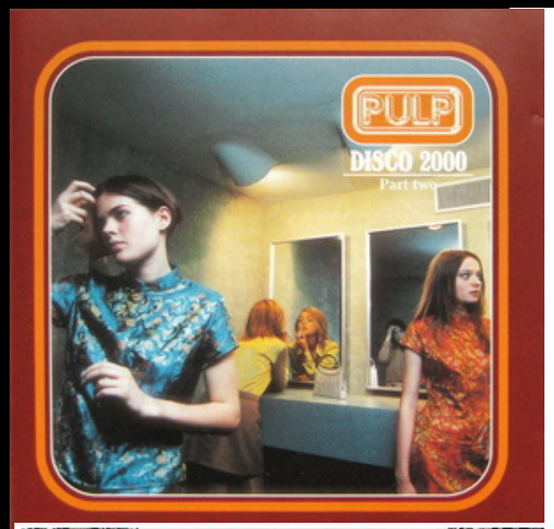
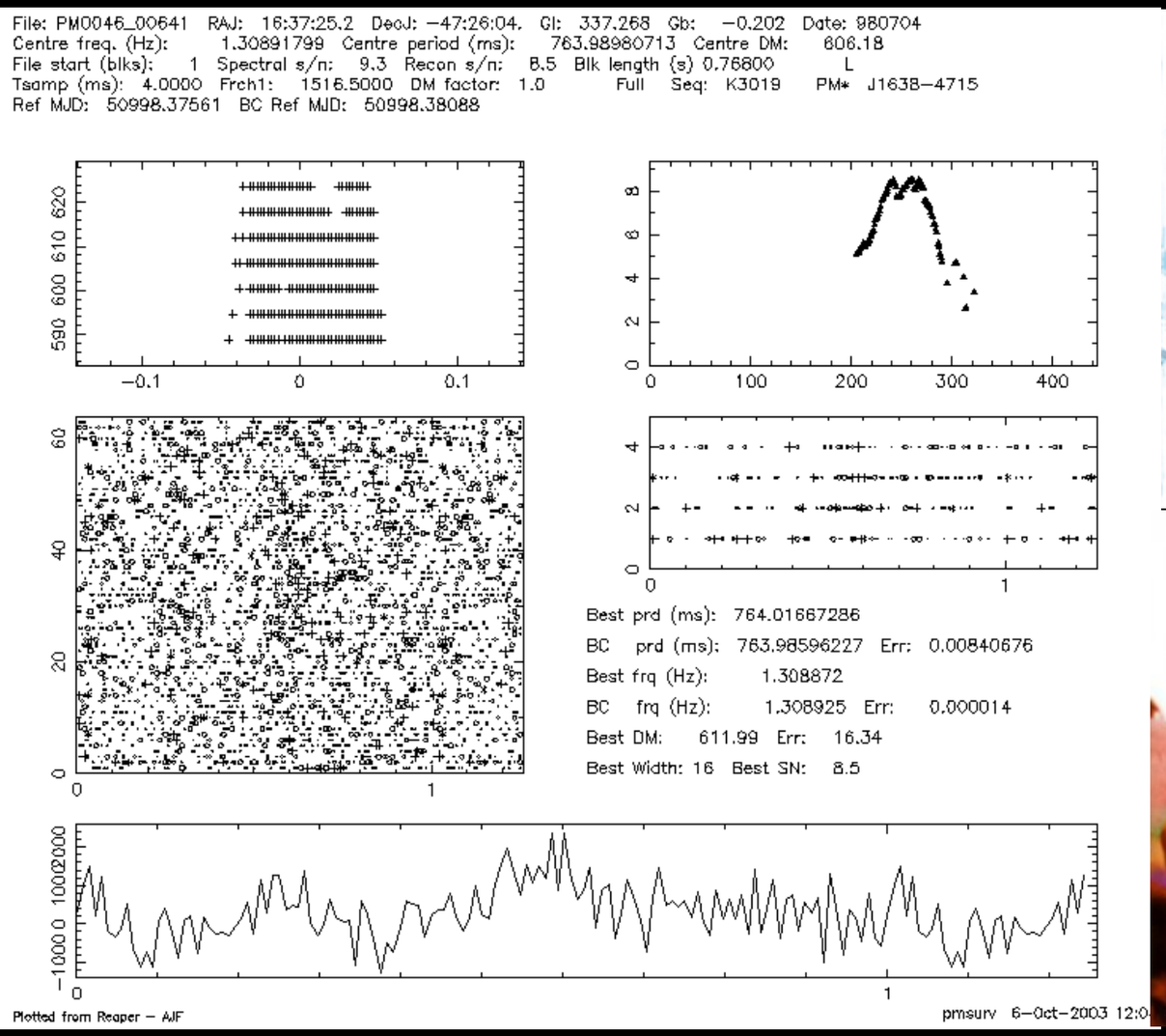
MPIfR Pulsar Journal Club, PSR J1638-4725

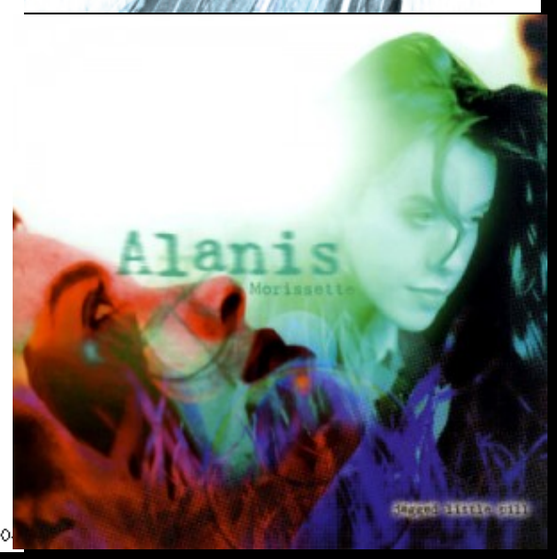
Ralph Eatough, 28/11/2018.

PSR J1638-4725

- Discovered in the Parkes multi-beam pulsar survey (PMPS) in an observation done in 1998.







http://www.jb.man.ac.uk/~pmsurv/class_plots/K3019_s.gif

Parkes multi-beam pulsar survey

- ~~Largest~~ and most successful pulsar survey ever completed (>800 pulsars as of 2013).

- 1.4 GHz ±5 degree strip along Galactic Plane, 13 beams, 35 minute integrations, x96 3 MHz frequency channels, 250 us 1-bit sampling.

Parkes Radio Telescope. Credit: CSIRO

Nichi D'Amico with AFB. Credit: J. Sarkissian

Parkes multi-beam pulsar survey

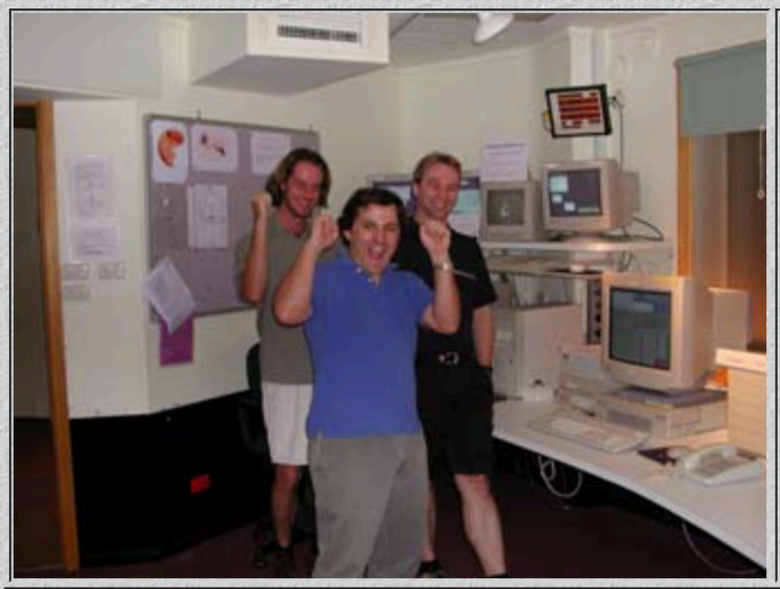
PMSURV Completed
14 March 2002.

Click on images to see the full-size versions

Michael Kramer, Paulo Freire and Dion Lewis begin the final pointing of PMSURV.

https://www.parkes.atnf.csiro.au/people/sar049/social/pmsurv/

Parkes multi-beam pulsar survey

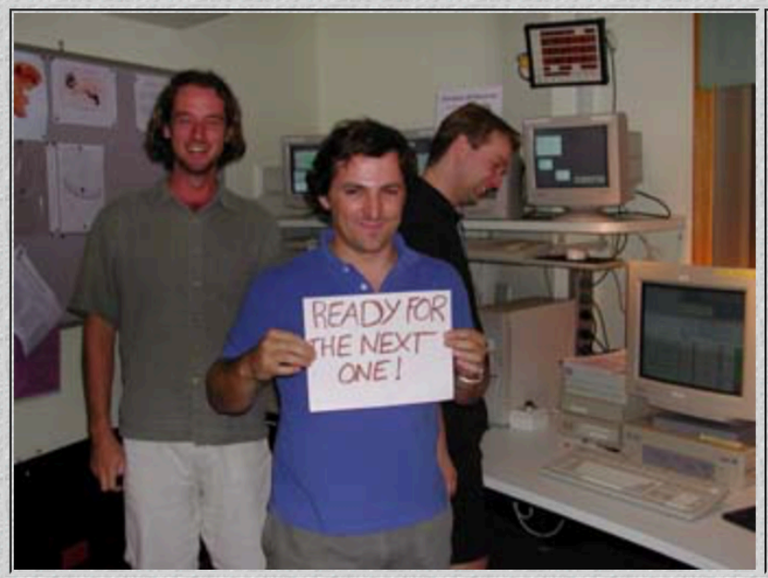


Ding Dong - it's over!

Over 600 pulsars found!

https://www.parkes.atnf.csiro.au/people/sar049/social/pmsurv/

Parkes multi-beam pulsar survey



What's next?

https://www.parkes.atnf.csiro.au/people/sar049/social/pmsurv/

PSR J1638-4725

- Binary system with high mass companion (>6 $M_\odot$), long orbital period (5.3 years), highest eccentricity (0.95) and with variable pulse dispersion and scattering near periastron (work by Lyne et al.).

P0: 0.7639 s, DM 552 units

- Puts PSR J1638-4725 in a similar class as other binaries with non-degenerate (or BH??) companions, e.g. PSRs B1259-63, J2032+4127.

Mon. Not. R. Astron. Soc. **372,** 777–800 (2006) doi:10.1111/j.1365-2966.2006.10887.x

The Parkes Multibeam Pulsar Survey – VI. Discovery and timing of 142 pulsars and a Galactic population analysis

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Accepted 2006 July 28. Received 2006 July 28; in original form 2006 July 11

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2651	J1824-2452D	fre08	0.776	0	fre08	misc
2652	B1820-11	cl86	0.794608	7	hlk+04	jb2,pksmb,htru_pks
2653	J0045-7319	mmh+91	0.807949	3	kbm+96	misc
2654	J1811-1736	lcm+00	0.828011	9	cks+07	pksmb,htru_pks
2655	J1824-2452C	fre08	0.847	0	fre08	misc
2656	B1259-63	jlm+92	0.86987970	6	sjm14	pks1,pksmb,htru_pks
2657	J0514-4002A	fgri04	0.8879773	3	frg07	misc
2658	J1638-4725	lfl+06	0.955	8	lfl+06	pksmb
2659	J2032+4127	aaa+09c	0.964	30	hnl+17	FermiBlind

[3]*Australia Telescope National Facility, CSIRO, PO Box 76, Epping, NSW 1710, Australia*
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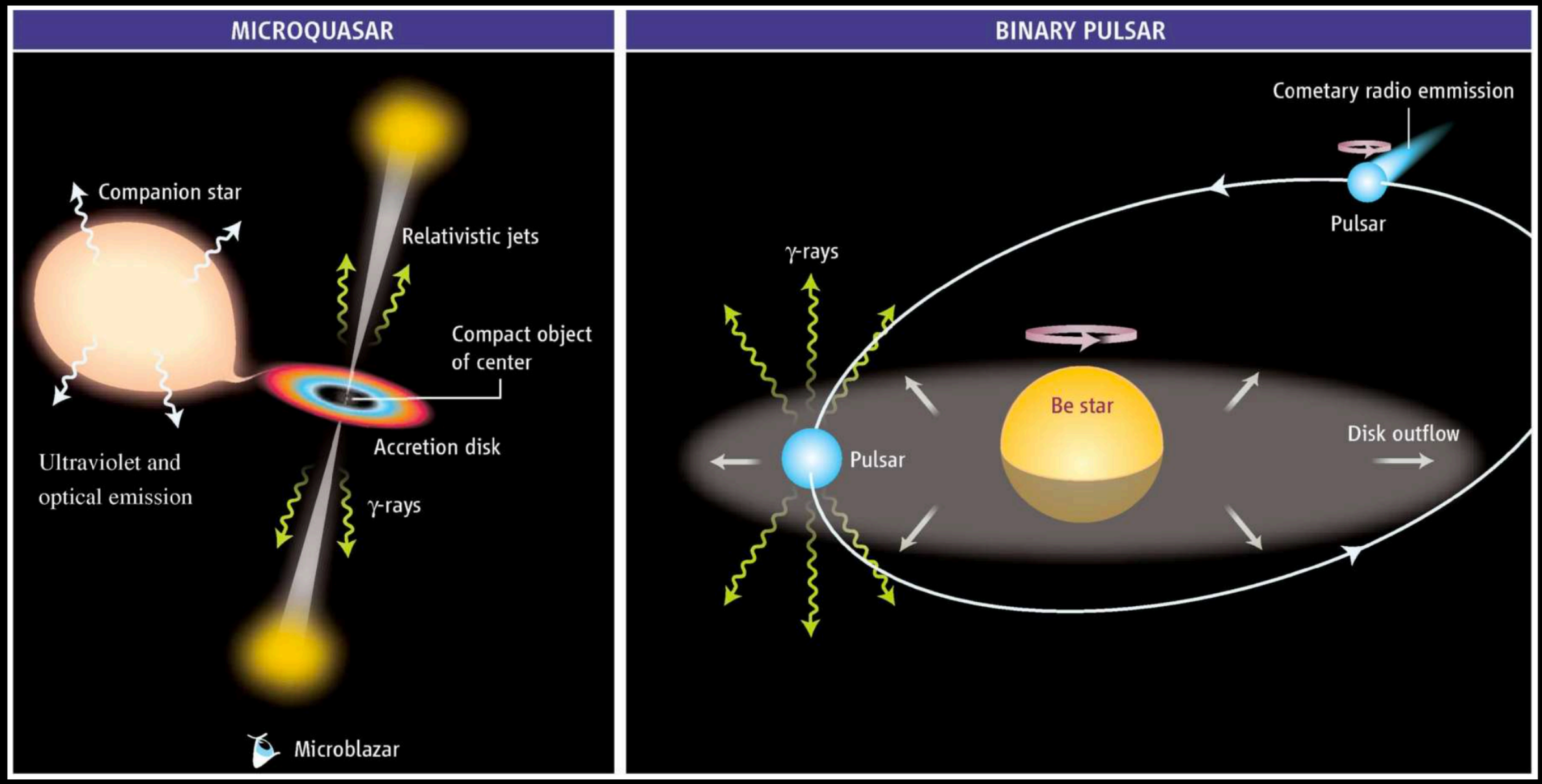
Why are PSR-(Be)Star binaries interesting?



Mirabel, Science, 2006.

Why are PSR-(Be)Star binaries interesting?

- Factories for production of some of the highest energy gamma-ray radiation (>100 GeV to TeV).—> Space & Ground based Cherenkov telescopes.

- PSR-Star's are precursor systems to more widespread HMXBs —> DNS.

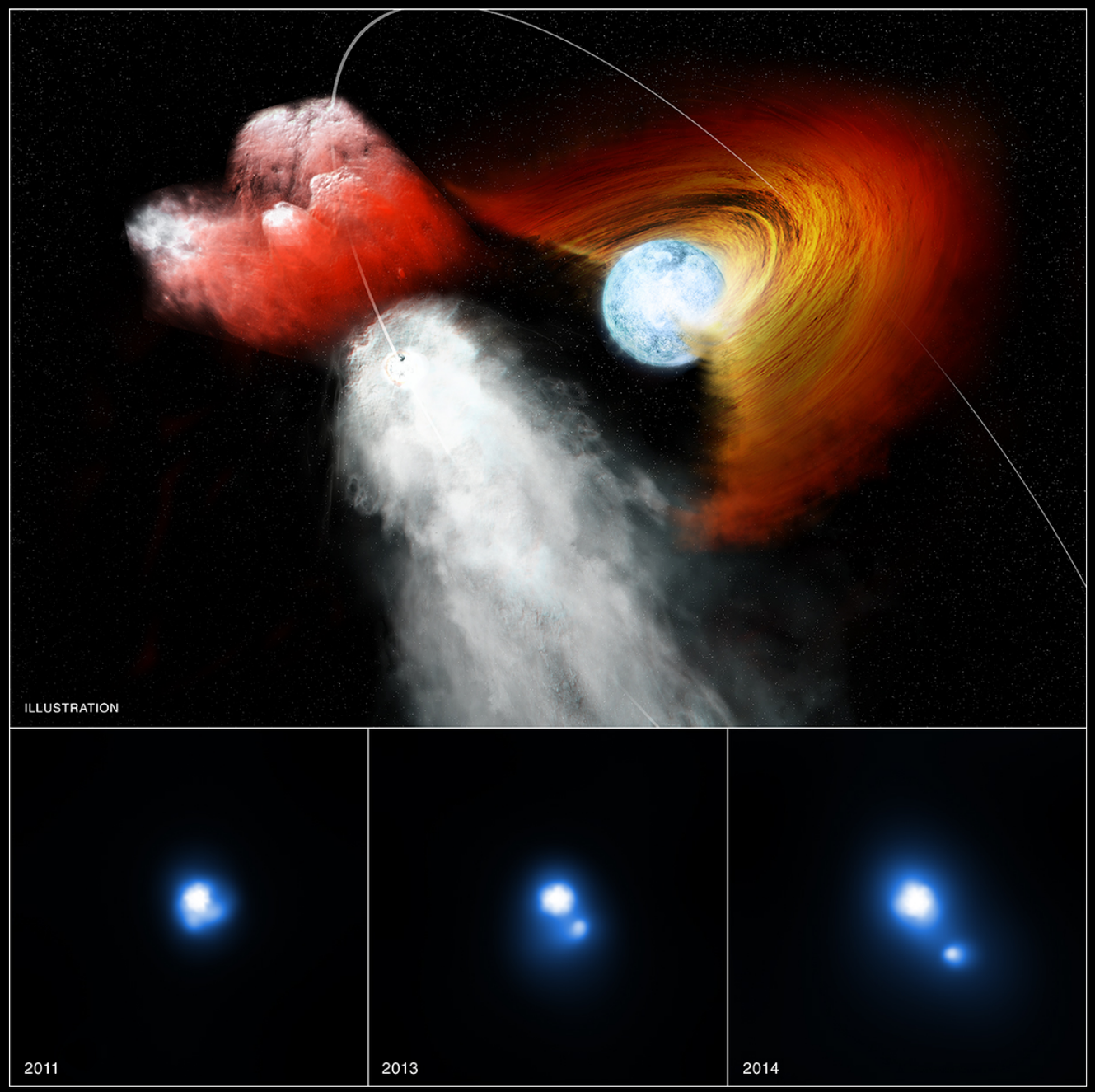
- Uniquely, pulsars act as a magneto ionic probes of stellar outflows (through changes in DM, RM and scattering).

PSR B1259-63

- Observational results from PSR B1259-64:

Chandra X-ray observations reveal Hole punched through stellar disk. Pavlov et al. 2015.

Image credit: NASA/CXC/PSU/ G.Pavlov et al



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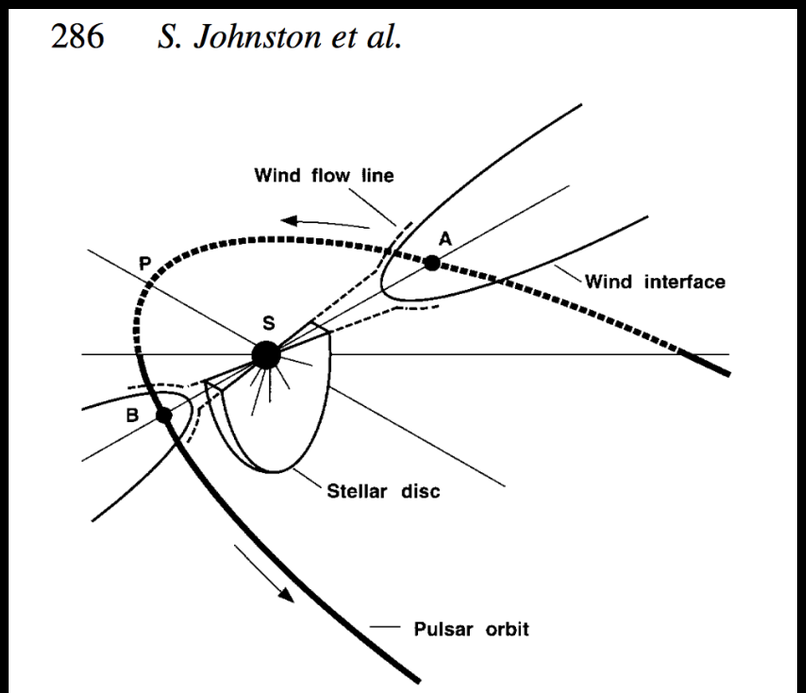


Figure 6. A schematic diagram showing the interaction of the wind from PSR B1259−63 with the disc of the Be star SS 2883. The pulsar moves around the orbit as indicated (the dashed portion of the orbit is behind the plane of the sky), passing behind the stellar disc before periastron (P). The stellar disc is believed to be inclined to the orbital plane, and so the pulsar passes through it twice, before periastron (A) and after periastron (B). The pulsar wind bubble is blown into a cometary shape by the ram pressure of the wind in the stellar disc.

2 “impacts” through edge on stellar disc, Johnston et al. 1999.

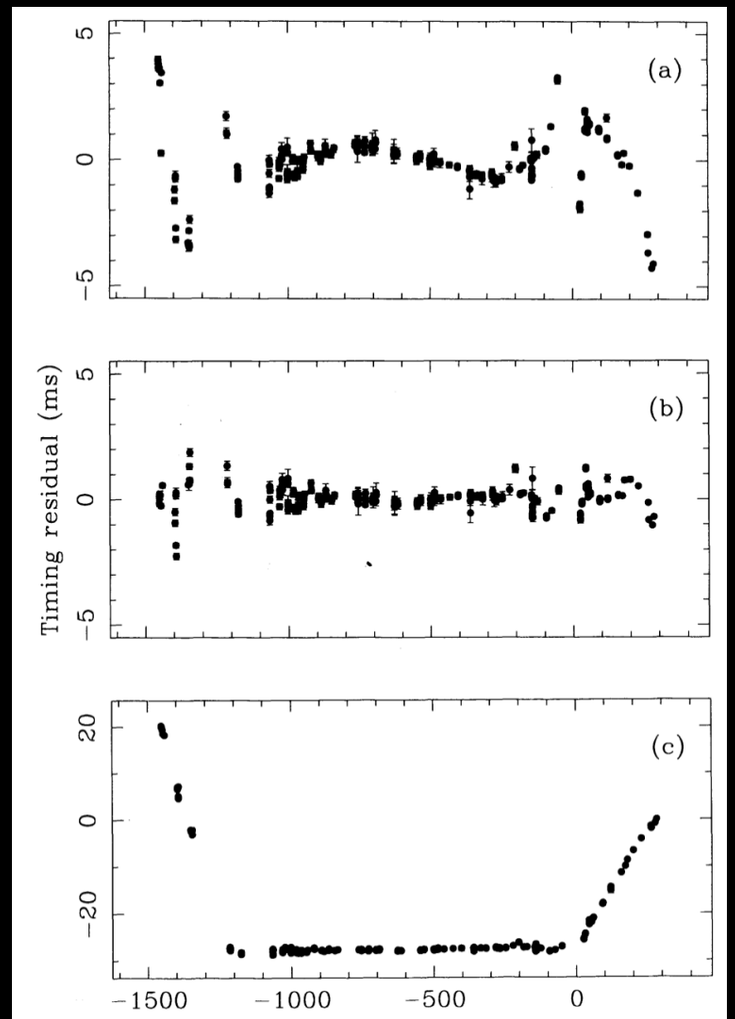


FIG. 1.—Timing residuals for PSR B1259−63. (*a*) Postfit residuals after solving for pulsar and binary parameters but not changes in pulsar period at periastron. (*b*) Postfit residuals after solving for pulsar and binary parameters including period steps at the two periastrons. (*c*) Prefit residuals corresponding to solution (*b*) showing the effect of the steps in period at periastron.

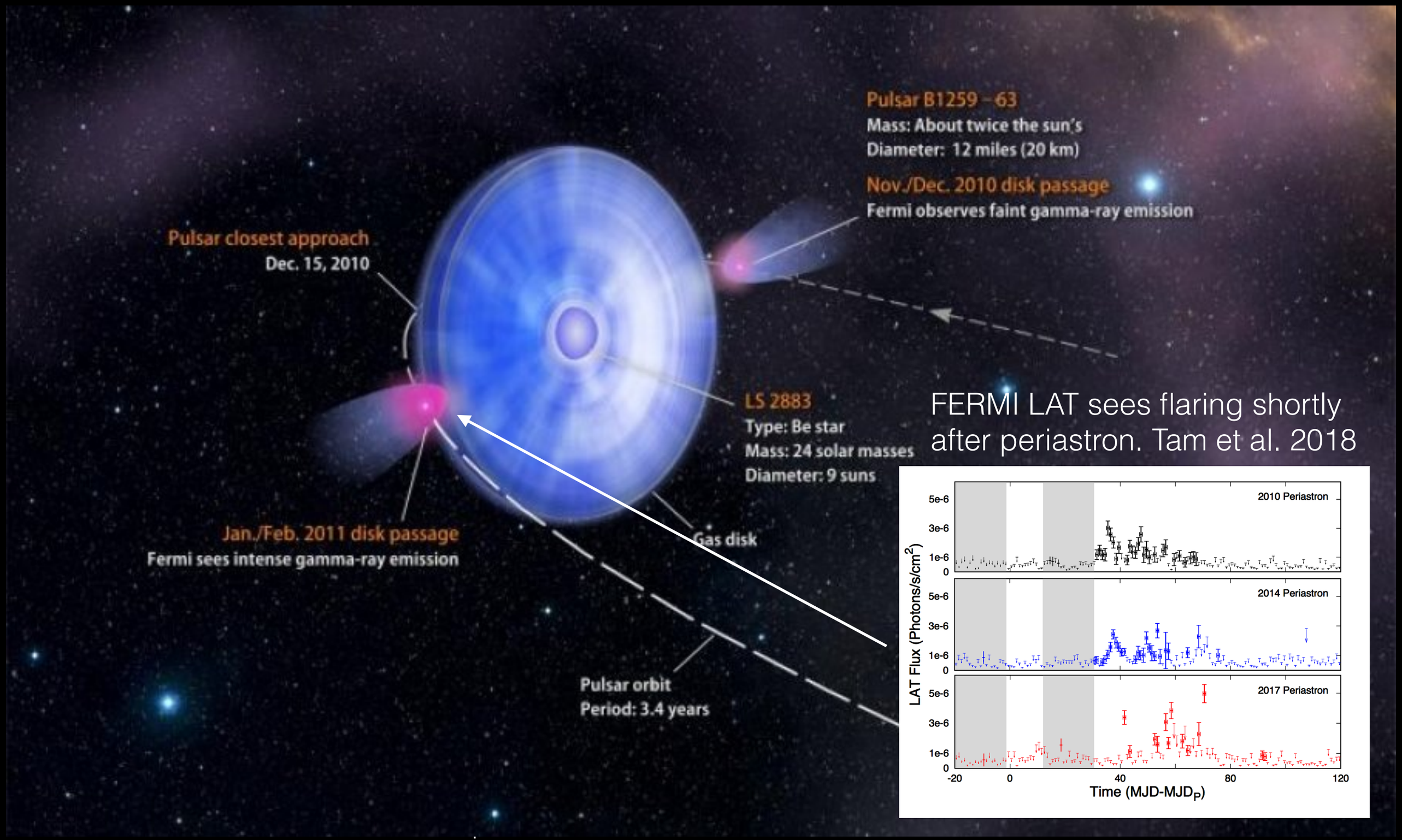
Distinct “propeller torques” near periastrons, Manchester et al. 1993.

Table 1. DM and RM variations and the inferred magnetic field for the 2004 periastron observations. The error in DM is typically 0.2 cm^{-3} pc.

Date	Day	ΔDM ($cm^{-3}pc$)	RM (rad m^{-2})	$B_{\|\|}$ (mG)
2004 Jan 27	−39.8	3.0	−3100 ± 300	−1.3 ± 0.1
2004 Jan 29	−37.7	2.5	−3800 ± 400	−1.9 ± 0.2
2004 Jan 31	−35.7	3.4	+1700 ± 200	+0.6 ± 0.1
2004 Feb 02	−33.7	5.6		
2004 Feb 04	−31.7	4.0	−1500 ± 200	−0.5 ± 0.1
2004 Feb 06	−29.7	3.9		
2004 Feb 08	−27.7	5.9		
2004 Feb 10	−25.7	4.9	+11500 ± 1100	+2.9 ± 0.3
2004 Feb 12	−23.7	5.3		
2004 Feb 14	−21.7	5.5		
2004 Feb 17	−18.8			
2004 Feb 18	−17.8	19.5		
2004 Feb 20	−15.8			
2004 Mar 23	16.1	3.2		
2004 Mar 25	18.1			
2004 Mar 28	21.2	1.0		
2004 Mar 29	22.1	1.2		
2004 Mar 31	24.1	0.8	+6000 ± 600	+10 ± 3
2004 Apr 02	26.2	0.7	−2500 ± 300	−4.5 ± 1.4
2004 Apr 04	28.2	0.5	−280 ± 30	−0.7 ± 0.3
2004 Apr 08	32.2	0.4	−500 ± 50	−1.4 ± 0.7
2004 Apr 14	38.2	0.4	−1080 ± 100	−3.3 ± 1.6
2004 Apr 22	46.1	0.2	−360 ± 40	−2 ± 2

RM variation —> magnetic field variation, Johnston et al. 2005.

PSR B1259-63



FERMI LAT sees flaring shortly after periastron. Tam et al. 2018

PSR B1259-63

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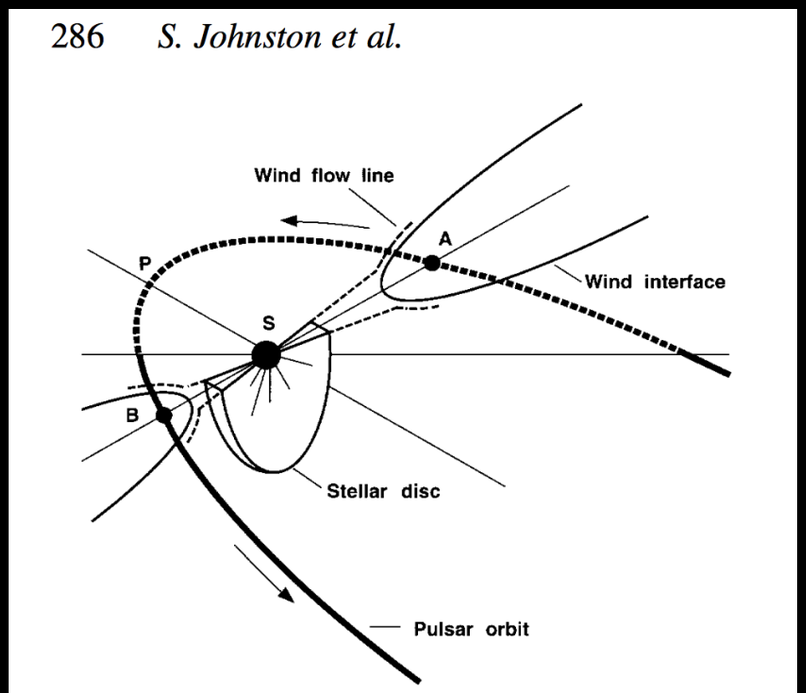

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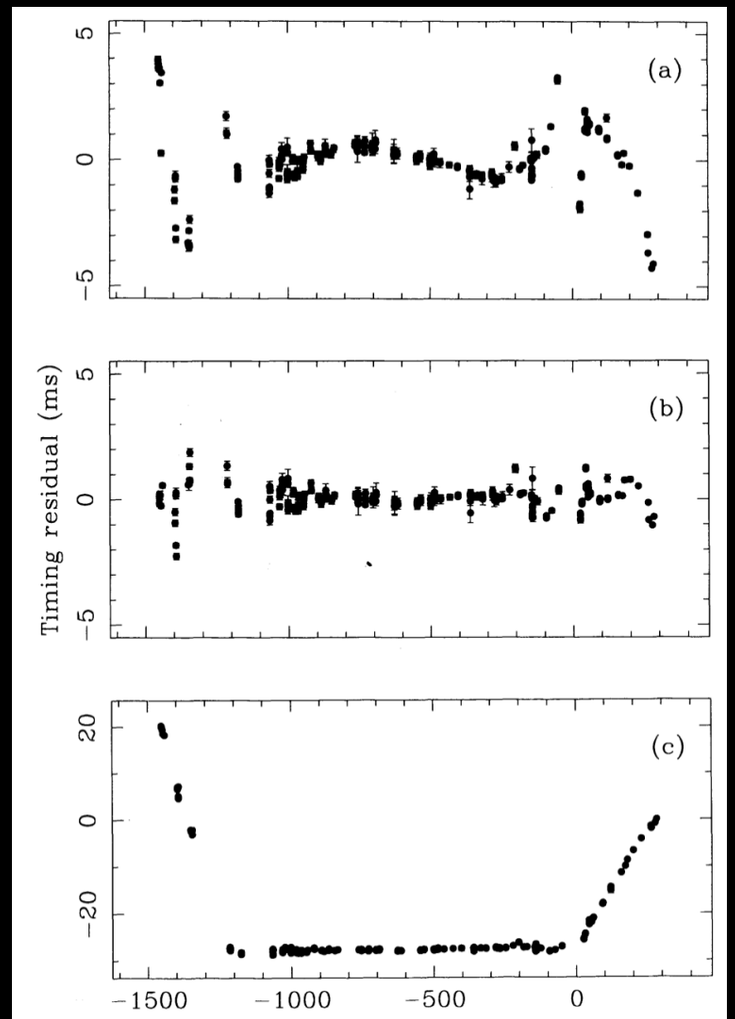

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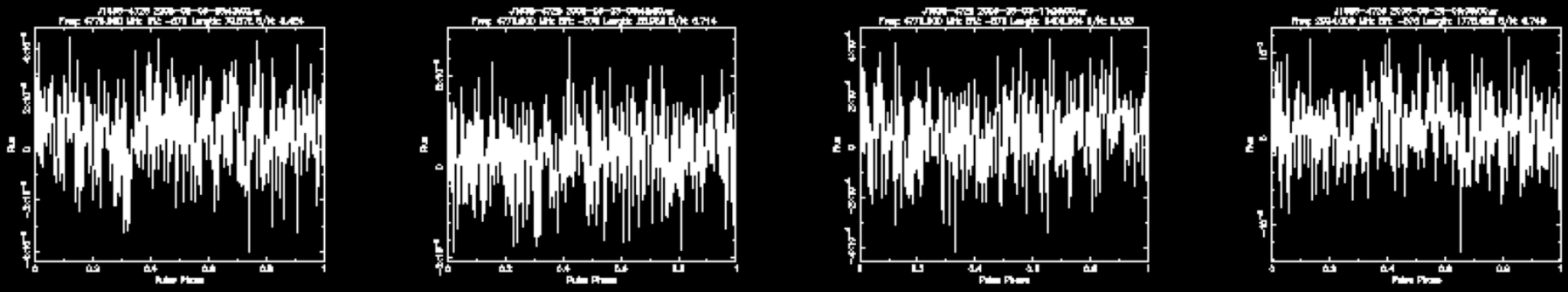
- Can clearly see radio pulsations are shut down near periastron. Higher frequencies at Parkes, e.g. X-band no longer possible.

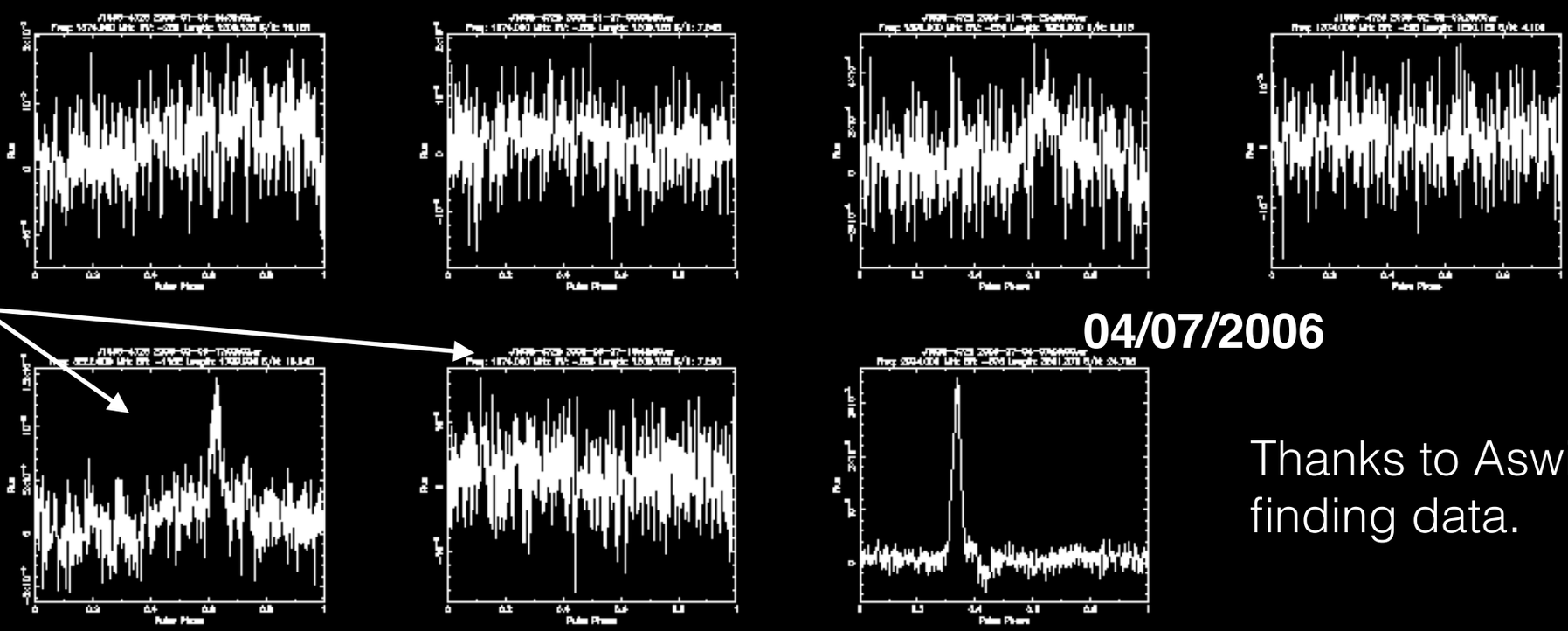
PSR J1638-4725

03/05/2005

- Ca stron.
  Hig ble.



Adjacent days



04/07/2006

-

Thanks to Aswin for finding data.

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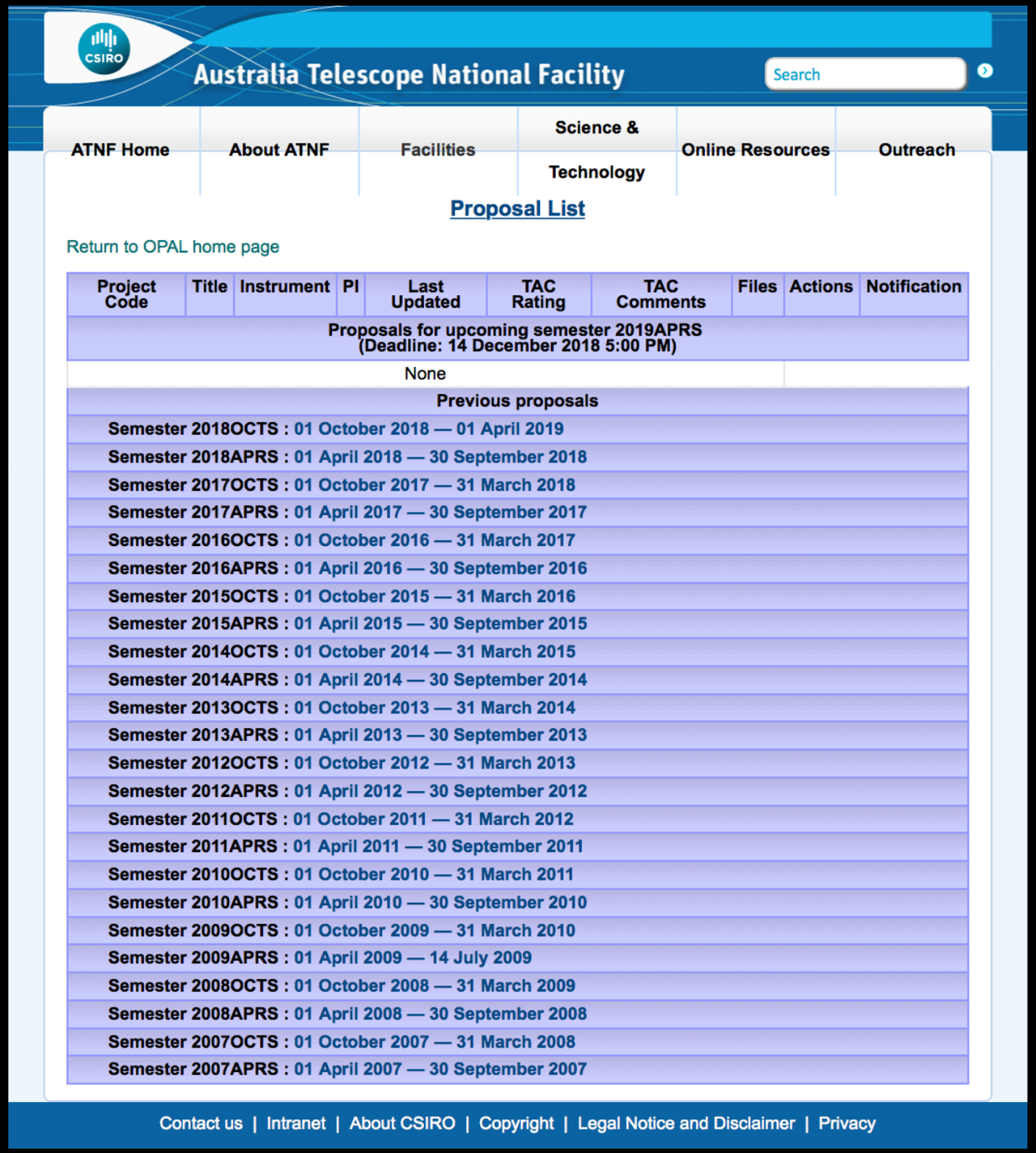
- Emission shut down occurs on extremely short timescales (10's of minutes!).

- ~465 observations with the Analog Filter Bank going back to 1999.

- ~X obs with Digital Filter Bank —> polarisation properties.

PSR J1638-4725

- For reference, Parkes proposals:



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Previous proposals									
Semester 2018OCTS : 01 October 2018 — 01 April 2019									
Semester 2018APRS : 01 April 2018 — 30 September 2018									
Semester 2017OCTS : 01 October 2017 — 31 March 2018									
Semester 2017APRS : 01 April 2017 — 30 September 2017									
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Semester 2016APRS : 01 April 2016 — 30 September 2016									
Semester 2015OCTS : 01 October 2015 — 31 March 2016									
Semester 2015APRS : 01 April 2015 — 30 September 2015									
Semester 2014OCTS : 01 October 2014 — 31 March 2015									
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Semester 2010OCTS : 01 October 2010 — 31 March 2011									
Semester 2010APRS : 01 April 2010 — 30 September 2010									
Semester 2009OCTS : 01 October 2009 — 31 March 2010									
Semester 2009APRS : 01 April 2009 — 14 July 2009									
Semester 2008OCTS : 01 October 2008 — 31 March 2009									
Semester 2008APRS : 01 April 2008 — 30 September 2008									
Semester 2007OCTS : 01 October 2007 — 31 March 2008									
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