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TOWARD AN EMPIRICAL THEORY OF PULSAR EMISSION. VI. THE GEOMETRY OF THE CONAL EMISSION REGION: APPENDIX AND TABLES

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ABSTRACT

This paper presents auxiliary material pertaining to an empirical analysis of the geometry of the conal emission region of pulsars. The primary discussion appears in Part I (1993 ApJ, 405, 285). An Appendix discusses the classification of pulsars with double-conal profiles, and eight tables with notes present the geometrical calculations on a pulsar-by-pulsar basis.

Subject heading: pulsars: general

APPENDIX[2]
CLASSIFICATION OF PULSARS WITH DOUBLE-CONAL PROFILES

0138+59.—Several observations, one at 415 MHz (LM)[3] and another at 610 MHz (Ba81) show a highly asymmetric profile which may have five components. Only the first and the last two are clear at 415 MHz, but the intervening features appear to be real, and one can also be seen at 610 MHz. The signal-to-noise ratio (S/N) of the existing observations at higher frequencies is so poor that little can be said of the profile structure (MGSBT), and the two existing observations at 102.5 MHz (MIS; Suleymanova 1989; many 102 MHz results were published in Suleymanova, Volodin, and Shitov 1988) are different enough that mode changing must be suspected. The B_{12}/P^2 value for this pulsar is only 0.47.

0402+61.—Two weak, but decently resolved profiles, one at 1700 MHz (XRSS) and a second at 409 MHz (L90), show a broad, "boxy" profile. The other observations at 610 and 102 MHz (Ba81 and MIS, respectively) are poorly resolved and thus give little information about the profile's form. No core component is clearly evident at either frequency. This is almost certainly then a five-component (M) profile. Its broad, "squarish" form suggests the latter, but the B_{12}/P^2 value seems anomalously large. High-quality polarimetric profiles are required to confirm this pulsar's classification.

0523+11.—Only a single published polarimetric observation exists for this pulsar (RSW), but the "boxy" shape and strong signature of circular polarization of this 21 cm profile suggest that this star is a member of the five-component (M) class. Two other total-intensity observations at 610 and 430 MHz (Ba81 and WABCBF) are again poorly resolved (the former much more than the latter) and do not adequately define the structure of the profile. No core component is discernible at 1720 MHz, but strong, antisymmetric circular polarization suggests the presence of core emission. New polarimetric measurements at meter wavelengths are needed.

0621−04.—Only a single total-power observation at 610 MHz exists for this star (Ba81), but it is adequately resolved and shows both four or five components and the overall "boxy" form so characteristic of the five-component (M) class. Polarimetric observations are needed at all frequencies on this pulsar.

0826−34m.—This star's exceedingly wide profile is suggestive of a nearly aligned rotator (Biggs et al. 1985), and polarization-angle modeling seems to bear this out (LM). On first glance the main pulse appears to have a conal double profile, but its circularly polarized signature suggests that rather we are seeing a five-component (M) profile with merged components—a conclusion which is supported by the five distinct "subpulse paths" in individual-pulse sequences (Fig. 2 of Biggs et al. 1985).

1039−19.—Again, only a single observation exists, a well-resolved 408 MHz polarimetric observation (LM) which appears to have five discernible features. Additionally, the profile has the characteristic *S*-shaped traverse of the linear position angle and what

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[2] This is a companion paper to that in ApJ, 405, 285.
[3] Citations first given in full in the companion paper.

appears to be a +/− antisymmetric signature of the circular polarization. This pulsar seems to be a good example of the five-component (M) species, but additional observations are needed at higher and lower frequencies to explore the evolution of its profile with frequency.

1237+25.—This pulsar is the prototype of the five-component class.[4] At frequencies below 1 GHz, its components are clearly distinguishable, but it is important to note that at higher frequencies its components merge, and the profile assumes an overall "boxy" shape. Above 400 MHz the central core component becomes less prominent, whereas at extreme low frequency components I and V weaken more rapidly than II and IV, yielding an overall triple form. Numerous studies have produced evidence underscoring the distinct features of the central component in terms of polarization, spectrum, modulation properties, and mode changing (cf. Papers I and III and references cited therein). Furthermore, the profile exhibits a +/− antisymmetric signature of circular polarization and a polarization angle traverse so shallow that it is interpreted as evidence that the sight line passes essentially over the polar cap (Paper V).

1451−68.—In previous papers I have classified this pulsar as having a triple (T) profile: at lower frequencies three components are clearly identifiable, the middle of which is clearly marked as a core component by its sense-reversing circular polarization; above 1 GHz the two "outer" components merge with the central core and lose their identity. Wu, Xu, & Rankin (1992b), however, have made a detailed study of the evolution of the star's profile and come to the conclusion that a second pair of unresolved conal components—interposed between the discernible three—are required to account for its overall form,[5] thus arguing that this is in fact a five-component (M) pulsar.

1633+24.—The published profiles for this pulsar at 1400 MHz (RSW) and 430 MHz (D86; HW; BCW) are rather different, the first showing a "messy" triple profile, and the others one with four "rough" components. In addition, the latter studies show a highly periodic modulation ($P_3 \sim 2.2$) associated with the bright, leading components. Therefore, all the components seem to be conal in nature, and the evolution from four to three is precisely what one could expect from a member of the cQ/cT class as the emission cones become ever narrower at high frequency.

1737+13.—This star provides another outstanding example of the five-component (M) species. Profiles have been measured over a wide range of frequencies (HR), and its behavior studied in detail at 21 cm (RWS). Interestingly, although the pulsar is strong and relatively nearby, none of the early profiles had quite enough resolution to distinguish all of its five components clearly (see Ba81 and WABCBF).

1738−08.—Two profiles exist for this pulsar, one at 610 MHz (Ba81) and a 409 MHz polarimetric observation (LM). Both show a "boxy" form, and the four clearly discernible components appear to represent two pairs of conal "outriders." No core component can be clearly distinguished, but if we take the weak +/− circular signature seriously, we can surmise that core emission is present in the profile. This then is probably a conal quadruple (cQ) profile, although observations at lower frequency are required to rule out the existence of a central core component.

1804−08.—The 1700 MHz observation (XRSS) reveals three prominent components with a possible pair of additional components on the leading and trailing edges of the profile, and an unpublished 611 MHz observation (L90) reiterates this general picture in less detail. The circular signature appears to change sense under the center of the profile and shows a negative feature on the trailing edge. This is then a five-component (M)—or possibly a triple (T)—pulsar.

1831−04.—Observations exist for this pulsar at 1720 (XRSS), 1440 (Backer 1976), 611 MHz (L90), 610 (Ba81), and 102 MHz (MIS); only the first and third are polarimetric. All but the 102 MHz observation show a broad "boxy" form with four or five components, and the 611 MHz profile is quite definitive in showing five. Furthermore, this latter observation shows almost no linear angle rotation (apart from a 90° "jump"), indicating that our sight line passes close to the magnetic pole. Some −/+ circular polarization is seen in the center of the profile. Therefore, this pulsar is a very plausible member of the five-component (M) class, but more work is required to define its profile form and spectral characteristics.

1845−01.—This pulsar exhibits three barely resolved components at 1612 (MHMa) and 1412 MHz (RSW). In addition, HW's fluctuation spectra reveal that all three components participate in correlated subpulse modulation with a P_3 of 14.2, showing that this pulsar has a conal triple (cT) profile.

1857−26.—This pulsar is a second prototype of the five-component (M) species. Apart from its larger circular polarization and steeper position angle traverse, its behavior is virtually identical to that of pulsar 1237+25 (cf. Papers I and III, and references therein).

1905+39.—Observations exist for this pulsar at 1700 (XRSS), 610 (Ba81), 408 (L83), and 102 MHz (MIS), but only the first and third are polarimetric. All of the profiles have a "boxy" form, and the two meter-wavelength profiles both seem to have five components; however, the S/N is not quite adequate to be certain. Significant positive circular polarization is also seen in the center of the profile. So, again, this pulsar is almost certainly a member of the five-component (M) species, but further observations are required to be certain.

1907+03.—This weak, slow pulsar also has a "boxy" profile, but no existing observation has achieved sufficient S/N to clarify the detailed structure of its profile. Significant antisymmetric circular polarization occurs near the center of the profile, and what

[4] A sixth component originally identified by Backer (1971) and resurrected at intervals by others (i.e., BMSH) is an artifact of polarization; see Paper III, note 1.

[5] This analytical technique, which assumes Gaussian components, could easily be applied to a number of other pulsars with triple (T) profiles. Many have power between the core component and the conal "outriders" which cannot easily be dismissed as the "tail" of the respective components. McKinnon & Hankins (1992) have carried out such an analysis for pulsar 0329+54. In this fashion it may be that a number of ostensible T pulsars will eventually be assimilated into the five-component (M) class.

appears to be the core component becomes ever stronger at low frequency. An unusual feature is the strong, narrow trailing component seen throughout the spectrum. This is either a triple (T) or five-component (M) pulsar.

1910+20.—This is a weak, slow pulsar. The best existing observation by Deich (1986) at 430 MHz seems to have the usual broad, "boxy" structure, and four or five components can be discerned. The other observations at 1400 (RSW) and 430 (RB[6]) MHz do not add much to this picture.

1918+19.—Both the 1412 (RSW) and 430 MHz (RB) profiles show a broad, "ragged" form with little polarization. Only in HW's work is the triplicity of the profile really clear. Of the three (cT) pulsars studied by HW, 1918+19 is by far the most complex; it exhibits at least three modes with drift patterns and profile changes corresponding to P_3 values of 5.8, 3.9, and 2.5.

1919+21.—Identification of this pulsar as having a double-conal configuration rests heavily both on the work of Cordes (1975, hereafter C75) and on that of Prószynski & Wolszczan (1986, hereafter PW). Only two or three broad components are visible in the average profile. PW's work, however, suggests that four conal components are responsible for the modulation pattern, and C75 shows how steadier emission fills out the center of the profile. At no frequency is a core component clearly discernible, nor is there any circularly polarized signature. This star then probably has a conal quadruple (cQ) profile.

1944+17.—This is the best studied of the pulsars with conal-triple (cT) profiles, and its classification was considered in detail in RSW. HR give a beautiful series of profiles which demonstrate its triplicity, and Deich et al. (1986) have studied its drift modes which correspond to P_3 values of 6.3 and 13.6.

1952+29.—Many profiles are available for this pulsar in the literature. Polarimetry has been carried out at 2650 and 1700 (MGSBT), 1400 (RSW), and 430 MHz (RB), and HR have given a set of aligned total-power profiles spanning the range 239–2380 MHz. Most of the profiles do not clearly show five components; rather, at first glance, the pulsar seems to exhibit the usual evolution of a triple pulsar. There are indications at the higher frequencies, however, of additional components, and HR's 932 MHz profile comes closest to exhibiting the full five components. This star seems to be an unusual five-component (M) pulsar. The profile does not assume a "boxy" form at high frequency; instead, components I and IV are brightest and their unusually prominent "tails" should apparently themselves be regarded as distinct components (i.e., II and V). The core component (III) has a much steeper spectrum than the conal components. Finally, the 932 and 430 MHz profiles have remarkably different shapes, and the components at the two frequencies align so poorly that they hardly seem to belong to the same pulsar![7]

2003−08.—Profiles have been measured for this pulsar at 1700 (XRSS), 610 (Ba81), and 408 MHz (L90). The higher frequency profiles have a trapezoidal, "boxy" shape wherein only the central core component can be readily distinguished; the 408 MHz profile, however, shows an even stronger core component as well as two clearly resolved sets of conal "outriders." Clearly, this is a five-component (M) pulsar.

2028+22.—The only profiles that begin to adequately delineate the shape of this pulsar's profile are those of HR. They give observations at 1414, 430, and 318 MHz which show four or five components and the usual "boxy" form of the double-conal species. Polarimetric observations are also available at 1400 (RSW) and 430 MHz (RB), but neither is very revealing owing to inadequate resolution and probably mode changing. No core component is readily identifiable. Additional polarimetry is required to clarify this star's classification.

2154+40.—All of the existing observations show a "messy" triple profile that changes little with radio frequency (MGSBT, Ba81, LM, MIS, Suleymanova et al. 1986), and the B_{12}/P^2 value for this pulsar is quite small (0.99). This seems a good candidate for a conal triple (cT) pulsar.

2210+29.—This pulsar is very weak, but total-power observations at 430 (Wolszczan 1987) and 1400 MHz show the usual "boxy" profile with five components. More sensitive, polarimetric observations are needed at all frequencies.

2310+42.—A 1700 MHz profile (XRSS) has five clear features and a pronounced change in the circular polarization near the center of the profile. None of the three other profiles, one at 610 MHz (Ba81), one at 408 MHz (L90), and another at 102 MHz (MIS), show this structure clearly, but neither are they incompatible with it. $B_{12}/P^2 = 1.66$ is again small.

2315+21.—The existing profiles have a "messy" form with three or four components (RSW, Ba81, WABCBF, D86, LM, and MIS). The low acceleration potential and the several features in the 1400 MHz linear polarization profile suggest that this pulsar might be a member of the cQ species.

2319+60.—Until recently, this pulsar has been studied principally by the Bonn group. Polarized profiles at 8700, 2650, and 1720 MHz have been published (MGSBT), and an important study of its mode-changing behavior at 1415 MHz has been carried out by Wright & Fowler (1981, hereafter WF). On the basis of this evidence, the pulsar's profile could be seen to have three or four components, but the "inner" ones could not be readily distinguished, and no core component was apparent. LM's 408 MHz profile (the first published meter-wavelength observation) clearly shows four components and consequently suggests that this pulsar has a conal quadruple (cQ) profile.

[6] This is a polarimetric observation, but part of the trailing edge of the profile has, unfortunately, been truncated.

[7] It is worth noting that apart from the binary and millisecond pulsars, this star has the smallest magnetic field value known. Indeed, it may well be a long-period binary, as it has a large proper motion which, given its small distance, might well be partly orbital in nature (Rankin & Mansfield 1977).

TABLE 1

CORE WIDTHS OF FIVE-COMPONENT (M) PULSARS

Pulsar[a]	Class	P (s)	B^{12}/P^2	$1/Q$	W_c[b]	W_{cap}	α
0138+59	M?	1.223	0.47	0.28	~6°5?	2°2	20°
0402+61	M?	0.595	5.21	1.76	≈3?	3.2	83
0523+11	M?	0.354	1.28	0.54	≈4?	4.1	78
0621−04	M	1.039	0.88	0.45	~5	2.4	32
0826−34*m*	M	1.849	0.40	0.25	~35?	1.8	3
1039−19	M	1.386	0.65	0.36	~4?	2.1	31
1237+25	M	1.382	0.61	0.34	~2.6?	2.1	53
1451−68	M?	0.263	2.35	0.86	~8.0	4.8	37
1737+13	M	0.803	1.70	0.74	~4.2	2.7	41
1804−08	M/T	0.164	2.59	0.88	~6.8	6.1	63
1831−04	M	0.290	2.87	1.02	~26?	4.5	10
1857−26	M	0.612	0.85	0.41	~7.5?	3.1	25
1905+39	M	1.236	0.54	0.31	≈4?	2.2	33
1910+20	M/T?	2.233	0.97	0.52	~3.4?	1.6	29
1952+29	M/T?	0.427	0.16	0.11	~7.5?	3.8	30
2003−08	M	0.581	0.46	0.25	~14	3.2	13
2028+22	M/cQ?	0.631	1.90	0.79	≈4?	3.1	50
2210+29	M	1.005	0.71	0.38	~3.7	2.4	41
2310+42	M?	0.349	1.66	0.67	~5?	4.1	56

[a] Suffixes "*m*", "*i*", and "*p*" imply main pulse, interpulse, and precursor, respectively.

[b] 7.2 implies 7.2 ± 0.1 or so, ~7.2, ~7.2?, 7, ~7, and ~7? progressively larger errors, and ≈7? a larger uncertainty yet, implying that the core component could not be clearly identified.

NOTES:

0138+59.—The core component seems to be discernible as an inflection at the half-power point on the leading edge of the 415 MHz profile (LM). Its width appears to be about 6°.

0402+61.—No core component can be clearly identified in either the 409 (L90) or 1700 MHz (XRSS) observations, although there is evidence of a circularly polarized signature in the former. LM obtain a very different α-value of 54°.

0523+11.—Again, the "boxy" 1400 MHz profile (RSW) exhibits no clearly resolved core component, but a strong antisymmetric circularly polarized signature is evident. LM find an α-value 49°, which is quite different.

0621−04.—Only a single total-power, 610 MHz profile is available (Ba81).

0826−34m.—No average profile shows components other than the "outer" two; however, Biggs et al. 1985 give an individual-pulse sequence which appears to show subpulses which correspond to a total of five components. These subpulses do not seem to drift, but rather appear to be modulated in intensity at particular longitudes as in other double-conal pulsars. LM's α-value of 2°1 agrees very well.

1039−19.—Only a single 408 MHz observation is available (LM); it suggests both a core component and a circularly polarized signature. LM obtain a very similar α-value of 34°.

1237+25.—This pulsar is one of the prototypes of the M species, and many observations exist. Nonetheless, it is not easy to measure the width of the core component because it is relatively weak and closely merged with component IV. Component III appears most clearly in the abnormal-mode profiles of BMSH, but some estimates of its width tend to values somewhat under 2°45 $P^{-1/2}$. This in turn suggests either that the profiles are inaccurately drawn (they appear to have been drafted for publication) or that the component is narrowed by the "absorption" phenomenon (see Paper II). New measurements of abnormal-mode sequences are thus needed to improve the accuracy of the resulting α-value. LM find that α is 48° which agrees very well.

1451−68.—Determinations of the core width have been given by Wu et al. (1992b). However, the widths seem to be slightly overestimated at the lower frequencies where direct comparison with the scaled measurements is possible. The 2×4°8 value at 950 MHz was thus adjusted to an estimate of 8°. LM find a rather different α-value of 23°5.

1737+13.—This core width was obtained by measuring the leading half-width of the 932 MHz observation (HR) and multiplying by 2. LM obtain an identical α-value of 41°.

1804−08.—The width of this core component is most easily measured using an unpublished 611 MHz profile (L90). LM find a rather disparate α-value of 47°.

1831−04.—The trailing half of the 610 MHz (Ba81) profile provides a reasonable estimate of the core width. LM's α-value of 8° is very close.

1857−26.—This pulsar's core component is most clearly visible in the 631 MHz profile of MHMa. LM obtain a similar α-value of 21°.

1905+39.—The core component is probably discernible in an unpublished 408 MHz profile (L83). LM find that α is 31°, a very similar value.

1910+20.—Only the 430 MHz profile (D86) clearly shows the core component.

1952+29.—The core component is readily measurable only between about 430 and 318 MHz, and measurements in this interval (HR) give values around 5°5. This value appears to be smaller than that at both higher and lower frequencies, and thus again this component seems to be narrowed by the "absorption" phenomenon (see Paper II). The width was thus estimated to be around 7°5. Accurately measured profiles and component fitting at a frequency around 1 GHz are needed to improve this estimate. LM find that α is 24°.

2003−08.—Again there is some evidence that the width of the core component at meter wavelengths

TABLE 1—*Continued*

(Ba81) is narrower than at 1.7 GHz (XRSS), suggesting "absorption." The high-frequency observation yields an estimate around 13°–14°. LM obtain an identical α-value of 13°.

2028+22.—No core component is clearly seen in the most accurately measured profiles (HR).

2210+29.—Only one published 430 MHz profile is available (BCW).

2310+42.—The core component can be identified in the 1.7 GHz observation of XRSS, but its width can only be roughly estimated at about 4°. LM find a very different α-value of 34°.

TABLE 2

CONAL GEOMETRY OF FIVE-COMPONENT (M) PULSARS

					INNER			OUTER			r (km)	
PULSAR	CLASS	α	$\Delta\chi/\Delta\varphi$ (°/°)	β	$\Delta\psi$	ρ	β/ρ	$\Delta\psi$	ρ	β/ρ	Inner	Outer
0138+59	M?	20°	−9[a]	+2°2	~18°?	3°9	0.56	27	5°3	0.41	123	228
0402+61	M?	83	+26[a]	+2.2	~10?	5.4	0.40	14	7.3	0.30	117	211
0523+11	M?	78	−9.5[a]	±5.9[b]	?	...	...	15.2	9.6	0.62	...	214
0621−04	M	32	∞[c]	0	~15?	4.0	0.00	22	5.9	0.00	111	238
0826−34*m*	M	3	+2.7[a]	+1.1	~100?	3.1	0.35	142	4.2	0.26	120	213
1039−19	M	31	−18[a]	+1.7	~13?	3.8	0.43	17	4.8	0.34	136	214
1237+25	M	53	∞	0.0	8.6	3.4	0.00	12.2	4.9	0.00	109	220
1451−68	M?	37	+5.7	−6.0	19.7	8.1	−0.74	33.1	10.9	−0.55	115	209
1737+13	M	41	−20	+1.9	~13	4.7	0.40	19.4	6.7	0.28	118	240
1804−08	M/T	63	−10	+5.1	~21	10.8	0.47	~30?	14.6	0.35	128	231
1831−04	M	10	−5[a]	+2.0	~85?	8.2	0.24	113	10.6	0.19	130	217
1857−26	M	25	−11	+2.2	~24?	5.6	0.39	33	7.5	0.29	130	228
1905+39	M	33	−15[a]	+2.1	~12?	4.0	0.53	16.4	5.1	0.41	131	214
1910+20	M/T?	29	+18	+1.5	~9.5	2.8	0.55	14	3.8	0.41	117	213
1952+29	M/T?	30	+4[a]	−7.2	~13?	7.7	−0.93	24	8.9	−0.81	170	226
2003−08	M	13	+4[a]	+3.3	~35?	5.5	0.59	53	7.5	0.44	119	217
2028+22	M/cQ?	50	−8	+5.5	~5?	5.9	0.94	12.2	7.4	0.75	145	229
2210+29	M	41	−35	+1.1	~13?	4.5	0.24	17	5.8	0.19	134	223
2310+42	M?	56	+7	+6.8	9.7	8.0	0.85	~15	9.4	0.73	148	204

[a] Values from Lyne & Manchester 1988.

[b] No available observation determines the sense of β.

[c] No measurements available; central traverse assumed.

NOTES:

0138+59.—The "outer" conal component-pair width is interpolated to 1 GHz using observations at 415 (LM) and 1720 MHz (MGSBT).

0402+61.—The conal widths were measured between 1.7 GHz (XRSS) and 409 MHz (L90), although a lower quality 610 MHz (Ba81) total-power profile is also available. The "inner" component pair is difficult to identify with any precision. The sense of the polarization-angle sweep rate is clear in L90.

0523+11.—Extrapolation of the "outer" conal width was possible between 1.4 GHz (RSW) and 430 MHz (WABCBF). The "inner" conal pair are not resolved in either profile.

0621−04.—Only a single total-power profile is available (Ba81), from which the "inner" width is very uncertain. As no polarization is available, a central traverse was assumed.

0826−34m.—The width of the "outer" conal pair was determined between 1420 and 408 MHz (LM), whereas all speculation about the various interior components relies on the work of Biggs et al. 1985.

1039−19.—All measurements are taken from LM's 408 MHz profile. The width of the "inner" conal component pair is poorly determined.

1237+25.—Many published observations are available for this star, but BMSH's set was particularly useful. A central traverse was assumed which is in keeping with the nearly constant polarization angle traverse.

1451−68.—The widths of the component pairs were taken from the 950 MHz fitting results of Wu et al. 1992b, and the P.A. information is from MHMa.

1737+13.—The widths of the component pairs were interpolated between 1400 (RSW) and 430 MHz (WABCBF), although the composite of HR was also useful. The P.A. information was taken from RSW.

1804−08.—The component-pair widths were measured at 1.7 GHz (XRSS), and here the "outer" pair is relatively weak and thus difficult to identify and measure. The P.A. rate is taken from XRSS.

1831−04.—The component-pair widths are scaled between 1.7 GHz (XRSS) and 611 MHz (L90).

1857−26.—The component-pair widths are interpolated between 1612 (MHMa) and 631 MHz (MHMA), and the P.A. rate is taken from MHMA.

1905+39.—The widths were measured between 1.7 GHz (XRSS) and 408 MHz (L83).

1910+20.—The conal component-pair widths are scaled between 1400 (RSW) and 430 MHz (D86), but only the latter observation resolves the "inner" components with any clarity. Both RSW and RB indicate P.A. rates of about +10°/°.

1952+29.—The conal component-pair widths were measured at 932 MHz (HR), although the 1.4 GHz (RSW) and 430 MHz (RB) profiles were also useful.

2003−08.—The "outer" component-pair width was interpolated between 1.7 GHz (XRSS) and 408 MHz (L90), whereas the "inner" pair was only resolvable at the lower frequency.

2028+22.—Polarimetric observations are available at both 1.4 GHz (RSW) and 430 MHz (RB), but only HR's composite begins to resolve the various components. The width of the "outer" pair was scaled between 1414 and 430 MHz. RB is the source for the P.A. data.

2210+29.—All data are taken from the single published profile available for this star (BCW).

2310+42.—Given the weakness of the "outer" component pair, the width of the "inner" pair is interpolated between 1.7 GHz (XRSS) and 408 MHz (L90). The P.A. rate is taken from XRSS.

TABLE 3

SPECTRAL PROPERTIES OF THE CONAL GEOMETRY OF FIVE-COMPONENT (M) PULSARS

FREQUENCY (MHz)	INNER $\Delta\psi$	INNER ρ	OUTER $\Delta\psi$	OUTER ρ	r (km) Inner	r (km) Outer
			PSR 1237+25			
4870	~7°8	3°1	10°8	4°3	90	172
2380	~8.0	3.2	11.5	4.6	95	196
1400	~8.0	3.2	11.8	4.7	95	206
610	~8.0	...	12.4	5.0	...	227
430	~8.8	3.5	13.4	5.4	115	266
278	...	...	14.9	6.0	...	328
178	...	...	16.1	6.4	...	383
111	~10.4	4.2	16.5	6.6	160	402
49	...	...	20.2	8.1	...	603
			PSR 1451−68			
1612	21.7	8.3	31.2	10.3	121	188
950	19.7	7.9	33.1	10.8	109	204
649	20.3	8.0	37.7	11.9	113	248
400	20.1	8.0	38.3	12.0	112	254
271	17.5	7.5	46.1	13.9	98	341
170	18	7.6	52.8	15.6	101	428
			PSR 1857−26			
2650	...	...	31.0	7.1	...	203
1612	...	...	30.8	7.0	...	201
631	...	...	37.2	8.3	...	284
408	...	...	39.0	8.7	...	310
268	...	...	42.0	9.3	...	356
170	...	...	48.4	10.7	...	465

NOTES:

1237+25.—All of the profile data in the table come from the unpublished Arecibo observations of Hankins et al. 1992 except for that at 610 MHz (BMSH) and both 278 and 178 MHz (MHMb).

1451−68.—The values quoted are from the fits carried out by Wu et al. 1992b which, apart from the 950 MHz observations, are based on MHMa (1612 MHz), MHMA (649 MHz), MHAK (400 MHz), and MHMb (271 and 170 MHz).

1857−26.—The 2650 MHz data is from MGSBT, and the rest as above (MHMa, MHMA, MHAK, and MHMb).

TABLE 4

CONAL GEOMETRY OF CORE SINGLE (S_t) PULSARS

Pulsar	Class	W_c	W_{cap}	α	$\Delta\chi/\Delta\varphi$ (°/°)	β	$\Delta\psi$	ρ	β/ρ	r (km)
0105+65	S_t	5°	2°2	26°	...	...	...	...	...	...
0136+57	S_t	7	4.7	42	+5.3[a]	−7°3	~10°	7°9	−0.92	113
0154+61	S_t	6.0	1.6	15	...	...	...	...	...	...
0355+54	S_t	8	6.2	51	−10[a]	+4.4	25	10.9	0.41	124
0540+23	S_t	8.0	4.9	38	...	...	...	...	...	...
0611+22	S_t	7.2	4.2	36	...	...	...	...	...	...
0626+24	S_t	7.2	3.5	30	?	...	?	...	...	...
0740−28	S_t	10	6.0	37	−3.5	−9.9	10.0	10.2	−0.97	116
0823+26*m*	S_t	3.38	3.4	84	+30	+1.9	~16	8.2	0.23	238
0833−45*m*	S_t	8.18	8.2	90	−4.8	+12.0	13.5	13.8	0.87	113
0835−41	S_t	3.7	2.8	50	...	...	...	...	...	...
0906−49*m*	$S_t/T_{1/2}$	...	7.5	...	...	...	...	...	...	...
0940−55	S_t	7	3.0	25	∞[b]	0.0	26	5.6	0.00	137
0959−54	S_t	3.9	2.0	32	...	...	...	...	...	...
1112+50	S_t	~3.6	1.9	32	+11	+2.8	6.5	3.3	0.84	119
1154−62	S_t	13	3.9	17	...	...	...	...	...	...
1240−64	S_t	7.2	3.9	33	...	...	...	...	...	...
1449−64	S_t	7	5.8	56	+7[a]	+6.8	18.3	10.4	0.65	128
1556−44	S_t	9	4.8	32	−13	+2.4	30	8.6	0.27	127
1557−50	S_t	7.0	5.6	53	...	...	...	...	...	...
1641−45	S_t	6.7	3.6	33	...	...	...	...	...	...
1642−03	S_t	4.2	3.9	70	+50[a]	−1.1	16	7.5	−0.14	147
1702−19*i*	S_t	4.5	4.5	85	...	...	...	...	...	...
1736−29*m, i*	S_t?	...	4.3	...	...	...	...	...	...	...
1749−28	S_t	4.9	3.3	42	+13	+2.9	13	5.3	0.55	107
1844−04	S_t/T?	~8	3.2	23	+5.5?	+4.1	~18	5.6	0.73	127
1859+03	$S_t(T_{1/2})$	5.25	3.0	35	−10[a]	−3.3	~16	5.5	−0.60	133
1900+05	S_t	6	2.8	28	∞[b]	0.0	~20	4.7	0.00	111
1900+01	S_t	4.1	2.9	44	+20[a]	+2.0	~12	4.7	0.42	108
1907+02	S_t	4.1	2.5	37	−15	−2.3	13	4.4	−0.52	130
1907+10	S_t	6.1	4.6	49	+13	+3.3	?	...	...	...
1907−03	S_t	6.3	3.4	33	...	...	...	...	...	...
1911−04	S_t	~3.0	2.7	64	−27[a]	−1.9	9.8	4.8	−0.40	125
1913+10	S_t/T	4.3	3.9	64	?	...	?	...	...	...
1914+13	S_t	~5?	4.6	67	+23	+2.3	10.2	5.3	0.44	52
1915+13	S_t	6.0	5.6	68	−8	+6.6	15	9.7	0.68	122
1924+16	S_t	5.7	3.2	34	...	...	...	...	...	...
1927+13	S_t?	...	2.8	...	...	...	...	...	...	...
1929+10*i*	S_t	5.15	5.1	88	...	...	...	...	...	...
1929+20	S_t	5.5	4.7	59	...	...	...	...	...	...
1930+22	S_t	6.5	6.4	83	?	...	?	...	...	...
1933+16	S_t?	~4.3?	4.1	72	−50[a]	+1.1	~20	9.6	0.11	220
1946+35	S_t(T)	~5.2	2.9	34	+9	−3.4	16	5.5	−0.63	142
1953+29	S_t/T	~45	31.3	44	?	...	108	...	...	...
1953+50	S_t	5.8	3.4	36	...	...	...	...	...	...
2053+36	S_t	9.3	5.2	34	...	...	...	...	...	...
2113+14	S_t?	7.4	3.7	30	...	...	...	...	...	...
2217+47	S_t	5	3.3	42	+8.5	+4.5	12	6.1	0.73	135
2255+58	S_t	10	4.0	24	...	...	...	...	...	...

[a] Values from Lyne & Manchester 1988.

[b] No measurements available; central traverse assumed.

NOTES:

0105+65.—No meter-wavelength polarimetry has been published for this star, and no conal outriders are apparent in the highest frequency observation available (1720 MHz; MGSBT). This later profile also provides the best estimate of the core width. LM's α-value is very close, 28°.

0136+57.—The "outriders" are just discernible at 1.7 GHz (XRSS); the core-width estimate is scaled from the profile in LM. LM find an α-value of 54°.

0154+61.—The core width estimate comes from Ba81's 610 MHz profile. No polarimetry has been published for this pulsar, and no "outriders" are apparent in a preliminary observation at 1434 MHz (Seiradakis 1985).

0355+54.—The core-width was measured at 410 MHz (LM). Many high-frequency observations are available, but those of XRSS and MSFB proved most useful. Interpretation of the P.A. information presents a problem as the traverse steepens asymmetrically toward the trailing edge of the profile; ultimately LM's value was adopted, but a less steep rate would be more appropriate for the center of the profile.

0540+23.—The core width was interpolated between 430 and 1418 MHz (BCW). This pulsar's profile changes little over a very large frequency range, and in particular no conal "outriders" are discernible even at 8.7 GHz (MGSBT).

0611+22.—The most accurate width determination is BCW's 430 MHz observation (the 1418 MHz one seems to have a scale problem). Again, this pulsar's profile undergoes little frequency evolution, and no conal "outriders" are discernible at 2.7 GHz (MGSBT). LM's α-value is 28°.

0626+24.—The core width is measured at 430 MHz (WABCBF). No conal "outriders" are clearly discernible at 1400 MHz (RSW), although there are indications that they might be at higher frequency; furthermore, the P.A. traverse here seems disjointed and unreliable.

0740−28.—The 631 MHz profile of MHMA was used to measure the core width. The appearance of the "outriders" is most clear at 1420 MHz (LM). The P.A. sweep rate has been scaled from LM's profile; the value they give in their Table 4 is much too steep.

0823+26m.—All the values including the core width are taken from an unpublished 430 MHz mode-separated profile and correspond to the secondary mode. LM obtain an α-value of 26° which is difficult to reconcile with the interpulse of this pulsar.

0833−45m.—The core width is interpolated between 631 (MHMA) and 1612 MHz (MHMa). It is remarkable how few well-measured high-frequency profiles have been published for this important pulsar. Observations at 4830 MHz (KMR) and 1665 MHz (M71) proved most useful. The problem is the P.A. sweep rate where values between −4 and −9 can be found, and there seems to be a general steepening toward higher frequency. The values at 1665 MHz (−5°.4/°) and 631 MHz (−4°.2/°; MHMA) were interpolated to 1 GHz to give a value of −4°.8/°. LM also obtain an α-value of 90° for this pulsar.

0835−41.—The core width is again interpolated between 631 (MHMA) and 1612 MHz (MHMa). No "outriders" are apparent for this pulsar at the highest frequency for which it has been observed, 1612 MHz (MHMa). LM find a similar α-value of 54°.

0906−49m.—None of the published profiles are drawn well enough to accurately measure the core width. The central component of the interpulse at 834 MHz (D'Amico et al. 1988) appears to have a width near 8° as expected; the main pulse appears wider and may be a composite of several unresolved components. A polarimetric observation at 1562 MHz (Wu et al. 1992a) shows no trace of conal "outriders."

0940−55.—The core width is interpolated between 631 (MHMA) and 1612 MHz (MHMa). The latter observation seems to show conal "outriders." The question is what to make of the P.A. traverse. The drop in fractional linear polarization in the center of the profile suggests a rapid sweep; therefore, the angle rate is taken as infinite for purposes of calculation. LM's α-value is 20°.

0959−54.—Again, the core width is interpolated between 631 (MHMA) and 1612 MHz (MHMa). No conal component pair is visible in the 1612 MHz observation (MHMa).

1112+50.—The conal component pair of this pulsar is readily seen above 1 GHz (MGSBT, XRSS). Both the core width and the P.A. rate are scaled from an unpublished 409 MHz observation (L90).

1154−62.—No conal "outriders" are seen in MHMa's 1612 MHz profile although the shape suggests that they might be at some higher frequency. LM obtain a very similar α-value of 18°.

1240−64.—The core width is interpolated between 631 (MHMA) and 1612 MHz (MHMa). Again, no conal components are clearly visible at the higher frequency. However, the extension of the leading edge of the profile and the steepening of the P.A. traverse suggest that they will be seen at higher frequency.

1449−64.—The relative narrowness of the 400 MHz profile (HMAK) suggests that both the 631 (MHMA) and 1612 MHz (MHMa) profiles are broadened by unresolved components. The core width is thus taken close to the 400 MHz value. Indeed, the linear polarization behavior at 1.6 GHz so clearly exhibits the effect of conal emission that the component-pair width can be estimated from the linear curve.

1556−44.—The core width is measured at 631 MHz (MHMA), and the effect of the conal component pair can be discerned at 1612 MHz (MHMa). The P.A. rate is scaled from the latter observation.

1557−50.—Only a single 1612 MHz observation has been published (MHMa) which is unimodal and exhibits no discernible conal contributions; thus the width of the component is taken as the core width.

1641−45.—Only a single relevant observation at 1612 MHz (MHMa) is available (a 638 MHz observation [MHMA] is broadened by scattering beyond recognition). This profile, although Gaussian in shape, shows the effect of a weak conal component pair. The problem is that the P.A. traverse is difficult to interpret and thus does not yield a reasonable estimate of the sweep rate.

1642−03.—At meter wavelengths the core component is "absorbed" (see Paper II). The 4°.2 value given represents an extrapolation to 1 GHz of higher frequency measurements, and the value could be somewhat greater depending upon how the character of the "absorption" at lower frequencies is interpreted. The conal component-pair width is scaled from the 2.7 GHz observation (SRW). LM's α-value of 68° is very similar.

1702−19i.—Only one 408 MHz observation is available for this pulsar (Biggs et al. 1988). It is not known whether the interpulse develops conal "outriders" at higher frequency. LM find that this pulsar has an α-value of 90°.

1736−29m, i.—No profiles are yet available for this interesting, but weak pulsar which have sufficient sensitivity and instrumental resolution to determine the widths and characters of the components. At the available resolution they appear single, but they could be composite at higher resolution.

1749−28.—This pulsar's core component is also "absorbed" (see Paper II) at meter wavelengths, and the value given is an extrapolation of high-frequency measurements. The conal "outriders" are most clearly seen at 4.9 GHz (SRW). The problem for this pulsar is obtaining a reliable value of the P.A. sweep rate as the linear polarization is very low and the resulting angle chaotic and apparently unreliable. LM's value seems too high, and so it has been scaled from MSC's 2.65 GHz profile and corrected upward somewhat to account for the dispersion broadening. LM find a somewhat disparate α-value of 58°.

1844−04.—Only one profile has been measured for this pulsar, at 1690 MHz (MGSBT), and its interpretation requires some guesswork. It appears to show a core component and leading "outrider," and the other "outrider" seems to be discernible as an inflection on the trailing edge of the profile. Similarly, little of the polarization traverse is measured, but what is indicates a value around +5°/°.

1859+03.—The core width is scaled from a 1.4 GHz profile (RSW), which clearly shows the leading conal "outrider" but not the trailing one. A 2650 MHz profile (MGSBT) has a trailing-edge feature which may be this second "outrider"; it is also possible that the core component overlies the trailing "outrider." On the strength of the 10 cm observation, the second possibility seems more likely. LM obtain a similar α-value of 39°.

1900+05.—The core width is estimated from the leading half of the profile at 1412 MHz (RSW) which shows evidence of the trailing "outrider" but not the leading one. Again, the leading "outrider" may be visible at 2.65 GHz (MGSBT), and the conal component-pair width is taken here. As no reliable P.A. traverse has been determined, a central traverse is assumed for purposes of calculation.

1900+01.—The core-width value is interpolated using both a well-resolved 21 cm observation (RSW) and the first half of one at 430 MHz (RB) which shows some scattering broadening. The effect of the conal component pair is discernible even at 631 MHz (MHMA) and is very clear in the above 21 cm profiles. LM find an utterly different α-value of 90°.

1907+02.—The core width is interpolated between 430 (Paper I) and 1412 MHz (RSW). The latter profile is broadened at its base showing the effects of the conal "outriders," from which the width of the conal component pair can be estimated. The P.A. rate is taken from the 430 MHz observation.

1907+10.—The core width is interpolated between 430 (RB) and 1400 MHz (RSW). The latter profile has a leading "outrider" but no trailing one. Observations at higher frequencies do not yet exist. LM's α-value of 90° is completely different.

1907−03.—Only a 610 MHz total-power (Ba81) and a 408 MHz polarimetric observation are available for this star, but the former is resolved so poorly that it is worthless. The core width then reflects only the 408 MHz profile, and, lacking any higher frequency observations, it is not clear whether this star develops conal "outriders."

1911−04.—The core-width value reflects measurements of several 400 MHz profiles (M71; LSG; HMAK). Again, the trailing "outrider" is much weaker than the leading one and is just apparent at 1664 MHz (M71) and at higher frequencies (MGSBT). LM calculate a fairly similar α-value of 71°.

1913+10.—The only profile that exists for this pulsar is at 21 cm (RSW), and this shows a feature on its trailing edge which could be a conal "outrider." The width of the profile is 4°.3 which is only just greater than the 3°.9 diameter of the polar cap. If one instead estimates the width as twice the leading 3 db point to the peak, the result is 3°.7 which is less than the polar-cap diameter. New observations at higher and lower frequencies are needed to resolve whether the trailing-edge feature is a conal "outrider" or the result of "absorption."

1914+13.—The only observation which clearly shows the structure of this pulsar's profile is the one at 1418 MHz (BCW) although, having seen this one, most of the features can also be discerned in RSW's profile. The profile is clearly triple at this frequency, and all of the data seemingly can be estimated with good accuracy from BCW's observation. The core width is least well determined, and only fitting would improve it. The resulting parameters imply a conal geometry which is significantly narrower than most of the other pulsars, and no revision of the core-width value will change this appreciably.

1915+13.—At 430 (RB) and 1400 MHz (RSW), the profiles have a feature on their trailing edge which appears to be one of the conal components. Measurements of the width of the first half of the profile, multiplied by two, then provide a reasonable estimate of the core-component width. The other conal component is difficult to discern. Both a 1690 and a 2650 MHz observation (MGSBT) show a feature which appears to be the leading "outrider," but the S/N of these observations is only about 20:1. Several more sensitive 21 cm profiles give very little indication of this feature, but their resolutions of 0°.5 (RSW) and 1°.5 (BCW) are insufficient to identify the leading feature. Several other unpublished 1400 MHz observations with about 0°.1 resolution clearly show the leading feature at an amplitude of about half that of the trailing "outrider." Both the conal component-pair width and the P.A. rate are scaled from the 1690 MHz profile.

1924+16.—The core width is interpolated between observations at 430 (RB) and 1400 MHz (RSW). No indication of conal features is apparent at the higher frequency.

1927+13.—Very little information is available for this pulsar. The only published profile at 430 MHz (GR) gives only the total power and is not well resolved. If this is a core component, its width (11°.3) would indicate a nearly aligned geometry, which is unusual for S_t pulsars. Thus the profile is likely either substantially narrower, or it is a composite of several closely spaced components, and only improved observations will be able to distinguish which is the case.

1929+10i.—The core width of this interpulse is interpolated between 430 (RB) and 1412 MHz (RSW). No hint of conal "outriders" are apparent at the latter frequency, although sensitive observations of the interpulse have not been conducted at even shorter wavelengths. LM's very different α-value of 6° reflects an entirely different interpretation of its geometry (see the Appendix of Paper IV).

1929+20.—The core width is measured at 1400 MHz (RSW); no "outriders" are apparent.

1930+22.—Only one high-resolution 1418 MHz profile (BCW) has been published for this pulsar. Its width at 5°.9 is slightly less than the polar-cap diameter. Probably a 1 GHz observation would yield a width of around 6°.4, implying a nearly orthogonal geometry. Lower frequency observations are needed to accurately interpolate the 1 GHz core width.

1933+16.—This is a very intriguing pulsar, but owing to the pulsar's short period and high dispersion, most published profiles are not as well resolved as would be desirable. The bulk of the emission at 430 (Hankins et al. 1992) and 1400 MHz (RSW) is in two closely spaced components, the earlier of which appears to be the core component by virtue of its strong antisymmetric signature of circular polarization. The width of this component is not easy to determine precisely short of fitting, but is certainly less than 5° and probably less than 4°.5—indicating a nearly orthogonal geometry. Prominent conal "outriders," however, develop at frequencies above 1000 MHz, making the overall evolution of the profile much like that of core-single stars. Perhaps we should regard the trailing feature as an "inner" conal "outrider," and indeed there is some suggestion of a leading "inner" feature in the linear polarization at 1400 MHz (RSW). We would then argue that this pulsar is an unusual five-component (M) star! In any case, the width of the ("outer"?) conal component pair is measured from profiles between 1400 MHz and 4.9 GHz (SRW). On the basis of the nearly constant polarization angle at the extreme "wings" of the 1400 MHz profile (RSW) the sweep rate is taken infinite. LM find an α-value of 65°, which is close.

1946+35.—The core-component width is measured at 1400 MHz (RSW) in that the only other lower frequency profile at 430 MHz (RB) shows significant scattering distortion. The width of the conal "outrider" pair is measured using the 1400 MHz observation as well as several higher frequencies (MGSBT). LM's value for the sweep rate as well as values scaled from the higher frequency observations are all around +9°/°. LM's value for α of 43° is comparable.

1953+29.—The evolution with frequency of this 6.1 ms pulsar is very similar to other S_t stars. Some high-quality observations at 430 MHz do show evidence of the leading conal "outrider", so perhaps we should regard this as a T pulsar, but this is merely a question of convention. The core width (~45°) is measured at 430 MHz (SBCDW) and is probably slightly overestimated because no extrapolation to higher frequencies is presently possible. The only other available profile is at 1387 MHz, and here the conal "outriders" are closely spaced, obscuring the wings of the central component. Unfortunately, no analysis of the conal geometry is possible for this pulsar because its linear polarization is so low, making the measurement of the P.A. traverse exceedingly difficult.

1953+50.—Only a single, total-power observation is available for this pulsar at meter wavelengths, at 610 MHz (Ba81), which is the basis for the core-width determination.

2053+36.—The core-width is determined by extrapolation between 430 (WABCBF) and 1400 MHz (RSW). No conal "outriders" are apparent at the higher frequency.

2113+14.—The core width is here again determined by extrapolation between 430 (WABCBF) and 1400 MHz (RSW). No clear conal component could be discerned at the latter frequency, but the profile is asymmetric, and it is possible that they may be seen in even higher frequency observations.

2217+47.—The core width is estimated from an old 408 MHz observation (LSG) with additional reference to a 102 MHz profile (MIS). The conal "outriders" are not clearly discernible either at 1612 or 2650 MHz (MGSBT), but the 4.9 GHz profile (SRW) can be measured easily to determine their width. LM's value for the sweep rate seems much too high; both the 1612 and 2650 MHz observations yield values around +8°.5/°.

2255+58.—No meter-wavelength profile is available for this pulsar, and those at higher frequencies (MGSBT) have a S/N of only about 10:1. If these profiles are truly single as they seem to be, then the core width is around 10°. No "outriders" are apparent in any of the observations.

TABLE 5

Conal Geometry of Triple (T) Pulsars

Pulsar	Class	W_c	W_{cap}	α	$\Delta\chi/\Delta\varphi$ (°/°)	β	$\Delta\psi$	ρ	β/ρ	r (km)
0149−16	T?	≈3°	2°7	84°	+30[a]	+1°9	8°2	4°5	0.42	113
0329+54	T/M?	5.8	2.9	30	−13.5	+2.1	24.9	6.7	0.31	217
0450+55	T	~8	4.2	32	−9[a]	+3.3	24	7.4	0.45	124
0450−18	T	~8	3.3	24	+6[a]	+4.0	20	5.9	0.67	129
0458+46	T?	~12.5	3.1	14	+2.2	+6.4	~20	7.0	0.91	211
0531+21*pm*	$T_{1/2}$	13.5	13.4	84	...	...	...	...	...	...
0656+14	T	~8	3.9	30	...	...	...	...	...	...
0736−40	T	~14	4.0	17	+3.8	+4.3	35	7.0	0.61	124
0906−49*i*	T?	7.5	7.5	89	??	...	34	...	...	...
0919+06	T	~5.0	3.7	48	+9	+4.8	11.5	6.5	0.73	122
0942−13	T?	4.6	3.2	45	...	...	...	...	...	...
1055−52*m*	T	≤6	5.5	~90	∞[b]	0.0	26	13.0	0.00	222
1221−63	T	~7	5.3	49	+6	+7.2	12.3	8.7	0.83	109
1508+55	T	~4	2.8	45	−15	−2.7	11	4.7	−0.58	109
1541+09	T	~32	2.8	5	∞[b]	0.0	120	5.1	0.00	128
1558−50	T	≈4	2.6	41	...	...	...	...	...	...
1604−00	T	5.1	3.8	48	−8?	+5.3	9.8	6.5	0.82	119
1700−32	T	~3	2.2	48	+24[a]	+1.8	12.3	5.0	0.36	198
1702−19*m*	T	4.5	4.5	85	−14[a]	−4.1	~14	8.1	−0.51	129
1706−16	T	~4?	3.0	49	−9[a]	−4.8	~7?	5.5	−0.88	130
1727−47	$T_{1/2}$	~3?	2.7	64	−24[a]	+2.1	9.8	4.9	0.43	134
1742−30	T?	~4.8	4.0	57	∞[b]	0.0	~16?	6.7	0.00	111
1745−12	T/M	~5?	3.9	51	−15?	+3.0	15.5	6.9	0.44	123
1747−46	T?	≈3.5?	2.8	54	−20[a]	+2.3	11	5.1	0.46	128
1818−04*m*	T	~3.5?	3.2	65	+15?	+3.5	9?	5.4	0.64	116
1821+05	T	5.4	2.8	32	−18[a]	+1.7	25.6	7.0	0.24	249
1822−09*m*	$T_{1/2}$	2.8	2.8	86	+50[a]	+1.1	23.9	12.0	0.10	736
1826−17	T?	~7?	4.4	39	+50[a]	+0.7	~24	7.7	0.09	120
1839+09	T	~4.0?	4.0	83	−42	+1.4	13	6.6	0.21	111
1842+14	T/S_t	≈4.5?	4.0	63	+12	+4.2	12	6.9	0.62	119
1848+04	T?	~23	4.6	12	∞[b]	0.0	112	10.8	0.00	219
1907+00	T	~3?	2.4	69	+90	+0.6	12.5	5.9	0.10	234
1907+03	T/M	15.0	1.6	6	−6[a]	+1.0	61	3.6	0.28	205
1911+13	T	≈4.3?	3.4	52	−24?	+1.9	18.2	7.5	0.25	196
1913+167	T/M?	~3	1.9	50	−40	+1.1	8.5	3.5	0.32	131
1913+16	T	14?	10.1	46	+51	+0.8	47	17.0	0.0	114
1914+09	$T_{1/2}$	~6.0?	4.7	52	...	...	...	...	...	...
1916+14	T?	2.3	2.3	79	+43?	+1.3	8	4.1	0.32	135
1917+00	T	≈2?	2.2	81	−45[a]	1.3	~10	4.9	0.26	200
1919+14	T?	7	3.1	26	−4.0	−6.4	16	7.1	−0.90	208
1920+21	T	3.4	2.4	44	−36[a]	+1.1	16	5.7	0.2	234
1926+18	T	~4	2.2	35	...	...	13.0	...	...	...
1929+10*m*	T?	5	5.1	90	−1.5?	+41.8	13.2	42.2	0.99	2692
2002+31	T	~2.2?	1.7	49	∞	0.0	11.2	4.2	0.00	250
2020+28	T?	~4	4.2	72	+15[a]	+3.6	13	7.3	0.49	123
2045−16	T	~3?	1.7	36	−30[a]	+1.1	14	4.3	0.26	240
2111+46	T	15	2.4	9	−6.7[a]	+1.4	66.0	5.8	0.24	229
2224+65	$T_{1/2}$	~11.0?	3.0	16	−4.5[a]	+3.4	44.9	7.5	0.46	253
2327−20	T	~2.2?	1.9	60	+15	+3.3	6.8	4.5	0.74	219

[a] Values from Lyne & Manchester 1988.

[b] No measurements available; central traverse assumed.

Notes:

0149−16.—The core component of this pulsar is not discernible at any frequency, but the strong, consistent circular signature suggests its existence. The core width is then taken close to the polar-cap width in agreement with LM's analysis (who find an α-value of 90°). The conal component-pair width is interpolated between observations at 610 (Ba81) and 1720 MHz (MGSBT).

0329+54.—The core width of this pulsar is difficult to measure because of "absorption"; the situation is even more severe than shown in Paper II (see Fig. 2) because more recent high-quality profiles have clear "absorption" notches at frequencies as high as 1.7 GHz (BMSH). The adopted value of 5°8 is an estimate which attempts to take this phenomenon into account. The conal component-pair width is easily measured at, for instance, 410 and 1665 MHz (M71), and the sweep rate represents the results of a fit (McKinnon & Hankins 1992). LM find a nearly identical α-value of 31°.

0450+55.—The core width is difficult to measure accurately. At 409 MHz (LM) there is a trailing edge feature, whereas at 1.7 GHz (XRSS) the core component and trailing "outrider," are very closely spaced, and it is not quite clear which features in the two profiles correspond to each other. Measurements at both frequencies give values close to 6°. The trailing-edge feature, however, is not the trailing "outrider," so it is unclear whether this feature is another component or an "absorption" feature. If so, of course, the core width would be greater, around 8°, and this value is what is tabulated. The conal component-pair width is most easily measured using the 409 MHz profile. Both additional observations and detailed study (including component fitting) are required to make a more certain interpretation of this pulsar's profile.

0450−18.—Apparently the core-component width can be measured using twice the first half of the 408 MHz profile (LM), but there is a feature on the trailing edge which may indicate "absorption," in which case the core width is larger, about 8°. Given the overall triplicity of the profile, the latter interpretation appears to be favored. The conal component-pair width was interpolated between 631 (MHMA) and 1612 MHz (MHMa). LM obtain a fairly similar α-value of 31°.

0458+46.—Only a single 610 MHz (Ba81) observation has been published for this pulsar, but the conal "outriders" are clearly discernible as features on the leading and trailing edges of the profile. The P.A. sweep rate is taken from LM, who find a virtually identical α-value of 15°.

0531+21pn.—The precursor-main-pulse profile is interpreted as a triple profile which is missing its leading conal "outrider" (Paper III). The core width is determined using the 606 MHz observation of Boriakoff & Payne 1973. As the leading "outrider" is missing, no further analysis of the conal geometry is possible.

0656+14.—The triplicity of this profile is not clearly shown in any published observation, although the 430 MHz profile of WABCBF comes closest. RSW's profile is smeared owing to observing with an incorrect period (Domingue et al. 1986). An unpublished 430 MHz profile (Hankins et al. 1992), however, clearly shows three closely spaced components, and the core width can be estimated at about 8°. The conal analysis is frustrated for lack of reliable polarization-angle data; that at 1400 MHz (RSW) is flattened by some unknown amount, and the value given by LM is far too small. LM's α-value of 8° also seems much too small.

0736−40.—This pulsar has a very wide profile. The core width can be estimated using observations at 631 (MHMA) and 1612 MHz (MHMa). Similarly, the conal component width can be interpolated using the same observations. The P.A. rate is scaled from the central region of the higher frequency profile. LM find a nearly identical α-value of 18°.

0906−49i.—The core-component width for this interpulse is taken from the 843 MHz observation of D'Amico et al. 1988. The evolution appears unusual, however, because a 1562 MHz profile (Wu et al. 1992a) appears single. No reliable P.A. sweep rate is available for the interpulse.

0919+06.—The core width is measurable as twice the first half of the component in BCW's 430 MHz profile, and the conal "outrider" configuration is most easily seen in this same observation. The P.A. sweep rate is also taken from BCW.

0942−13.—No observation above 1 GHz is available for this pulsar. The core width may be as large as 4°6 (Ba81), although the P.A. suggests that conal emission is strong in the "wings" of the profile (LM).

1055−52m.—The core width of this pulsar can be estimated from the 631 MHz observation (MHMA; see also LM); it is certainly less than 6° and probably less than 5°5 and is thus compatible with the interpretation that α is about 90°. (LM's utterly different α-value of 18° reflects a different interpretation of its geometry; see the Appendix of Paper IV). The width of the conal component pair is also readily scaled from this observation. What is problematic is the P.A. sweep rate, as its ostensible value is around +1°0/°. This would imply that β is also around 90°, which is clearly unreasonable. The P.A. traverse is instead interpreted as being a highly central one, and this line of argument seems to yield a reasonable result.

1221−63.—The only well-measured profile for this pulsar is at 1612 MHz. It has a central core component with the conal "outrider" pair just discernible as "breaks" along each edge. The core width appears to be about 7°, and the conal "outrider" width about 14°. The most monotonic P.A. traverse is found in MHMA's 631 MHz observation wherein the angle rate seems to be about 6°/°.

1508+55.—The most reliable estimate of the core width comes from measuring the trailing half of the core component in LM's 610 MHz profile and multiplying by two. The conal component-pair width is also readily determined using this observation, although compatible values can be found using profiles at 410 (M71) and 1612 MHz (MGSBT). The P.A. data are interpolated between 410 and 1665 MHz (M71). LM obtain a very different α-value of 80°.

1541+09.—The core component of this pulsar clearly shows leading-edge "absorption" at 430 MHz (Paper I), so the core width was determined by taking twice the trailing width of the profile at 1400 MHz (RSW). The conal component-pair width was interpolated between these same observations. Given the similarity of the P.A. values at the edges of the profile, the sight-line traverse was assumed to pass very close to the magnetic axis. LM find a virtually identical α-value of 6°.

1558−50.—The evolution between 631 (MHMA) and 1612 MHz (MHMa) is very characteristic of a triple profile, but lower frequency observations are required to clearly distinguish the core component. Its width can be estimated at about 4°.

1604−00.—All values for this pulsar are taken from the mode-separated profiles in Rankin 1988.

1700−32.—The triple structure of this pulsar's profile is most apparent in the 409 MHz profile of LM, wherein the core width can be estimated as about 4°5. The conal component-pair width is interpolated between 409 and 1612 MHz (MHMa). LM calculate a virtually identical α-value of 47°.

1702−19m.—The core-component width is not easily determined among the three closely spaced components, so the same value is assumed as was determined for the interpulse above. The conal component-pair width is scaled from the 408 MHz profile of Biggs et al. 1988. LM also find that α is essentially 90°.

1706−16.—The triangular shape of this pulsar's profile over a wide frequency range suggests that it consists of a closely overlapping composite of a core component and a pair of conal "outriders"; at no frequency, however, can one find clear verification of this premise. If this were so, the core component and the conal "outrider" pair would seem to have widths of about 4° and 7°, respectively. LM's value of α is close at 55°.

1727−47.—This seems to be a triple pulsar in which the core component and leading "outrider" are closely merged; only at 400 MHz (MHAK) and below (MHMb) can the weak central component be identified at all. The core component then would have a width of about 3°. LM find an α-value of 87°.

1742−30.—The core component of this very interesting pulsar seems to *follow* the trailing "outrider"—a very unusual configuration! (Could this be evidence for strong multipole contributions to the magnetic field?) The core width can be interpolated between 950 MHz (L90) and 1.7 GHz (XRSS). The width of the conal component pair is then more difficult to estimate, but appears to be about 16° at 1.7 GHz (XRSS). Apart from 90° "jumps" the linear polarization angle varies rather little; therefore a central traverse of the sight line is assumed.

1745−12.—The width of the core component can be estimated roughly at both 1700 (XRSS) and 611 MHz (L90), the latter by scaling the second half and multiplying by two. The conal component-pair width can also be interpolated between these two frequencies. Here the P.A. sweep rate is uncertain, but it appears to be steeper than −7°/° in the 611 MHz observation; in fact, a rate of −15°/° has been taken for calculation, which is not far different than assuming a central traverse.

1747−46.—The core component is not clearly discernible in any available profile, and mode switching apparently has distorted the usual pattern of triple-profile evolution. Note the form of the profile at 400 MHz (MHAK) as compared with that at first 631 MHz (MHMA, also LM) and then 1612 MHz (MHMa). The width of a core component compatible with the other components in the 400 MHz profile appears to be 3°–4°, and the conal component-pair width can be scaled from the 1612 MHz observation. LM find a very different α-value of 90°.

1818−04m.—Much of how we interpret this pulsar's profile turns on the accuracy of the 2.7 GHz observations reported by SRW: Two components and a much weaker trailing-edge feature are visible, but the baseline noise is also large and quasi-periodic. Down's 1979 observation at 2388 MHz, however, seems to show much the same structure. The central component is then apparently the core component, and its width can be estimated at about 3°5. The conal component-pair width seems to be about 9° (M71, MGSBT), and the P.A. rate about +15°/°.

1821+05.—The width of the core component is readily measured at 430 MHz (WABCBF), and the value can be verified at 1400 MHz (RSW) by taking the first half of the component and multiplying by two. The conal component-pair width is interpolated between these two observations. LM obtain a similar α-value of 28°.

1822−09m.—The core component is identified as the leading component of the composite second "component" of the main pulse (Paper III), and the mode-switching study of Fowler & Wright 1982 provides the most favorable situation in which to measure this width. The association seems justified in that the measured core width is 3°0 or perhaps slightly less, which implies that $\alpha > 70°$ as is appropriate for a two-pole interpulsar. The conal component width is then measured between the outside 3 db points of the two principal components of the main pulse and interpolated between 631 (MHMA) and 1720 MHz (MGSBT), yielding a value of 23°.9. 1822−09 is one of the only pulsars exhibiting a ρ-value which appears incompatible with the others, and this circumstance may indicate a fundamental misunderstanding of this pulsar's unusual profile.

1826−17.—The pulsar's core component seems to subside greatly between 1612 MHz (MHMa) and 2.7 GHz (MGSBT). No meter wavelength profiles have been published for this pulsar, however; therefore we have no way to determine whether it is a triple (T) or core-single (S_t) star. The core width is most easily estimated using the 1612 MHz profile (MHMa), but the core component is not clearly discernible. LM's α-value is 40°.

1839+09.—While older observations (Ba81, WABCBF) suggest a single form, more recent, high-resolution ones show that the profile is not at all "single" at 430 MHz (Hankins et al. 1992). The core width is estimated using the latter 430 MHz observation as well as others at 1400 MHz (RSW, BCW). The conal component-pair width can best be estimated at the higher frequency. The P.A. sweep rate is taken from the analysis of BCW. LM also find that this pulsar has an α-value of nearly 90°.

1842+14.—High-resolution observations (Hankins et al. 1992) suggest that the "single" profile is composite at 430 MHz; the core width is then very much smaller than the profile width but cannot be clearly identified in any existing observation. The conal component-pair width is easily measured at 1400 MHz (RSW), and the P.A. rate is also taken from this profile, although the overall behavior is strange.

1848+04.—The only available profiles for this pulsar have been published by Boriakoff et al. (1992), and total-power observations at 1414, 430, and 318 MHz are given. The pulsar's profile consists of a very broad main pulse and a bright interpulse. Lacking any polarization data to estimate β, a central traverse was assumed. The resulting value of ρ suggests an outer cone, which seems compatible with the form of the profile. This geometry does not, however, seem to explain the interpulse and thus may well be incorrect.

1907+00.—The core component width is determined using the published profiles at 430 (RB) and 1400 MHz (RSW). However the width at the lower frequency is slightly smaller than that at the higher suggesting "absorption," and so the higher frequency width was taken as more indicative. The conal component-pair width is interpolated between the two profiles, and the P.A. rate is scaled from the higher frequency profile.

1907+03.—This pulsar's profile is truly complex. Beyond a core component and a conal "outrider" pair, it is not clear whether there are others as well. The core-component width is estimated from a profile at 317 MHz (HR), whereas the conal component-pair width is interpolated between observations at 1400 (RSW) and 430 MHz (WABCBF). LM obtain a virtually identical α-value of 6°.5.

1911+13.—The core width is interpolated between observations at 430 (GR) and 1412 MHz (RSW) as are the conal component-pair widths. The P.A. sweep rate is scaled from the latter observation, but is not uniquely determined as several interpretations of the curve can be made.

1913+167.—It is not clear how to classify this pulsar on the basis of the information available: No core component is identifiable although the circularly polarized signature suggests that one is present in the profile. If there were a core component, its width could not be much larger than 2°.5. The conal component-pair width is interpolated between 430 (RB) and 1400 MHz (RSW), and the P.A. sweep rate is scaled from the 430 MHz observation. LM find a similar α-value of 54°.

1913+16.—The highest quality profiles available for this important pulsar are those recently published by BCW. The core width can be estimated for the leading half of the component at 430 MHz and then doubled, whereas the conal component-pair width can be interpolated between the two frequencies with some precision. The linear P.A. rate is also taken from BCW, and α may well be about 45° because the orbital plane is also inclined by about this angle (Taylor et al. 1976).

1914+09.—This profile exhibits a pattern of evolution characteristic of the triple except that the leading "outrider" is not clearly present. The core-component width can be estimated from the first half of the leading component, but, given the lower resolution of the 430 MHz observation, the 1.4 GHz profile probably gives a more correct value. LM find a nearly identical α-value of 50°.

1916+14.—The 1418 MHz profile published by BCW is the highest quality one available. It seems compatible in form with MGSBT's 1720 MHz profile but not with RSW's 1400 MHz observation. The differences in form suggest that the star has several stable profile modes. The core width seems to be about 2°.3, and the conal component-pair width about 8°. The P.A. sweep rate is taken from BCW. LM obtain a rather different α-value of 56°.

1917+00.—The core width is interpolated between 430 (RB) and 1400 MHz (RSW) as is the conal component-pair width. The core-width value at the lower frequency includes a correction for "smearing" due to dispersion and integration. LM find a similar value of α (78°).

1919+14.—Here the core component is not clearly discernible at any frequency, but the circularly polarized signature reveals its presence in the profile. The 7° estimate is plausible and gives an α-value which agrees closely with the one determined by LM (25°). The conal component width is measured using the 1400 MHz observation (RSW), and the P.A. sweep rate is scaled from this as well as the 430 MHz profile (RB).

1920+21.—The structure of this pulsar's profile is not easy to discern in any published profile; the core component is so "early" that it virtually overlies the leading "outrider." This structure is obscured by poor resolution at 430 MHz (RB), and at 1400 MHz (RSW) the pulsar is apparently in a mode wherein this leading "outrider" is weak. Newer, high-resolution observations show the three components quite clearly (Hankins et al. 1992). The core-component width is measured at 430 MHz, and that of the conal component pair at 1400. LM's α-value of 47° is very close.

1926+18.—The core width of this interesting triple pulsar has been determined through the analysis in Ferguson et al. 1981. Unfortunately, no polarimetry is available, so we at present have no means to estimate the angle β. (An "inner" cone would result for a rate of 22°/°, and an "outer" for ~8°/° [$\beta < 0$] or 9°/° [$\beta > 0$].)

1929+10m.—This is a difficult pulsar: The main pulse consists of three closely spaced components (HR), the center of which is apparently the core component, but its width is difficult to measure with any precision owing to the presence of the other two. This central component is most clearly resolved at about 1.5 GHz, and a reasonable estimate can be made, for instance, at 1665 MHz (M71), which at about 5° agrees well with determinations of the interpulse core component. Neither is it easy to measure the conal component-pair width because the half-power points are difficult to fix; the tabulated value was interpolated between 1412 MHz (RSW) and 430/227 MHz (HR). The most serious difficulty, however, is with the polarization-angle sweep rate which is about −1°.5/1°. Carrying through the conal analysis using this value yields values for β and ρ of about 42°—values which are utterly incompatible with other triple pulsars and indeed pulsars of any species! (Conversely, if we interpret the shallow linear sweep rate as evidence of a "corrupted" central traverse, then setting $\beta = 0$, then the resulting value of ρ is about 2°.6—too small to be compatible with the other stars.) Taking this value seriously implies that 1929+10 should have a tangential sight-line traverse and thus a featureless S_d profile, which of course it does not. Second, it implies that the pulsar is a one-pole interpulsar—despite having $\alpha \approx 90°$—which is again problematic because the main pulse to interpulse separation does not change with frequency. It is not clear how we might resolve the paradox which this pulsar presents. LM find a completely different α-value of 6°, implying that the pulsar *is* a single-pole interpulsar!

2002+31.—Both the core-component and the conal component-pair widths are interpolated between 430 (RB) and 1400 MHz (RSW), and the core width at the lower frequency is corrected for dispersion broadening. Both profiles suggest that the sight-line traverse is a highly central one.

2020+28.—This pulsar's two conal components are so prominent that they almost obscure the weak core component on the trailing edge of the leading one. This core component is therefore not easy to study, but its width can be estimated with reasonable accuracy at 430 MHz in mode-separated profiles (CRB). The width of the conal component pair is interpolated between 1404 MHz (SCRWB) and 430 MHz. LM's α-value of 71° is almost identical.

2045−16.—The core component width can be estimated between frequencies of 600 and 1700 MHz (MHMA, LM, MHMa) by measuring its leading half and multiplying by two, resulting in values around 4°. The conal component-pair width is interpolated between 410 and 1665 MHz (M71). LM obtain a nearly identical α-value of 37°.

2111+46.—The core width is easily measured a meter wavelengths, and there is some evidence that the component is narrower below 1 GHz implying "absorption." The tabulated width above reflects this possibility. The width of the conal "outriders" was interpolated between 1720 (MGSBT) and 409 MHz (L83). LM's α is also 9°.

2224+65.—This profile has two well-separated components of which the first seems to be the core component on the basis of its steeper spectrum. The width of this component is best measured at 408 MHz (LM). On the assumption that the core component overlies the leading conal "outrider," the conal component-pair width can be interpolated between 408 MHz and 1.7 GHz (MGSBT). The procedure seems to give a reasonable result.

2327−20.—The core-component width can be estimated at 648 MHz (MHMA). In this same observation the trailing "outrider" can just be discerned as a "break" on the edge of the profile. The P.A. rate is also scaled from this profile, but the traverse must be corrected for a mode change at about 22° longitude.

TABLE 6

GEOMETRY OF CONAL TRIPLE (cT) AND QUADRUPLE (cQ) PULSARS

								INNER			OUTER			r (km)	
PULSAR	CLASS	W_c	W_{cap}	α	α_{LM}	$\Delta\chi/\Delta\varphi$ (°/°)	β	$\Delta\psi$	ρ	β/ρ	$\Delta\psi$	ρ	β/ρ	Inner	Outer
1633+24	cQ/cT	≈11°?	3°5	19°	23°	+4	−4°8	∼20°?	5°6	−0.85	47°	8°3	−0.58	102	225
1738−08	cQ?	≈4?	1.7	26	29	+15[a]	+1.7	∼11	3.0	0.56	16	4.0	0.42	123	216
1845−01	cT	≈5?	3.0	39	35	+8[a]	+4.5	∼9?	5.4	0.84	16	6.9	0.65	128	211
1918+19	cT	≈13?	2.7	12	14	−2.6	−4.6	20.5	4.9	−0.94	51.3	6.2	−0.74	131	210
1919+21	cQ?	≈3?	2.1	45	45	−11	−3.7	∼4?	3.9	−0.94	9.2	4.8	−0.76	137	209
1944+17	cT	≈12?	3.7	19	...	+3??	+6.1	∼14?	6.7	0.92	31.4	8.4	0.73	130	208
2154+40	cT?	≈5.8?	2.0	20	22	+8[a]	+2.5	∼13?	3.4	0.72	∼22	4.7	0.53	117	221
2315+21	cQ?	≈2.0?	2.0	88	...	+17	+3.4	∼3?	3.7	0.91	∼6	4.5	0.75	131	196
2319+60	cQ?	≈5.2?	1.6	18	19	−8[a]	+2.2	∼10	2.8	0.80	19	3.9	0.58	117	225
1929+10*m*	cT?	≈17?	5.1	18	6, 15	−1.5[a]	+11.6	∼5?	11.7	1.00	13.2	11.9	0.98	206	215

[a] Values from Lyne & Manchester 1988.

NOTES:

1633+24.—No core component is apparently seen in this profile, so a "core width" is chosen to give an α-value close to that one determined by LM (23°). The "outer" conal component-pair width is interpolated between 430 (BCW) and 1400 MHz (RSW). The "inner" width is scaled from the BCW observation at 430 MHz. This is undoubtedly an overestimate; simple interpolation is probably neither justified nor correct here. The P.A. rate is also measured from the BCW observation. Interestingly, the width of the central component at 1.4 GHz, which we assume is the "inner" cone, here cut tangentially by the sight line, has a width near that of the unseen core component.

1738−08.—The width of the unseen core component is here again adjusted to yield an α-value near that deduced by LM (29°). The "outer" conal component-pair width is interpolated using the 409 (LM) and 610 MHz (Ba81) observations. The "inner" conal width is estimated from LM.

1845−01.—The width of the "core component" is adjusted to give a value of α near that calculated by LM (35°). The "inner" conal component width is estimated at 1400 MHz (RSW), and the "outer" is interpolated between this observation and one at 430 MHz (HW).

1918+19.—The width of the unseen core component is adjusted to given a value of α near that found by LM (14°). Both the "inner" and "outer" conal component widths are interpolated from unpublished, total-power profiles at 1414 and 430 MHz (H83). The P.A. data are measured using the 430 MHz observation of RB.

1919+21.—Again the width of the unseen core component is determined by the constraint that the resulting value of α be close to that determined by LM (45°). The "outer" conal component-pair width is interpolated using a number of observations (M71, LSG, MGSBT), and the P.A. sweep rate is scaled from an observation at 278 MHz (MHMb). No existing profile shows the "inner" conal component pair well enough even to make a guess of their width; instead this width was estimated from the cross-correlation display at 408 MHz (PW).

1944+17.—Here no α-value was available from LM, so that the width of the unseen core component was adjusted to give overall agreement with the ρ-dependence established above for the five-component (M) pulsars. The "outer" conal component-pair width was measured at 932 MHz (HR), and the "inner" one estimated at around 1.4 GHz (SCRWB, H83). The difficulty here is again the P.A. traverse, which is overall so shallow ($\lesssim$1°/°) that no reasonable geometrical interpretation can be made. For purposes of making the calculation a somewhat steeper rate has been tabulated; this value was scaled from the 1404 MHz profile, but is by no means typical.

2154+40.—The width of the unseen core component is adjusted to yield a value of α which is in near agreement with that of LM (22°). The width of the "outer" conal component pair is interpolated between 1420 (LM) and 102.5 MHz (Suleymanova et al. 1986). The width of the "inner" conal component was estimated from the 1420 MHz observation of LM.

2315+21.—LM did not compute an α-value for this pulsar, so the width of the unseen core component is adjusted to provide the closest possible match to the behavior of the five-component (M) pulsars discussed above. The "outer" conal width is determined using observations at 1.4 GHz (RSW) and 430 MHz (Deich 1986), and the "inner" one is estimated from the 1400 MHz observation giving particular attention to the features in the fractional linear polarization. The P.A. sweep rate is determined at 409 MHz (LM), taking the shallowest part of the curve near the profile peak.

2319+60.—The width of the unseen core component is again taken to given a value of α near that which was determined by LM (19°). The width of the "outer" conal component pair is interpolated between 1412 (WF) and 409 MHz (LM), and the "inner" one is estimated using the latter observation.

1929+10m.—The possibility is explored here that 1929+10*m* is actually a member of the cT species. On this premise, it is possible to adjust the width of the unseen core component to give good agreement with the larger of the two values determined by LM (15°, 6°). The width of the conal component pair in Table 5 is here the "outer" width, and the central component width here the "inner" one. The "inner conal radius," however, is much too large (and the situation is virtually the same if β is taken negative), undermining entirely any confidence in the correctness of this approach.

TABLE 7

GEOMETRY OF CONAL DOUBLE (D) PULSARS

Pulsar	Class	α	α_{LM}	$\Delta\chi/\Delta\varphi$ (°/°)	β	$\Delta\psi$	ρ	β/ρ	r (km)
0148−06	D	14°5	15°5	+7.4[a]	+1°9	32°0	4°7	0.42	213
0301+19	D	30	32	−17[a]	+1.7	13.0	3.7	0.45	129
0525+21	D	21	23	+36	+0.6	16.0	3.0	0.19	218
0751+32	D	26	...	+25	+1.0	21.1	4.8	0.21	222
0818−41	D	...	...	...	...	...	...	...	...
0834+06	D	30	61	+8.5	+3.4	7.5	3.9	0.86	129
0957−47	D	...	...	...	...	...	...	...	...
1133+16	D	46	51	+10	+4.1	9.0	5.3	0.78	223
1601−52	D	...	...	...	...	...	...	...	...
1906+09	D	...	...	...	...	...	...	...	...
1911+09	D	...	...	...	...	...	...	...	...
1924+14	D	12	13	+8[a]	+1.5	~43	4.9	0.30	215
1942−00	D	26	29	−30[a]	+0.8	~19	4.3	0.19	129
2021+51	D/S_d	23	...	+4[a]	+5.6	10.3	6.0	0.93	128
2044+15	D	40	41	+11[a]	+3.4	13.0	5.5	0.61	227
2122+13	D	50	...	−27	+1.6	~13	5.3	0.31	130
2306+55	D	38	39	+25[a]	+1.4	~20	6.4	0.22	130
2323+63	D/T	10	10	+5[a]	+2.0	~32	3.6	0.55	126

[a] Values from Lyne and Manchester 1988.

NOTES:

0148−06.—The value of α is fixed at 14°5, which is very near the 15°5 value determined by LM. There is also an "inner" cone solution at about 11°5. The conal component-pair width is interpolated between 611 (LM) and 1700 MHz (XRSS).

0301+19.—Here α is taken as 30° which is in excellent agreement with the 32° value computed by LM. There is an "outer" cone solution at 41°. The width of the conal component pair is interpolated using the 430 and 1418 MHz profiles of BCW.

0525+21.—The value of α is taken to be 21° which agrees with the 23° found by LM, although 16° gives an "inner" cone solution. The width of the conal component pair is interpolated between 410 (M71) and 1418 MHz (BCW). The P.A. sweep rate also comes from the determination of BCW.

0751+32.—No α-determination is available from LM; α was chosen as 26°, giving an "outer" cone, although a value of about 19° yields an "inner" one. The width of the conal component pair was interpolated between 610 (Ba81) and 1418 MHz (BCW). The P.A. data were also taken from this latter work.

0818−41.—No conal geometry computation could be made because no polarimetry has yet been carried out for this pulsar.

0834+06.—The conal component-pair width is interpolated between 636 (MHMA) and 1612 MHz (MHMa). The sweep rate of the linear P.A. is taken as +8°5/° and is scaled from polarization histograms at 430 (BR) and 1404 MHz (SCRWB). The value of α is taken as 30° as compared to LM's 61°, placing this pulsar on the "inner" curve". Even if we fix ρ on the "outer" curve, α assumes a value of only 40°.

0957−47.—No polarimetry is available for this pulsar.

1133+16.—An α-value of 46° is adopted, which is close to the 51° value determined by LM (the "inner" cone solution is at 33°). The width of the conal component pair is interpolated between 430 and 1420 MHz (BCW and HIMRSS). The linear P.A. sweep rate was taken to be +10°/° which reflects a number of measurements at meter wavelengths.

1601−52.—No polarimetry is available for this pulsar.

1906+09.—No polarimetry is available for this pulsar.

1911+09.—No polarimetry is available for this pulsar.

1924+14.—Here α is taken to be 12°, near the LM value of 13°, but also near the "inner" cone solution of 9°. Only 430 MHz observations have been conducted (GR, RB).

1942−00.—The value of α is taken to be 26° which agrees quite well with LM's 29°, although there is an "outer" cone solution at 35°. The best measured profile available is at 430 MHz (WABCBF).

2021+51.—The width of the conal component-pair was measured at 1 GHz by interpolation using profiles at 410 (M71), 610 (Ba81) and 1665 MHz (M71). The value of α was taken to be 23°, though there is an "outer" cone solution at 31°.

2044+15.—Here α is taken as 40° as compared to LM's value of 41° (the "inner" cone solution is at 29°). The conal component-pair width is interpolated between 430 (WABCBF, D86) and 1400 MHz (RSW).

2122+13.—LM made no α-determination for this pulsar. The "outer" cone solution of 90° seems implausible, thus the "inner" was chosen. The only published observation of this pulsar is at 430 MHz in BCW, who also determined the rate of sweep of the linear P.A.

2306+55.—The adopted α-value is 38°, which agrees well with LM's 39° (the "outer" solution is at 53°). The conal component-pair width is measured at 610 MHz (Ba81).

2323+63.—Here α was fixed at 10° which is exactly what LM determined (though the "outer" solution is at only 12°). The width of the conal component pair was determined at 610 MHz (Ba81).

TABLE 8

GEOMETRY OF CONAL SINGLE (S_d) PULSARS

Pulsar	Class	α	α_{LM}	$\Delta\chi/\Delta\varphi$ (°/°)	β	$\Delta\psi$	ρ	β/ρ	r (km)
0031−07	S_d	6°	...	−1.0	+6°0	17°0	6°1	0.98	236
0320+39	S_d	69	...	+23	+2.3	~5	3.3	0.70	221
0628−28	S_d	13.5	16°	−4.2[a]	+3.2	18.5	4.0	0.80	132
0643+80	S_d	...	...	...	...	...	...	...	...
0655+64	S_d	...	...	...	...	...	...	...	...
0809+74	S_d	9	...	−2[a]	+4.5	21.5	4.9	0.91	210
0818−13	S_d	15.5	90	+3	+5.1	6.3	5.2	0.98	223
0820+02	S_d	46	...	+12	+3.4	9.0	4.8	0.72	132
0943+10	S_d	11.5	12	−2.1[a]	+5.4	~11	5.6	0.97	230
0950+08*m*	S_d?	12	6, 10	−1.4[a]	+8.5	12.2	8.7	0.98	128
1530+27	S_d?	26	...	+5	+5.0	8.8	5.4	0.92	222
1540−06	S_d?	...	...	...	...	...	...	...	...
1612+07	S_d	24.5	...	−4.6	+5.2	4.5	5.3	0.98	224
1923+04	S_d/cT?	34.5	...	+6	−5.4	5.5	5.6	−0.97	225
1940−12	S_d	...	...	...	...	...	...	...	...
2016+28	S_d	39	40	+5	+7.2	8.2	7.7	0.93	223
2043−04	S_d	...	...	...	...	...	...	...	...
2110+27	S_d	76	...	−11	+5.1	2.9	5.3	0.96	221
2148+63	S_d	10.5	13	+1.5[a]	+7.0	13.9	7.2	0.97	130
2303+30	S_d	20.5	...	+4.5[a]	+4.5	4.3	4.5	0.98	216

[a] Values from Lyne & Manchester 1988.

NOTES:

0031−07.—As with many other conal single (S_d) pulsars, (1) the fractional linear polarization is small, (2) the polarization-angle traverse is consequently difficult to measure, and (3) the rate is anomalously small ($|d\chi/d\varphi|_{max} \lesssim 1°/°$). Measurements of this pulsar frequently yield values less than unity, and indeed LM quote a value of −0°5/°, but are unable to make a self-consistent calculation of α because the value is so small. Using the 268 MHz observation (MHMb) a value of about −1°0/° is obtained, and other profiles at 400 (MHAK), 170 (MHMb), and 102.5 MHz (Suleymanova et al. 1986) appear compatible with this value. A number of profile-width measurements (SRW, M71, MGSBT, MHAK) are interpolated to 1 GHz; the profile is narrowed by "absorption," but apparently only at frequencies below 1 GHz (Paper II). The angle α is then adjusted to yield a ρ-value close to the "outer" conal curve obtained above for the five-component (M) pulsars. A slightly different α-value (4°3) would place ρ on the "inner" curve, but, given the pulsar's regular drifting subpulses, the "outer" curve seemed a better guess; periodic subpulse modulation appears somewhat more characteristic of the "outer" cone when both are present.

0320+39.—LM give no analysis; α is adjusted to give an "outer" cone (69°), but an "inner" solution of 45° also exists. The conal width is measured at 610 MHz (Ba81), the only published meter-wavelength observation available. The P.A. sweep rate has been evaluated at 102.5 MHz using the work of Suleymanova et al. 1986 as no higher frequency determination exists.

0628−28.—Observations at 649 (MHMA), 1420 (SW73), 1612 (MHMa), and 1720 MHz (MGSBT) are interpolated to 1 GHz to determine the conal width. The value of α (13°5) is adjusted near that determined by LM (16°) to fix ρ near the "inner" curve. A somewhat larger value (17°5) would place ρ on the "outer" curve; no periodic subpulse modulation has been detected in this pulsar, however, so the "inner" curve seems a better guess.

0643+80.—No polarimetry is available for this pulsar.

0655+64.—No polarimetry is available for this pulsar.

0809+74.—This pulsar exhibits more "absorption" than any other known pulsar (Paper II). Its conal component width is determined at 1 GHz by interpolating measurements above 2.5 GHz (SRW, MGSBT) and at 29 MHz (Izvekova 1981). Here α is chosen (9°) so that ρ falls on the "outer" curve because this pulsar also has strong, regular subpulse modulation. However, a very small change (7°) yields an "inner" solution.

0818−13.—The width of this conal profile is interpolated to 1 GHz using observations at 631 (MHMA) and 1720 MHz (MGSBT). LM give a value of +30 for the P.A. sweep rate which, in the terms of their study, implies an α-value of 90°. Using their sweep rate and value of α, ρ falls near the "inner" curve. However, I see no evidence in the published observations that $|d\chi/d\varphi|_{max}$ is anywhere near this large. A value around +3°/° seems much more likely, and then ρ falls on the "outer" curve for an α-value of about 15°5 (and on the "inner" for a value of about 11°5). Prominent drifting subpulses have been observed in this pulsar also.

0820+02.—The width of the cone is interpolated between measurements at 430 (H85) and 1400 MHz (RSW). The only indication of the P.A. sweep rate comes from the latter observation wherein it appears to be rather steep (+12°/°). An α-value of 46° fixes ρ on the "inner" curve (and about 70° on the "outer"). Although quasi-periodic subpulse modulation has been observed in this star (Ba81), the "inner" curve seems a better guess.

0943+10.—This pulsar has never been observed above 1 GHz, so the ~11° width value is a rough extrapolation of its 11°4 width at 430 MHz. The P.A. sweep rate is again shallow and difficult to measure. Suleymanova et al. 1986, however, give results which suggest that the sweep rate is different in the "burst" and the "quiescent" modes. α (11°5) is adjusted to fix ρ on the "outer" curve (8°5 would fix it on the "inner" one) in view of the pulsar's well-known drifting subpulses; LM obtain an α-value of 12°.

0950+08.—The conal width is interpolated to 1 GHz using a variety of observations (LSG, MHMa, M71, MGSBT, and HIMRSS). The P.A. sweep rate is small, but not impossibly so. An α-value of 10° places ρ on the "inner" curve (and a value of some 16° on the "outer"). This compares with LM's results of 6° by one method of analysis and 10° by another. Here it appears that the "outer" value of 16° really is too large, and furthermore 0950+08 exhibits no periodic subpulse modulation.

1530+27.—The conal component width of this pulsar is interpolated to 1 GHz using 430 and 1418 MHz profiles (BCW), and the polarization-angle sweep rate is also taken from this paper. An α-value of 26° places ρ on the "outer" curve—and there is evidence of drifting subpulses in the sequences of this star—although an "inner" solution lies quite close at 19°.

1540−06.—No polarimetry is available for this pulsar.

1612+07.—The conal width of this pulsar is interpolated between 430 (WABCBF) and 1412 MHz (RSW). In that the value of the P.A. sweep rate given by LM seems impossibly large, it is scaled from the 1412 MHz observation. α (24°5) is chosen to place ρ on the "outer" curve (18°5 would place it on the "inner") in that there is some evidence for drifting subpulses (D86).

1923+04.—The width of the profile is interpolated to 1 GHz using observations at 430 (WABCBF) and 1400 MHz (RSW). No other determination of the

TABLE 8—*Continued*

P.A. sweep rate was available, so a value was scaled from the latter observation. The cross-correlation display of individual-pulse modulation (D86) leaves some doubt as to whether this is a S_t pulsar; the "discrete" quality of the "drift band" is more characteristic of the conal triple (cT) species, although the profile appears absolutely unimodal. Consequently α (34°.5) was adjusted to fix ρ on the "outer" curve (25°.5 would have fixed it on the "inner" curve).

1940−12.—No polarimetry is available for this pulsar.

2016+28.—Several different observations were used to obtain a 1 GHz interpolated value of the conal width (MGSBT, M71, SCRWB, also an unpublished Arecibo 430 MHz profile). High-frequency values of the P.A. sweep rate run about −6°/°, which is also the value quoted by LM; meter-wavelength values, however, tend to be much lower, −3°.5/°, for instance, at 430 MHz. The value of α (39°) was chosen to place ρ on the "outer" curve (29° would place it on the "inner" one). LM obtained a value of 40° in their analysis.

2043−04.—No polarimetry is available for this pulsar.

2110+27.—The width of the conal component was interpolated to 1 GHz using observations at 409 (L83) and 1418 MHz (BCW). The rate of the P.A. sweep seems well determined in the 1418 MHz observation of BCW, but their value (−27°/°) does not agree with that scaled from their figure ~ −11°/°. Here α is set to a value of 76°, placing ρ on the "outer" of the two curves, although a value of 48° would fix it on the "inner." Little is known about the subpulse modulation pattern of this pulsar.

2148+63.—A rough interpolation using profiles at 408 (L83) and 1720 MHz (MGSBT) was made to determine the width of the profile at 1000 MHz. An α-value of 10°.5 was found to place ρ on the "inner" curve, although a value of 13°.5 would place it on the "outer" one. Little is known about the subpulse modulation pattern of this pulsar.

2303+30.—The width of the profile at 1 GHz was determined by interpolation using observations at 430 (RCB) and 1400 MHz (RSW). The value of α was fixed at 20°.5, placing ρ on the "outer" of the two curves (a value of 15°.5 would place it on the 'inner'). The pulsar has strong, highly periodic drifting subpulses.

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