Polarization Observations of 20 millisecond pulsars

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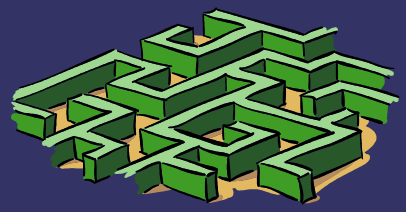

Outline

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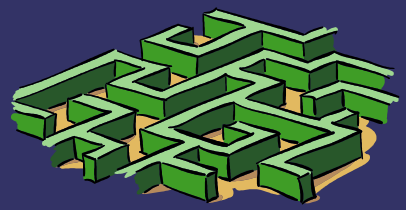
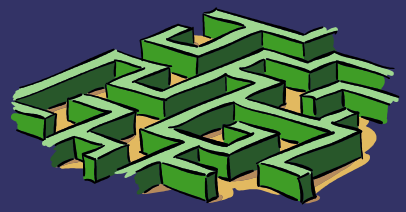


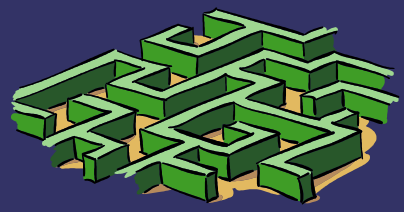
Background

- Pulsars are highly polarized radio sources.
- Polarization measurements can give us a lot of information.
- MSPs have very different properties to those of 'normal' pulsars.
- The polarization characteristics of MSPs are remarkably similar to those of normal pus-lars.
- The PA variaitons in MSPs are often com-plex and do not fit the RVM well.



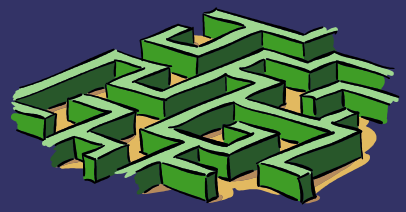
Observations(1/3)

- The observations were made using the centre beam of the Parkes 20cm Multibeam receiver with PDFB2 between 2007 June and 2009 November.
- The total bandwidth was 256 MHz centred at 1369 MHz with 1024 channels across the band for most of the 20 pulsars.
- 17 pulsars were observed for 64 minutes each time, and 32 minutes for the other 3 pulsars (PSRs J1857+0943, J1939+2134, J2124-3358).



Observation(2/3)

- All data were recorded using the PSRFITS data format with 1-minute sub-integrations.
- A 2-minute calibration observation was made before each pulsar observation.
- Flux density scales were established using observations of Hydra A.
- Cross coupling between the two signal feed probes of the MB receiver was measured.



Observations(3/3)

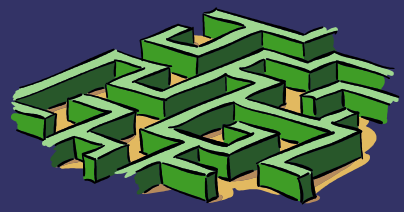
Table 1. Observational parameters for the 20 PPTA MSPs

PSR	P (ms)	DM (cm^{-3} pc)	Nr of Channels	Nr of Bins	DM Smear (bins)	Nr of Obs.	Integ. Time (h)
J0437−4715	5.757	2.64	1024	1024	0.4	92	96.3
J0613−0200	3.062	38.78	1024	512	5.2	41	43.3
J0711−6830	5.491	18.41	1024	512	1.4	28	29.1
J1022+1001	16.453	10.25	1024	2048	1.0	34	34.3
J1024−0719	5.162	6.49	1024	1024	1.0	29	30.0
J1045−4509	7.474	58.17	2048	512	1.6	33	34.1
J1600−3053	3.598	52.33	1024	512	6.0	28	29.7
J1603−7202	14.842	38.05	1024	1024	2.1	23	23.7
J1643−1224	4.622	62.41	1024	512	2.8	34	36.1
J1713+0747	4.570	15.99	1024	1024	2.9	40	40.7
J1730−2304	8.123	9.62	1024	1024	1.0	23	23.7
J1732−5049	5.313	56.82	2048	512	2.2	24	24.7
J1744−1134	4.075	3.14	512	1024	1.3	33	34.4
J1824−2452	3.054	120.50	2048	256	4.1	27	28.0
J1857+0943	5.362	13.30	1024	1024	2.1	26	13.4
J1909−3744	2.947	10.39	1024	512	1.5	67	69.6
J1939+2134	1.558	71.04	1024	256	9.4	26	13.8
J2124−3358	4.931	4.60	1024	1024	0.8	25	13.1
J2129−5721	3.726	31.85	1024	512	3.5	25	25.5
J2145−0750	16.052	9.00	1024	2048	0.9	29	29.6

Yan et al. (2011)

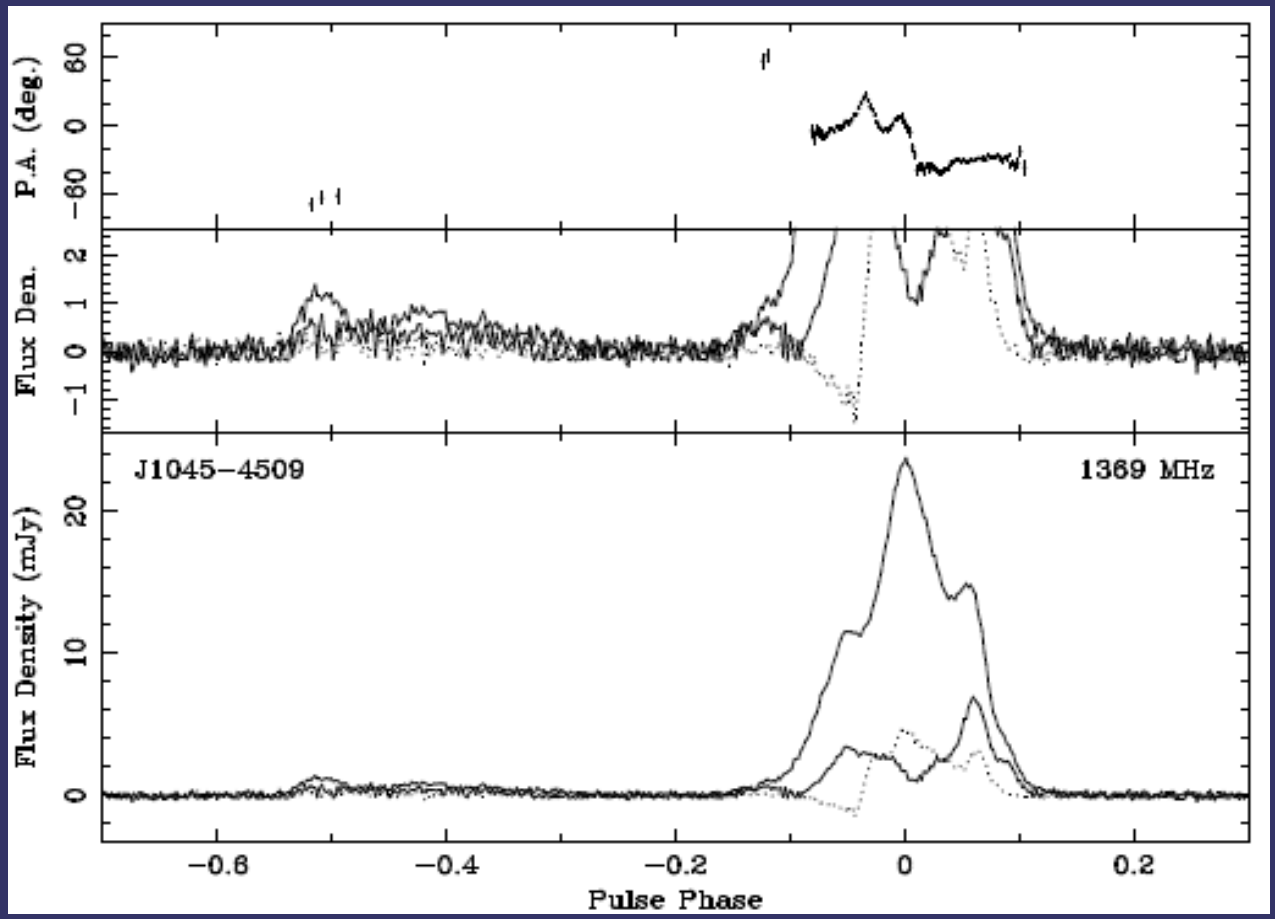
Data analysis

- All data were processed using the PSRCHIVE software package.
- We take the weighted average of RMs for each observation as the value of RM for a given pulsar.
- The ionosphere RM contribution was estimated using FARROT (at DRAO, Canada) and removed from the total RM.
- In order to accurately align the profiles,TEMPO2 was used to fit the TOAs for all observations for a given pulsar to give a timing model.



Polarization profiles(1/3)

- PSR J1045-4509



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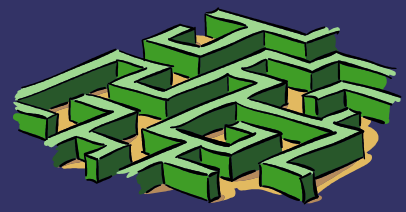
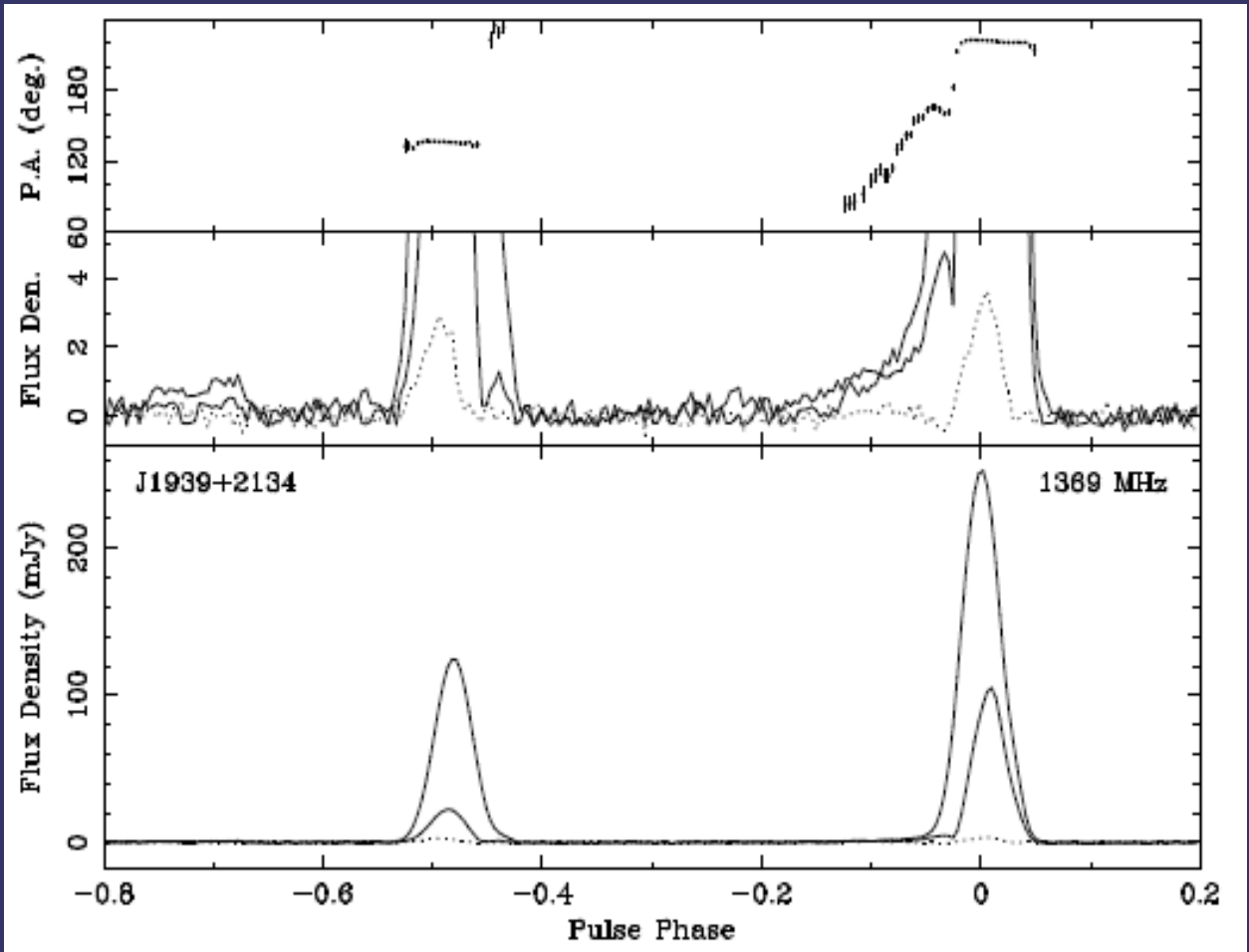


Polarization profiles(2/3)

- PSR J1939+2134(PSR B1937+21)



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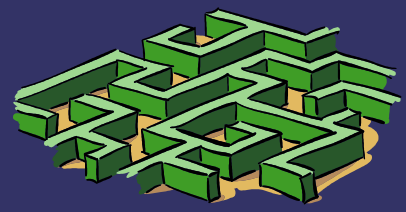
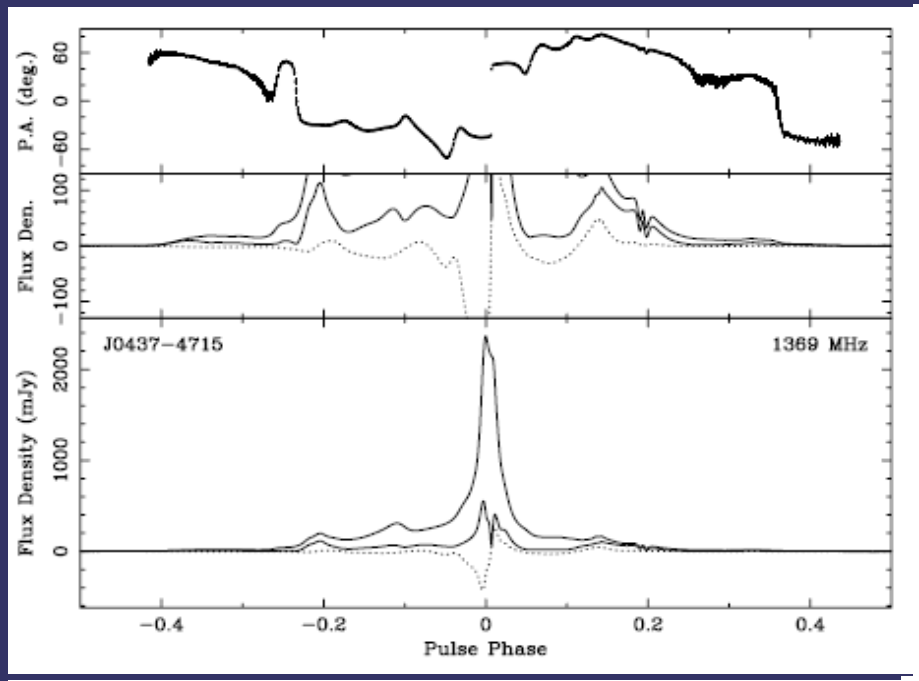
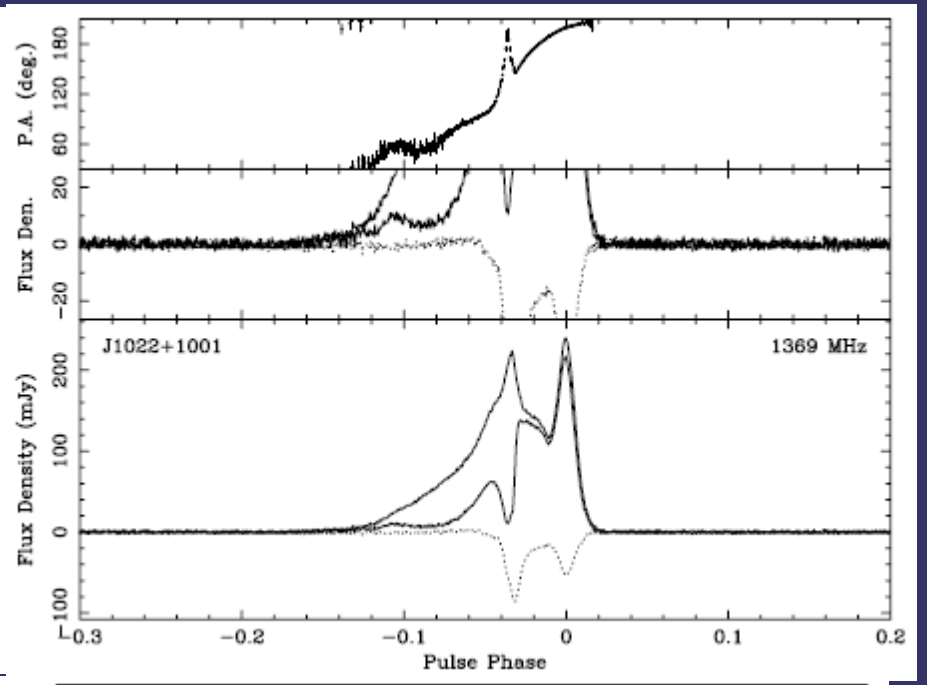
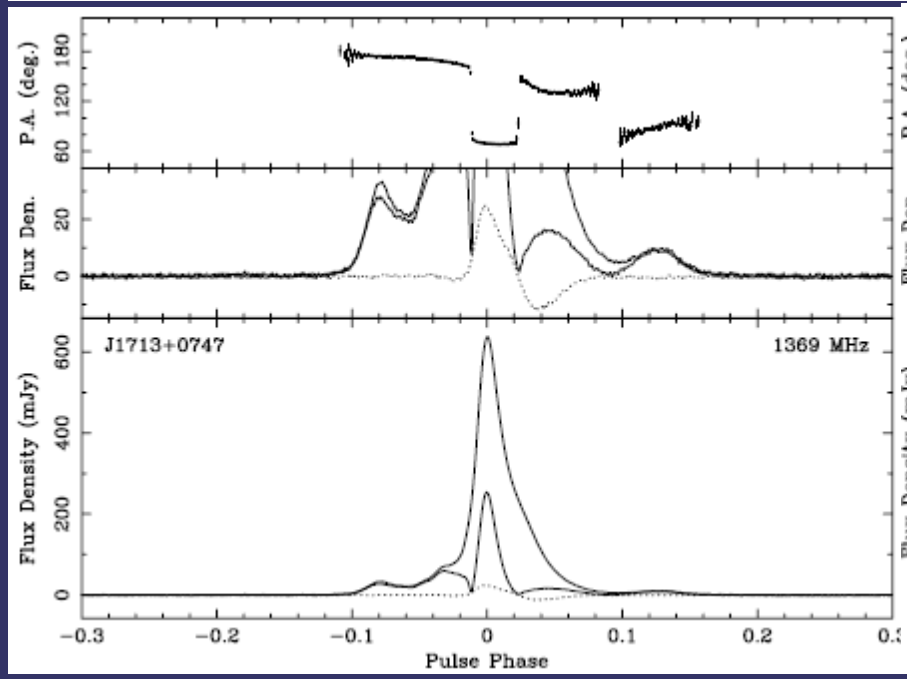
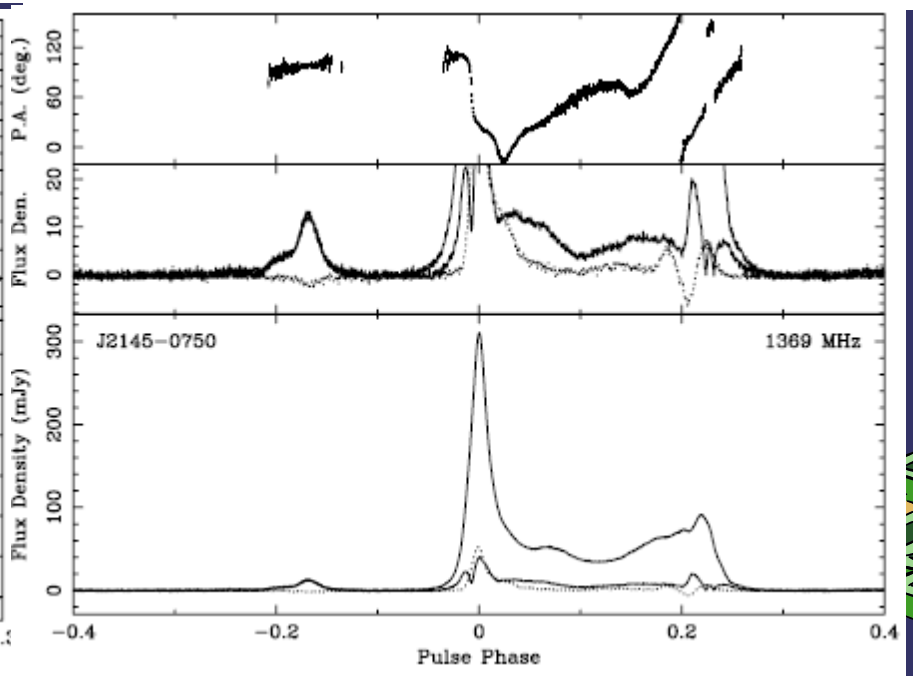


Polarization profiles(3/3)









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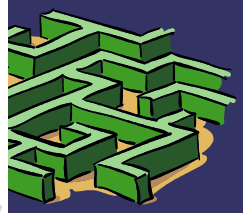
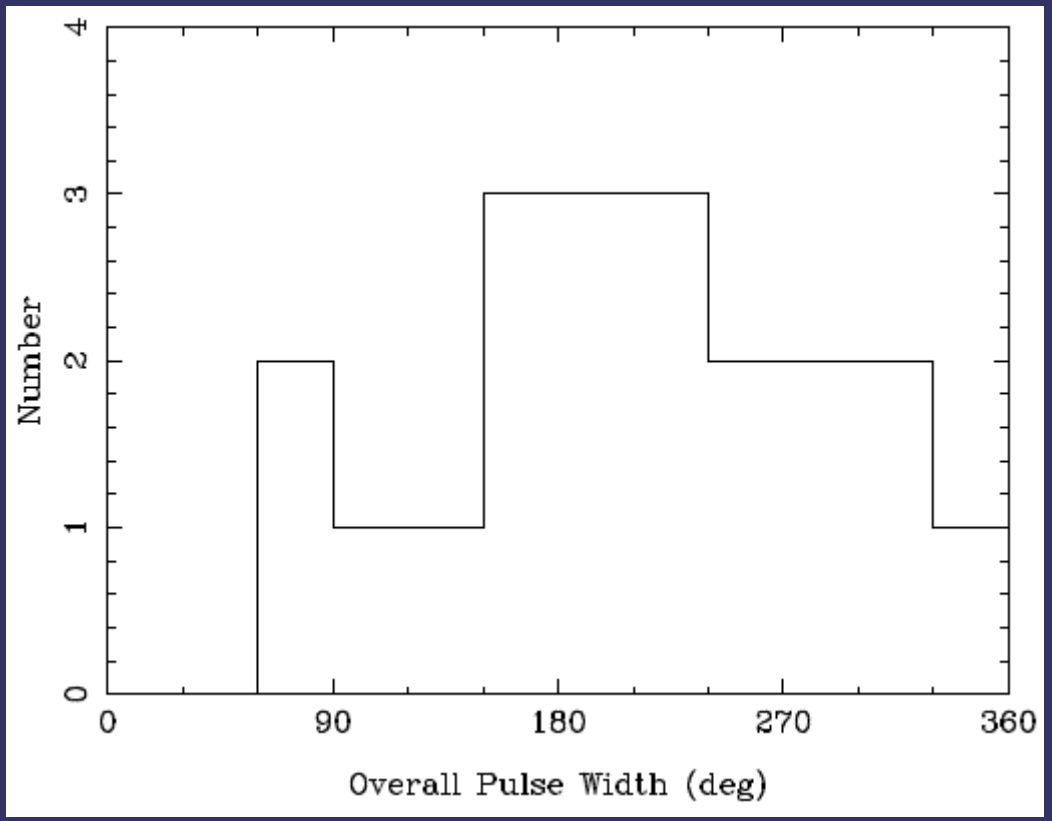


Overall pulse width

- Seven pulsars have emission spanning less than half of the period
- Five have emission over more than three quarters of the period



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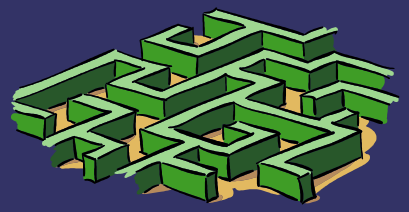

Rotation Measure

PSR	Gal. l (deg)	Gal. b (deg)	Dist. (kpc)	RM (This work) (rad m^{-2})	RM (Prev. Publ.) (rad m^{-2})	$\langle B_{\|\|} \rangle$ (μG)
J0437−4715	253.39	−41.96	0.16	0.0 ± 0.4	1.5 ± 5[a]	−0.0 ± 0.19
J0613−0200	210.41	−9.30	1.25	9.7 ± 1.1	19 ± 14[b]	0.31 ± 0.03
J0711−6830	279.53	−23.28	0.86	21.6 ± 3.1	67 ± 23[b]	1.45 ± 0.21
J1022+1001	231.79	+51.10	0.56	−0.6 ± 0.5	—	−0.07 ± 0.06
J1024−0719	251.70	+40.52	0.53	−8.2 ± 0.8	—	−1.56 ± 0.15
J1045−4509	280.85	+12.25	0.30	92.0 ± 1.0	82 ± 18[b]	1.95 ± 0.02
J1600−3053	344.09	+16.45	5.00	−15.5 ± 1.0	—	−0.36 ± 0.02
J1603−7202	316.63	−14.50	1.17	27.7 ± 0.8	20.1 ± 5[b]	0.90 ± 0.03
J1643−1224	5.67	+21.22	0.45	−308.1 ± 1.0	−263 ± 15[b]	−6.08 ± 0.02
J1713+0747	28.75	+25.22	1.05	8.4 ± 0.6	—	0.65 ± 0.05
J1730−2304	3.14	+6.02	0.53	−7.2 ± 2.2	—	−0.92 ± 0.28
J1732−5049	340.03	−9.45	1.41	−8.5 ± 6.7	—	−0.18 ± 0.15
J1744−1134	14.79	+9.18	0.42	−1.6 ± 0.7	—	−0.63 ± 0.27
J1824−2452	7.80	−5.58	4.90	77.8 ± 0.6	1 ± 12[c]	0.80 ± 0.01
J1857+0943	42.29	+3.06	0.91	16.4± 3.5	53 ± 9[d]	1.52 ± 0.32
J1909−3744	359.73	−19.60	1.27	−6.6 ± 0.8	—	−0.78 ± 0.09
J1939+2134	57.51	−0.29	8.33	6.7 ± 0.6	−10 ± 9[c]	0.12 ± 0.01
J2124−3358	10.93	−45.44	0.32	−5.0 ± 0.9	1.2 ± 1[b]	−1.34 ± 0.24
J2129−5721	338.01	−43.57	0.53	23.5 ± 0.8	37.3 ± 2[b]	0.91 ± 0.03
J2145−0750	47.78	−42.08	0.62	−1.3 ± 0.7	12 ± 8[b]	−0.18 ± 0.1

References: (a) Navarro et al. (1997); (b) Manchester & Han (2004); (c) Rand & Lyne (1994); (d) Han et al. (2006).

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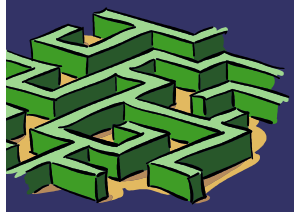
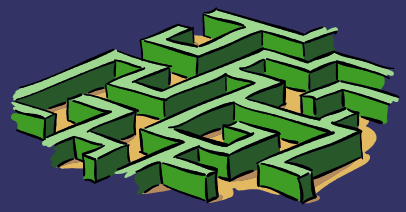


Summary

- Our polarization profiles generally have very high S/N ratios compared to earlier results.
- We have not only defined the polarization properties more accurately, but also re-vealed previously unknown profile features in many of the pulsars.
- We derive RMs for all 20 pulsars, eight of which have no previously published RMs.



THANKS!