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Multifrequency polarimetry of 300 radio pulsars

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ABSTRACT

Polarimetric observations of 300 pulsars have been conducted with the 76-m Lovell telescope at Jodrell Bank at radio frequencies centred around 230, 400, 600, 920, 1400 and 1600 MHz. More than half of the pulsars have no previously published polarization profiles and this compilation represents about three times the sum of all previously published pulsar polarization data. A selection of integrated polarization profiles is provided. Tables of pulse widths and the degree of both linear and circular polarization are given for all pulsars, and these act as an index for all the data, which are available by anonymous ftp in numerical and graphical form.

Key words: polarization – pulsars: general.

1 INTRODUCTION

Observations of the shape and polarization of the average pulse profiles of radio pulsars are fundamental in establishing the form and origin of the beaming of the emission. The radiation is believed to arise from particles streaming outward along open field lines above the poles of an essentially dipolar magnetic field. Each part of the integrated profile is believed to originate in a small part of this polar region, so that the integrated profile represents a cut across a distributed source. The linear polarization at any point in the profile is related to the orientation of the magnetic field at the corresponding point of origin. The observed rotation of the plane of polarization through the profile can then be related to the geometry of the field lines above the poles.

Such a 'rotating vector' model, originally expounded by Radhakrishnan & Cooke (1969), has been successfully developed and refined by several other authors such as Komesaroff (1970), Rankin (1983), Lyne & Manchester (1988) and Gil, Kijak & Zycki (1993) and explains many of the features of the observed emission.

The degree of linear or circular polarization in individual pulses observed from the stronger pulsars often approaches 100 per cent; the integrated profiles may, however, be much less polarized since they represent the sum of pulses with different handedness of circular or position angle of linear polarization. Nevertheless, the average profiles are remarkably stable from one observation to another, and they have provided the basis for studies of the location of the emitting region within the light cylinder (Cordes, Rankin & Backer 1978; Radhakrishnan & Rankin 1990; Blaskiewicz, Cordes & Wasserman 1991), the beaming process (Narayan & Vivekanand 1983; Lyne & Manchester 1988; Biggs 1990) and investigations of secular changes in magnetic field strength and alignment (Candy & Blair 1983; Krishnamohan & Downs 1983; Lyne & Manchester 1988).

These studies are mostly limited by the quantity and quality of the observational data. A number of papers have each presented a few dozen integrated polarization profiles, usually at a single frequency (Manchester 1971; Hamilton et al. 1977; McCulloch et al. 1978; Manchester, Hamilton & McCulloch 1980; Rankin & Benson 1981; Rankin, Stinebring & Weisberg 1989; Xilouris et al. 1989; Wu et al. 1993), although a number of multifrequency studies have also been published (Lyne, Smith & Graham 1971; Morris et al. 1981; Lyne & Manchester 1988; Qiao et al. 1995).

Since these studies have only been concerned with a minority of the known pulsars, we have carried out a much larger programme to expand the available data by a substantial factor. In this paper, we report on observations at Jodrell Bank of polarization profiles for 300 pulsars at frequencies near 230, 400, 600, 920, 1400 and 1600 MHz. More than half of these pulsars have no previously published polarimetry. This data set thus constitutes an unparalleled collection of pulsar polarization material, exceeding the sum of all previously published data by a factor of about 3.

The observations were conducted over a period of several years and were designed not only for the polarization studies described here, but to permit the monitoring of glitch activity (Shemar & Lyne 1996), the study of timing noise (Martin & Lyne, in preparation), the measurement of pulsar spectra (Lorimer et al. 1995) and the determination of Faraday rotation measures for the investigations of the Galactic magnetic field (Rand & Lyne 1994).

2 THE OBSERVATIONS

The observations were carried out using the 76-m Lovell Telescope at Jodrell Bank with polarimeters which consisted of two orthogonal dipoles and a hybrid or quarter-wave plate, providing the left-hand (L) and right-hand (R) circular polarizations. These two signals were amplified using low-noise FET amplifiers before being filtered and mixed down to a central intermediate frequency of between 4 and 40 MHz. The dispersive effects of the interstellar medium cause smearing of the pulses in the large receiver bandwidths required to achieve high sensitivity. For this reason, each band was split into either 8 or 32 channels in a filterbank which formed, by analogue multiplication and manipulation, the four polarization parameters L^2, R^2, $Q = L \times R$ and $U = L \times R \times e^{i\pi/2}$. For each of the four parameters, the outputs of the contiguous frequency channels in the filterbank were digitized and added into successive elements of a shift register, the clock rate being determined by the time taken for the pulse to sweep from one frequency channel to the next and calculated from the dispersion measure of the pulsar and the observing frequency.

The dedispersed signal from the output of each shift register was then folded at the topocentric period of the pulsar and consecutive pulses were coherently summed over an integration time set by the observer. The required number of bins across the pulse period is set by the observer but the on-line computer selects the actual number to be used consistent with the clock rate of the dedispersing shift register.

A typical observation of a pulsar on any one occasion produces six contiguous 3-min integrations over an 18-min period. On-line plots of these integrations were used to monitor the data as they came off the telescope. The raw data are stored on disk or magnetic tape.

The observations were carried out over a period of almost 4 yr, from 1987 December 1 to 1991 September 9, mostly as part of the ongoing timing program at Jodrell Bank. Table 1 details all the observing sessions. In general, each of about 250 pulsars was observed on two or three separate occasions in each observing session. This results in well over 12 000 individual observations for all the observing sessions together. The maximum time resolution available is determined by the time taken for the dispersed pulsar signal to sweep through a single filterbank element. In order to calculate the time resolution achieved for a particular pulsar, the value in the final column of Table 1 should be multiplied by the dispersion measure (DM) of the pulsar.

About 330 pulsars known to us with declination greater than −34° were observed, although not all were observed at every frequency. This was because some pulsars had insufficient signal-to-noise ratio due to low pulsar flux density at either low or high frequencies, or high galactic background emission or interstellar scattering at low frequencies.

3 DATA REDUCTION

A comprehensive pulsar profile analysis package, PSRPROF, is available at Jodrell Bank and is used in this experiment for the reading of pulsar data and for performing a number of operations on the data. There are five main stages involved in reducing the polarization material to a single, accurate, high-quality representative profile at each frequency.

(i) Stage 1 – *data editing*

Since some of the 3-min integrations are occasionally seriously affected by impulsive interference, the data were inspected visually and any spoilt integrations were deleted. The rest were added together to produce a single set of four polarization profiles for the observation.

(ii) Stage 2 – *fitting off-pulse baselines*

For each polarization, the average off-pulse emission level was calculated from the part of the pulsar period lying outside the pulse profile and this was then subtracted from the whole of the data. At the same time, the off-pulse rms fluctuation of the noise level σ was also calculated.

(iii) Stage 3 – *calibration*

The data were now corrected for instrumental polarization and converted to Stokes parameters. With a perfect polarimeter, the gains of the four receiver channels, L^2, R^2, Q and U, would be equal and there would be no cross-talk within the polarimeter which

Table 1. List of observing sessions.

Freq. (MHz)	Start Date	Finish Date	Total BW (MHz)	Filter BW (MHz)	Maximum time resolution/DM (μs cm^3 pc^{-1})
234	87/12/01	87/12/10	4	0.125	82.8
408	91/03/26	91/04/08	4	0.125	15.6
410	91/09/02	91/09/09	8	0.250	30.8
606	88/12/21	89/01/05	4	0.125	4.8
606	89/03/10	89/04/03	8	0.250	9.5
606	89/09/04	89/09/08	4	0.125	4.8
606	89/12/18	90/01/08	8	0.250	9.5
606	90/08/29	90/09/17	8	0.250	9.5
606	91/03/11	91/03/24	8	0.250	9.5
925	89/07/21	89/08/14	8	0.250	2.7
911	90/04/04	90/04/10	8	0.250	2.8
1406	88/08/05	88/08/09	40	5.000	15.3
1404	89/08/19	89/08/21	32	1.000	3.1
1404	90/01/09	90/01/22	32	1.000	3.1
1404	90/05/24	90/08/13	32	1.000	3.1
1404	91/01/08	91/01/17	32	1.000	3.1
1418	91/04/08	91/05/09	32	1.000	3.0
1594	88/07/21	88/08/05	40	5.000	10.5
1642	89/04/28	89/06/07	40	5.000	9.6
1610	90/08/20	90/08/24	40	5.000	10.2

would result in finite values of Q and U on an unpolarized source. In practice the polarimeter is imperfect and corrections were required which were equivalent to a spurious polarization of around 5 per cent. These corrections were determined from the observation of an unpolarized continuum source of known flux density (3C123, 3C144 or 3C409), together with a switched linearly polarized noise signal which was injected into the feed. After correction, the parameters $I = L^2 + R^2$ and $V = L^2 - R^2$ were calculated, with Q and U making a full set of Stokes parameters. Variable systematic errors remaining in Q, U and V, due for example to differential scintillation over the wide observing bandwidth, are all estimated to be about 3 per cent of the corresponding value of I.

(iv) Stage 4 – *computation of a session average*

The Stokes parameters for the individual observations within a session required careful alignment both in pulse longitude and in position angle and were averaged to produce a profile for that session. The shift of each profile which was required to achieve alignment in longitude was determined by cross-correlation of the total intensity profile I with the best individual profile. All four Stokes parameters were then shifted appropriately before position angle alignment was carried out. This position angle alignment was required, particularly at low frequencies, since the Faraday rotation of the linear polarization in the ionosphere could not be predicted with sufficient confidence. The required rotation for alignment was calculated by forming the sum across the pulse of $\Delta\psi = 0.5\arctan\left[\sum_{i=1}^{n} U_i/\sum_{i=1}^{n} Q_i\right]$, where Q_i and U_i are the values of Q and U in the ith bin and n is the number of bins across the pulse.

(v) Stage 5 – *computation of a global average*

This final stage involved the alignment and averaging of the Stokes parameters from all the session profiles which were available at similar frequencies, thus producing a 'super' polarization profile. The procedures used were identical to those used in the previous stage.

These five stages produce the best quality profile possible, each containing data from a total of about 3 h of observation. Inspection of the resulting profiles (see Section 5 for some examples) reveals the quality of the profile shapes and the consistency of the evolution between the different frequencies, showing the value of the aligning and averaging processes of stages 4 and 5, particularly for the weaker pulsars.

It is important to note that the method of production of these profiles, used in stages 4 and 5 described above, results in calculated position angles of polarization that are not absolute values. This means that the data presented here cannot be used to calculate rotation measures or position angles of the rotation axes. However, rotation measures derived from the data set have been published previously (Hamilton & Lyne 1988; Rand & Lyne 1994). Likewise, the flux densities of pulsars obtained from these data are not indicated here; they have already been published (Lorimer et al. 1995) and represent long-term statistical averages over a 4-yr period.

4 SUMMARY OF RESULTS

The number of pulsars for which a good quality polarimetric profile exists at a particular frequency is given in Table 2, amounting to a total of 1399 profiles for 300 pulsars. Since it is not practical to present the polarization profiles of all the pulsars at each frequency, we present and discuss in the next section a few examples (Figs 1–7) and also provide a tabular summary of the whole data set which is available from the authors on the World Wide Web, by anonymous ftp or by email request (see the Appendix for access details). Tables 3 and 4 summarize the results for every pulsar and every frequency at which a satisfactory polarimetric profile is available. Entries in this table indicate that there is a corresponding polarization profile available in the data set.

Table 2. Number of pulsars with polarization profiles at each frequency.

Frequency (MHz)	230	400	600	920	1400	1600
No. of pulsars	94	245	287	246	280	247

The columns of Table 3 are as follows: the B name of the pulsar; the J name of the pulsar; then six groups of 3 columns give a summary of the polarization for each of the six frequencies. The three columns are the mean percentage linear polarization ($L = \sqrt{Q^2 + U^2}$), computed from the ratio of the areas under the linearly polarized and total intensity curves; and the percentage circular polarizations, computed from the ratios of the areas under the circularly polarized curves and the total intensity curve, without regard to handedness $|V|$, and with regard to handedness V.

Similarly, the columns of Table 4 are the B name of the pulsar followed by six groups of 3 columns giving the pulse widths for each of the six frequencies. The three columns are the pulse full width at half the peak intensity W_{50}, measured in degrees of longitude; pulse width at one-tenth of the peak intensity W_{10}, in degrees of longitude; and the equivalent width W_e, in degrees of longitude, defined by pulse energy divided by peak intensity. A rectangular pulse with this width and the same amplitude as the pulse peak would contain the same amount of energy. All widths have errors of less than about 10 per cent of the value. For some profiles, the signal-to-noise ratio was not sufficient to establish a reliable value of W_{10} and no value is then quoted for this parameter.

The superscripts to the J names of some pulsars in the second column of Table 4 indicate that some of the data are believed to be affected by interstellar scattering as follows: the pulse profile is significantly affected by interstellar scattering at frequencies of a – 400 MHz and below, b – 600 MHz and below, c – 920 MHz and below, d – 1400 MHz and below, and e – 1600 MHz and below.

5 THE PULSARS

Integrated polarization profiles are given for a selection of pulsars in Figs 1 through 7. These 15 pulsars are chosen to be reasonably typical of the sample and display a variety of features. Three of the pulsars presented exhibit an interpulse. In these cases, the *centre of the display* for the interpulse is separated by 180° of longitude from the *centre of the display* for the main pulse.

The polarization characteristics of the selected pulsars illustrate features seen in most of the pulsars in the data set and are discussed briefly below.

PSR B0136+57

See Fig. 1(a). The profile consists of a central component which develops additional features on the leading and trailing edges at the higher frequencies. A remarkable feature of this pulsar is its very high linear polarization, about 80 per cent. There is a shallow rotation of the position angle through the pulse. The pulsar also has an appreciable amount of left-hand circular polarization under the central component. The high-resolution observation at 1700 MHz by Xilouris et al. (1989) is consistent with the high-frequency profiles presented here.

Table 3. Degree of polarization.

PSR B	PSR J	Degree of polarization																	
		230 MHz			400 MHz			600 MHz			920 MHz			1400 MHz			1600 MHz		
		L	$\|V\|$	V	L	$\|V\|$	V	L	$\|V\|$	V	L	$\|V\|$	V	L	$\|V\|$	V	L	$\|V\|$	V
		%	%	%	%	%	%	%	%	%	%	%	%	%	%	%	%	%	%
0011+47	0014+4746	—	—	—	4	11	0	13	6	−5	18	20	−20	25	5	−1	27	3	−1
0031−07	0034−0721	21	10	5	14	6	−6	8	5	4	8	3	−2	5	3	3	13	8	8
0037+56	0040+5716	11	16	16	8	6	−4	8	18	−17	29	12	−12	19	10	−9	32	15	−6
0045+33	0048+3412	12	15	−7	12	15	−7	25	4	−1	—	—	—	—	—	—	—	—	—
0052+51	0055+5117	21	20	19	21	20	19	25	8	6	27	21	8	27	6	5	38	8	3
0053+47	0056+4756	—	—	—	47	11	−7	38	11	3	—	—	—	—	—	—	—	—	—
0059+65	0102+6537	—	—	—	14	16	16	16	9	7	22	20	2	11	8	8	3	12	7
0105+65	0108+6608	33	14	−7	24	12	−8	43	6	−4	66	14	−12	26	4	−3	11	8	6
0105+68	0108+6905	13	7	−6	27	23	−23	24	18	−14	17	24	−18	22	20	−20	44	28	−14
0114+58	0117+5914	—	—	—	9	5	−1	14	4	−3	—	—	—	21	14	5	—	—	—
0136+57	0139+5814	52	10	10	69	8	7	73	15	15	84	8	8	82	11	11	77	13	13
0138+59	0141+6009	5	10	−10	23	10	−2	24	8	−4	24	11	−5	20	17	−17	21	14	−13
0144+59	0147+5922	29	9	5	8	13	−12	17	11	−10	43	26	−15	14	24	−24	26	29	−26
0148−06	0151−0635	24	10	−4	30	20	−19	24	7	−4	44	30	−29	8	13	−1	19	15	6
0149−16	0152−1637	8	10	−5	5	10	−2	4	10	0	19	9	2	18	7	−2	—	—	—
0153+39	0156+3949	—	—	—	—	—	—	69	38	−38	—	—	—	—	—	—	—	—	—
0154+61	0157+6212	—	—	—	17	16	−14	9	10	−10	34	6	0	18	6	−5	9	11	−9
0226+70	0231+7026	—	—	—	12	9	0	20	7	1	—	—	—	26	11	6	—	—	—
0301+19	0304+1932	26	9	9	11	9	8	7	11	11	12	12	12	5	14	14	7	16	16
0320+39	0323+3944	9	4	−1	16	8	−6	24	4	1	30	11	3	28	18	18	33	27	27
0329+54	0332+5434	3	14	5	11	10	7	3	8	6	2	11	9	3	8	4	7	13	13
0331+45	0335+4555	9	14	9	10	13	8	21	10	9	14	10	4	12	4	3	42	11	−1
0339+53	0343+5312	—	—	—	20	17	17	25	10	−10	—	—	—	34	13	0	34	16	2
0353+52	0357+5236	—	—	—	9	9	3	8	6	4	28	9	2	9	3	1	8	6	−2
0355+54	0358+5413	18	7	−1	14	7	−6	13	3	−2	27	7	0	34	9	−5	33	11	−9
0402+61	0406+6138	31	7	−4	22	10	−7	16	8	−7	12	14	−2	10	6	−5	15	14	−13
0410+69	0415+6954	—	—	—	5	9	8	12	6	4	39	20	−13	20	10	−3	—	—	—
0447−12	0450−1248	14	5	1	31	7	−3	25	4	−2	26	15	−10	19	8	−2	—	—	—
0450+55	0454+5543	20	7	−4	10	6	−3	19	8	−4	14	8	−6	24	5	−5	31	11	−11
0450−18	0452−1759	27	10	7	23	3	−2	17	2	−1	12	6	−3	12	2	0	13	3	1
0458+46	0502+4654	—	—	—	24	11	10	15	6	3	20	6	4	2	5	−1	12	8	−1
0523+11	0525+1115	—	—	—	15	9	7	15	12	11	28	13	11	7	14	10	12	18	8
0525+21	0528+2200	36	11	−11	42	6	−6	35	3	−3	34	7	−7	27	5	−5	27	7	−7
0531+21	0534+2200	—	—	—	—	—	—	30	5	−5	25	5	−4	43	4	1	34	16	−15
0540+23	0543+2329	73	8	−5	75	10	−10	64	10	−10	52	14	−13	43	12	−12	36	14	−14
0559−05	0601−0527	—	—	—	5	19	−2	17	13	1	16	17	−2	27	13	3	31	17	−2
0609+37	0612+3721	12	9	−5	7	14	−8	14	6	0	29	10	1	8	5	−1	19	13	−5
0611+22	0614+2229	34	9	8	70	14	14	79	10	9	66	24	24	66	17	17	71	16	11
0621−04	0624−0424	—	—	—	44	13	0	11	9	4	34	16	2	19	10	4	—	—	—
0626+24	0629+2415	4	15	13	26	12	9	24	8	7	8	9	6	1	11	11	12	10	7
0628−28	0630−2834	34	5	−5	32	9	−7	33	4	−4	36	8	−7	29	6	−5	31	7	−6
0643+80	0653+8051	—	—	—	43	18	−17	32	10	−6	57	17	3	24	15	−10	33	23	8
0655+64	0700+6418	—	—	—	2	5	2	4	9	−1	8	14	1	13	17	−15	—	—	—
0656+14	0659+1414	87	12	5	92	9	−9	84	10	−3	76	18	−16	79	17	−16	80	21	−20
0727−18	0729−1836	1	20	−19	19	10	−9	25	10	−7	12	15	−13	19	9	−8	12	17	−14
0740−28	0742−2822	22	8	−7	54	6	−6	82	3	−3	78	10	−9	79	5	−5	76	10	−10
0751+32	0754+3231	25	38	38	16	11	−9	19	8	−8	33	14	−1	11	12	−11	39	23	−16
0756−15	0758−1528	21	13	−13	23	7	6	18	2	1	30	10	7	9	2	1	5	8	−5
0809+74	0814+7429	11	4	3	28	4	−3	9	1	0	30	7	−4	31	6	−3	36	10	−9
0818−13	0820−1350	—	—	—	8	7	5	15	10	−9	7	11	−8	6	8	−7	7	5	−4
0820+02	0823+0159	4	5	2	4	2	−1	12	3	−2	2	6	2	2	4	−2	1	6	5

Table 3 – *continued*

PSR B	PSR J	Degree of polarization																	
		230 MHz			400 MHz			600 MHz			920 MHz			1400 MHz			1600 MHz		
		L	$\|V\|$	V	L	$\|V\|$	V	L	$\|V\|$	V	L	$\|V\|$	V	L	$\|V\|$	V	L	$\|V\|$	V
		%	%	%	%	%	%	%	%	%	%	%	%	%	%	%	%	%	%
0823+26m	0826+2637m	—	—	—	29	6	2	21	6	4	23	5	4	18	2	1	21	6	−5
0823+26i	0826+2637i	—	—	—	18	32	−13	32	37	−33	12	15	3	51	12	−1	32	27	27
0826−34	0828−3417	—	—	—	—	—	—	17	22	5	—	—	—	14	13	4	—	—	—
0834+06	0837+0610	—	—	—	3	11	−11	11	4	−3	15	8	−6	4	5	−4	12	31	−25
0841+80	0849+8028	—	—	—	—	—	—	21	17	1	—	—	—	—	—	—	—	—	—
0844−35	0846−3533	—	—	—	—	—	—	37	13	−7	22	21	−15	—	—	—	23	16	−16
0853−33	0855−3331	—	—	—	10	6	3	7	6	−5	—	—	—	13	4	−2	19	22	1
0906−17	0908−1739	2	8	7	11	4	−4	12	3	−1	6	10	2	6	6	2	10	10	2
0917+63	0921+6254	12	7	−7	27	12	−12	16	5	1	6	15	−10	2	8	1	—	—	—
0919+06	0922+0638	27	11	10	34	4	1	38	5	5	48	6	5	50	12	12	58	14	14
0940+16	0943+1631	29	12	−11	26	10	−4	24	6	0	29	16	15	7	7	0	29	14	−2
0942−13	0944−1354	23	14	10	22	23	19	13	22	20	2	24	21	10	15	15	4	11	6
0943+10	0946+0951	—	—	—	23	10	5	33	7	−1	—	—	—	—	—	—	—	—	—
0950+08	0953+0755	31	6	−6	17	14	−14	7	6	−6	3	8	−7	4	6	−6	13	20	−19
1010−23	1012−2337	27	10	9	4	11	11	23	9	8	—	—	—	—	—	—	—	—	—
1016−16	1018−1642	26	12	10	17	18	9	11	18	14	42	18	14	16	18	16	—	—	—
1039−19	1041−1941	25	8	4	38	28	17	5	6	5	13	10	10	3	14	11	3	12	7
1112+50	1115+5030	—	—	—	20	3	−3	20	3	0	17	3	2	14	4	0	28	9	−8
1133+16	1136+1551	25	12	−12	23	16	−16	20	10	−10	16	12	−12	9	8	−8	16	7	−7
1237+25	1239+2453	44	11	−6	56	6	−1	45	5	3	41	6	2	35	8	0	33	10	−3
1254−10	1257−1027	—	—	—	17	7	2	5	5	−4	13	8	0	27	6	−1	32	15	−12
1309−12	1311−1228	21	7	−7	33	13	−13	26	11	−10	10	31	−31	4	10	−10	10	17	−17
1322+83	1321+8323	—	—	—	90	19	−15	68	17	−14	88	11	−7	42	21	−18	—	—	—
1508+55	1509+5531	—	—	—	15	8	0	16	13	2	13	14	3	20	8	0	19	11	−6
1530+27	1532+2745	19	4	−1	33	6	−3	20	5	−4	30	5	−2	26	9	−4	7	12	−5
1540−06	1543−0620	15	5	−5	25	7	−7	15	6	4	4	9	8	8	8	7	6	5	1
1541+09	1543+0929	57	34	−33	36	18	−12	15	13	−7	13	17	1	12	13	−7	5	14	−7
1552−23	1555−2341	—	—	—	14	7	−1	16	6	1	27	15	12	18	8	2	24	9	2
1552−31	1555−3135	—	—	—	7	9	−6	14	3	2	33	12	9	5	11	−4	11	7	−2
1600−27	1603−2712	—	—	—	36	16	−8	26	9	5	35	15	11	28	9	0	22	13	−1
1604−00	1607−0032	4	5	−4	14	8	−6	6	4	−1	9	5	0	4	7	−1	1	7	−3
1607−13	1610−1322	—	—	—	5	15	−15	4	5	−1	25	13	13	13	12	−5	—	—	—
1612+07	1614+0737	19	15	2	35	12	−4	13	9	1	82	12	5	17	4	4	—	—	—
1612−29	1615−2940	—	—	—	45	11	6	29	8	−6	—	—	—	—	—	—	—	—	—
1620−09	1623−0908	—	—	—	15	7	−1	14	5	3	29	7	−2	5	8	−8	13	12	−12
1620−26	1623−2631	—	—	—	24	37	−37	40	14	−9	38	19	−8	33	19	−12	31	14	−14
1633+24	1635+2418	—	—	—	16	13	−1	13	9	−2	15	21	−5	19	14	−6	—	—	—
1642−03	1645−0317	22	4	−3	14	3	−3	10	2	−1	17	4	−2	8	3	−1	12	4	−2
1648−17	1651−1709	—	—	—	25	7	3	9	5	0	—	—	—	15	13	−7	—	—	—
1649−23	1652−2403	—	—	—	21	8	−8	13	7	−6	10	11	7	4	4	2	16	6	4
1657−13	1659−1305	—	—	—	13	29	29	26	15	12	41	33	15	—	—	—	—	—	—
1700−18	1703−1846	—	—	—	50	3	−1	35	2	1	34	14	13	30	11	7	28	10	1
1700−32	1703−3255	—	—	—	22	11	−7	13	4	0	—	—	—	—	—	—	—	—	—
1702−19m	1705−1905m	—	—	—	29	30	−26	24	28	−21	29	26	−19	30	20	−17	31	19	−7
1702−19i	1705−1905i	—	—	—	35	33	−28	30	41	−38	90	37	−36	71	22	−22	83	14	−10
1706−16	1709−1640	—	—	—	11	6	−6	14	2	0	16	3	2	10	2	1	7	3	−1
1709−15	1711−1509	—	—	—	33	7	0	9	8	6	14	21	18	13	15	−9	8	8	0
1714−34	1717−3425[b]	—	—	—	—	—	—	21	15	−15	—	—	—	11	10	−8			
1717−16	1720−1633	—	—	—	15	4	0	12	4	4	9	9	2	2	5	3	4	9	−9
1717−29	1720−2933	—	—	—	6	10	5	13	11	9	13	17	−15	13	8	6	20	17	1
1718−02	1720−0212	—	—	—	27	8	−1	28	6	0	37	15	−7	4	23	−16	—	—	—

Table 3 – *continued*

PSR B	PSR J	Degree of polarization																	
		230 MHz			400 MHz			600 MHz			920 MHz			1400 MHz			1600 MHz		
		L %	|V| %	V %	L %	|V| %	V %	L %	|V| %	V %	L %	|V| %	V %	L %	|V| %	V %	L %	|V| %	V %
1718−19	1721−1936	—	—	—	31	11	4	41	12	1	—	—	—	—	—	—	—	—	—
1718−32	1722−3207	—	—	—	12	11	−10	3	6	−2	3	5	0	8	5	3	16	6	2
1718−35	1721−3532[d]	—	—	—	—	—	—	—	—	—	—	—	—	22	15	6	—	—	—
1726−00	1728−0007	—	—	—	14	9	7	12	10	−1	25	19	11	18	6	1	30	26	−23
1727−33	1730−3350[d]	—	—	—	—	—	—	—	—	—	—	—	—	48	9	−4	—	—	—
1730−22	1733−2228	—	—	—	11	14	3	10	13	0	20	11	−3	11	14	−4	9	18	2
1732−02	1734−0212	—	—	—	43	23	12	18	8	−1	—	—	—	27	20	−1	—	—	—
1732−07	1735−0724	—	—	—	10	3	3	21	4	−1	15	12	10	26	5	3	27	7	−2
1734−35	1737−3555	—	—	—	—	—	—	44	17	−9	—	—	—	34	18	−16	—	—	—
1735−32	1738−3211	—	—	—	32	23	−23	16	5	−1	5	10	−3	4	10	−5	19	11	−9
1736−29m	1739−2903m	—	—	—	—	—	—	10	7	5	6	8	1	5	4	1	2	3	1
1736−29i	1739−2903i	—	—	—	—	—	—	4	8	1	26	8	2	24	6	−6	26	13	−12
1736−31	1739−3131[e]	—	—	—	—	—	—	29	15	−11	19	12	−5	8	5	−3	17	8	−7
1737+13	1740+1311	—	—	—	11	8	6	15	6	4	22	8	−2	20	5	4	15	8	5
1737−30	1740−3015[b]	—	—	—	5	18	−17	22	21	−20	73	22	−21	75	37	−37	64	45	−45
1738−08	1741−0840	—	—	—	23	16	−16	13	7	−3	18	10	−2	11	5	−2	19	3	−2
1740−03	1743−0337	—	—	—	—	—	—	24	12	5	—	—	—	17	12	7	26	9	7
1740−13	1743−1351	—	—	—	20	4	0	33	8	−4	—	—	—	27	14	−8	43	30	2
1740−31	1743−3150	—	—	—	21	20	−17	8	11	−9	—	—	—	10	3	−2	—	—	—
1742−30	1745−3040	—	—	—	23	7	−6	33	6	−3	42	6	−4	37	4	−2	33	7	−6
1745−12	1748−1300	—	—	—	10	5	−2	10	4	3	26	14	9	1	8	1	7	8	3
1746−30	1749−3002[b]	—	—	—	—	—	—	15	19	15	—	—	—	20	14	11	—	—	—
1747−31	1750−3157	—	—	—	—	—	—	20	15	−2	—	—	—	21	16	−11	—	—	—
1749−28	1752−2806	—	—	—	14	2	−1	15	2	−2	6	9	9	3	7	3	7	9	4
1750−24	1753−25[e]	—	—	—	—	—	—	—	—	—	—	—	—	2	9	6	24	10	7
1753+52	1754+5201	—	—	—	12	14	−8	24	13	−1	—	—	—	9	17	15	12	24	0
1753−24	1756−2435[b]	—	—	—	—	—	—	8	12	6	16	13	3	28	15	12	29	21	21
1754−24	1757−2421[a]	—	—	—	38	16	6	27	6	−1	11	5	4	19	4	−1	20	7	−4
1756−22	1759−2205[a]	—	—	—	21	13	7	20	8	5	23	6	−3	21	5	4	19	4	1
1758−03	1801−0357	—	—	—	13	16	−4	10	17	−4	50	18	−2	12	23	−3	5	22	−7
1758−23	1801−23[e]	—	—	—	—	—	—	—	—	—	—	—	—	15	10	10	15	12	12
1758−24	1801−2451[b]	—	—	—	—	—	—	21	17	17	—	—	—	71	21	20	—	—	—
1800−21	1803−2137	—	—	—	38	30	3	41	27	25	50	28	24	38	28	27	36	28	27
1800−27	1803−2712	—	—	—	—	—	—	—	—	—	—	—	—	36	7	0	—	—	—
1802+03	1805+0306	—	—	—	—	—	—	10	13	−1	46	18	−2	—	—	—	28	13	−13
1802−07	1804−0735	—	—	—	—	—	—	52	15	11	—	—	—	25	13	−12	37	26	26
1804−08	1807−0847	—	—	—	17	3	0	10	4	0	3	6	4	5	9	5	10	6	3
1804−27	1807−2715	—	—	—	—	—	—	9	11	9	43	12	4	16	12	2	5	16	−4
1805−20	1808−2057[c]	—	—	—	—	—	—	8	11	8	21	9	8	8	5	3	10	6	3
1806−21	1809−2109[b]	—	—	—	—	—	—	12	11	9	39	17	−9	15	6	4	13	4	4
1809−173	1812−1718	—	—	—	—	—	—	34	27	21	11	28	−2	18	8	−6	18	9	2
1809−176	1812−1733	—	—	—	—	—	—	—	—	—	—	—	—	28	19	12	34	14	14
1810+02	1812+0226	—	—	—	18	8	−3	13	12	12	70	37	33	20	11	10	20	13	2
1811+40	1813+4013	—	—	—	19	17	5	9	15	−12	27	27	−26	13	18	−15	6	23	−12
1813−17	1816−1729[c]	—	—	—	—	—	—	4	17	5	32	12	4	6	9	−6	19	8	−3
1813−26	1816−2649	—	—	—	14	12	5	37	15	13	—	—	—	19	12	9	20	14	7
1813−36	1817−3618	—	—	—	—	—	—	10	17	−16	13	23	−23	—	—	—	26	21	2
1815−14	1818−1422[e]	—	—	—	—	—	—	36	19	11	20	17	13	8	7	7	7	6	5
1817−13	1820−1346[e]	—	—	—	—	—	—	14	36	21	15	9	−2	8	8	3	16	7	−2
1817−18	1820−1818	—	—	—	—	—	—	—	—	—	—	—	—	22	5	−4	15	8	2
1818−04m	1820−0427m[a]	—	—	—	12	10	−10	9	11	−9	12	10	−8	20	9	−6	21	11	−10

Table 3 – *continued*

PSR B	PSR J	Degree of polarization																	
		230 MHz			400 MHz			600 MHz			920 MHz			1400 MHz			1600 MHz		
		L %	|V| %	V %	L %	|V| %	V %	L %	|V| %	V %	L %	|V| %	V %	L %	|V| %	V %	L %	|V| %	V %
1819−22	1822−2256	—	—	—	31	12	−10	35	6	−5	29	7	−3	18	6	−6	15	13	−13
1820−11	1823−1115[b]	—	—	—	83	61	55	11	5	1	5	5	2	11	4	4	14	5	5
1820−14	1822−1400[c]	—	—	—	—	—	—	15	19	−2	28	16	2	9	8	3	38	8	6
1820−30B	1823−30B	—	—	—	22	13	−10	35	17	−13	—	—	—	—	—	—	—	—	—
1820−31	1823−3106	—	—	—	24	15	−14	46	6	−5	50	6	−2	47	9	−8	34	6	−1
1821+05	1823+0550	9	8	5	10	13	2	14	10	5	9	11	0	11	12	1	10	10	−3
1821−11	1824−1118[c]	—	—	—	—	—	—	51	32	8	34	13	10	11	10	−4	24	8	1
1821−19	1824−1945[b]	—	—	—	9	7	−6	12	2	0	3	4	2	3	4	−3	7	7	−7
1822+00	1825+0004	—	—	—	41	15	−8	17	19	−11	5	11	0	20	8	0	26	15	−6
1822−09m	1825−0935m	—	—	—	24	6	3	29	3	0	30	4	−1	29	5	5	33	11	11
1822−09i	1825−0935i	—	—	—	25	31	−12	10	10	−8	48	14	11	11	7	−3	32	23	4
1822−14	1825−1446[c]	—	—	—	—	—	—	—	—	—	39	24	19	23	10	−5	33	9	−5
1823−11	1826−1131[a]	—	—	—	23	13	10	5	7	−6	20	15	−14	12	6	−5	22	14	−8
1823−13	1826−1334	—	—	—	—	—	—	—	—	—	90	31	29	75	37	37	74	35	35
1824−10	1827−0958[c]	—	—	—	—	—	—	43	35	−33	18	19	−8	2	6	5	17	11	11
1826−17	1829−1751[b]	—	—	—	8	23	−23	7	15	−15	8	14	−12	8	10	−10	5	11	−11
1828−10	1830−1059[b]	—	—	—	—	—	—	62	19	−19	94	10	−1	79	22	−21	85	22	−21
1829−08	1832−0827[b]	—	—	—	8	21	−17	11	8	−8	11	8	−8	12	6	−4	10	3	−1
1829−10	1832−1021[c]	—	—	—	92	97	−89	8	17	15	27	22	7	16	12	10	11	8	5
1830−08	1833−0827[b]	—	—	—	—	—	—	32	12	−5	16	8	1	6	5	−4	5	3	−3
1831−00	1834−0010	—	—	—	8	16	−6	—	—	—	38	18	−4	—	—	—	73	9	−5
1831−03	1833−0338[b]	—	—	—	22	5	−5	16	10	−9	18	12	−10	10	14	−13	13	15	−13
1831−04	1834−0426	—	—	—	25	9	−3	8	4	0	6	7	−3	6	7	−5	7	5	−3
1832−06	1835−0643[d]	—	—	—	—	—	—	—	—	—	—	—	—	12	14	−6	35	6	−5
1834−04	1836−0436[b]	—	—	—	—	—	—	11	8	8	57	15	0	13	12	12	16	13	12
1834−06	1837−0653[b]	—	—	—	—	—	—	19	14	−3	8	18	−15	19	9	−8	40	15	−15
1834−10	1836−1008[c]	—	—	—	17	9	−7	12	11	10	24	5	4	5	7	6	8	7	7
1838−04	1841−0425[c]	—	—	—	76	32	21	32	12	−10	91	8	−3	58	6	−4	63	12	−12
1839+09	1841+0912	—	—	—	23	12	11	14	15	14	14	9	9	12	7	−4	7	8	−2
1839+56	1840+5640	18	14	7	29	14	14	31	14	12	44	22	18	31	14	12	18	20	18
1839−04	1842−0359	—	—	—	18	24	−16	30	4	4	35	8	6	28	5	0	30	7	3
1841−04	1844−0433[a]	—	—	—	31	21	−18	20	14	−12	37	17	0	23	13	−11	27	14	−14
1841−05	1844−0538[c]	—	—	—	—	—	—	52	10	8	61	9	4	44	10	10	45	8	8
1842+14	1844+1454	—	—	—	15	6	−5	24	4	−2	40	7	3	30	3	0	36	10	7
1842−02	1844−0244	—	—	—	—	—	—	—	—	—	—	—	—	1	10	−6	14	1	−1
1842−04	1845−0434	—	—	—	—	—	—	39	20	3	73	21	−4	15	9	−7	15	8	−4
1844−04	1847−0402[a]	—	—	—	4	5	3	10	4	2	10	7	5	8	5	1	17	7	−2
1845−01	1848−0123[b]	—	—	—	25	10	−10	11	3	−1	11	5	2	5	2	1	6	4	−1
1845−19	1848−1952	—	—	—	15	8	−6	18	12	−10	39	26	−21	55	11	−3	28	8	5
1846−06	1849−0636[a]	—	—	—	12	4	1	10	3	1	11	6	−1	8	4	−1	16	7	−4
1848+04	1851+0418	—	—	—	10	28	8	12	9	−5	—	—	—	21	13	−9	12	23	−18
1848+12	1851+1259	—	—	—	7	6	6	24	6	5	—	—	—	21	5	4	12	6	−1
1848+13	1850+1335	—	—	—	14	13	−12	60	8	−7	81	32	−30	57	7	−6	32	15	−15
1849+00	1852+0031[e]	—	—	—	—	—	—	—	—	—	—	—	—	13	10	−5	11	7	−3
1851−14	1854−1421	—	—	—	19	12	−11	19	6	−4	15	6	1	15	4	−3	19	7	−4
1853+00	1857+0057	—	—	—	15	38	−30	30	21	1	—	—	—	—	—	—	33	20	−20
1853+01	1856+0113	—	—	—	24	10	2	38	8	−1	—	—	—	38	12	0	70	16	14
1855+02	1857+0212[c]	—	—	—	—	—	—	19	10	6	26	12	−3	5	4	−1	5	4	1
1855+09	1857+0943	—	—	—	19	14	2	20	3	−1	26	17	13	5	5	−3	12	14	−9
1857−26	1900−2600	—	—	—	31	17	−5	23	13	−1	24	14	−3	11	16	−1	17	18	−5
1859+01	1901+0156	—	—	—	23	13	−12	27	9	−5	64	18	−9	22	15	−6	22	26	7

Table 3 – *continued*

PSR B	PSR J	Degree of polarization																	
		230 MHz			400 MHz			600 MHz			920 MHz			1400 MHz			1600 MHz		
		L %	$\|V\|$ %	V %	L %	$\|V\|$ %	V %	L %	$\|V\|$ %	V %	L %	$\|V\|$ %	V %	L %	$\|V\|$ %	V %	L %	$\|V\|$ %	V %
1859+03	1901+0331[b]	—	—	—	5	13	11	25	12	12	32	13	6	25	9	2	27	11	−1
1859+07	1901+0716	—	—	—	37	16	16	21	5	−5	27	6	2	13	5	4	18	10	−7
1900+01	1903+0135[b]	—	—	—	11	4	1	11	10	10	7	13	11	6	8	7	3	8	3
1900+05	1902+0556[a]	—	—	—	20	14	−9	20	5	−5	30	7	−4	20	5	−3	24	11	−3
1900+06	1902+0615[b]	—	—	—	28	16	16	12	4	3	13	5	4	3	2	1	8	2	−1
1900−06	1903−0632[a]	—	—	—	6	4	−4	18	7	1	17	8	0	11	8	−3	8	9	−8
1902−01	1905−0056	—	—	—	11	11	−11	15	6	−6	37	11	7	20	7	−4	22	12	−9
1903+07	1905+0709	—	—	—	—	—	—	21	9	−2	19	9	−6	21	6	−2	33	7	−5
1904+06	1906+0641	—	—	—	40	49	45	45	18	6	18	16	8	17	8	−7	15	6	−1
1905+39	1907+4002	—	—	—	13	6	4	7	5	0	22	9	4	2	8	0	41	28	17
1906+09	1908+0916	—	—	—	—	—	—	11	23	−2	—	—	—	25	34	22			
1907+00	1909+0007	—	—	—	10	8	−4	10	3	1	15	8	−1	11	8	5	26	8	5
1907+02	1909+0254	—	—	—	6	14	−3	16	11	−6	12	16	−9	8	14	−5	18	25	−25
1907+03	1910+0358	—	—	—	44	26	−19	32	16	−15	11	23	−18	16	15	−15	5	32	−13
1907+10	1909+1102	—	—	—	5	8	−8	14	11	−11	34	9	0	16	18	−18	17	19	−13
1907−03	1910−0309	—	—	—	10	26	−26	40	19	−17	43	24	−14	31	15	3	10	25	20
1910+20	1912+2104	—	—	—	27	15	−10	40	5	−5	34	9	0	24	18	−17	—	—	—
1911+11	1914+1122	—	—	—	47	42	42	6	30	24	—	—	—	6	14	−7	—	—	—
1911+13	1913+1400	—	—	—	9	28	−28	11	21	−17	15	24	−9	9	19	−16	20	23	−18
1911−04	1913−0440	—	—	—	5	7	−4	4	5	−3	3	5	−3	6	3	−3	3	4	−4
1913+10	1915+1009[b]	—	—	—	26	16	14	43	22	22	85	35	35	50	42	42	51	45	45
1913+16	1915+1606	—	—	—	—	—	—	54	26	−9	7	19	8	28	17	−10	—	—	—
1913+167	1915+1647	—	—	—	28	14	−7	15	12	6	54	32	32	82	18	−12	26	20	17
1914+09	1916+0951	—	—	—	12	10	−1	29	8	3	17	12	12	31	11	4	16	10	6
1914+13	1916+1312	—	—	—	13	8	−5	11	8	−7	35	21	−19	12	18	−15	6	23	−23
1915+13	1917+1353	17	14	−14	15	10	−10	40	9	−9	43	12	−12	39	12	−10	35	15	−15
1916+14	1918+1444	—	—	—	31	26	16	19	13	4	—	—	—	11	11	11	10	10	8
1917+00	1919+0021	—	—	—	10	9	4	6	11	8	21	9	5	10	7	−5	10	6	−1
1918+19	1921+1948	—	—	—	55	17	−17	16	6	−5	6	8	−1	4	13	−1	5	13	−11
1918+26	1920+2650	—	—	—	22	47	20	18	33	26	—	—	—	13	31	13	21	20	14
1919+14	1921+1419	—	—	—	37	31	−31	49	20	−14	22	19	−16	28	11	−5	47	15	−5
1919+21	1921+2153	—	—	—	29	4	2	6	4	4	14	3	0	3	4	0	9	5	2
1920+20	1922+2018	—	—	—	49	20	−17	31	14	−7	—	—	—	27	29	21	—	—	—
1920+21	1922+2110	21	19	18	21	14	12	13	16	15	14	12	6	9	10	10	21	10	1
1922+20	1924+2040	—	—	—	—	—	—	18	18	−15	—	—	—	—	—	—	—	—	—
1923+04	1926+0431	—	—	—	26	12	−11	21	2	1	48	5	4	9	5	0	20	15	14
1924+14	1926+1434	—	—	—	—	—	—	6	14	−10	36	34	−27	14	17	−15	51	27	27
1924+16	1926+1648	—	—	—	21	8	7	64	8	7	86	6	−2	62	15	15	57	11	5
1929+10	1932+1059	—	—	—	79	18	−18	69	13	−12	86	19	−17	69	3	−3	69	9	−8
1929+20	1932+2020[b]	—	—	—	—	—	—	10	3	−1	9	8	6	9	6	3	24	9	−7
1930+22	1932+2220	—	—	—	63	8	6	80	10	10	87	16	15	50	7	6	48	4	4
1931+24	1933+24	—	—	—	20	13	−13	31	24	−24	—	—	—	—	—	—	—	—	—
1933+16	1935+1616	—	—	—	10	4	1	14	9	4	11	17	−2	18	15	−2	26	12	0
1935+25	1937+2544	40	9	−4	27	14	−2	31	5	−2	15	18	−4	22	9	−8	20	9	−1
1937−26	1941−2602	—	—	—	38	15	−13	49	8	−7	54	5	−5	46	13	−12	50	16	−16
1940−12	1943−1237	—	—	—	18	4	4	8	2	−1	33	7	−2	10	7	4	6	14	5
1941−17	1944−1750	—	—	—	14	12	10	2	9	8	20	6	2	16	19	−3	—	—	—
1942−00	1945−0040	—	—	—	27	14	−5	20	8	5	15	14	4	3	13	9	22	30	26
1943−29	1946−2913	—	—	—	43	10	−5	19	11	5	25	9	−4	11	9	9	26	29	0
1944+17	1946+1805	—	—	—	55	15	−14	25	12	−12	50	25	−24	28	5	−3	28	10	−8
1946+35	1948+3540[b]	13	40	40	19	27	26	18	18	18	16	10	9	8	6	6	10	5	3

Table 3 – *continued*

PSR B	PSR J	Degree of polarization																	
		230 MHz			400 MHz			600 MHz			920 MHz			1400 MHz			1600 MHz		
		L	|*V*|	V	L	|*V*|	V	L	|*V*|	V	L	|*V*|	V	L	|*V*|	V	L	|*V*|	V
		%	%	%	%	%	%	%	%	%	%	%	%	%	%	%	%	%	%
1946−25	1949−2524	—	—	—	8	17	−17	13	3	1	21	18	18	6	10	−10	—	—	—
1951+32	1952+3252	13	5	−5	20	4	−2	41	5	−4	45	19	−13	27	11	−9	8	6	4
1952+29	1954+2923	—	—	—	30	35	−31	21	34	−28	27	25	−18	24	24	−22	12	20	−15
1953+50	1955+5059	25	20	−10	22	7	−5	19	7	−6	24	3	−1	10	3	−2	12	8	0
2000+32	2002+3217	—	—	—	25	6	−2	24	6	−5	28	6	6	23	5	−5	27	11	−11
2000+40	2002+4050	—	—	—	10	4	−1	8	10	10	8	7	7	4	5	0	9	6	2
2002+31	2004+3137	—	—	—	24	9	−7	10	7	−4	18	5	−2	11	4	3	18	6	3
2003−08	2006−0806	30	20	6	10	12	−2	9	9	2	35	15	4	26	13	−1	28	19	8
2011+38	2013+3845	—	—	—	52	4	4	61	6	−6	62	6	4	66	7	−7	64	7	−4
2016+28	2018+2839	12	13	−13	10	3	−3	16	7	−7	8	12	−11	5	7	−6	7	4	−1
2020+28	2022+2854	10	4	−2	13	15	−8	18	11	−10	14	11	−9	12	9	−9	12	7	−3
2021+51	2022+5154	49	6	1	65	2	1	45	8	8	45	3	3	40	3	2	32	1	0
2022+50m	2023+5037m	—	—	—	18	7	−6	11	6	−5	26	6	−4	10	6	−3	14	7	−6
2022+50i	2023+5037i	—	—	—	98	6	−4	47	12	−2	20	11	1	64	9	3	30	15	−12
2027+37	2029+3744	—	—	—	7	12	−4	20	9	−7	32	10	−9	24	3	1	24	6	−1
2028+22	2030+2228	—	—	—	—	—	—	13	28	8	—	—	—	—	—	—	—	—	—
2035+36	2037+3621	—	—	—	—	—	—	15	9	−6	15	23	4	23	5	2	34	6	0
2036+53	2038+5319	—	—	—	—	—	—	23	21	11	—	—	—	15	14	−12	—	—	—
2043−04	2046−0421	25	4	−1	16	6	0	14	11	−11	19	13	1	6	13	−13	6	18	−14
2044+15	2046+1540	5	11	1	23	15	−15	12	6	−3	11	9	−1	17	3	3	10	13	−7
2045+56	2046+5708	—	—	—	44	15	−9	62	11	−7	—	—	—	25	9	5	41	31	27
2045−16	2048−1616	—	—	—	27	5	4	21	5	5	24	6	3	21	4	2	18	4	2
2053+21	2055+2209	13	24	24	29	6	4	35	12	10	27	25	25	9	19	16	8	25	14
2053+36	2055+3630[a]	—	—	—	16	6	1	14	8	−2	7	20	−13	13	17	−16	7	16	−13
2106+44	2108+4441	17	22	−20	20	12	−7	8	6	−5	8	9	−6	10	7	−6	12	7	−4
2110+27	2113+2754	12	7	7	17	13	−13	13	6	−4	13	5	−4	10	3	−3	17	3	−1
2111+46	2113+4644	10	10	−2	7	12	−4	11	9	−2	17	11	1	19	9	−4	24	10	−2
2113+14	2116+1414	9	15	2	16	6	−2	19	11	−2	38	21	−12	13	10	−1	21	14	3
2122+13	2124+1407	24	41	−41	—	—	—	40	17	12	—	—	—	—	—	—	—	—	—
2148+52	2150+5247	26	17	17	15	9	−1	8	5	−1	9	6	6	4	3	0	3	8	3
2148+63	2149+6329	16	8	−5	14	12	−11	20	11	−10	23	9	−9	25	8	−8	30	5	−4
2152−31	2155−3118	16	7	0	5	20	4	17	15	13	16	13	10	11	19	17	—	—	—
2154+40	2157+4017	22	6	−4	23	6	−6	17	6	−5	18	7	−5	18	3	−3	24	2	−2
2210+29	2212+2933	—	—	—	21	19	−16	6	9	−7	15	19	−4	9	8	−1	0	27	1
2217+47	2219+4754	5	2	1	5	3	−2	11	4	3	11	5	4	4	4	3	4	9	4
2224+65	2225+6535	34	9	4	29	6	0	32	4	3	52	10	−7	43	7	−2	56	9	5
2227+61	2229+6205	23	5	−1	18	8	−2	15	6	4	10	18	−6	7	5	0	27	19	−13
2241+69	2242+6950	—	—	—	—	—	—	36	8	−5	32	32	−23	41	17	−12	—	—	—
2255+58	2257+5909	—	—	—	15	7	6	5	4	2	3	7	4	5	4	0	10	4	−1
2303+30	2305+3100	5	20	13	21	7	−5	8	9	−8	19	10	−7	18	2	−1	28	3	−1
2303+46	2305+4707	—	—	—	33	9	0	20	9	7	—	—	—	40	23	1	33	22	7
2306+55	2308+5547	12	13	−2	5	17	−16	7	14	−13	7	20	−15	4	17	−12	15	38	−20
2310+42	2313+4253	2	4	−3	17	9	−8	22	12	−11	32	9	−6	14	7	−6	13	12	−11
2315+21	2317+2149	17	7	3	9	12	−9	13	14	−13	21	22	−22	7	16	−16	—	—	—
2319+60	2321+6024	14	11	−9	14	10	−5	15	3	−3	8	5	1	19	1	0	17	2	−1
2323+63	2325+6316	42	29	−28	31	13	1	31	6	0	24	14	5	25	9	5	17	9	4
2324+60	2326+6112	52	19	3	16	15	7	9	9	4	15	7	1	11	7	3	18	6	3
2327−20	2330−2005	25	19	−19	24	13	−11	3	13	−12	10	12	−9	9	8	−8	—	—	—
2334+61	2337+6151	8	30	−30	14	7	−2	5	5	−2	2	8	−5	17	4	−2	26	7	−3
2351+61	2354+6155	5	10	9	15	8	2	22	6	3	14	5	5	19	6	4	16	7	4

Table 4. Pulse widths.

PSR B	Pulse widths																	
	230 MHz			400 MHz			600 MHz			920 MHz			1400 MHz			1600 MHz		
	W_{50} (°)	W_{10} (°)	W_{e} (°)	W_{50} (°)	W_{10} (°)	W_{e} (°)	W_{50} (°)	W_{10} (°)	W_{e} (°)	W_{50} (°)	W_{10} (°)	W_{e} (°)	W_{50} (°)	W_{10} (°)	W_{e} (°)	W_{50} (°)	W_{10} (°)	W_{e} (°)
0011+47	—	—	—	27.4	—	25.6	20.8	60.2	29.2	23.4	—	38.1	20.1	52.1	26.5	17.9	45.9	22.3
0031−07	22.2	46.2	23.4	22.0	40.9	24.0	24.6	43.8	26.7	23.4	47.3	26.3	21.8	45.4	24.2	15.5	39.4	18.7
0037+56	9.5	—	14.4	4.0	8.0	4.5	3.8	7.0	3.9	3.3	5.7	3.3	3.7	6.9	4.1	4.1	—	4.8
0045+33	5.2	—	7.7	6.5	10.0	6.5	5.5	9.5	7.4	—	—	—	—	—	—	—	—	—
0052+51	15.9	—	12.5	12.8	15.7	5.3	12.1	15.3	6.2	11.0	—	4.5	10.1	13.6	5.3	10.5	13.7	5.3
0053+47	—	—	—	7.5	—	10.4	10.3	—	9.2	—	—	—	—	—	—	—	—	—
0059+65	—	—	—	19.4	23.5	10.7	18.5	21.9	11.0	18.5	—	8.6	16.9	20.7	8.0	17.8	21.4	9.1
0105+65	8.2	—	12.1	7.5	18.0	10.9	7.2	14.9	8.7	8.6	—	8.3	7.5	17.3	9.5	7.3	16.1	8.6
0105+68	4.2	32.4	1.7	28.0	—	20.1	28.0	—	17.9	27.1	—	12.7	26.7	—	19.8	25.8	—	13.4
0114+58	—	—	—	15.8	30.4	17.9	13.1	21.8	12.5	—	—	—	11.7	—	12.4	—	—	—
0136+57	9.3	19.3	10.8	7.0	12.9	7.8	6.3	11.3	6.6	6.0	10.8	6.3	6.5	12.4	7.0	6.7	12.3	7.0
0138+59	10.3	31.5	12.0	11.5	31.7	14.3	11.8	30.7	14.4	12.0	31.2	13.8	13.5	33.1	16.4	14.3	35.0	18.0
0144+59	24.5	85.5	30.2	13.5	18.0	12.3	11.2	17.2	10.7	4.6	—	6.5	4.8	12.1	5.6	4.0	10.8	4.9
0148−06	39.4	44.7	12.0	36.0	41.8	14.7	33.5	40.3	15.7	30.5	—	20.9	29.0	37.8	15.5	31.4	37.9	14.4
0149−16	8.1	13.1	6.7	7.9	11.8	6.9	7.7	12.0	7.1	8.1	—	7.9	7.3	10.9	6.4	—	—	—
0153+39	—	—	—	—	—	—	8.3	—	4.3	—	—	—	—	—	—	—	—	—
0154+61	—	—	—	5.3	—	6.1	5.9	11.6	6.5	5.9	10.0	4.6	5.7	11.7	6.3	6.1	14.4	7.0
0226+70	—	—	—	8.8	—	8.2	8.2	10.2	6.6	—	—	—	7.1	—	6.4	—	—	—
0301+19	17.8	—	10.9	15.2	18.9	8.7	13.8	18.2	10.1	12.5	17.1	9.2	11.9	16.3	9.1	11.5	15.7	8.3
0320+39	5.5	8.9	5.1	5.1	9.0	5.5	5.3	10.7	5.9	5.0	11.5	5.5	6.6	11.9	7.2	7.8	—	4.7
0329+54	4.6	9.7	5.7	3.3	15.9	4.7	4.1	17.0	6.2	4.3	24.1	7.0	4.5	24.7	8.0	4.8	24.7	8.5
0331+45	10.0	—	9.3	8.6	—	10.6	8.4	13.5	7.8	7.8	—	7.6	6.8	11.8	6.1	6.9	—	7.5
0339+53	—	—	—	6.9	—	7.4	7.4	12.0	7.4	—	—	—	5.7	—	7.8	—	—	6.0
0353+52	—	—	—	22.9	47.7	25.0	13.1	30.0	14.4	8.2	—	11.5	9.4	24.0	12.3	10.0	20.7	11.3
0355+54	10.9	24.4	12.4	9.1	25.1	12.6	8.6	27.2	12.4	10.1	36.4	15.8	20.2	39.4	22.4	19.1	38.3	20.6
0402+61	10.0	21.7	11.6	14.3	19.8	11.7	14.3	17.9	11.0	14.9	—	13.9	13.6	17.8	10.7	12.8	17.6	6.8
0410+69	—	—	—	4.1	11.0	5.2	4.4	10.9	5.4	5.2	—	2.4	3.9	10.0	5.1	—	—	—
0447−12	13.7	24.8	14.3	16.0	24.0	16.2	17.9	28.4	18.5	18.1	—	18.5	20.0	27.4	19.7	—	—	—
0450+55	11.1	32.3	13.5	9.2	31.0	13.4	12.7	32.0	16.6	17.8	33.0	16.9	19.5	32.4	18.0	20.2	33.0	19.6
0450−18	21.1	29.9	20.3	19.0	24.8	15.8	18.5	24.3	17.0	18.0	24.5	17.0	18.3	25.6	17.3	18.5	26.0	17.5
0458+46	—	—	—	12.6	—	12.2	11.9	16.7	11.9	11.4	15.3	10.2	10.6	14.4	9.6	10.7	14.4	9.0
0523+11	—	—	—	16.3	21.8	14.9	15.1	19.0	12.2	14.6	18.9	12.4	14.5	20.2	11.4	11.5	17.9	9.4
0525+21	19.5	22.6	8.0	18.0	20.8	8.5	17.1	20.4	8.5	16.2	19.4	7.3	15.6	18.8	7.3	15.0	18.8	6.8
0531+21	—	—	—	175.6	223.0	62.5	154.9	181.4	24.2	6.6	156.4	6.2	6.7	155.3	9.6	13.1	165.2	10.5
0540+23	11.6	32.0	17.9	9.8	27.6	12.2	8.8	24.3	11.4	7.9	24.2	11.1	9.6	25.7	12.2	10.0	26.5	12.7
0559−05	—	—	—	11.1	26.3	14.5	14.9	23.9	13.4	14.5	22.1	14.1	16.3	22.7	14.4	16.2	23.5	15.3
0609+37	10.9	—	15.7	7.5	23.1	12.7	8.1	21.3	10.5	9.2	23.0	12.7	7.3	19.8	9.4	8.7	20.1	11.6
0611+22	25.9	71.6	35.7	7.8	15.9	9.0	7.0	14.2	7.9	7.5	15.8	8.1	7.7	14.8	8.4	8.2	15.5	9.5
0621−04	—	—	—	18.6	25.2	10.0	17.1	25.4	11.6	16.0	—	11.0	3.6	24.1	10.2	—	—	—
0626+24	6.1	18.2	8.1	6.8	16.2	7.7	7.6	16.6	8.9	8.4	18.0	9.7	10.0	17.7	10.0	11.5	19.7	11.9
0628−28	20.5	40.1	23.9	18.7	38.2	22.6	18.3	38.0	21.5	19.1	37.1	21.1	18.7	35.6	20.5	18.2	33.4	19.6
0643+80	—	—	—	4.2	11.6	5.7	4.7	12.0	5.8	—	—	3.3	3.6	10.7	4.5	4.1	—	4.1
0655+64	—	—	—	11.4	18.7	12.4	10.4	16.9	10.4	8.8	—	8.6	10.6	—	10.2	—	—	—
0656+14	24.2	—	26.3	19.8	42.2	20.4	17.0	33.8	18.6	17.4	—	21.8	15.9	33.4	18.5	14.4	30.5	16.1
0727−18	14.9	—	14.1	14.3	21.7	10.5	13.8	21.0	12.2	13.9	18.2	11.0	11.9	18.6	10.4	13.0	18.2	12.6
0740−28	16.0	36.2	19.0	12.3	20.9	12.9	10.2	17.0	10.4	9.3	15.8	9.8	11.1	17.6	11.7	11.2	17.9	11.6
0751+32	3.5	—	0.4	4.7	26.6	8.5	4.2	24.4	8.2	4.4	24.7	9.8	19.0	25.6	10.7	22.1	—	6.1
0756−15	4.8	8.7	5.3	—	8.5	—	4.5	8.1	4.9	4.0	7.3	3.7	4.2	7.4	4.4	4.3	7.3	3.3
0809+74	12.9	27.7	14.9	12.1	25.9	13.9	12.5	26.9	14.3	11.7	26.2	14.5	15.4	27.7	15.8	16.5	27.2	16.6
0818−13	—	—	—	6.5	10.5	6.5	6.9	10.9	6.9	6.9	10.6	6.7	7.1	10.9	7.1	7.0	10.7	6.7
0820+02	12.9	19.0	13.0	9.0	14.8	9.4	8.8	15.2	9.7	9.0	14.4	8.3	9.0	15.1	9.5	9.2	15.0	8.7

Table 4 – *continued*

PSR B	Pulse widths																	
	230 MHz			400 MHz			600 MHz			920 MHz			1400 MHz			1600 MHz		
	W_{50} (°)	W_{10} (°)	W_e (°)	W_{50} (°)	W_{10} (°)	W_e (°)	W_{50} (°)	W_{10} (°)	W_e (°)	W_{50} (°)	W_{10} (°)	W_e (°)	W_{50} (°)	W_{10} (°)	W_e (°)	W_{50} (°)	W_{10} (°)	W_e (°)
0823+26m	—	—	—	3.9	8.4	4.7	3.8	8.5	4.7	3.5	7.8	4.3	3.1	6.7	3.7	3.1	6.6	3.1
0823+26i	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
0826−34	—	—	—	—	—	—	224.9	279.5	132.5	—	—	—	77.3	305.1	125.6	—	—	—
0834+06	—	—	—	6.8	9.6	5.6	7.4	10.6	6.5	7.3	10.3	5.9	7.8	10.5	6.1	8.4	—	8.6
0841+80	—	—	—	—	—	—	19.7	—	16.4	—	—	—	—	—	—	—	—	—
0844−35	—	—	—	—	—	—	8.1	28.6	13.0	5.5	25.0	8.4	—	—	—	7.2	—	8.9
0853−33	—	—	—	7.0	—	6.8	6.5	9.9	6.5	—	—	—	6.3	9.3	6.2	6.4	—	5.6
0906−17	9.0	24.1	11.4	8.9	22.0	9.9	8.6	20.8	10.4	9.5	—	10.5	8.5	21.0	10.2	8.7	21.1	10.4
0917+63	10.4	12.2	5.5	9.0	11.4	3.8	8.5	10.9	4.4	7.9	—	6.2	8.1	10.8	5.0	—	—	—
0919+06	10.9	24.6	13.1	9.6	21.1	11.2	7.4	17.4	8.7	6.7	15.1	7.8	5.5	12.6	6.6	5.3	11.3	6.0
0940+16	29.2	—	46.2	24.5	—	28.8	24.9	51.8	30.4	21.1	—	22.3	18.5	44.0	25.5	23.0	—	29.7
0942−13	4.1	8.4	4.6	4.3	7.0	4.2	4.5	7.5	4.7	5.0	8.5	5.3	4.9	7.5	4.8	4.8	—	6.3
0943+10	—	—	— —	20.5	—	8.0	—	8.3	—	—	—	—	—	—	—	—	—	
0950+08	15.2	33.3	19.8	13.5	29.4	17.0	12.7	29.2	16.2	12.4	29.5	15.8	12.9	30.8	16.4	13.1	31.4	16.8
1010−23	7.3	—	9.9	5.9	9.9	5.0	5.1	8.5	5.6	—	—	—	—	—	—	—	—	—
1016−16	6.9	—	4.9	5.9	10.4	5.0	6.6	11.7	7.2	—	—	—	7.0	10.0	6.6	—	—	—
1039−19	20.0	—	16.9	16.6	20.0	12.6	15.7	19.6	12.1	14.6	18.9	11.7	14.1	17.7	10.4	13.7	18.1	11.0
1112+50	—	—	—	3.9	7.8	4.2	4.3	9.6	5.6	4.1	8.9	4.3	5.9	8.9	5.0	3.8	8.4	4.0
1133+16	10.5	13.9	7.2	9.8	13.0	7.5	8.6	12.1	6.0	2.7	11.3	5.2	3.2	11.4	5.3	2.6	10.5	4.3
1237+25	1.8	16.3	5.1	13.4	16.0	7.5	13.0	16.1	9.8	12.6	14.8	8.9	12.2	14.8	9.2	11.9	14.5	8.4
1254−10	—	—	—	3.5	15.8	5.9	3.9	16.0	5.8	3.9	17.4	6.4	5.7	19.5	8.2	7.3	—	9.7
1309−12	7.0	11.7	5.1	5.5	11.7	5.5	5.5	10.5	5.9	4.7	9.6	4.1	5.2	10.5	6.1	7.0	—	5.2
1322+83	—	—	—	11.3	21.2	12.5	12.3	57.8	15.5	13.1	—	11.6	11.7	50.0	15.3	—	—	—
1508+55	—	—	—	5.9	13.2	6.7	6.8	13.5	7.4	8.9	13.6	8.5	9.3	13.8	8.8	9.0	13.3	8.1
1530+27	10.1	15.3	9.7	6.2	13.3	6.2	6.1	14.1	7.8	5.5	12.5	6.6	5.7	62.9	7.5	5.6	43.3	5.2
1540−06	4.4	9.7	4.6	4.5	8.8	4.7	5.2	10.3	5.8	4.7	10.2	5.5	4.0	9.3	4.8	3.9	9.2	4.5
1541+09	23.1	90.2	35.8	27.1	88.5	38.5	33.3	119.8	51.1	68.0	—	66.1	67.5	127.6	64.8	65.3	129.2	58.6
1552−23	—	—	—	8.1	19.5	11.8	9.3	19.9	10.5	12.5	18.2	10.7	10.0	18.2	9.1	11.7	18.4	16.2
1552−31	—	—	—	19.4	23.7	10.3	20.1	25.1	13.6	20.2	24.5	11.9	19.7	24.2	18.0	19.8	24.1	17.1
1600−27	—	—	—	9.1	14.0	7.8	8.8	15.3	9.1	8.1	16.5	10.3	8.9	17.4	10.2	9.4	18.0	8.9
1604−00	11.5	16.5	11.0	11.5	16.6	11.0	9.6	16.4	10.0	9.8	15.9	10.1	8.9	15.3	8.7	8.2	14.7	8.8
1607−13	—	—	—	13.9	31.9	15.3	22.0	35.5	19.3	20.3	—	12.4	23.3	—	22.6	—	—	—
1612+07	2.6	7.8	3.7	3.4	7.2	3.2	4.8	8.4	4.7	2.9	—	3.2	4.6	8.5	4.7	—	—	—
1612−29	—	—	—	3.3	8.4	0.5	4.2	10.0	3.9	—	—	—	—	—	—	—	—	—
1620−09	—	—	—	4.1	7.5	4.4	3.3	6.4	3.4	3.4	5.4	2.7	3.4	5.9	4.6	3.4	6.0	3.1
1620−26	—	—	—	—	—	—	39.8	84.9	43.8	18.5	69.5	29.2	23.5	73.8	34.4	54.4	—	54.3
1633+24	—	—	—	—	—	—	13.0	39.5	19.0	11.9	—	20.6	10.9	49.5	19.5	—	—	—
1642−03	6.9	13.3	7.4	4.0	7.6	4.4	4.1	7.8	4.5	4.0	7.7	4.5	4.2	9.3	5.2	4.1	9.5	5.1
1648−17	—	—	—	9.9	13.0	5.5	11.0	14.1	8.0	—	—	—	11.1	13.2	6.8	—	—	—
1649−23	—	—	—	7.5	11.5	7.7	7.5	11.3	7.4	7.0	11.2	6.1	7.7	11.2	7.0	7.7	11.1	6.5
1657−13	—	—	—	7.4	13.9	7.0	10.2	38.1	14.7	10.0	—	10.5	—	—	—	—	—	—
1700−18	—	—	—	5.8	10.4	5.1	5.6	11.8	6.6	5.7	11.0	6.8	6.2	10.5	6.8	5.2	9.9	4.3
1700−32	—	—	—	13.2	18.5	10.2	12.9	16.1	11.5	—	—	—	—	—	—	—	—	—
1702−19m	—	—	—	9.0	17.3	9.4	9.7	18.0	10.5	10.9	18.0	10.9	11.0	17.3	11.3	11.1	18.2	11.7
1702−19i	—	—	—	3.9	—	4.9	4.0	7.9	3.4	3.9	7.7	4.0	3.6	8.0	5.0	3.9	8.3	4.9
1706−16	—	—	—	6.3	12.8	7.3	6.0	12.2	6.7	5.3	11.8	6.2	5.1	10.9	5.7	5.0	10.9	5.6
1709−15	—	—	—	5.1	8.0	1.6	4.9	8.6	4.8	4.1	7.9	2.8	5.1	8.4	6.2	5.1	7.9	4.8
1714−34	—	—	—	—	—	—	92.4	197.5	98.1	—	—	—	7.2	15.4	9.0	—	—	—
1717−16	—	—	—	4.3	11.1	5.4	4.5	11.4	5.4	4.0	10.0	5.4	4.1	9.9	4.7	4.1	10.0	4.0
1717−29	—	—	—	17.7	23.2	14.9	16.5	25.0	16.2	13.8	—	17.7	12.5	20.5	11.3	6.7	17.9	11.0
1718−02	—	—	—	46.2	93.3	45.6	45.2	64.6	44.4	38.5	—	41.9	37.1	—	45.4	—	—	—

Table 4 – *continued*

PSR B	Pulse widths																	
	230 MHz			400 MHz			600 MHz			920 MHz			1400 MHz			1600 MHz		
	W_{50} (°)	W_{10} (°)	W_e (°)	W_{50} (°)	W_{10} (°)	W_e (°)	W_{50} (°)	W_{10} (°)	W_e (°)	W_{50} (°)	W_{10} (°)	W_e (°)	W_{50} (°)	W_{10} (°)	W_e (°)	W_{50} (°)	W_{10} (°)	W_e (°)
1718−19	—	—	—	7.5	15.0	3.6	7.9	15.4	6.0	—	—	—	—	—	—	—	—	—
1718−32	—	—	—	13.4	22.6	13.4	10.8	16.3	10.2	9.3	16.6	9.1	9.7	17.2	9.6	10.2	16.8	9.9
1718−35	—	—	—	—	—	—	—	—	—	—	—	—	31.8	100.0	43.2	—	—	—
1726−00	—	—	—	15.7	43.0	17.0	19.1	39.8	18.1	20.7	—	9.2	21.6	28.0	22.4	20.3	28.0	13.9
1727−33	—	—	—	—	—	—	—	—	—	—	—	—	21.9	51.8	26.9	—	—	—
1730−22	—	—	—	6.0	34.5	9.8	24.7	36.4	17.2	26.1	40.0	22.8	25.3	34.2	19.7	25.9	34.0	20.1
1732−02	—	—	—	7.7	—	10.2	10.3	15.0	11.7	—	—	—	12.0	—	7.8	—	—	—
1732−07	—	—	—	7.0	16.8	8.0	5.2	16.9	7.0	6.2	19.2	8.6	5.2	19.9	8.4	5.2	19.5	11.0
1734−35	—	—	—	—	—	—	8.6	20.5	10.3	—	—	—	5.3	10.7	5.7	—	—	—
1735−32	—	—	—	8.9	—	6.3	7.0	14.8	8.5	6.6	13.4	8.5	6.0	12.1	7.1	6.0	11.4	5.4
1736−29m	—	—	—	—	—	—	9.3	17.5	10.8	6.6	13.4	7.0	7.6	12.9	7.6	7.9	13.5	7.7
1736−29i	—	—	—	—	—	—	11.9	20.3	10.5	9.0	15.7	7.8	8.5	16.5	9.3	7.6	15.4	7.4
1736−31	—	—	—	—	—	—	263.5	343.6	205.7	75.5	230.5	87.2	15.2	36.8	18.3	13.3	30.8	16.0
1737+13	—	—	—	14.9	20.6	10.0	15.4	23.8	13.1	16.3	22.0	13.0	12.9	22.0	10.8	10.3	21.5	10.7
1737−30	—	—	—	24.4	58.0	28.6	7.7	15.9	8.6	3.6	7.5	4.1	3.9	8.0	4.4	3.7	7.7	4.3
1738−08	—	—	—	17.6	20.0	21.5	14.6	20.2	13.3	13.7	18.9	11.8	10.7	16.8	9.3	10.8	17.5	11.6
1740−03	—	—	—	—	—	—	5.3	12.5	7.1	—	—	—	5.6	12.7	6.5	4.4	11.2	5.4
1740−13	—	—	—	14.5	27.7	15.1	10.7	22.8	13.1	—	—	—	15.1	21.0	15.2	10.7	—	15.7
1740−31	—	—	—	—	—	—	8.5	17.4	9.7	—	—	—	7.0	10.5	7.1	—	—	—
1742−30	—	—	—	7.5	28.7	11.0	5.1	21.3	7.3	5.2	20.9	7.4	8.0	22.7	9.7	8.9	23.7	10.9
1745−12	—	—	—	11.6	20.0	13.9	9.6	19.2	11.1	9.9	16.8	12.1	14.7	20.2	14.6	14.4	19.9	13.5
1746−30	—	—	—	—	—	—	50.4	130.8	60.0	—	—	—	28.4	52.6	26.2	—	—	—
1747−31	—	—	—	—	—	—	33.6	40.0	20.8	—	—	—	6.0	35.2	13.5	—	—	—
1749−28	—	—	—	4.6	8.4	4.9	4.6	8.3	4.8	4.7	8.7	5.1	4.9	9.2	5.4	4.6	9.1	5.3
1750−24	—	—	—	—	—	—	—	—	—	—	—	—	47.9	133.0	61.5	37.8	90.0	45.6
1753+52	—	—	—	14.1	22.0	9.9	16.4	21.4	16.6	—	—	—	15.8	20.2	13.7	14.2	—	14.0
1753−24	—	—	—	—	—	—	41.7	70.0	49.1	14.4	21.0	14.8	14.0	24.3	14.9	13.2	20.9	12.6
1754−24	—	—	—	52.1	100.0	56.8	19.7	37.6	21.7	16.6	26.4	17.9	16.1	30.2	16.1	17.6	34.7	18.5
1756−22	—	—	—	9.1	37.7	13.8	4.9	12.2	5.8	2.5	8.1	2.8	3.2	9.9	4.3	4.1	9.5	4.5
1758−03	—	—	—	5.1	11.3	5.8	4.1	10.7	5.0	4.2	10.8	4.6	5.0	11.8	6.6	7.6	11.8	7.8
1758−23	—	—	—	—	—	—	—	—	—	—	—	—	80.6	199.9	97.3	51.3	127.2	65.2
1758−24	—	—	—	—	—	—	55.3	146.4	73.2	—	—	—	14.4	27.3	13.0	—	—	—
1800−21	—	—	—	63.4	—	82.1	39.2	119.4	51.6	35.5	113.7	44.5	36.6	119.0	48.0	38.5	120.1	49.8
1800−27	—	—	—	—	—	—	—	—	—	—	—	—	21.2	30.3	20.1	—	—	—
1802+03	—	—	—	—	—	—	7.5	32.1	11.5	16.7	—	18.4	—	—	—	13.6	—	11.2
1802−07	—	—	—	—	—	—	94.1	147.7	82.6	—	—	—	38.5	93.4	45.8	61.2	68.6	62.5
1804−08	—	—	—	15.4	36.7	18.3	9.4	28.3	12.9	7.5	26.4	12.0	19.3	27.9	16.6	21.0	30.5	20.2
1804−27	—	—	—	—	—	—	6.9	13.3	7.7	6.0	10.5	6.5	5.4	11.8	4.8	6.8	12.5	5.8
1805−20	—	—	—	—	—	—	79.9	222.5	101.2	27.8	60.0	31.9	12.0	33.2	15.7	12.2	32.0	14.9
1806−21	—	—	—	—	—	—	15.9	33.6	16.4	5.5	10.0	7.5	5.4	9.3	5.4	6.2	10.7	5.3
1809−173	—	—	—	—	—	—	—	—	—	—	—	—	5.7	11.5	6.7	5.4	11.7	6.8
1809−176	—	—	—	—	—	—	—	—	—	—	—	—	40.1	82.0	46.7	39.9	69.8	39.7
1810+02	—	—	—	5.8	11.4	6.2	6.1	9.2	5.2	7.6	—	6.3	7.0	9.5	6.0	6.3	—	4.2
1811+40	—	—	—	6.0	—	5.8	8.9	15.7	9.9	7.0	15.2	7.4	9.9	15.1	9.4	9.7	15.0	11.7
1813−17	—	—	—	—	—	—	67.4	170.0	71.2	14.9	22.0	12.7	6.9	13.3	7.6	8.6	15.8	9.9
1813−26	—	—	—	32.7	40.5	21.2	28.4	38.2	21.8	—	—	—	25.4	35.2	18.3	23.4	32.0	21.6
1813−36	—	—	—	—	—	—	6.1	13.7	7.0	7.2	16.9	7.6	—	—	—	10.7	—	9.4
1815−14	—	—	—	—	—	—	175.0	257.8	144.8	69.8	220.0	89.7	23.4	59.1	27.1	26.3	54.6	30.1
1817−13	—	—	—	—	—	—	245.7	292.5	168.8	38.1	90.0	43.9	16.9	50.2	26.6	14.5	33.4	16.9
1817−18	—	—	—	—	—	—	—	—	—	—	—	—	15.7	26.8	15.3	18.8	33.0	15.1
1818−04m	—	—	—	6.5	13.2	7.2	5.3	10.8	5.9	5.5	11.3	6.1	6.9	12.4	7.4	7.0	12.8	7.5

Table 4 – *continued*

PSR B	Pulse widths																	
	230 MHz			400 MHz			600 MHz			920 MHz			1400 MHz			1600 MHz		
	W_{50} (°)	W_{10} (°)	W_{e} (°)	W_{50} (°)	W_{10} (°)	W_{e} (°)	W_{50} (°)	W_{10} (°)	W_{e} (°)	W_{50} (°)	W_{10} (°)	W_{e} (°)	W_{50} (°)	W_{10} (°)	W_{e} (°)	W_{50} (°)	W_{10} (°)	W_{e} (°)
1819−22	—	—	—	13.8	19.2	10.2	10.7	18.5	10.9	10.4	16.6	11.2	9.2	17.0	10.0	8.3	16.4	9.1
1820−11	—	—	—	136.0	250.0	124.0	75.3	165.4	90.3	40.2	76.2	41.0	38.2	58.1	37.2	40.8	70.8	43.2
1820−14	—	—	—	—	—	—	71.3	180.0	94.7	20.3	36.8	31.6	14.2	25.8	16.8	32.8	57.2	27.6
1820−30B	—	—	—	5.6	12.0	5.1	5.2	11.5	5.6	—	—	—	—	—	—	—	—	—
1820−31	—	—	—	8.1	15.2	7.9	7.2	14.1	7.8	6.5	13.4	7.0	6.1	12.3	7.0	5.4	11.3	6.1
1821+05	8.1	20.0	8.7	5.0	25.9	8.3	6.3	29.5	12.5	19.4	30.9	15.4	23.1	29.5	16.1	23.4	33.3	17.8
1821−11	—	—	—	—	—	—	99.0	263.1	125.2	30.8	77.3	31.9	11.9	27.1	14.8	13.4	25.1	14.8
1821−19	—	—	—	47.6	112.5	57.2	14.9	34.8	17.4	5.1	10.1	5.2	5.0	9.7	5.6	11.1	20.0	11.3
1822+00	—	—	—	5.4	11.8	5.8	4.9	13.7	5.4	5.8	13.8	7.3	6.3	16.4	6.9	6.6	13.8	9.6
1822−09m	—	—	—	5.8	10.6	6.7	6.2	22.6	7.4	5.7	22.7	7.5	5.7	23.3	7.7	4.6	22.7	6.7
1822−09i	—	—	—	15.5	—	12.8	6.9	16.0	7.8	6.1	12.6	10.1	7.1	14.7	7.1	11.0	14.0	2.0
1822−14	—	—	—	—	—	—	—	—	—	48.3	75.0	57.3	14.1	32.4	18.3	16.9	33.3	20.1
1823−11	—	—	—	18.7	—	16.0	7.7	17.0	9.3	6.3	15.2	6.6	5.5	15.8	7.8	5.5	14.0	8.7
1823−13	—	—	—	—	—	—	—	—	—	32.6	128.0	48.8	24.7	125.8	42.0	31.2	130.5	48.7
1824−10	—	—	—	—	—	—	143.4	170.0	88.1	61.2	130.0	83.4	32.1	54.0	33.1	35.9	58.0	45.6
1826−17	—	—	—	59.3	119.5	64.5	17.4	37.9	20.2	14.3	23.6	13.0	17.6	23.5	16.7	18.6	26.3	18.1
1828−10	—	—	—	—	—	—	8.9	20.0	13.7	3.4	6.8	4.9	3.7	8.1	4.5	2.9	5.6	3.0
1829−08	—	—	—	16.9	—	24.2	10.2	20.7	11.0	4.5	13.5	6.3	5.0	15.3	6.8	4.6	15.0	6.0
1829−10	—	—	—	186.9	303.6	139.9	107.5	298.1	139.3	25.9	53.0	26.7	9.2	18.9	11.3	16.9	27.5	21.9
1830−08	—	—	—	—	—	—	99.4	231.1	120.6	28.6	64.2	36.0	19.8	54.1	26.0	52.2	106.9	57.7
1831−00	—	—	—	21.2	—	16.1	—	—	—	11.9	—	9.5	—	—	—	4.6	7.7	4.1
1831−03	—	—	—	14.5	34.2	18.6	6.4	14.8	7.5	3.9	10.7	4.9	4.3	12.0	5.5	5.2	13.2	6.4
1831−04	—	—	—	24.8	121.4	40.6	108.6	126.8	67.7	108.8	134.5	75.8	110.9	131.9	73.2	111.9	135.1	73.7
1832−06	—	—	—	—	—	—	—	—	—	—	—	—	40.2	87.5	46.4	38.8	70.4	41.2
1834−04	—	—	—	—	—	—	41.0	76.1	41.2	12.9	17.7	14.6	10.9	17.5	9.9	11.5	18.1	11.0
1834−06	—	—	—	—	—	—	33.4	69.0	38.5	18.4	34.5	21.5	23.4	36.1	18.6	18.6	27.9	5.0
1834−10	—	—	—	72.5	230.6	104.8	20.9	56.3	27.4	7.1	14.8	8.0	5.7	11.4	6.6	7.1	13.9	7.8
1838−04	—	—	—	62.7	270.6	77.8	53.7	118.9	61.2	15.2	29.5	16.6	10.1	18.4	11.1	18.4	32.7	18.2
1839+09	—	—	—	7.5	12.6	6.5	8.0	13.6	8.1	8.8	15.1	9.0	9.3	15.5	9.9	9.4	14.9	9.0
1839+56	3.1	12.7	5.9	6.2	12.5	6.9	7.7	12.2	7.2	7.9	12.4	8.3	7.3	11.6	7.1	7.9	12.5	11.2
1839−04	—	—	—	71.7	—	39.2	65.9	81.9	38.2	61.6	74.5	39.1	55.7	70.7	32.4	55.3	66.7	28.1
1841−04	—	—	—	11.7	27.1	9.9	6.7	13.8	7.6	4.9	10.6	5.5	5.2	13.1	6.0	5.0	9.9	5.9
1841−05	—	—	—	—	—	—	115.0	259.8	123.3	25.1	58.0	30.2	11.4	23.6	12.8	16.6	29.2	15.7
1842+14	—	—	—	9.0	14.4	8.7	9.5	14.6	9.2	11.6	15.1	11.3	11.7	16.8	10.6	11.6	15.4	9.6
1842−02	—	—	—	—	—	—	—	—	—	—	—	—	11.7	24.2	15.4	13.3	23.0	9.6
1842−04	—	—	—	—	—	—	49.7	—	46.0	47.0	—	53.1	36.2	51.4	33.6	36.2	54.9	36.5
1844−04	—	—	—	15.9	39.1	19.5	11.0	18.7	10.9	12.5	18.8	11.0	13.0	18.6	10.9	6.1	18.1	9.3
1845−01	—	—	—	24.9	61.4	25.0	13.6	32.8	17.0	9.6	20.3	10.9	10.3	20.7	10.8	10.9	21.3	12.4
1845−19	—	—	—	5.6	7.9	5.0	5.5	7.6	5.0	4.8	7.0	4.8	5.2	6.7	5.4	4.9	7.5	5.6
1846−06	—	—	—	5.9	15.6	6.6	4.2	8.9	4.9	3.4	8.5	4.0	3.6	8.8	4.6	3.5	13.9	4.7
1848+04	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
1848+12	—	—	—	4.5	7.9	5.6	3.6	6.6	3.8	—	—	—	3.8	6.5	3.8	3.0	—	4.3
1848+13	—	—	—	8.3	14.5	8.0	7.2	13.8	8.0	4.9	11.5	6.6	6.1	11.9	6.6	7.1	13.0	5.8
1849+00	—	—	—	—	—	—	—	—	—	—	—	—	43.6	232.5	77.4	33.0	120.1	48.3
1851−14	—	—	—	6.4	15.6	8.1	6.6	15.2	8.3	6.4	14.2	7.4	8.2	17.3	9.8	7.1	14.2	7.1
1853+00	—	—	—	26.7	35.0	13.1	31.1	36.0	26.1	—	—	—	—	—	—	15.8	25.0	13.6
1853+01	—	—	—	19.2	29.0	17.7	6.1	10.6	6.5	—	—	—	10.2	13.6	8.7	6.2	10.5	5.8
1855+02	—	—	—	—	—	—	69.3	182.4	85.5	17.2	30.0	16.8	11.3	18.1	10.7	14.2	25.5	14.8
1855+09	—	—	—	62.2	243.0	91.8	49.8	229.9	64.9	40.8	215.0	60.2	38.4	219.7	50.4	38.8	228.1	54.2
1857−26	—	—	—	21.1	41.8	18.1	27.7	40.9	26.0	32.5	41.1	28.2	31.8	40.1	29.3	30.6	39.2	27.3
1859+01	—	—	—	8.4	19.6	9.1	5.0	16.3	6.6	4.5	—	5.8	7.3	14.5	8.2	6.7	—	9.1

Table 4 – *continued*

PSR B	Pulse widths																	
	230 MHz			400 MHz			600 MHz			920 MHz			1400 MHz			1600 MHz		
	W_{50} (°)	W_{10} (°)	W_e (°)	W_{50} (°)	W_{10} (°)	W_e (°)	W_{50} (°)	W_{10} (°)	W_e (°)	W_{50} (°)	W_{10} (°)	W_e (°)	W_{50} (°)	W_{10} (°)	W_e (°)	W_{50} (°)	W_{10} (°)	W_e (°)
1859+03	—	—	—	47.5	131.8	64.6	12.8	29.2	15.3	6.4	18.7	7.8	6.9	21.4	9.3	8.0	23.9	10.8
1859+07	—	—	—	15.5	—	12.0	10.7	25.7	11.8	8.7	19.7	10.6	8.7	21.4	10.0	8.9	20.4	11.2
1900+01	—	—	—	14.4	30.7	15.5	5.1	10.7	5.7	4.4	9.4	4.8	4.7	11.1	5.5	5.3	11.8	6.1
1900+05	—	—	—	14.3	29.0	15.8	7.1	14.4	7.2	7.8	15.7	7.8	6.5	14.4	8.0	6.9	14.7	6.7
1900+06	—	—	—	46.7	96.5	49.4	12.5	27.0	14.0	3.9	8.0	3.9	4.0	8.1	4.3	8.4	15.8	8.8
1900−06	—	—	—	16.6	36.5	18.2	7.6	17.3	9.0	6.2	14.1	7.5	9.7	15.7	9.1	11.0	15.5	12.9
1902−01	—	—	—	11.4	21.5	10.4	4.2	8.9	4.9	2.8	5.4	2.1	3.2	8.1	4.0	4.1	10.7	5.5
1903+07	—	—	—	—	—	—	28.1	58.0	32.9	21.9	39.5	21.9	20.0	37.5	21.2	19.9	33.5	23.6
1904+06	—	—	—	—	—	43.4	—	—	37.5	19.0	—	24.1	24.3	34.2	21.6	29.5	49.4	30.5
1905+39	—	—	—	17.0	21.2	13.8	16.8	21.8	15.4	16.8	21.5	14.2	16.3	21.7	16.4	14.2	20.0	8.4
1906+09	—	—	—	—	—	—	8.1	—	14.3	—	—	—	15.7	—	16.5	—	—	—
1907+00	—	—	—	3.9	7.6	3.8	2.8	5.7	3.4	2.3	9.2	3.1	3.7	9.9	4.8	2.8	8.3	4.2
1907+02	—	—	—	5.2	9.5	4.3	4.9	11.3	5.4	3.9	11.6	5.2	3.8	12.8	5.5	4.4	14.7	5.2
1907+03	—	—	—	44.5	79.0	35.9	47.0	75.5	37.7	44.9	72.0	33.4	49.1	73.8	32.0	50.4	65.0	30.3
1907+10	—	—	—	11.9	23.6	11.7	7.1	13.9	7.8	5.6	13.0	6.3	6.4	16.4	8.1	6.2	16.9	7.5
1907−03	—	—	—	10.9	23.2	13.1	6.0	15.1	7.6	5.1	14.5	6.3	7.6	19.8	7.9	15.6	—	19.0
1910+20	—	—	—	2.1	—	7.4	2.7	15.8	5.1	2.5	—	3.5	4.8	15.5	6.4	—	—	—
1911+11	—	—	—	11.5	17.0	−5.1	11.2	14.2	7.4	—	—	—	11.4	15.0	6.3	—	—	—
1911+13	—	—	—	6.1	—	6.9	4.4	15.2	6.2	4.6	14.3	3.9	4.5	14.0	5.9	6.2	15.7	7.6
1911−04	—	—	—	3.6	7.1	4.0	3.7	7.1	4.0	4.0	7.8	4.3	5.0	9.5	5.4	4.4	8.7	4.8
1913+10	—	—	—	35.2	76.2	40.8	9.2	20.1	10.0	5.8	11.1	6.1	6.1	11.6	6.4	7.6	13.8	7.5
1913+16	—	—	—	—	—	—	47.9	—	46.0	48.3	—	25.2	45.0	54.0	28.8	—	—	—
1913+167	—	—	—	8.2	13.6	8.5	8.0	12.5	7.1	8.0	—	9.1	6.2	9.2	9.0	8.2	—	6.9
1914+09	—	—	—	7.8	18.5	8.3	11.7	16.3	8.9	12.3	17.2	8.8	13.5	20.3	12.9	13.0	17.2	11.1
1914+13	—	—	—	24.3	—	23.3	10.2	19.7	11.0	8.4	14.2	8.8	7.3	13.2	7.8	9.2	16.4	8.5
1915+13	35.6	65.7	38.3	9.4	19.7	10.8	7.5	16.9	8.4	7.6	16.3	8.9	8.7	17.5	9.7	9.6	18.9	10.4
1916+14	—	—	—	4.4	9.1	5.5	5.0	9.4	5.6	—	—	—	3.6	8.0	4.0	3.6	7.6	4.3
1917+00	—	—	—	4.4	11.2	5.0	5.6	11.7	6.2	5.2	10.5	5.7	6.4	11.9	6.8	4.0	10.4	4.2
1918+19	—	—	—	19.0	34.7	14.3	25.7	58.3	29.7	27.6	54.0	23.5	28.8	55.0	38.0	30.9	55.0	33.5
1918+26	—	—	—	6.8	8.5	5.6	7.3	10.5	7.4	—	—	—	5.6	—	1.7	6.3	11.0	7.7
1919+14	—	—	—	12.7	—	8.0	14.6	22.0	16.7	11.1	23.0	13.6	14.6	23.5	15.2	11.9	24.0	14.7
1919+21	—	—	—	8.4	11.4	7.1	8.9	12.3	7.8	9.2	12.3	8.0	9.2	12.2	8.0	9.4	13.2	8.1
1920+20	—	—	—	21.7	—	27.0	18.5	23.5	8.5	—	—	—	17.0	—	4.6	—	—	—
1920+21	17.7	34.3	18.8	—	14.0	—	5.6	16.0	6.9	5.6	18.9	8.9	7.7	18.2	8.3	6.9	18.7	9.2
1922+20	—	—	—	—	—	—	14.6	22.0	15.5	—	—	—	—	—	—	—	—	—
1923+04	—	—	—	5.2	9.1	3.8	5.3	9.8	5.8	5.4	8.5	4.5	5.4	10.9	5.7	5.7	8.9	4.8
1924+14	—	—	—	—	—	—	7.0	47.5	13.3	6.2	—	18.0	6.7	43.5	15.6	6.5	—	20.3
1924+16	—	—	—	8.8	14.3	6.6	6.4	13.2	7.5	5.7	13.1	6.8	6.2	13.3	6.9	5.8	15.6	7.3
1929+10	—	—	—	9.0	20.9	10.1	9.1	20.4	10.5	9.7	19.8	10.6	10.2	19.1	11.0	9.7	18.1	10.4
1929+20	—	—	—	—	—	—	10.1	21.5	11.5	6.2	10.5	6.7	7.6	12.3	8.3	8.8	19.7	9.9
1930+22	—	—	—	21.9	38.1	20.8	13.3	26.3	13.9	6.0	12.2	5.5	7.9	17.6	9.6	15.7	28.8	15.7
1931+24	—	—	—	12.2	20.0	12.0	15.8	21.0	15.3	—	—	—	—	—	—	—	—	—
1933+16	—	—	—	11.7	21.7	12.1	7.1	12.4	7.4	6.5	9.3	6.2	6.4	10.4	6.9	6.8	12.1	7.4
1935+25	48.4	—	35.0	40.3	—	29.3	28.8	38.2	15.9	29.0	35.0	19.5	26.6	34.2	15.4	26.5	32.3	12.9
1937−26	—	—	—	4.2	11.5	4.9	4.0	10.9	5.0	3.8	10.5	4.4	3.6	10.4	4.5	4.2	11.1	4.8
1940−12	—	—	—	4.4	7.9	3.6	4.1	8.9	4.8	4.8	8.5	3.5	4.5	10.5	6.0	3.4	9.2	5.5
1941−17	—	—	—	8.5	13.1	8.1	8.5	13.5	8.6	11.6	17.3	10.6	11.4	—	13.8	—	—	—
1942−00	—	—	—	—	—	—	19.0	25.0	16.7	17.5	21.0	12.9	18.6	23.2	18.1	17.0	—	13.0
1943−29	—	—	—	3.5	8.2	3.7	4.6	10.2	5.4	4.8	10.0	5.7	4.2	9.5	5.8	3.4	—	1.7
1944+17	—	—	—	14.3	30.9	16.8	21.4	37.9	21.7	24.1	39.5	23.5	27.9	43.5	26.6	28.7	44.8	25.2
1946+35	62.8	175.2	75.5	11.4	28.2	14.6	6.3	13.1	7.2	5.4	11.4	6.3	5.8	16.5	7.7	6.8	17.7	8.6

Table 4 – *continued*

PSR B	Pulse widths																	
	230 MHz			400 MHz			600 MHz			920 MHz			1400 MHz			1600 MHz		
	W_{50} (°)	W_{10} (°)	$W_{\rm e}$ (°)	W_{50} (°)	W_{10} (°)	$W_{\rm e}$ (°)	W_{50} (°)	W_{10} (°)	$W_{\rm e}$ (°)	W_{50} (°)	W_{10} (°)	$W_{\rm e}$ (°)	W_{50} (°)	W_{10} (°)	$W_{\rm e}$ (°)	W_{50} (°)	W_{10} (°)	$W_{\rm e}$ (°)
1946−25	—	—	—	3.7	9.2	3.4	4.7	8.5	5.0	5.0	10.7	5.7	3.8	7.1	3.6	—	—	—
1951+32	33.7	95.0	38.2	47.6	92.5	51.8	30.4	63.1	34.3	27.5	58.0	28.0	24.6	62.4	27.4	23.1	42.0	26.5
1952+29	—	—	—	5.7	31.5	10.5	14.2	35.7	16.1	11.5	30.0	13.2	18.2	30.0	12.2	18.7	28.6	10.8
1953+50	6.3	—	11.1	4.9	9.9	4.9	4.5	9.7	5.2	4.2	8.7	4.8	4.2	8.7	4.7	4.0	8.3	4.8
2000+32	—	—	—	9.2	21.2	10.3	6.8	13.3	7.9	5.9	12.9	5.8	6.0	11.7	6.6	6.8	11.4	7.1
2000+40	—	—	—	10.6	20.6	10.2	7.0	20.7	9.5	7.3	20.6	8.9	7.3	20.1	9.8	6.7	21.1	9.3
2002+31	—	—	—	4.0	7.5	3.9	2.6	4.9	3.0	2.4	4.4	2.8	2.9	6.2	3.4	2.9	9.6	3.2
2003−08	64.8	—	28.6	20.1	66.0	28.5	44.3	63.0	32.7	48.2	61.0	45.4	47.5	60.2	39.3	51.4	63.0	50.7
2011+38	—	—	—	39.2	72.7	43.1	28.3	51.1	30.4	25.4	43.8	27.8	24.0	43.7	25.7	23.7	40.2	26.0
2016+28	10.7	15.6	9.1	9.7	14.7	9.8	9.1	15.0	9.4	8.9	15.4	9.2	8.7	15.7	9.1	9.0	16.0	9.3
2020+28	16.5	25.8	12.1	13.2	17.0	6.2	13.1	17.3	8.0	12.8	16.9	8.8	12.9	16.8	9.5	12.5	16.2	8.5
2021+51	6.5	24.8	8.7	5.5	20.5	9.6	9.5	19.7	10.1	9.0	17.8	10.0	8.8	16.9	9.8	9.3	17.4	10.2
2022+50m	—	—	—	4.3	12.4	5.9	4.4	12.7	6.3	3.3	11.7	3.9	3.8	9.5	4.9	4.3	10.4	5.6
2022+50i	—	—	—	—	—	—	5.6	11.0	5.5	3.1	7.4	0.9	6.2	9.5	8.1	7.5	11.5	8.4
2027+37	—	—	—	7.1	13.1	7.5	5.8	11.8	6.6	5.6	10.5	5.7	5.8	11.4	6.4	6.6	11.6	7.2
2028+22	—	—	—	—	—	—	12.1	13.8	5.9	—	—	—	—	—	—	—	—	—
2035+36	—	—	—	—	—	—	18.3	23.7	14.7	11.5	17.4	9.5	10.4	19.5	10.2	11.1	18.9	11.1
2036+53	—	—	—	—	—	—	4.8	10.0	5.5	—	—	—	4.9	10.0	5.6	—	—	—
2043−04	6.0	12.6	6.8	4.9	7.9	4.6	5.0	9.0	5.3	5.3	9.6	4.6	5.1	9.2	5.4	5.2	8.3	6.5
2044+15	14.3	18.4	8.0	3.4	16.2	5.7	3.9	16.5	7.0	4.6	17.3	8.1	4.5	16.1	7.3	4.5	16.4	7.1
2045+56	—	—	—	10.3	—	15.0	8.9	15.8	10.6	—	—	—	9.4	16.8	9.7	14.1	—	16.9
2045−16	—	—	—	15.6	18.6	11.3	14.5	17.4	9.1	13.3	16.4	8.1	12.9	16.1	7.4	12.2	15.5	6.4
2053+21	8.2	12.4	5.8	8.3	11.1	7.4	7.3	10.7	5.8	7.1	9.4	3.6	6.4	10.3	6.1	3.1	10.0	5.0
2053+36	—	—	—	12.3	27.0	14.2	6.9	15.4	8.0	6.3	12.7	6.4	6.1	14.0	7.4	5.8	14.9	7.9
2106+44	40.7	—	38.3	24.9	—	33.1	21.0	32.5	20.0	20.4	34.2	20.0	21.6	32.3	21.0	22.4	33.9	20.6
2110+27	4.4	8.3	5.2	4.0	7.0	4.4	3.7	6.9	4.1	3.0	5.9	3.3	3.4	6.6	3.9	3.7	6.9	3.9
2111+46	11.1	58.7	18.0	11.4	56.1	18.4	13.2	73.1	25.6	44.3	75.5	36.8	47.6	74.8	44.4	49.3	74.6	43.3
2113+14	8.4	—	10.8	7.4	14.5	7.3	6.6	15.8	8.1	9.4	15.5	10.9	8.0	17.6	10.3	9.1	15.0	11.7
2122+13	16.6	—	8.2	—	16.0	—	14.3	15.8	10.4	—	—	—	—	—	—	—	—	—
2148+52	—	—	—	12.6	28.1	15.1	11.9	22.6	13.3	12.3	19.4	12.6	11.7	18.5	11.4	12.4	17.6	12.1
2148+63	44.5	—	84.8	17.2	32.7	17.2	15.5	25.6	15.8	14.0	22.9	14.7	12.4	21.0	13.1	12.3	18.5	11.9
2152−31	9.3	13.8	10.7	7.0	11.2	7.0	7.4	12.4	7.9	6.6	11.2	5.8	7.5	11.5	7.2	—	—	—
2154+40	10.9	28.7	15.7	10.7	27.7	13.2	16.1	27.5	15.3	16.8	27.3	16.1	15.6	25.6	15.1	16.6	26.0	14.9
2210+29	—	—	—	19.0	21.5	17.2	18.0	21.1	12.8	16.6	—	14.3	16.3	20.2	10.3	17.4	19.3	15.1
2217+47	7.7	14.3	8.1	5.2	9.2	4.7	5.3	10.1	5.8	5.7	10.9	6.1	6.3	12.7	7.0	6.9	12.9	7.7
2224+65	11.1	58.8	16.7	11.1	58.1	12.0	39.2	51.8	19.9	40.4	52.6	23.1	37.3	46.6	17.1	37.5	48.0	18.6
2227+61	30.7	56.7	31.1	21.7	37.0	19.5	17.6	27.8	14.1	18.2	23.5	11.2	7.5	26.8	12.5	18.3	21.0	7.8
2241+69	—	—	—	—	—	—	5.9	11.1	6.3	6.5	—	6.6	4.5	10.0	3.0	—	—	—
2255+58	—	—	—	15.5	31.0	15.8	10.1	22.1	11.6	10.3	18.5	11.4	10.8	21.4	12.4	10.9	20.6	11.6
2303+30	6.0	—	6.0	4.0	7.8	4.3	4.7	8.9	5.1	4.0	8.3	4.8	4.3	8.1	4.5	4.6	8.0	4.3
2303+46	—	—	—	5.2	—	6.7	8.9	19.7	10.4	—	—	—	12.7	—	12.1	12.2	15.8	8.6
2306+55	22.4	26.3	18.0	20.7	26.9	19.6	20.2	26.6	20.0	19.1	25.3	15.7	18.4	24.1	17.1	5.7	24.2	14.6
2310+42	9.4	17.4	10.3	9.1	15.2	8.8	9.8	15.7	9.7	10.3	16.4	10.5	10.6	15.6	10.6	10.9	15.8	10.9
2315+21	5.7	9.6	6.5	5.4	9.2	5.1	5.4	9.0	5.6	5.0	8.6	4.8	5.1	9.0	5.5	—	—	—
2319+60	24.8	32.1	13.3	20.6	25.5	13.3	20.1	26.1	16.0	17.5	23.6	12.6	17.0	22.9	13.3	16.0	22.0	12.0
2323+63	51.9	—	50.0	33.5	37.9	34.1	31.2	37.0	27.8	28.4	36.3	21.2	27.5	34.2	24.3	26.5	34.6	25.5
2324+60	38.9	—	53.4	23.1	38.0	22.9	19.6	31.3	20.0	16.0	26.2	16.5	15.2	26.4	16.2	14.3	24.6	15.3
2327−20	4.2	7.6	1.0	3.6	8.1	4.0	4.3	8.3	4.3	2.3	7.0	3.4	2.4	8.0	3.8	—	—	—
2334+61	6.1	—	9.2	10.5	25.2	12.0	11.6	25.8	14.7	17.9	26.5	15.9	17.7	26.3	17.5	16.9	25.9	16.7
2351+61	5.0	15.5	5.8	4.3	14.2	5.1	4.4	13.7	5.9	4.7	12.5	5.6	5.2	12.2	6.4	6.1	12.4	6.9

PSR B0144+59

See Fig. 1(b). The intensity of the leading component of this pulsar is significantly reduced at the higher frequencies. There is a substantial amount of right-hand circular polarization under the trailing component. The position angle undergoes a 90° discontinuity near the centre of the pulse.

PSR B0402+61

See Fig. 1(c). The profiles consist of many components. This complexity in pulse shape can also be seen in a weak but high-resolution observation at 1700 MHz by Xilouris et al. (1989). The leading component has a much steeper spectrum than the trailing component. The position angle follows an 'S-shaped' excursion with a 90° jump above the trailing component. The linear polarization is reduced at the higher frequencies. There is also some right-hand circular polarization.

PSR B0628−28

See Fig. 2(a). The 410-MHz observation of this pulsar shows emission extending over nearly 200° of longitude. This extended low-level emission can also be seen to a lesser extent at the other frequencies. The central component consists of two closely spaced

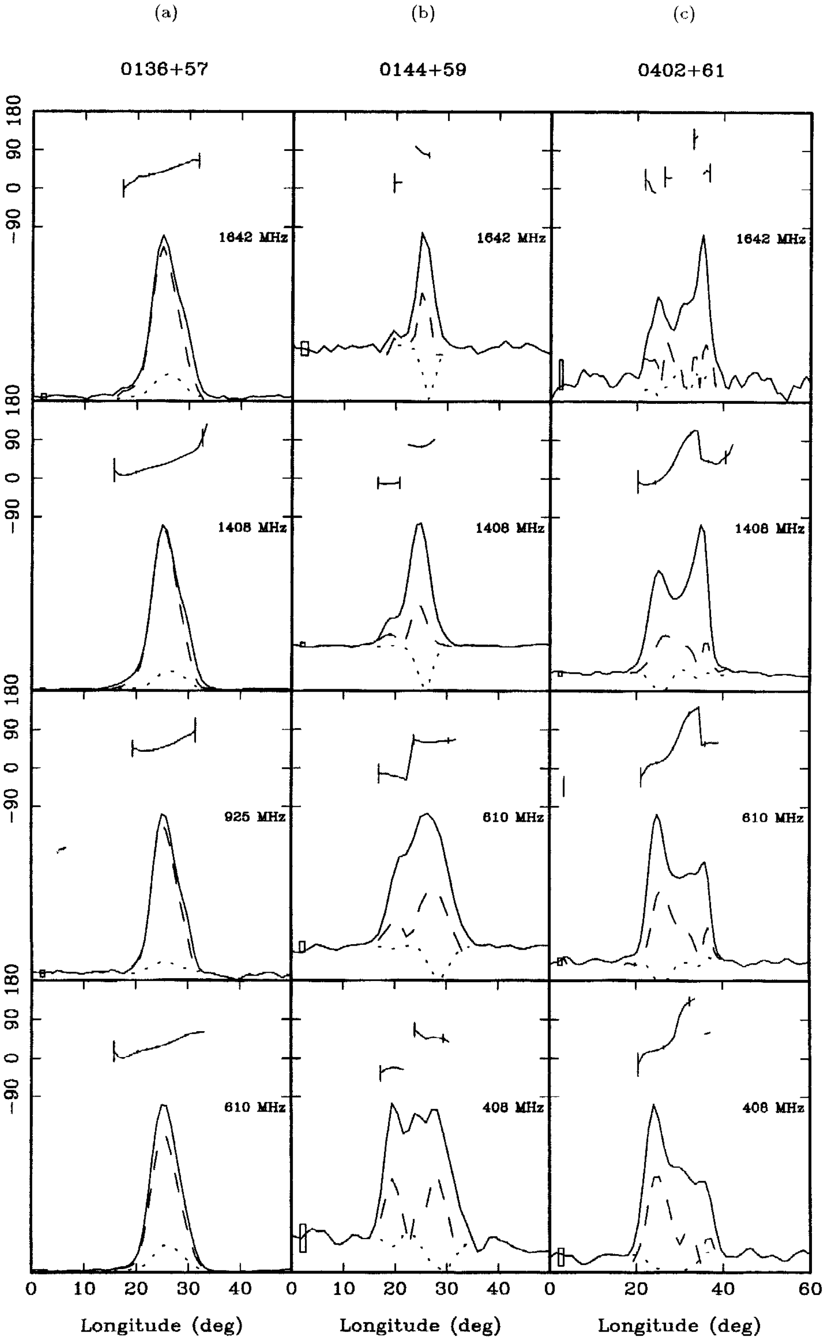

Figure 1. Polarization profiles for PSRs B0136+57, B0144+59 and B0402+61. For each profile the lower part gives the total intensity *I* (full line), linearly polarized component, $L = (Q^2 + U^2)^{1/2}$ where *Q* and *U* are the linear Stokes parameters (dashed line) and the circular Stokes parameter $V = I_L - I_R$ (dotted line). The width of the rectangular box in the lower left-hand corner of each profile indicates the instrumental time resolution, while the height indicates twice the rms noise. In the upper part the position angle of the linear component $\psi = 1/2 \times \arctan(U/Q)$ is shown with, in most cases, $\pm 2\sigma$ error bars.

components. The pulsar is highly linearly polarized with a significant amount of right-hand circular polarization. The position angle follows an ‘S-shaped’ excursion across the pulse. Other polarimetry observations by Hamilton et al. (1977), McCulloch et al. (1978) and Manchester et al. (1980) are consistent with the profiles presented here.

PSR B0656+14

See Fig. 2(b). The central component appears to be flanked by two sets of shoulders. The inner set is more clearly seen at 408 and 610 MHz while the outer set is more apparent in the high-quality 1408-MHz profile (where the inner set has merged with the central component). The pulsar radiation is almost completely linearly polarized with a shallow asymmetric swing of the position angle. There is significant right-hand circular polarization. The high-frequency results are consistent with the 21-cm observation of Rankin et al. (1989).

PSR B1039−19

See Fig. 2(c). The profile of this pulsar has many components, the relative intensity of these changing little with frequency. The profiles are more linearly polarized at the lower frequencies with the position angle following the classic ‘S-shaped’ variation across the pulse. There is a sense reversal of the circular polarization from right-hand to left-hand under the leading part of the profiles. The 408-MHz observation of Lyne & Manchester (1988) confirms the morphology of this pulsar.

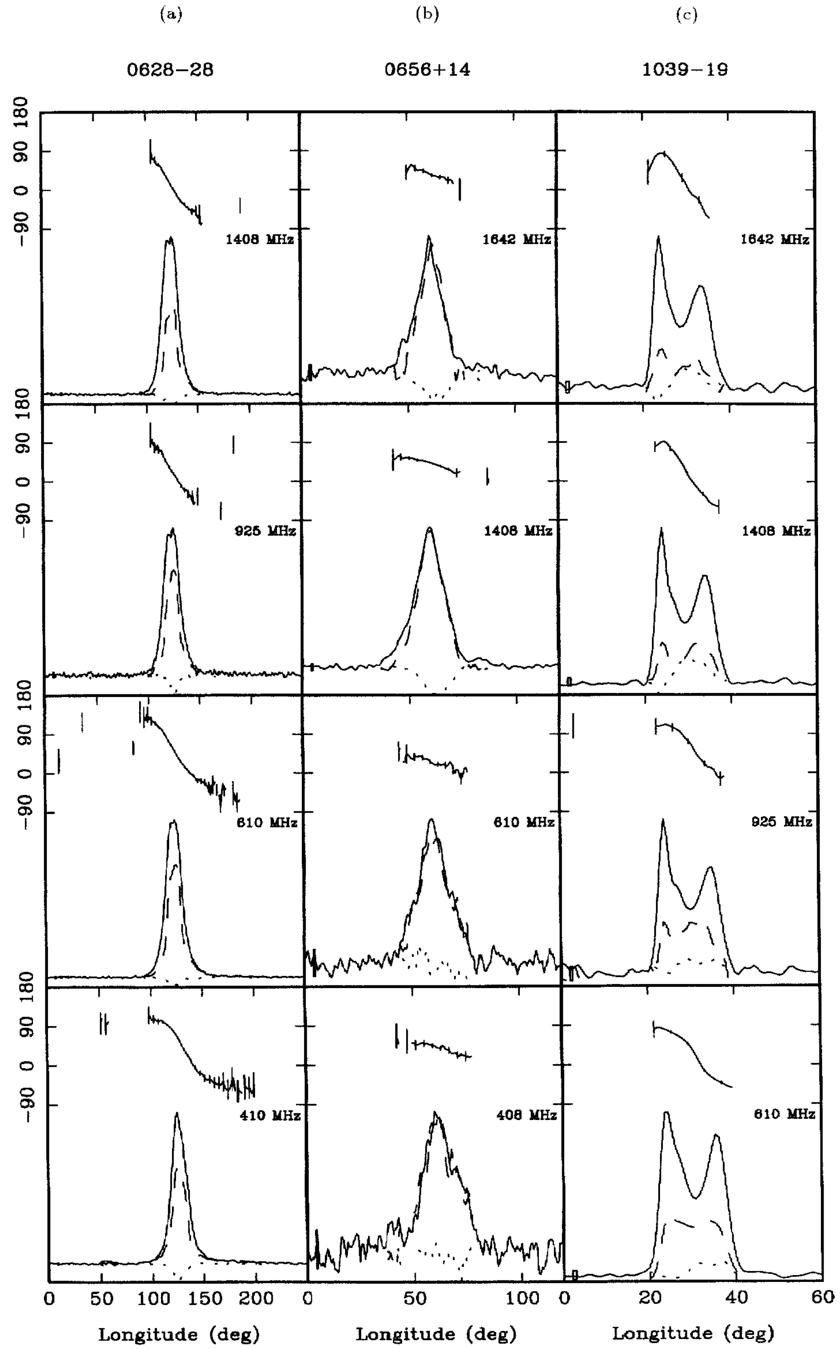

Figure 2. Polarization profiles for PSRs B0628−28, B0656+14 and B1039−19. See Fig. 1 for key.

PSR B1702−19

See Fig. 3. The main pulse of this pulsar is followed half a rotation period later by an interpulse. The main pulse consists of at least two components with evidence for additional low-level emission on the leading and trailing edges developing at the higher frequencies. The main pulse is depolarized on its leading edge due to orthogonally polarized radiation (OPR) but is moderately polarized elsewhere. The position angle follows an 'S-shaped' excursion apart from the 90° discontinuity at the location of depolarization. There is a high degree of right-hand circular polarization under the centre of the profile with a smaller amount of left-hand under the trailing part.

The interpulse consists of a single component at all frequencies, and it increases in intensity with respect to the main pulse with increasing frequency. This component is almost completely linearly polarized at the higher frequencies but substantially depolarized at 610 MHz. The position angle does show some evidence for OPR at these lower frequencies and has an essentially flat rotation at the higher frequencies. This pulse also has substantial amounts of right-hand circular polarization.

PSR B1736−29

See Fig. 4. The main pulse is followed half a rotation period later by a very strong interpulse. The main pulse possibly consists of two closely spaced components. The pulse is very low in linear

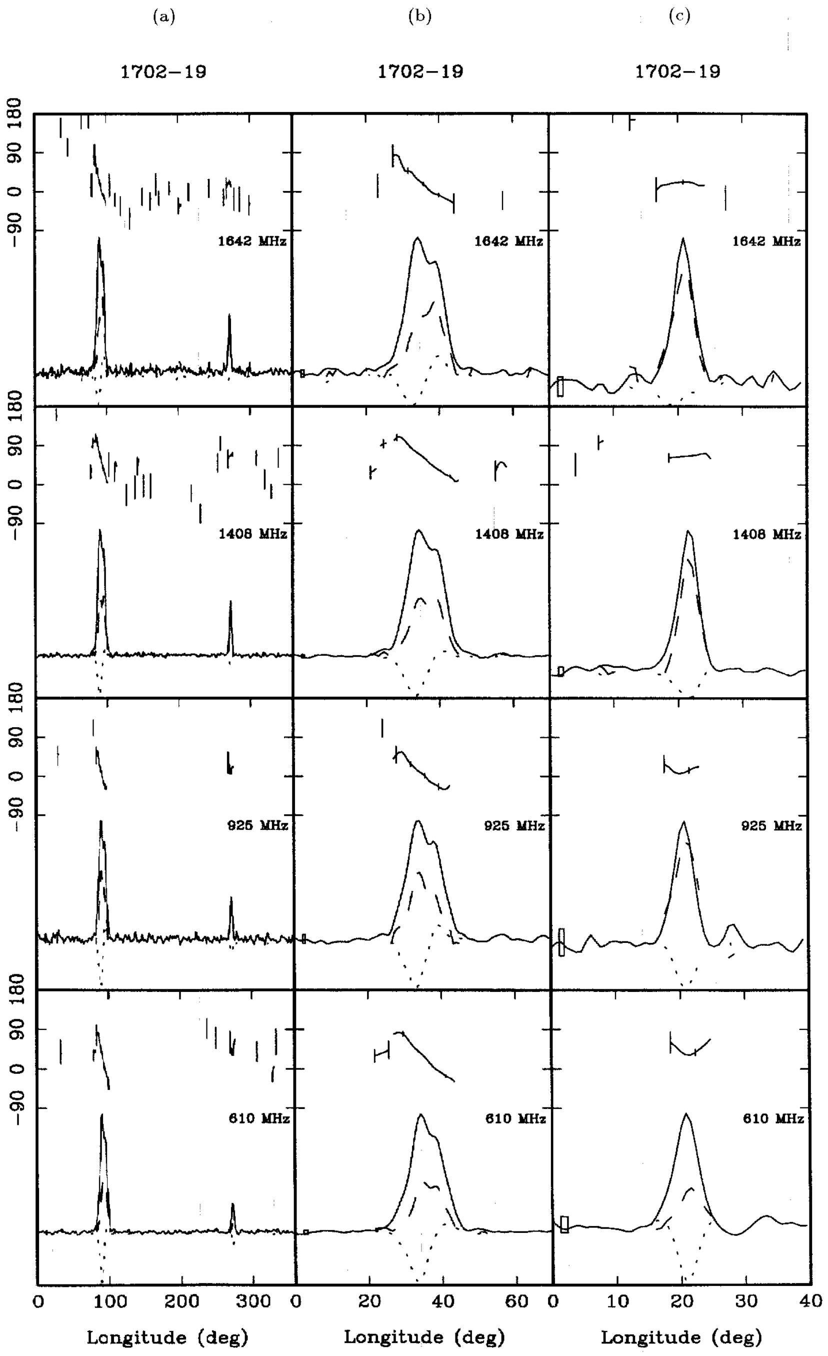

Figure 3. Polarization profiles for PSR B1702−19; (a) the whole period, (b) the main pulse and (c) the interpulse. See text in Section 5 for pulsars with interpulses, and Fig. 1 for key.

polarization and thus there are very few position angle data. The pulse possesses a small sense reversal of the circular polarization from right-hand to left-hand, apparent in the 1408-MHz profile.

The interpulse may also be composite. It is more polarized than the main pulse and the position angle rotation is relatively rapid. There is a small amount of right-hand circular polarization under the pulse.

Neither the main pulse nor the interpulse evolves greatly with frequency. Similarly, the relative intensity of the two pulses remains fairly constant with frequency.

PSR B1800−21

See Fig. 5(a). The pulse is very wide and consists of many components; the complexity in pulse shape is clearly seen in the 1408-MHz profile. Although the profiles at the lower frequencies are of poorer quality, the central component appears to be stronger than at the higher frequencies. The centre and trailing edge of the pulse are almost totally depolarized but the remaining parts of the pulse are high in both linear and left-hand circular polarizations. The position angle follows an 'S-shaped' excursion through the pulse. An observation at 1560 MHz by Wu et al. (1993) is consistent with the high-frequency profiles presented here.

PSR B1823−13

See Fig. 5(b). There are many components to the profile of this pulsar. The whole pulse is highly linearly polarized with an 'S-shaped'

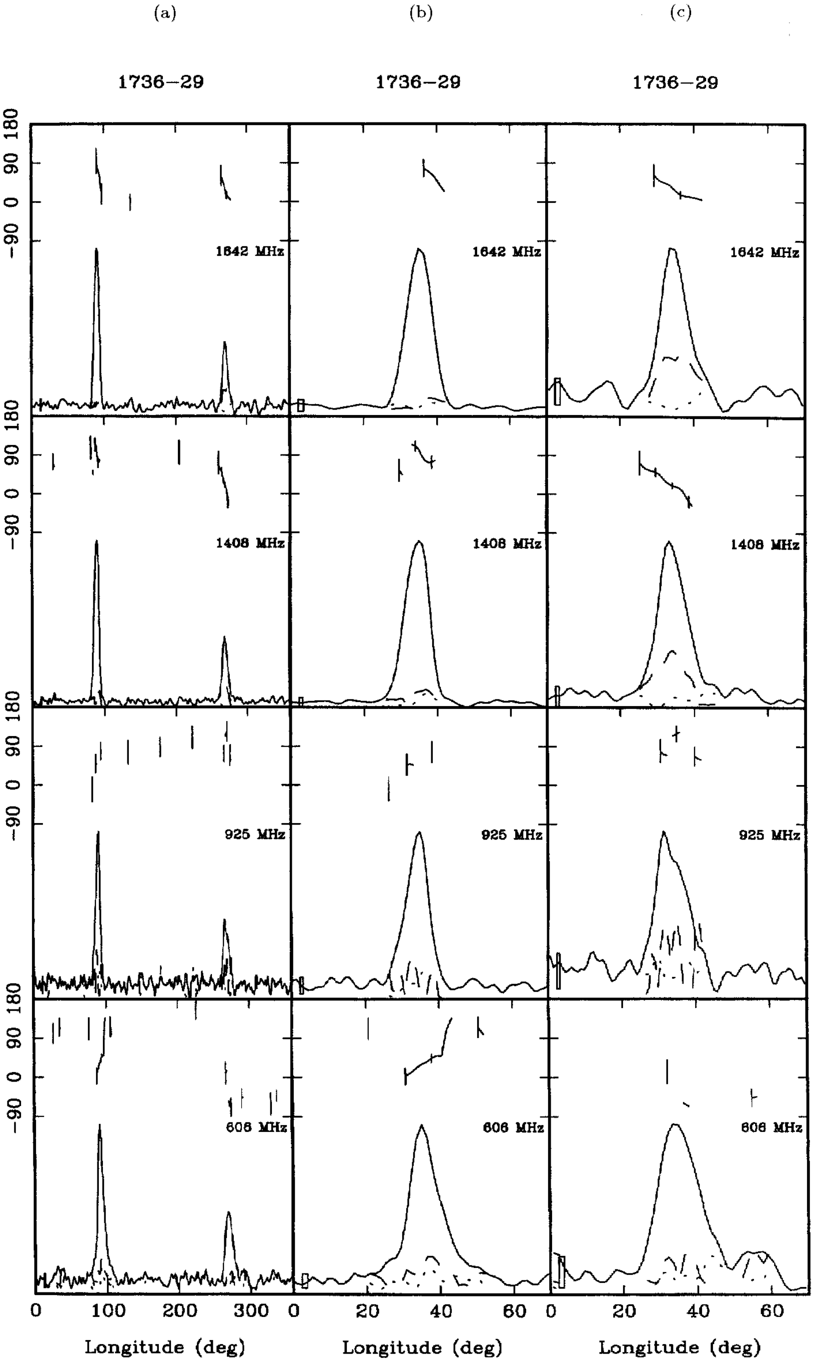

Figure 4. Polarization profiles for PSR B1736−29: the whole period, the main pulse and the interpulse. See text in Section 5 for pulsars with interpulses, and Fig. 1 for key.

variation of the polarization angle. Large amounts of left-hand circular polarization can be seen under the trailing half of the profile. Both the spin-down and the polarization properties of this pulsar are very similar to those of PSR 1800−21.

PSR B1839−04

See Fig. 5(c). The two main peaks of these wide profiles appear to be composite and there is evidence for additional emission in the saddle region between them. The pulsar is moderately linearly polarized with an 'S-shaped' excursion of the position angle. A small amount of right-hand circular polarization develops under the trailing edge of the pulse at the higher frequencies. The same basic features can be seen in the only other profile available for this pulsar, namely the 1560-MHz observation of Wu et al. (1993).

PSR B1913+10

See Fig. 6(a). This pulsar shows significant interstellar scattering at 600 MHz and below. The pulse is singular in form at all frequencies and highly linearly and left-hand circularly polarized with a shallow rotation of the position angle. The 21-cm observation of Rankin, Stinebring & Weisberg (1989) confirms these characteristics.

PSR B2003−08

See Fig. 6(b). The outer components of this wide pulsar have a flatter spectrum than the central component. The pulsar is quite highly linearly polarized with a large rotation of the position angle. The rotation of the position angle is not entirely monotonic; in particular, the direction reverses at the position of the central

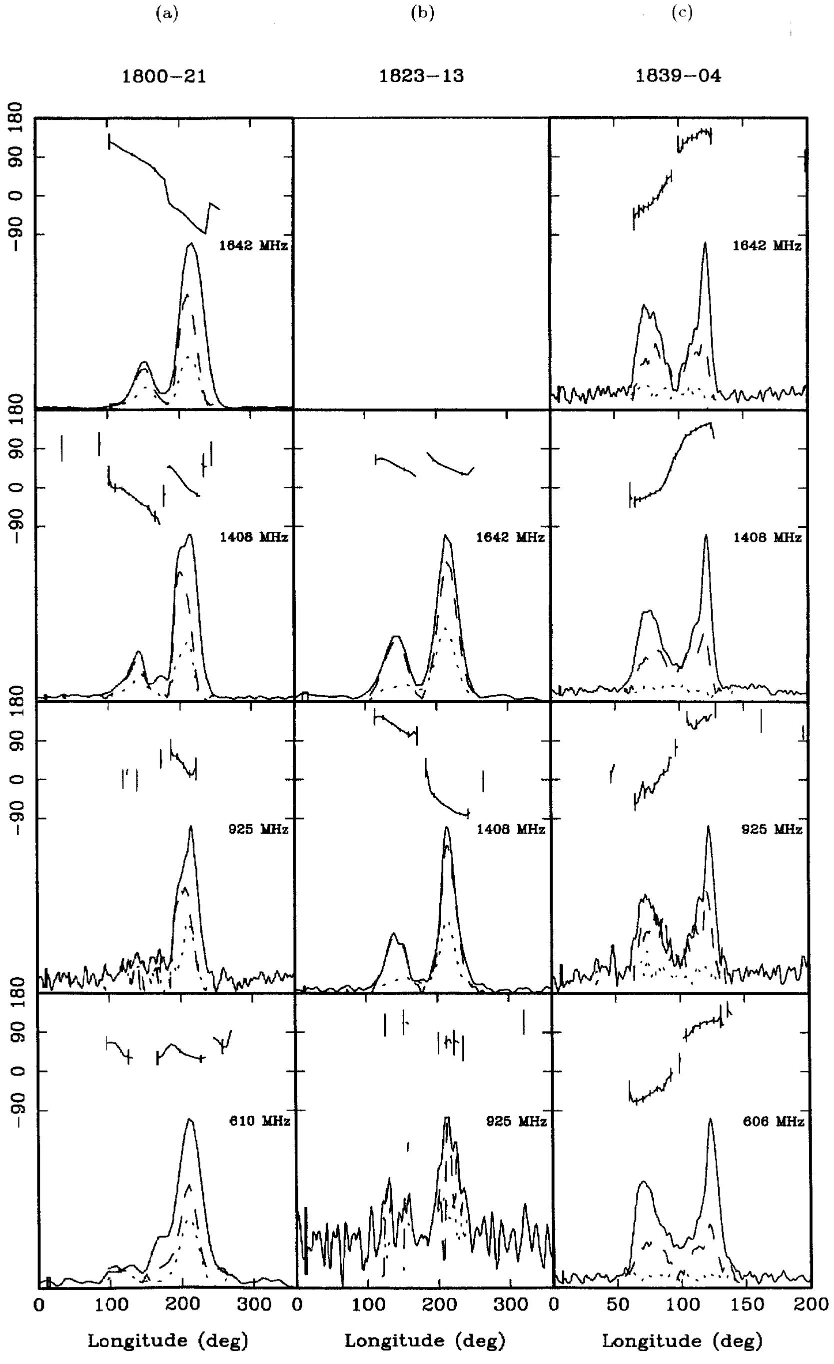

Figure 5. Polarization profiles for PSRs B1800−21, B1823−13 and B1839−04. See Fig. 1 for key.

component of the pulse, an effect which is clearest at the higher frequencies. This is most unusual, since most departures from a monotonic rotating vector model usually arise when the degree of polarization is small.

A strong sense reversal of the circular polarization from left-hand to right-hand under the centre of the pulse also develops at the higher frequencies. These results are consistent with a 1700-MHz observation by Xilouris et al. (1989).

PSR B2011+38

See Fig. 6(c). The pulse is singular at all frequencies, although the 1408-MHz profile shows some evidence for additional emission on the leading and trailing edges. The pulsar is highly linearly polarized apart from its leading edge with a shallow rotation of the position angle. The profiles are right-hand circularly polarized.

PSR B2022+50

See Fig. 7. The main pulse is followed half a rotation period later by an interpulse. The pulse consists of a strong central component with additional emission on the leading and trailing edges. The main pulse is linearly depolarized with a shallow swing of the position angle with the leading edge emitted in an orthogonal mode to the rest of the pulse. It also shows significant circular polarization.

The interpulse consists of closely spaced components. It decreases in intensity with respect to the main pulse with increasing

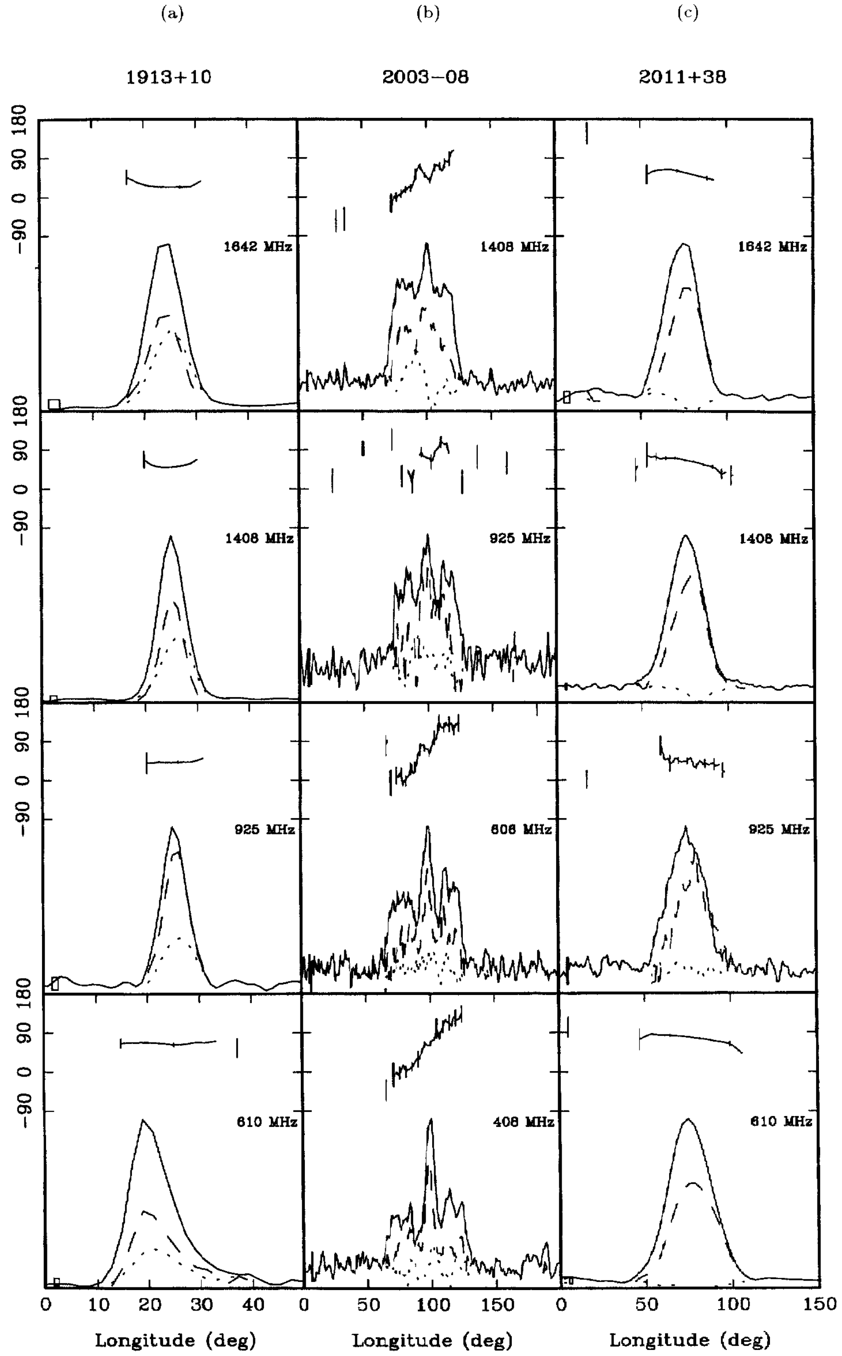

Figure 6. Polarization profiles for PSRs B1913+10, B2003−08 and B2011+38. See Fig. 1 for key.

frequency. The leading half of the interpulse is highly linearly polarized with a shallow rotation of the position angle. The interpulse also appears to be right-hand circularly polarized.

5.1 Interstellar multipath scattering

Within this large data base there are many pulsars, the pulse profiles of which are significantly affected by multipath scattering in the interstellar medium as indicated in Table 4. The extent of the broadening generally scales as ν^{-4}, where ν is the observing frequency, as expected for scattering in an inhomogeneous medium (Williamson 1973). This subset of profiles is also the largest such data base so far published. Some striking examples of profiles broadened by scattering are shown in Fig. 8.

6 DISCUSSION

The extent and quality of the statistical data contained in the data set are illustrated in Figs 9–12. Fig. 9 shows the pulse width at 10 per cent against pulsar period at both 600 and 1400 MHz. These diagrams clearly show the well-established lower bound of the pulse width noted and discussed by others (Rankin 1983; Lyne & Manchester 1988) and which has the general form $W_{10} \propto P^{-0.5}$. The scatter above the line is probably due to geometric effects such as

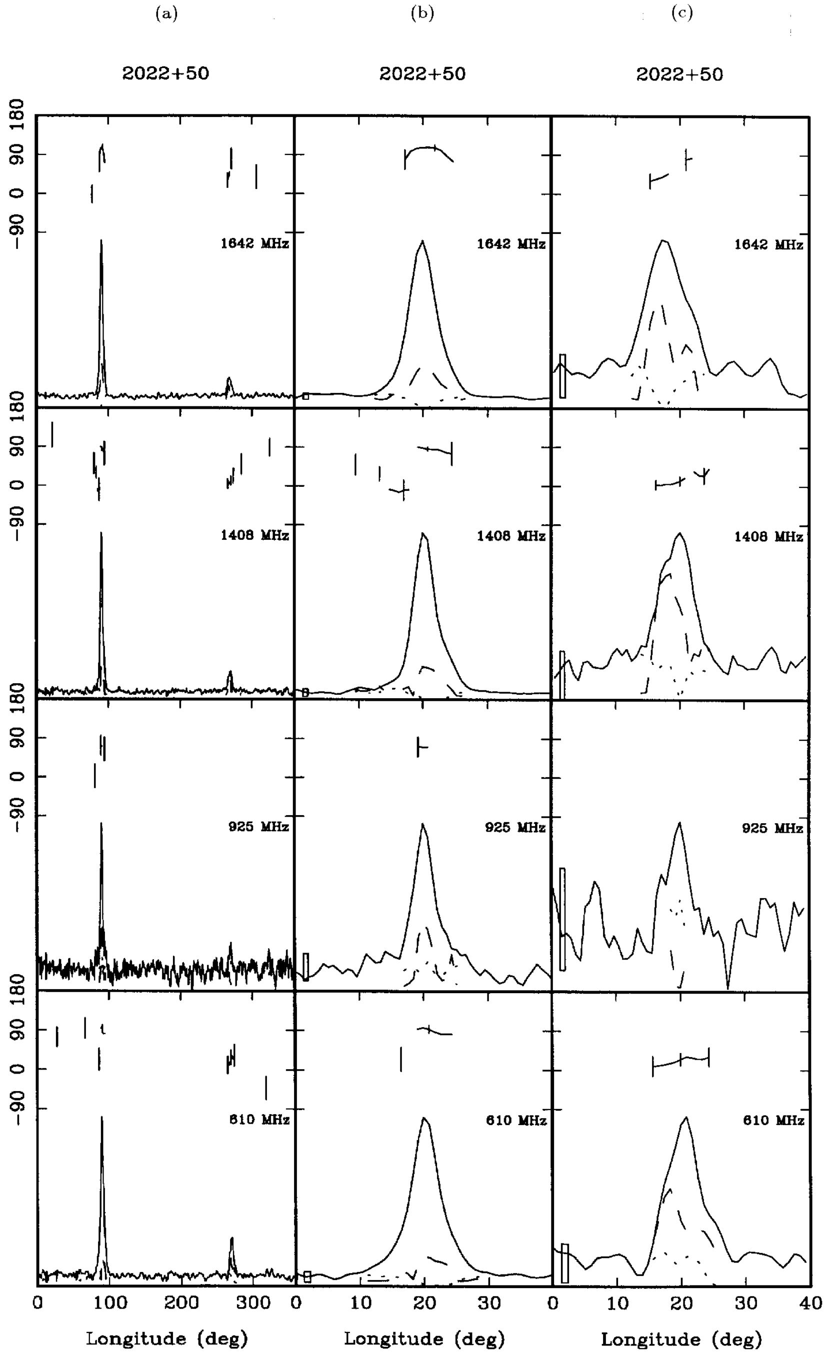

Figure 7. Polarization profiles for PSR B2022+50: the whole period, the main pulse and the interpulse. See text in Section 5 for pulsars with interpulses, and Fig. 1 for key.

small inclinations between the rotation and magnetic axes which increase the width of the observed pulse (Lyne & Manchester 1988).

Fig. 10 plots the pulse width at 10 per cent for 600 MHz against the pulse width at 10 per cent for 1400 MHz. While the majority of pulsars lie above the line, indicating that the pulse width increases at lower frequencies, this is not universally true and 10–15 per cent show a significant increase in width at the higher frequency. While it is generally the case that components move outwards in the profile at low frequency as the location of the radio-emitting source moves to greater distance from the neutron star, where the flare-angle of the bundle of open magnetic field lines is greatest, for a minority the rather flatter spectral index of the outer components can result in an effective increase in pulse width at high frequency (Lyne & Manchester 1988). This can be seen for example in the case of PSR B1800−21 (Fig. 5a).

Figs 11 and 12 show the degrees of linear and circular polarization plotted against four pulsar parameters. While there is clearly large scatter in the amount of linear polarization from pulsar to

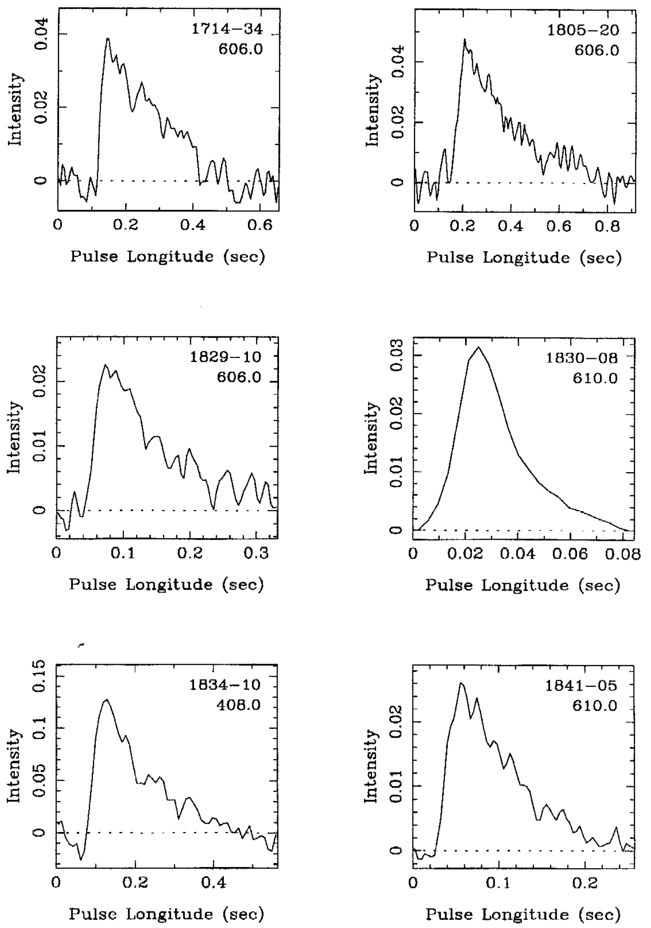

Figure 8. Total intensity profiles for some selected pulsars exhibiting interstellar scattering.

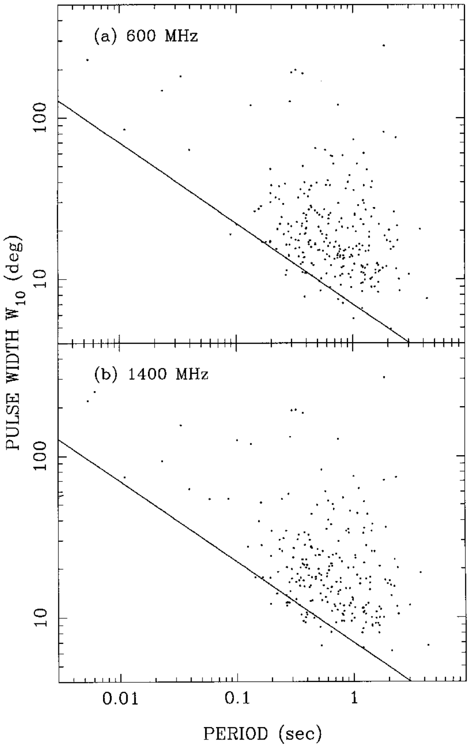

Figure 9. The pulse width W_{10} plotted against period, at (a) 600 MHz and (b) 1400 MHz. The lower bound of pulse width is indicated by lines with slope −0.5 in these logarithmic plots.

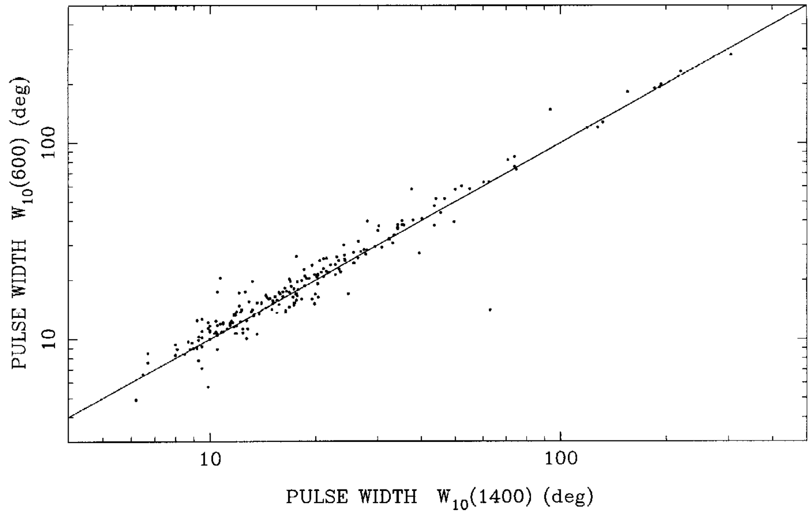

Figure 10. The pulse width W_{10} for 600 MHz plotted against the pulse width W_{10} for 1400 MHz. The line corresponds to equal widths at the two frequencies.

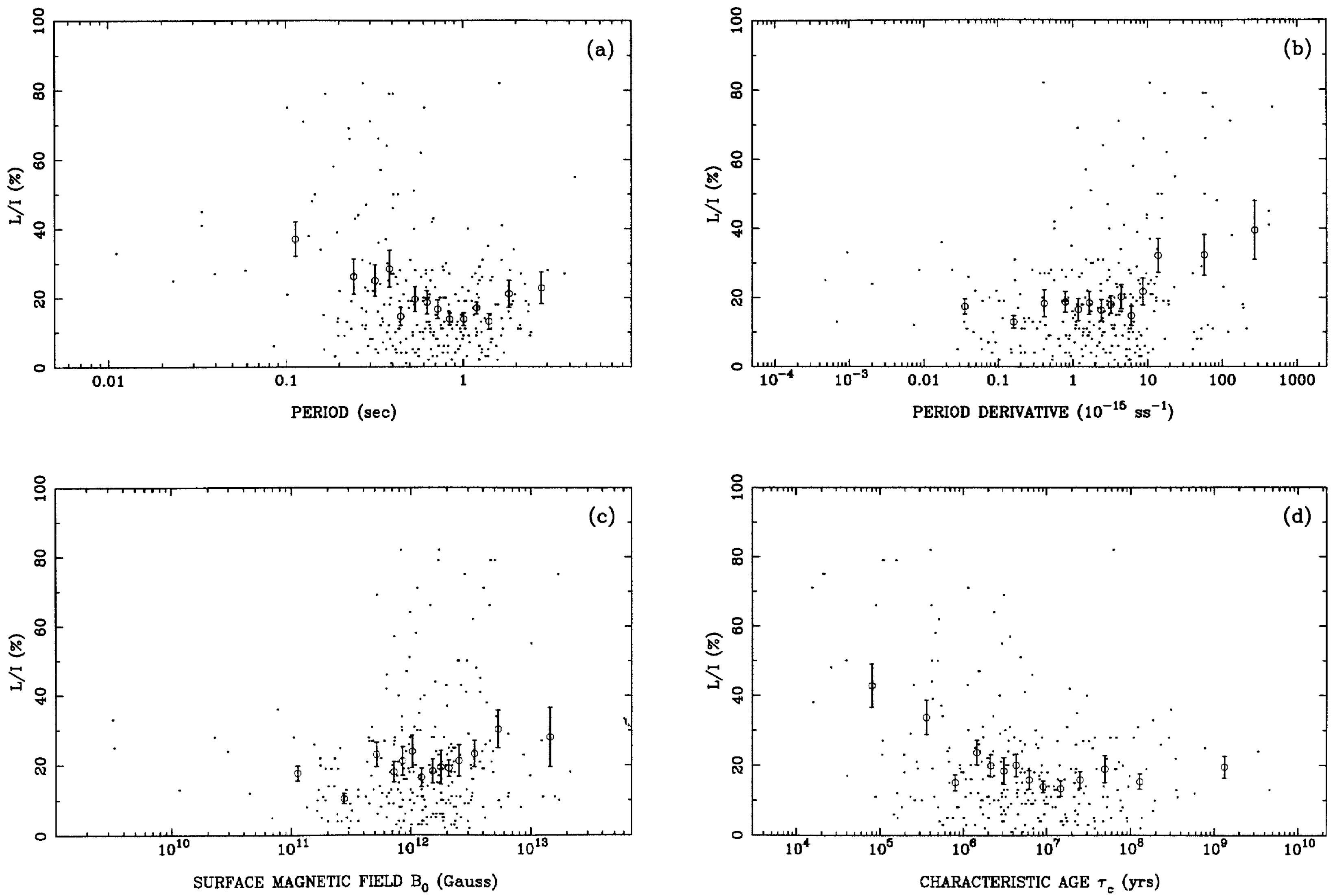

Figure 11. Plots of the degree of linear polarization against (a) pulsar period, (b) period derivative, (c) surface magnetic field strength, B_0, and (d) characteristic age, τ_c. Averages over groups of 20 pulsars are shown as circles with error bars.

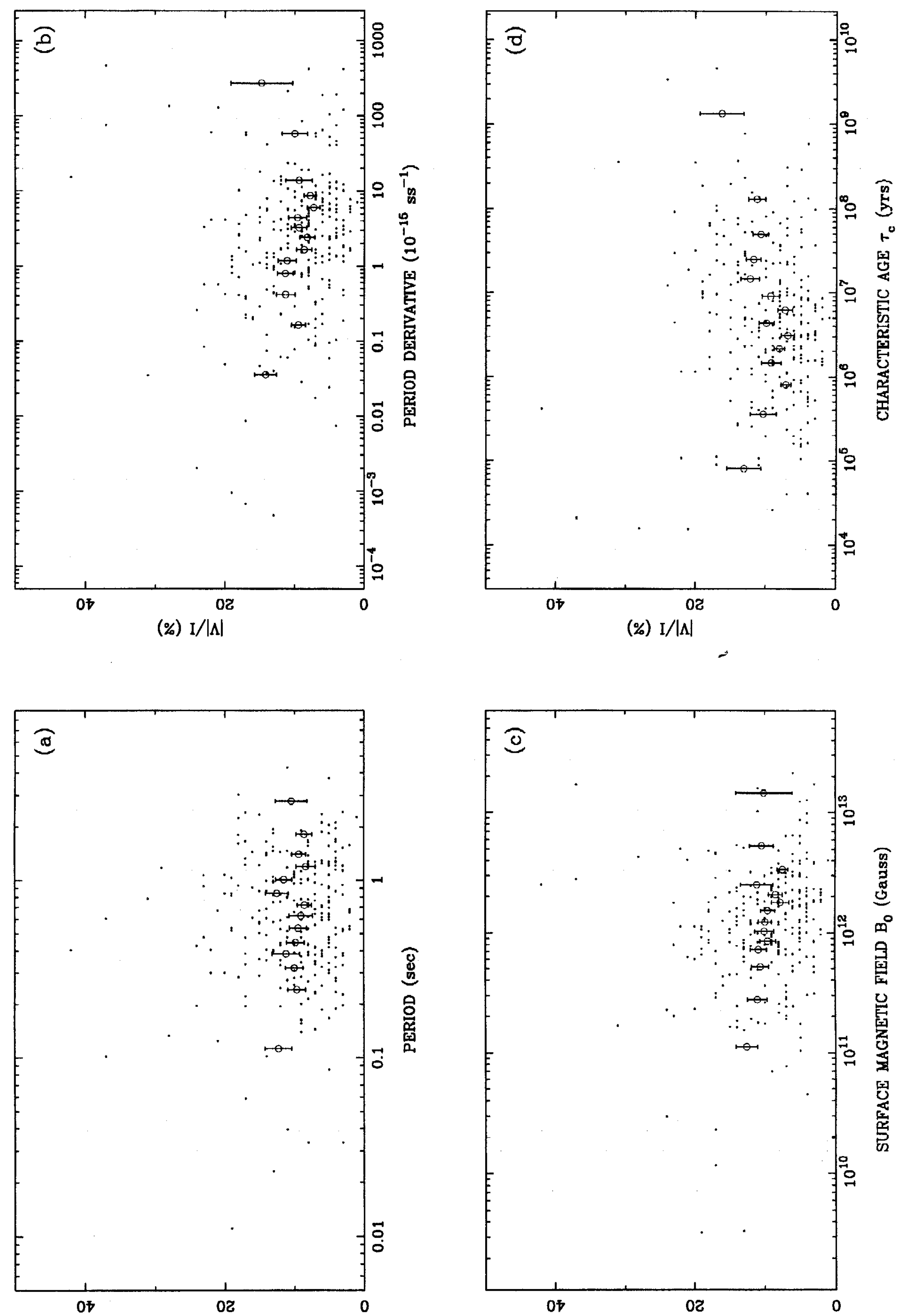

Figure 12. Plots of the degree of circular (without regard to handedness, $|V|/I$) polarization against (a) pulsar period, (b) period derivative, (c) surface magnetic field strength, B_0, and (d) characteristic age, τ_c. Averages over groups of 20 pulsars are shown as circles with error bars.

pulsar, the mean values reveal some clear trends. In particular, high linear polarization is associated with small characteristic age, with pulsars of age <0.5 Myr having a mean polarization of ∼40 per cent, while older pulsars have a mean polarization of about half of this value.

Similar, but less marked trends are seen in the net circular polarization in Fig. 12. While the mean circular polarization is typically 8 per cent for pulsars with ages between 1 Myr and 10 Myr, there are marginally significant increases both for the youngest pulsars, with age <0.2 Myr, and for the oldest.

These issues and others which are relevent to the shape and evolution of the radiation beam and identifying the location of the emitting region within the pulsar magnetosphere are discussed in another paper.

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APPENDIX: ACCESS TO THE COMPUTER DATA BASE

The whole data set, which consists of profiles in graphical or digital form and the tabular information on the polarization and pulse widths, is freely available over the Internet, either by anonymous FTP, on the World Wide Web or directly from the authors by e-mail request.

For anonymous FTP, type `ftp ftp.jb.man.ac.uk` and log in with the user name `anonymous` and your e-mail address as the password. Enter `cd pub/psr/pol` and `get README` to download a short file containing further instructions.

For World Wide Web, in an appropriate World Wide Web browser access the URL `ftp://ftp.jb.man.ac.uk/pub/psr/pol` to select the data that you wish to download.

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