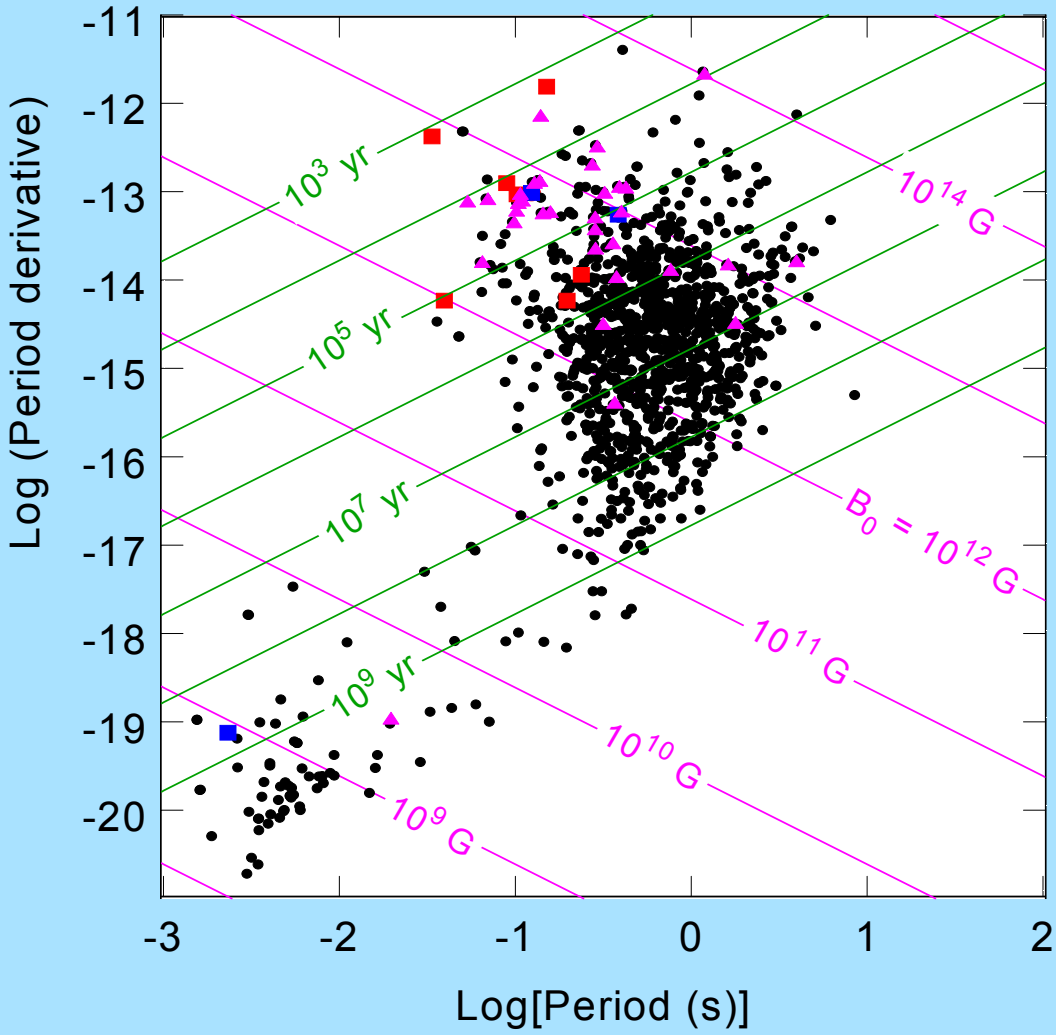




Princeton Pulsar Catalog
c. 1995



ATNF Pulsar Catalog
c. 2002



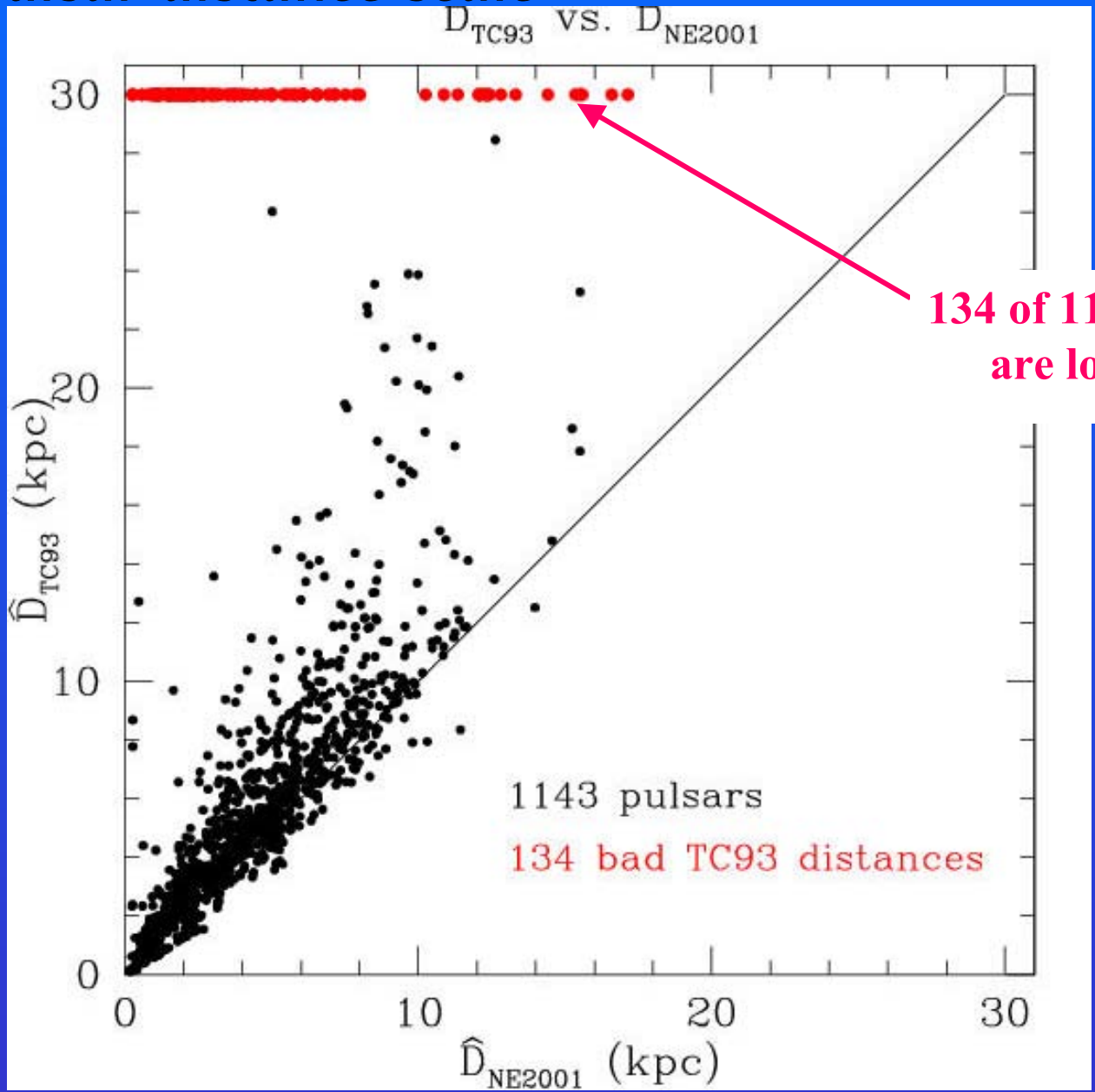
Radio pulsars and EGRET UnID sources

EGRET 3EG	PSR	P(s)	Pdot (10^{-15} s s^{-1})	d(kpc)	Age(yr)	L_{SD}(erg/s)	Comments
J1014-5705	J1015-5719	0.140	57.368	4.94	3.97E+04	8.27E+35	
J1013-5915	J1016-5857	0.107	80.618	9.31	2.16E+04	2.60E+36	G284.3-1.8
J1102-6103	J1105-6107	0.063	15.8266	7.07	6.50E+04	2.48E+36	
J1410-6147	J1413-6141	0.285	333.440	3.00	1.39E+04	5.70E+35	
J1410-6147	J1412-6145	0.315	98.660	9.32	5.20E+04	1.25E+35	G312.4-0.4
J1420-6038	J1420-6048	0.068	83.167	7.69	1.33E+04	1.05E+37	Kookaburra
J1639-4702	J1637-4642	0.154	59.204	5.72	4.24E+04	6.41E+35	G337.8-0.1
J1639-4702	J1638-4608	0.278	51.5041	5.85	8.80E+04	9.47E+34	
J1649-1611	J1650-1654	1.750	3.2012	2.14	8.90E+06	2.37E+31	
J1714-3857	J1713-3949	0.392	60.000	5.00	1.07E+05	3.93E+34	G347.3-0.5
J1714-3857	J1715-3903	0.278	37.688	4.81	1.20E+05	6.90E+34	
J1734-3232	J1734-3333	1.169	2278.98	7.41	8.35E+03	5.64E+34	
J1734-3232	J1735-3258	0.351	26.08	11.10	2.19E+05	2.39E+34	
J1736-2908	J1736-2819	1.592	14.921	4.97	1.74E+06	1.46E+32	
J1741-2050	J1741-2019	3.905	16.26	2.00	3.91E+06	1.08E+31	
J1744-3011	J1745-3040	0.367	10.6649	2.08	5.61E+05	8.51E+33	
J1746-1001	J1745-0952	0.019	9.50E-05	2.38	3.32E+09	5.17E+32	
J1746-2851	J1747-2958	0.099	61.360	2.00	2.62E+04	2.52E+36	Mouse
J1800-2338	J1801-2451	0.125	127.984	4.61	1.59E+04	2.60E+36	W28
J1824-1514	J1825-1446	0.279	22.685	5.42	2.00E+05	4.12E+34	
J1837-0423	J1838-0453	0.381	115.660	8.28	5.36E+04	8.29E+34	
J1837-0606	J1837-0604	0.096	45.201	6.19	3.46E+04	2.02E+36	
J1903+0550	J1902+0556	0.747	12.896	3.93	9.43E+05	1.23E+33	
J1928+1733	J1930+1852	0.136	750.57	5.00	2.95E+03	1.18E+37	G54.1+0.3
J1958+2909	J1957+2833	0.308	3.124	6.98	1.60E+06	4.24E+33	
J2227+6122	J2229+6114	0.052	78.300	3.00	1.07E+04	2.26E+37	X-ray psr
J2021+3716	J2021+3651	0.104	96.000	10.00	1.76E+04	3.38E+36	
J1826-1302	J1826-1334	0.101	75.487	4.12	2.19E+04	2.86E+36	
J1800-2338	J1801-2304	0.416	112.882	13.50	6.00E+04	6.21E+34	W28
J1800-2338	J1803-2137	0.134	134.432	3.94	1.62E+04	2.23E+36	
J1856+0114	J1856+0113	0.267	208.408	2.78	2.09E+04	4.31E+35	W44

Parkes MB survey, Parkes and Arecibo deep searches – 27 pulsars

Previous surveys – 4 pulsars

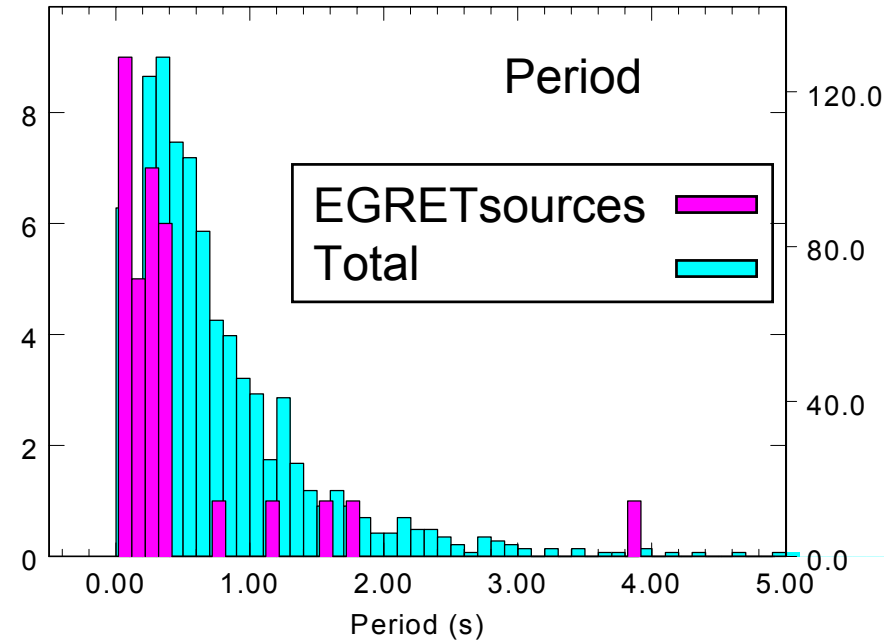
Old (Taylor & Cordes 1993) vs. New (Cordes & Lazio 2002) pulsar distance scale

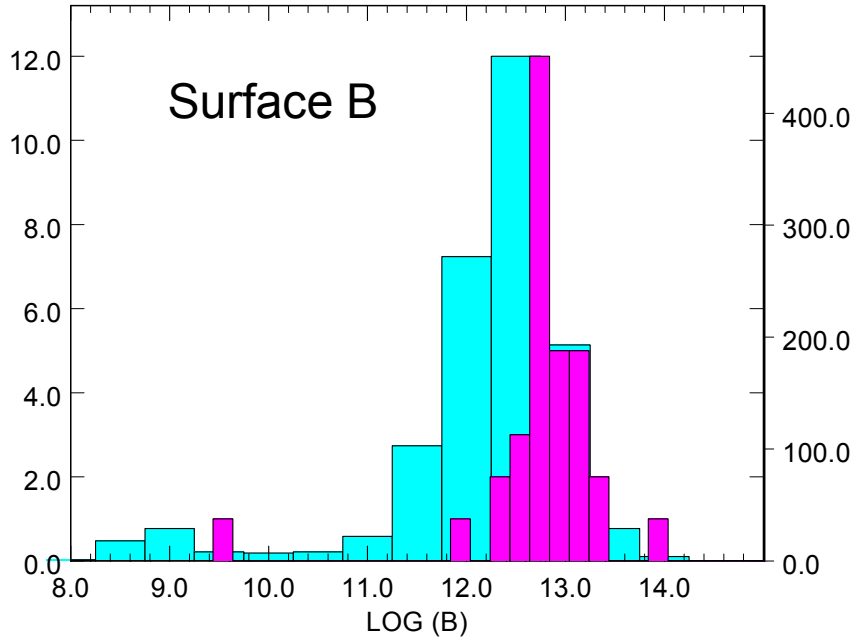


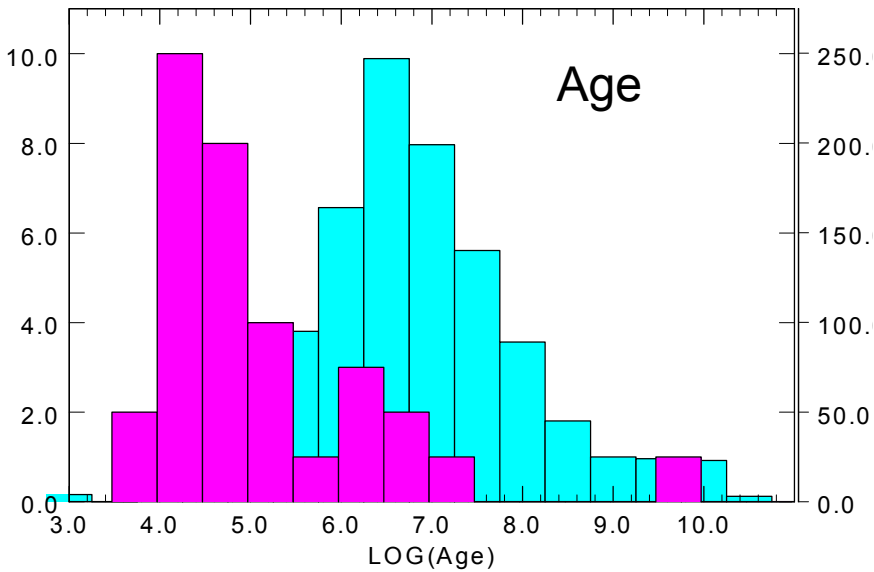
134 of 1143 TC93 distances are lower bounds

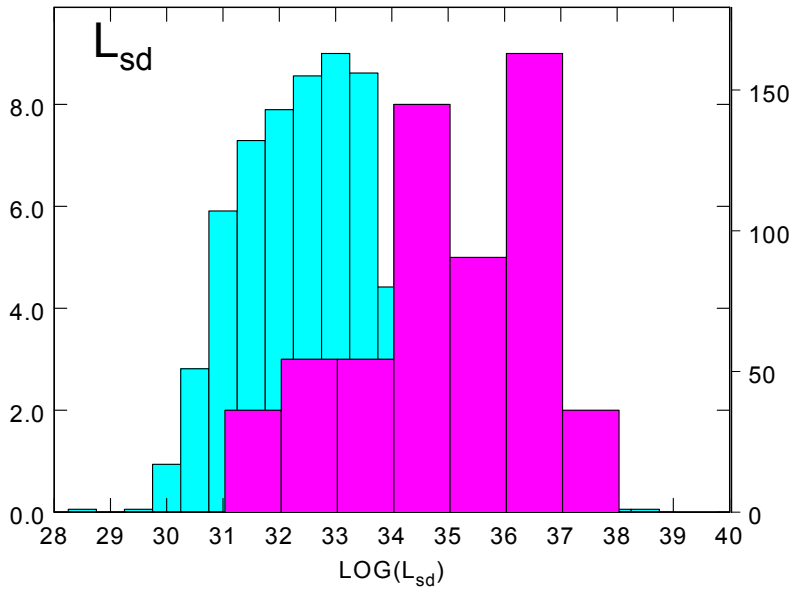
Courtesy of Jim Cordes

Radio pulsar statistical properties









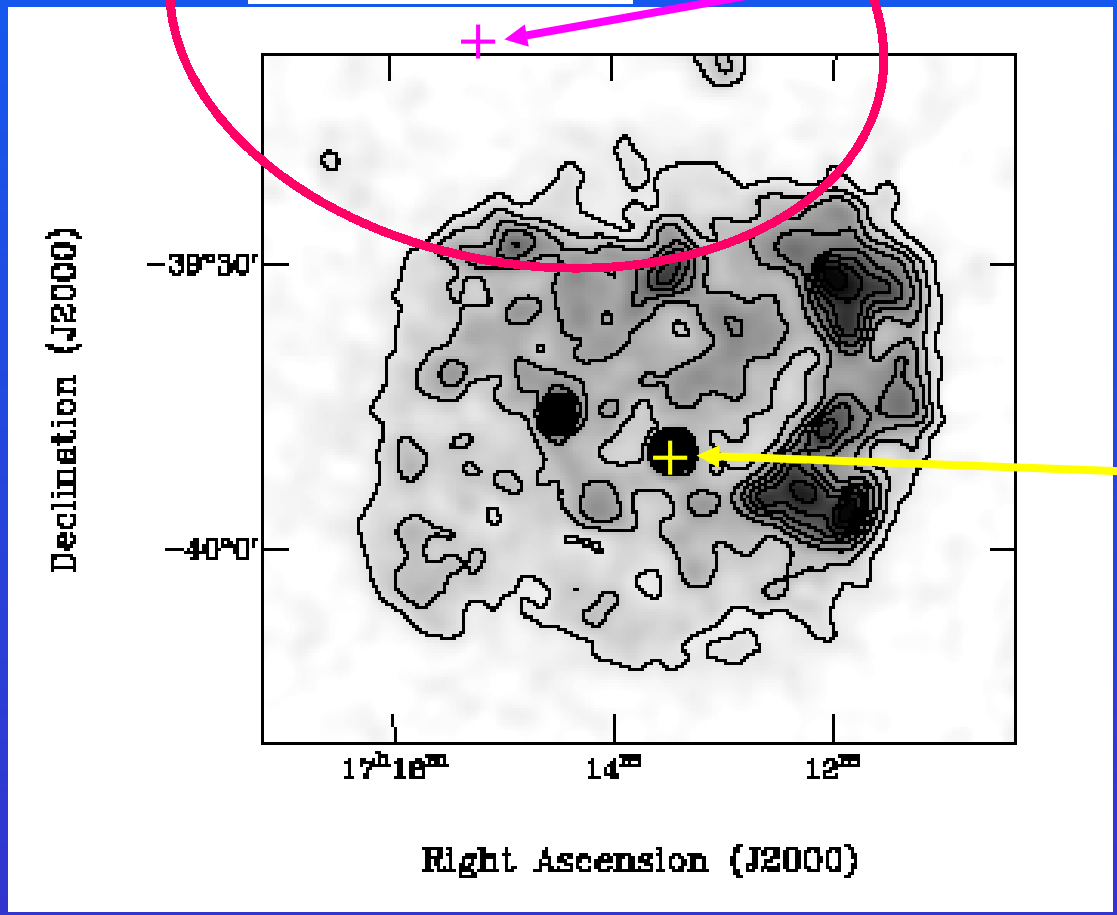
PSR J1713-3949 in SNR G347.3, PSRJ1715-3903 and 3EG J1714-3857

(Crawford et al 2001, Slane et al. 1999)

EG J1714-3857

PSR J1715-3903

258 ms, 120 kyr



PSR J1713-3949

392 ms, 107 kyr

PSR J1016-58 and 3EG1013-5915

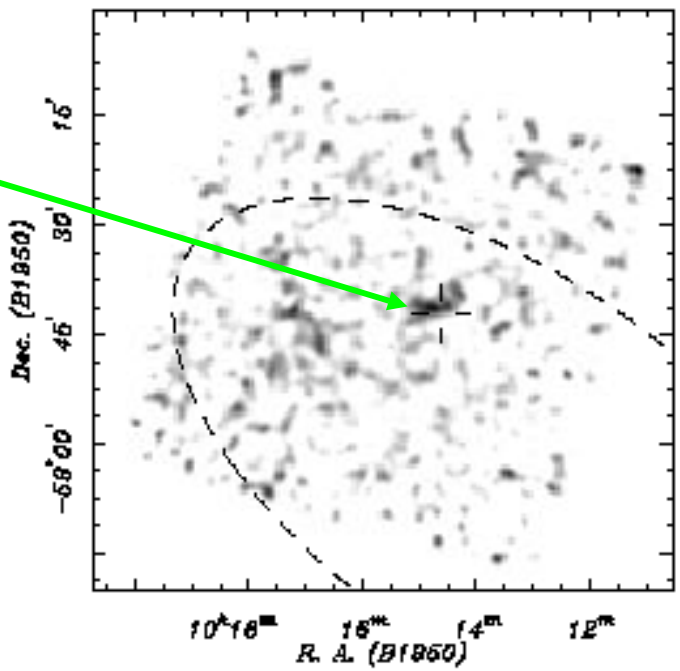
PSR J1016-58

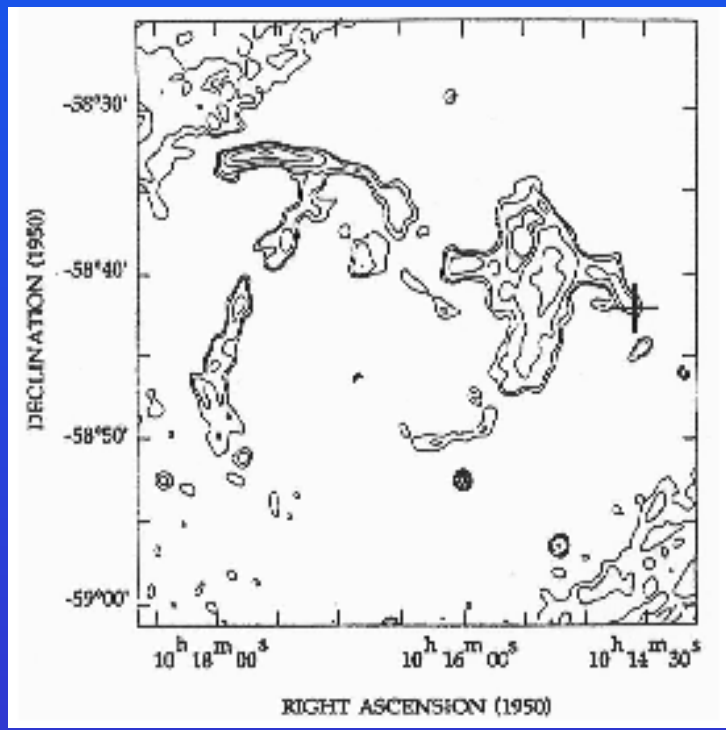
107 ms, 21 kyr

D ~ 3 kpc ?

$\dot{E}$ = 2.6 10^{36} erg/s

(Camilo et al. '01)





3EG1013-5915

$E^{-2.32\pm0.13}$ > 100 MeV and stable in γ

centrally peaked, non-thermal X-ray nebula

outside SNR G284.3-1.8 interacting with H_2 cloud

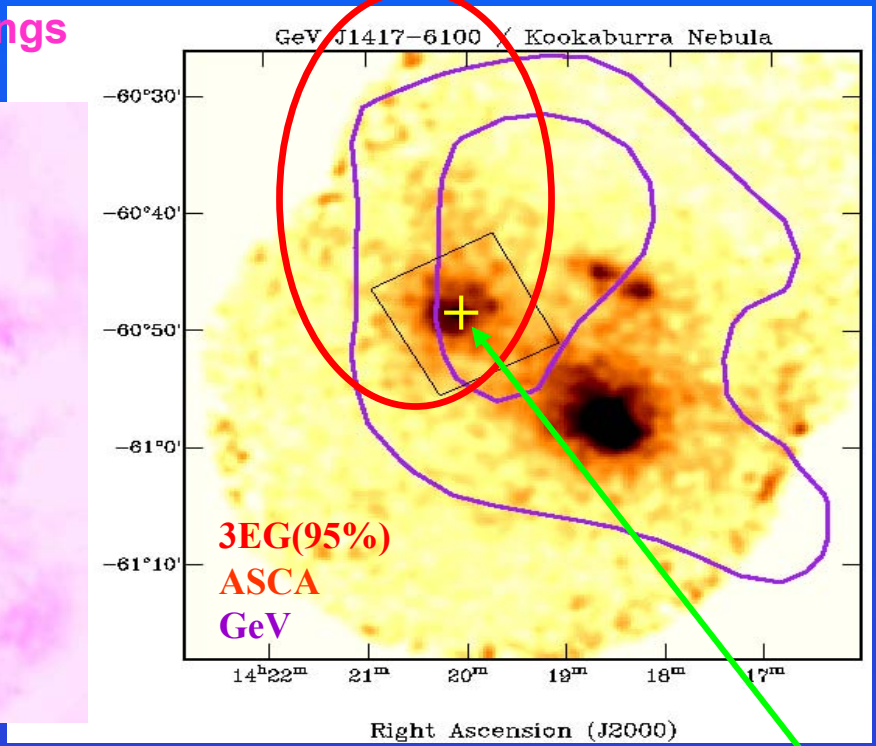
PSR J1420-6048, 3EG J1420-6038 and the Kookaburra (Roberts et al. 2001)

non thermal+asca hot spots

non thermal wings

HII
13.4 kpc
radiogal.

thermal shell



the Kookaburra :

non thermal radio and X(2-10 keV) in G313.4+0.2 SNR

the Rabbit :

centerfilled

non thermal radio

10% polarization

X(2-10 keV)

plerion ?

PSR J1420-6048:

68 ms, 13 kyr

D ~ 2 or 7.7 kpc

$\dot{E} = 2\ 10^{36}$ erg/s

3EG 1420-6038 :

$E^{-2.02\pm0.14}$ > 100 MeV and variable

3EG J1410-6147:
PSR J1412, J1413 and SNR G312.4-0.4

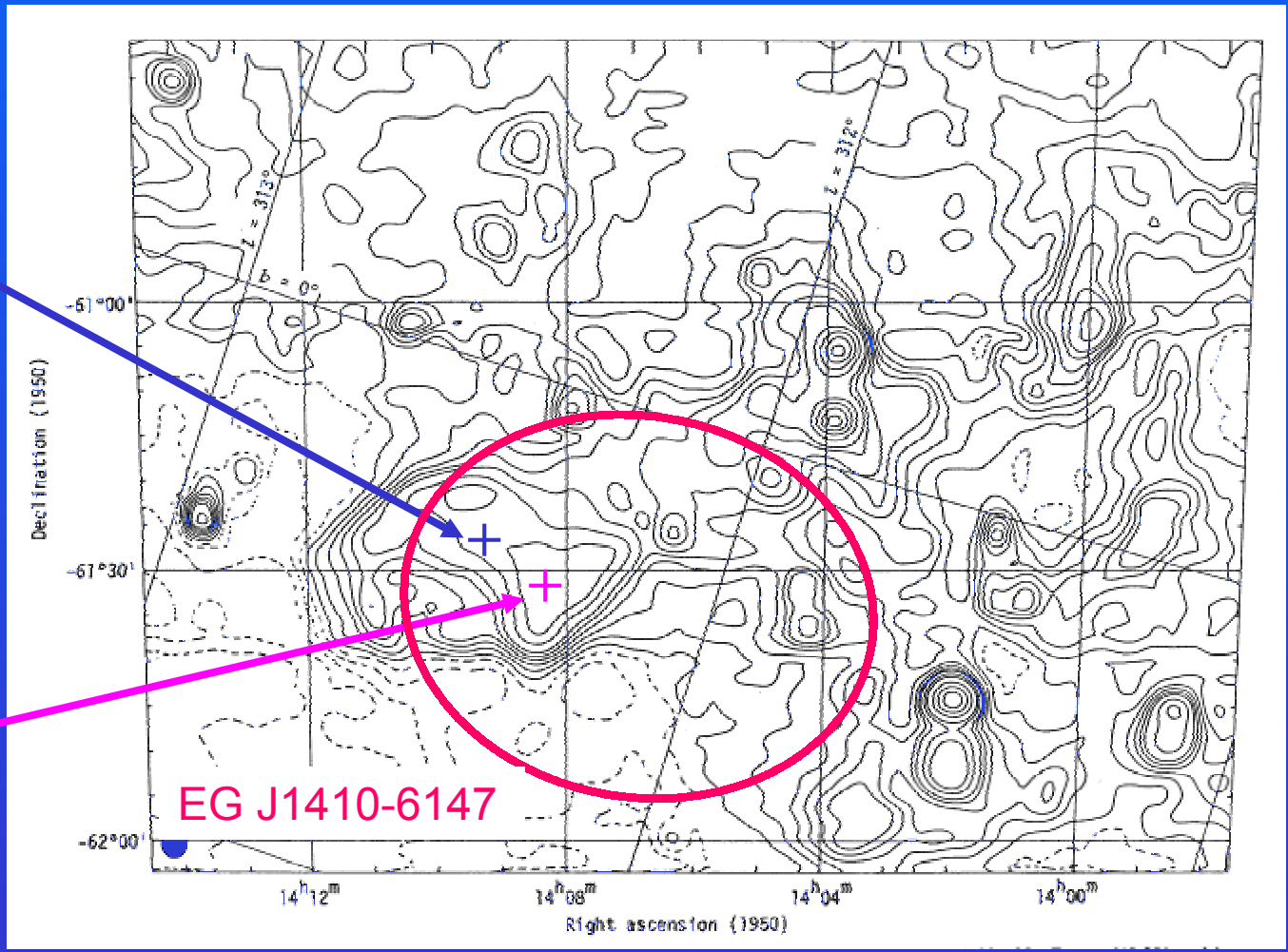
(Torres et al 2001)

PSR J1413-6141

285 ms, 14 kyr

PSR J1412-6145

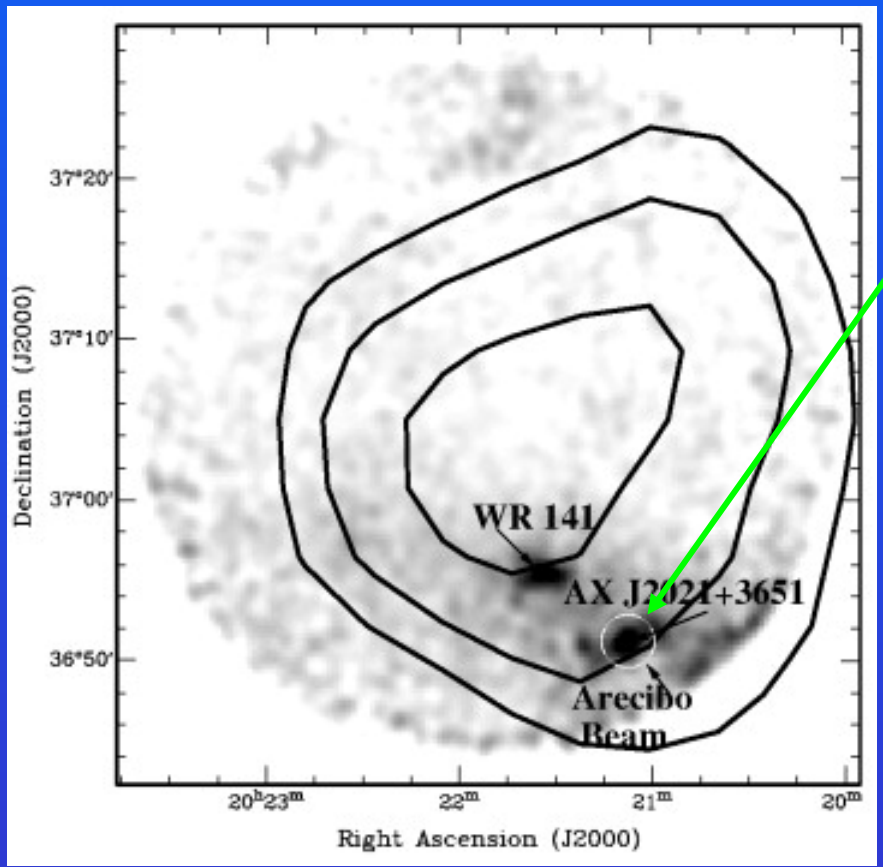
315 ms, 52 kyr



Caswell & Barnes 1985

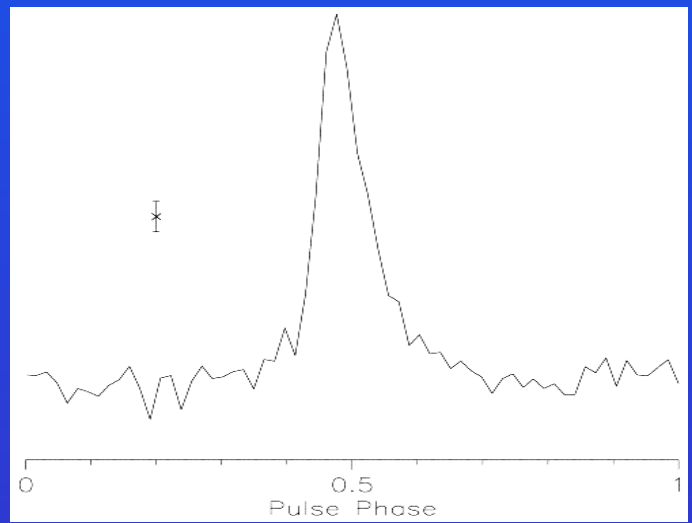
PSR J2021+3651 in EG J2021+3716

(Roberts et al 2002)



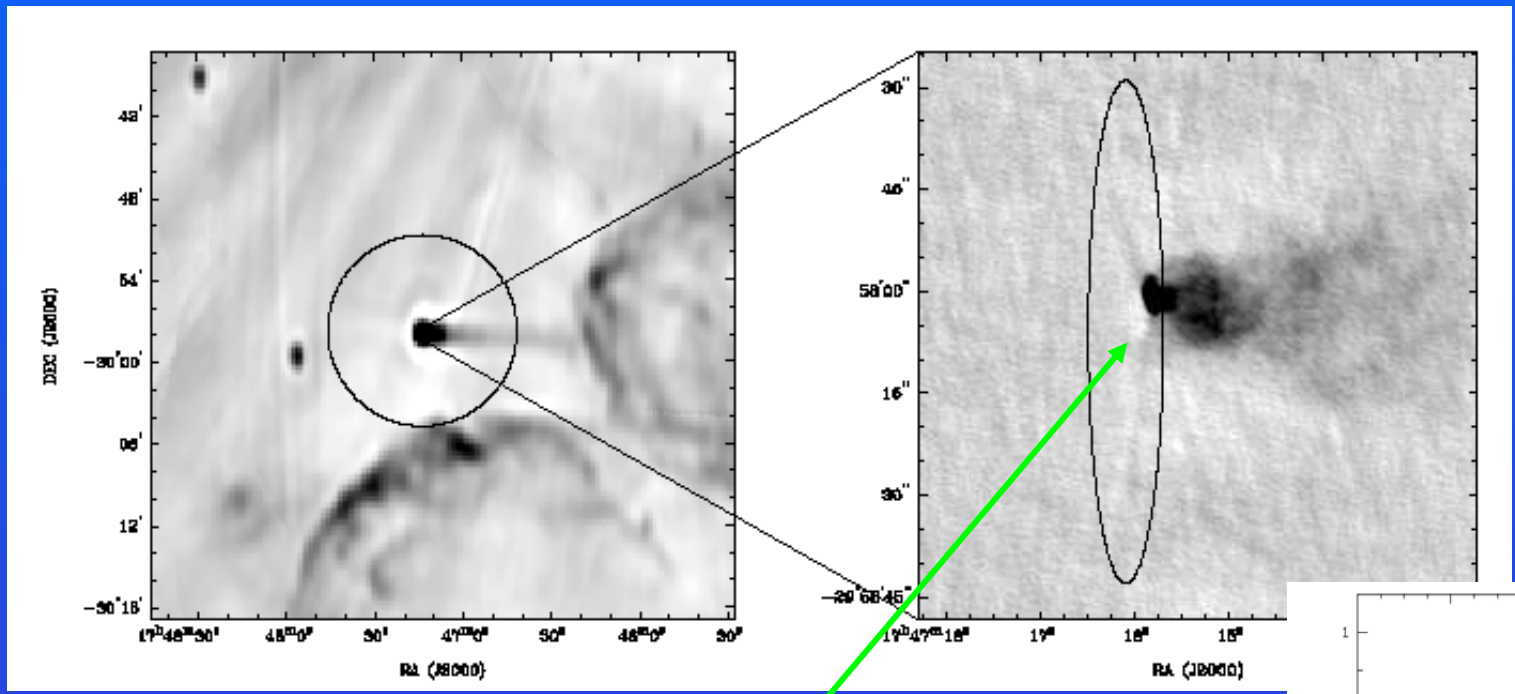
PSR J2021+3651

P = 104 ms, τ = 17 kyr



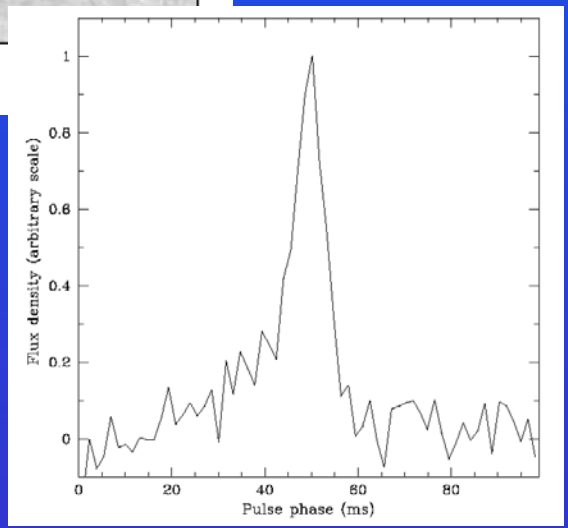
PSR J1747-2958 and the 'Mouse' nebula

(Camilo et al 2002)



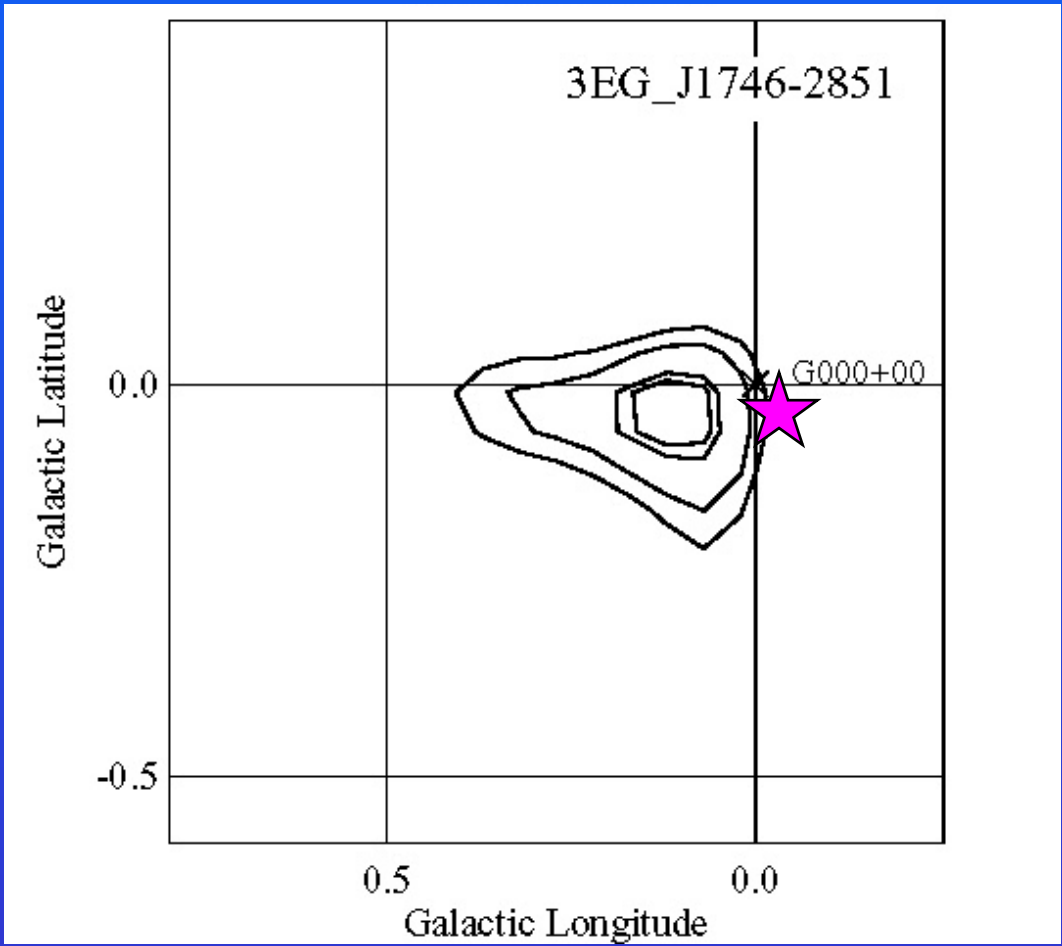
PSR J1747-2958

P = 98 ms, τ = 25 kyr



PSR J1747-2958 and the 'Mouse' nebula

(Camilo et al 2002)

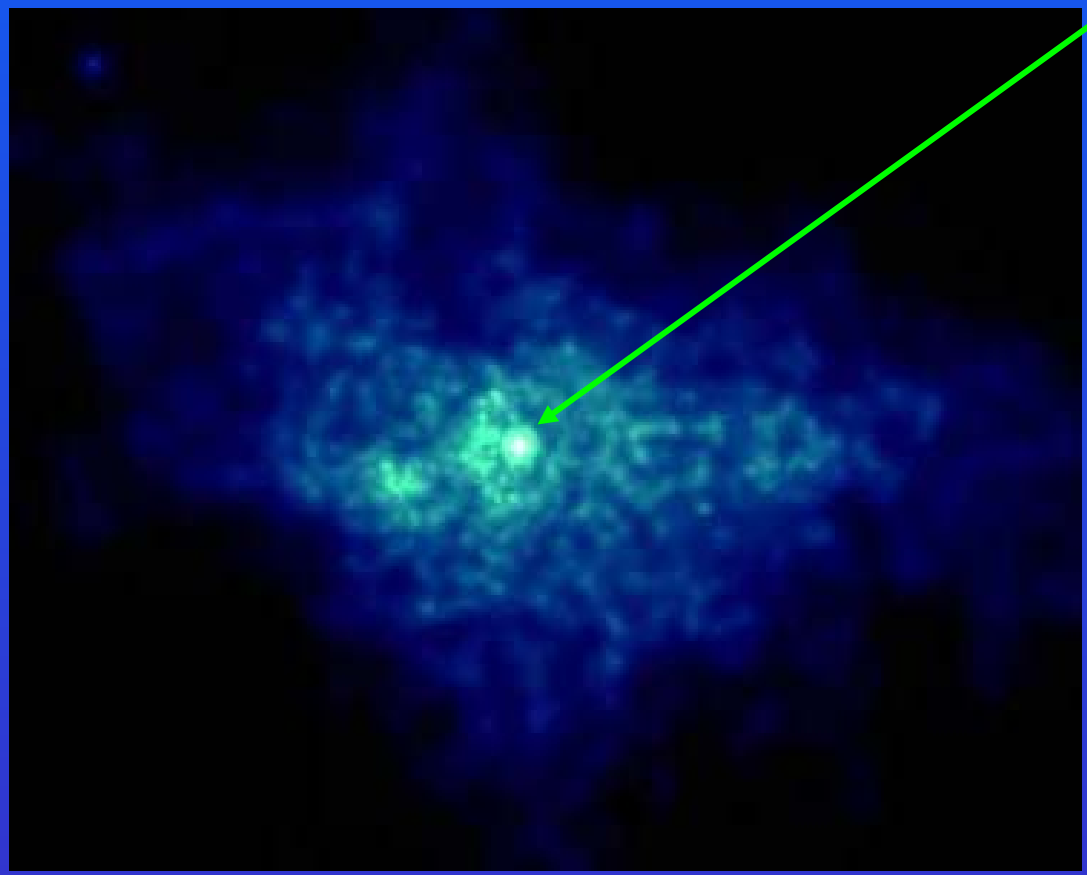


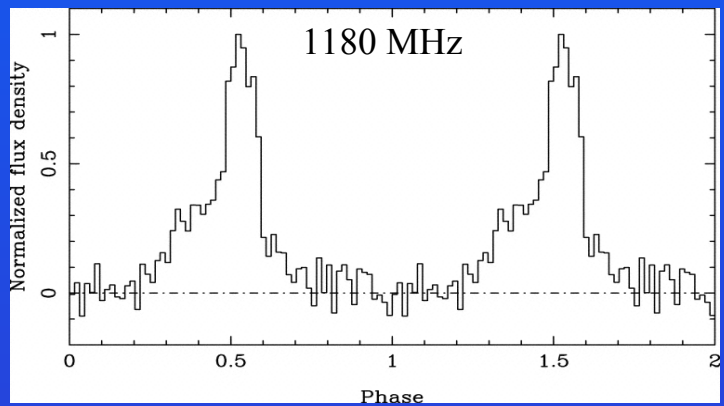
PSR J1930+1852 'Bull's Eye' pulsar in G54.1+0.3

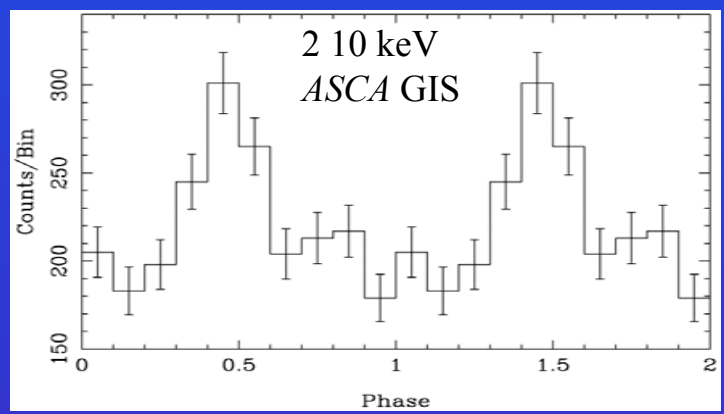
(Camilo et al 2002)

PSR J1930+1852

P = 136 ms, τ = 2.9 kyr

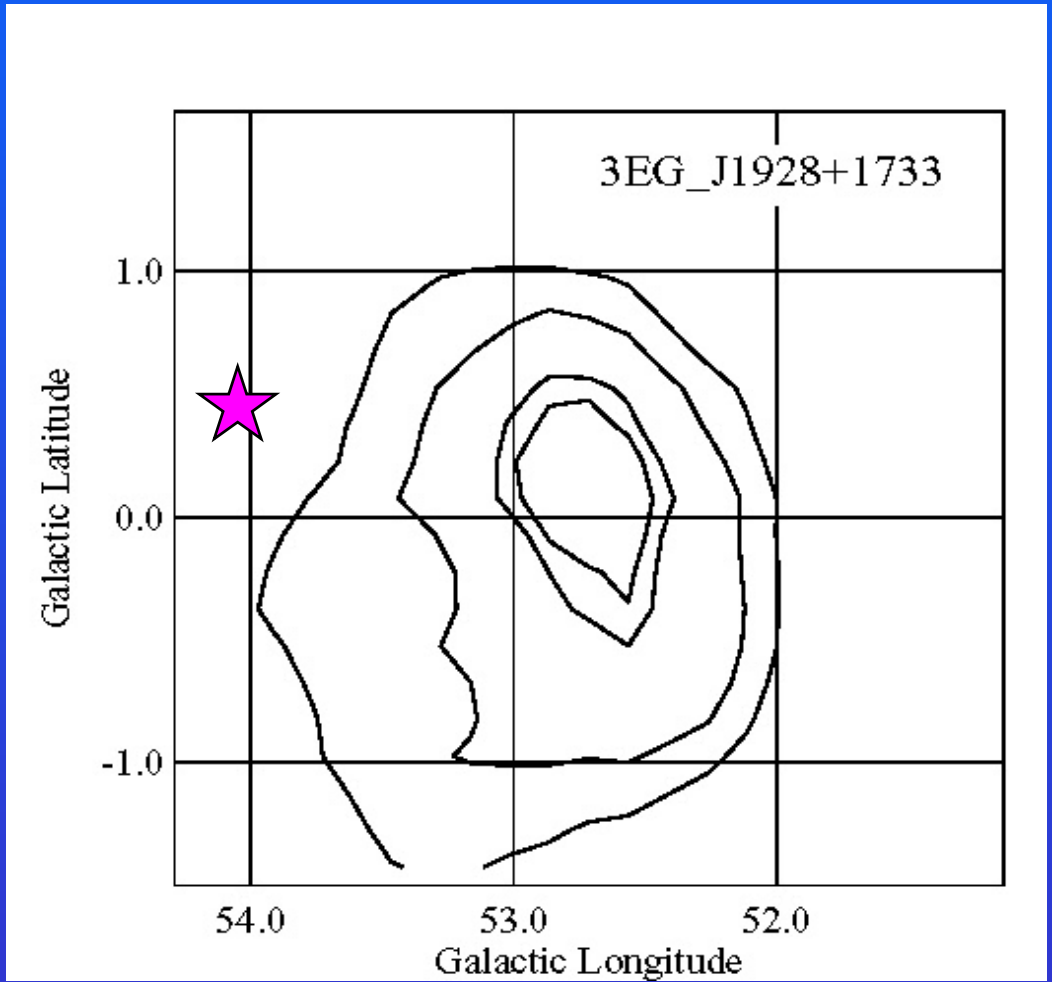






PSR J1930+1852 'Bull's Eye' pulsar in G54.1+0.3

(Camilo et al 2002)

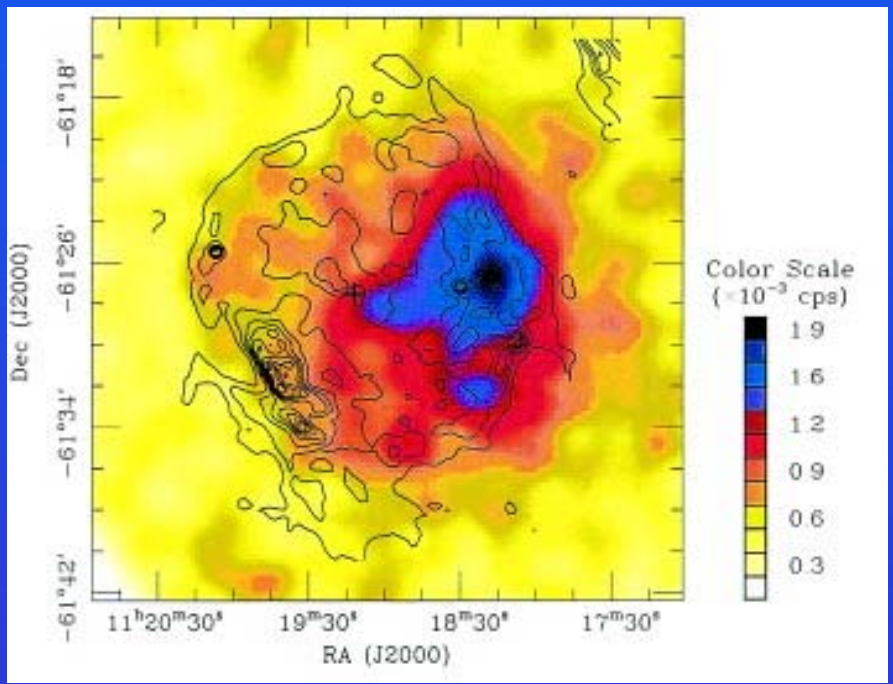


PSR J1119-6127 in SNR G292.2-0.5

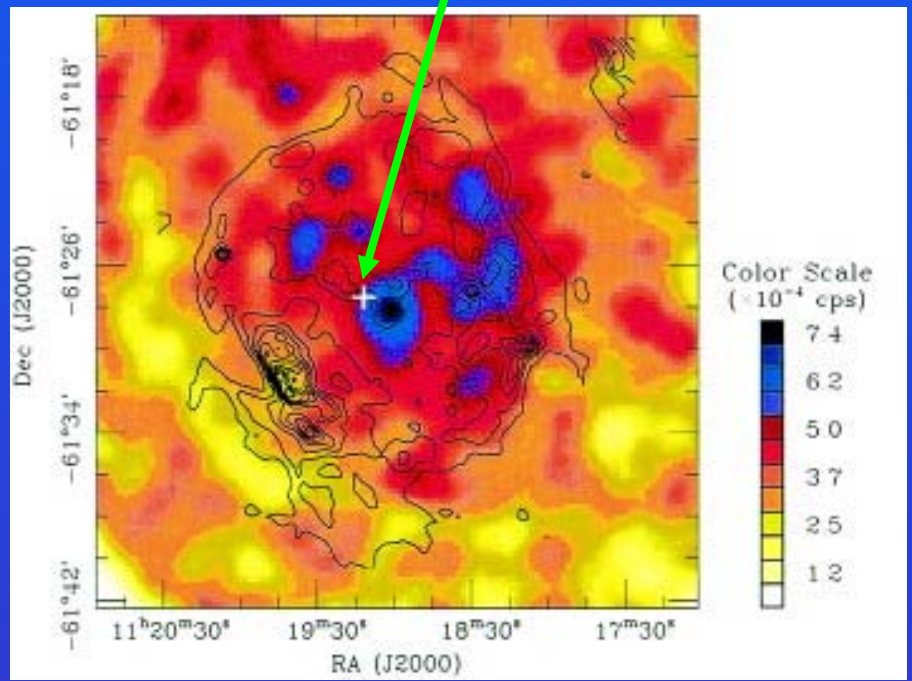
(Pivovaroff et al 2001)

PSR J1119-6127

407 ms, 1.6 kyr



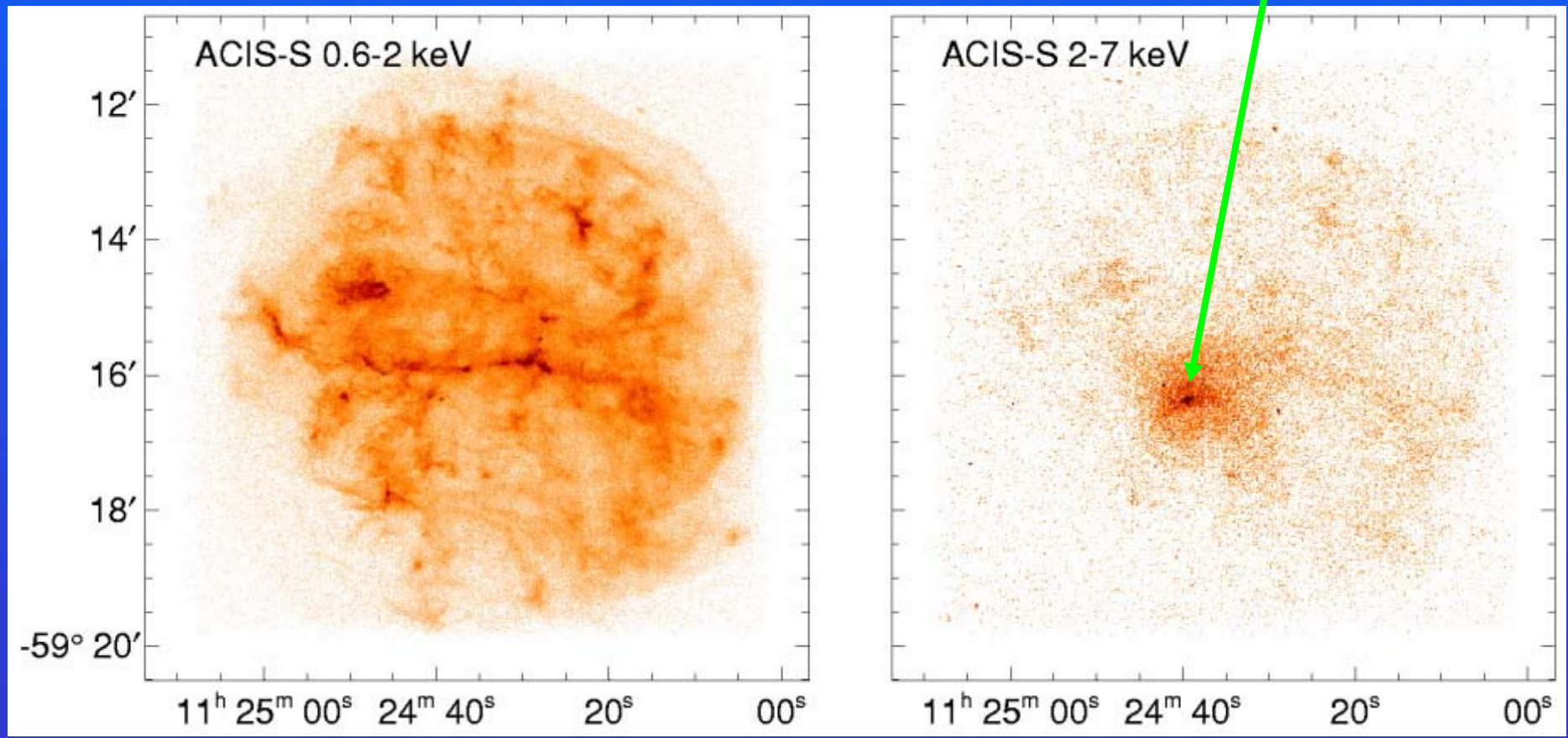
ASCA GIS – Soft band



ASCA GIS – Hard band

PSR J1124-5916 in SNR G292.0+1.8

(Camilo et al 2002)

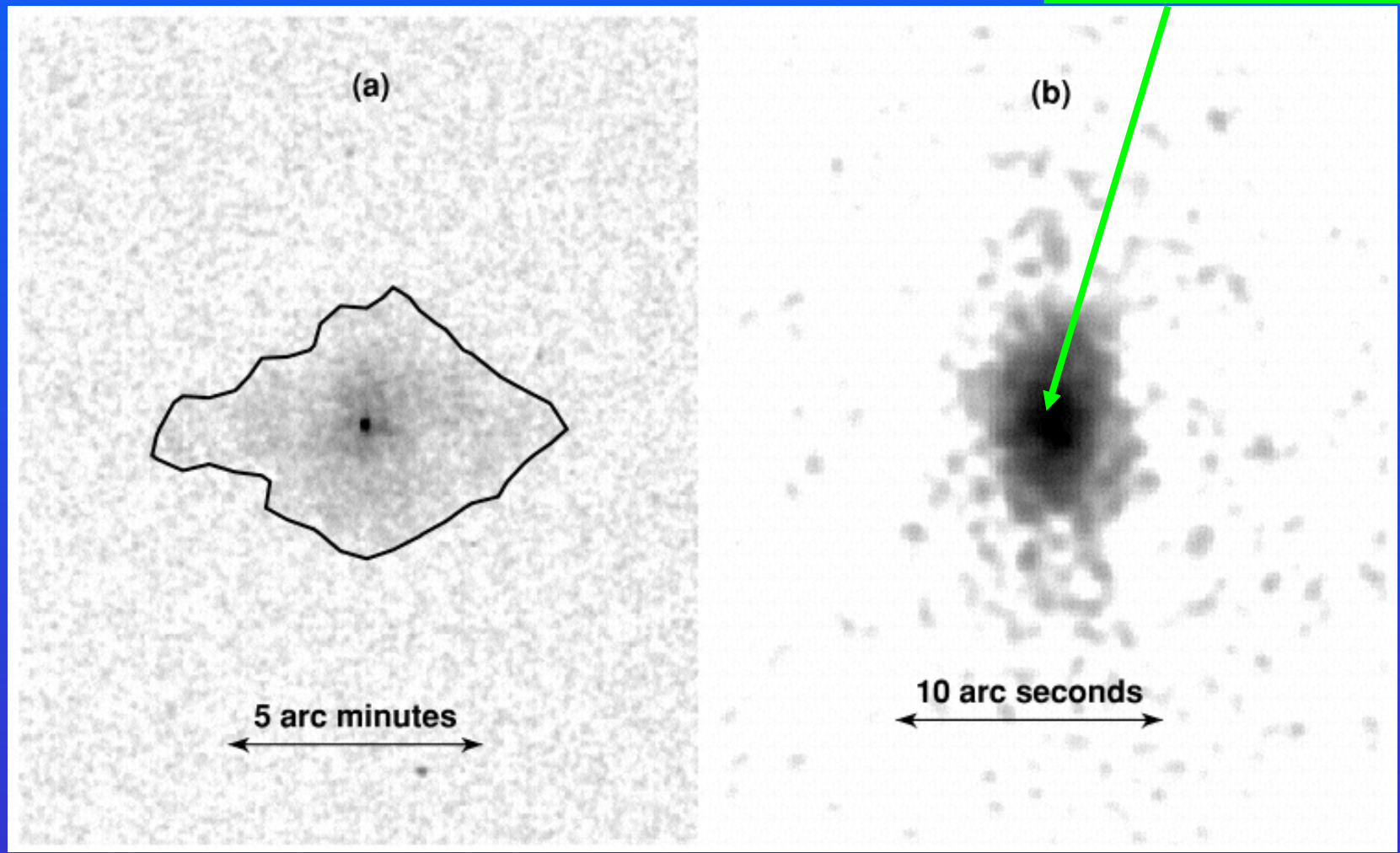


Hughes et al. 2001

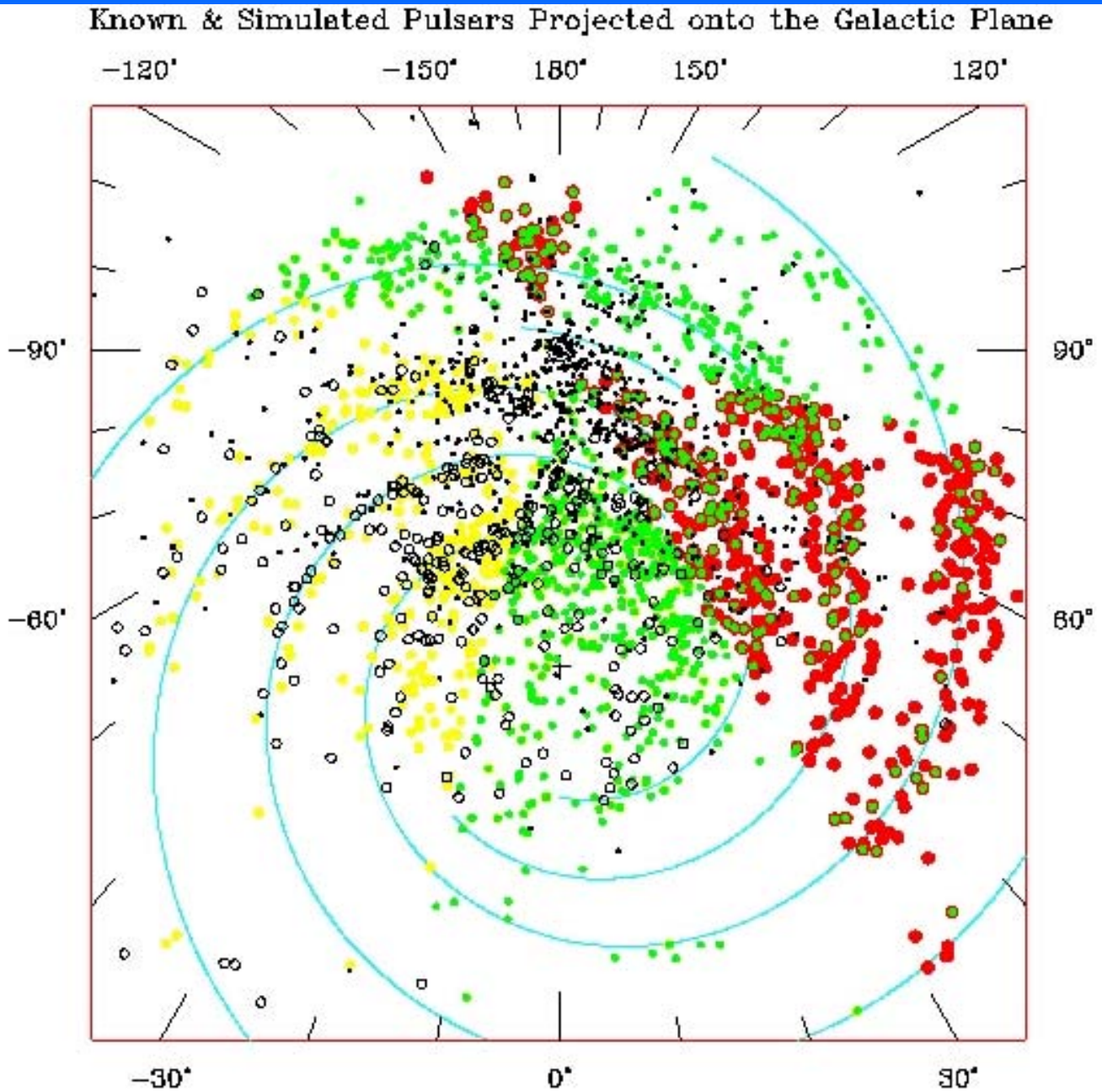
PSR J0205+6449 in SNR 3C 58

(Camilo et al 2002, Murray et al. 2002)

Youngest known radio pulsar



Arecibo Multibeam Surveys

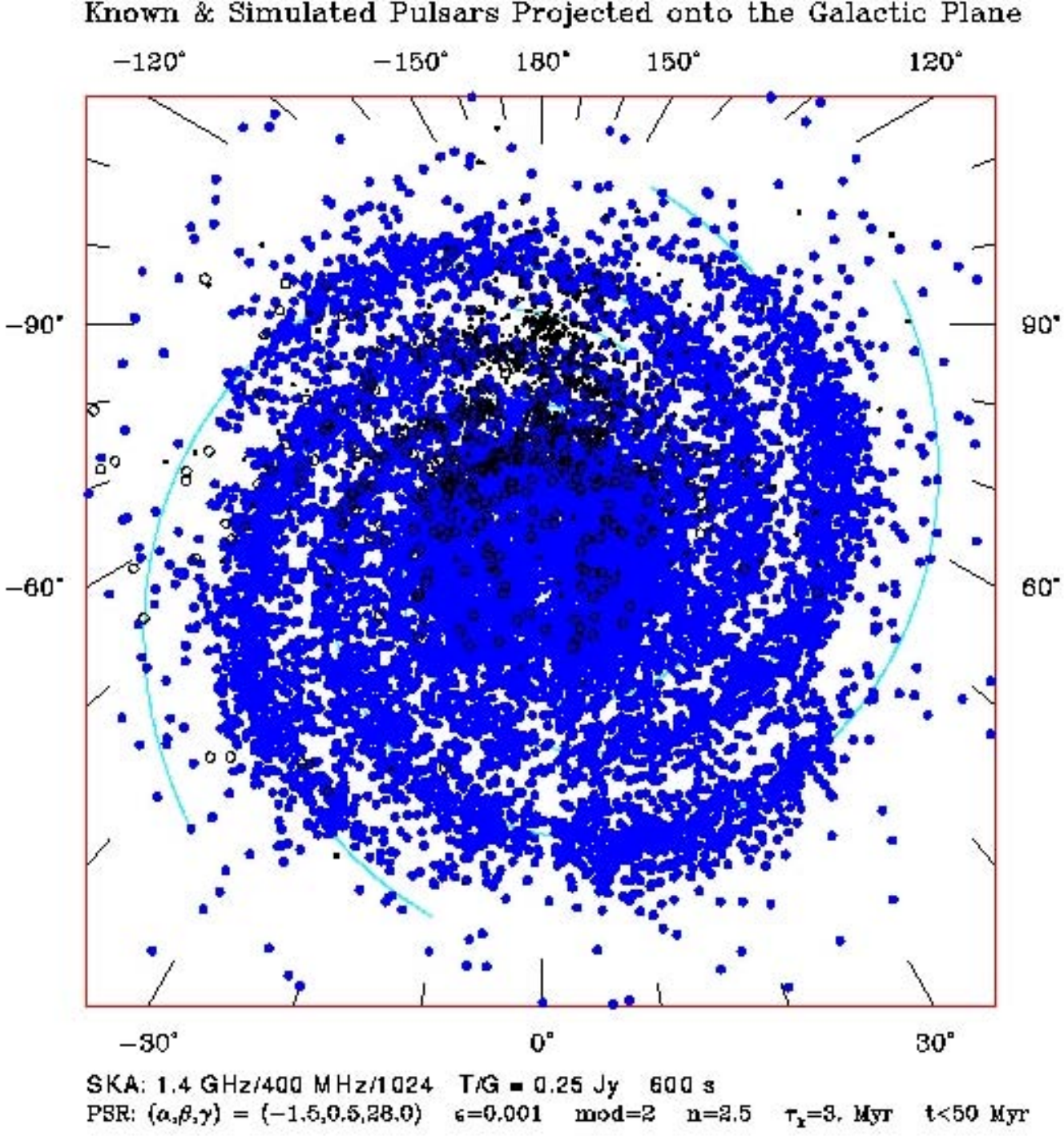


Surveys with Parkes, Arecibo & GBT.

Simulated & actual

Yield ~ 1000 pulsars.

Courtesy of Jim Cordes



SKA pulsar survey

600 s per beam

~10^4 psr's

Courtesy of Jim Cordes

Issues for GLAST

- **Source confusion**
  - **Multiple pulsars in close proximity**
  - **Background from PWN**
- **Coordinate radio timing**
  - **With pulsed searches**
  - **With LAT sky survey?**
- **Follow-up radio pulsar searches of GLAST sources**
  - **Radio beam sizes (Parkes 14', Arecibo 3')**