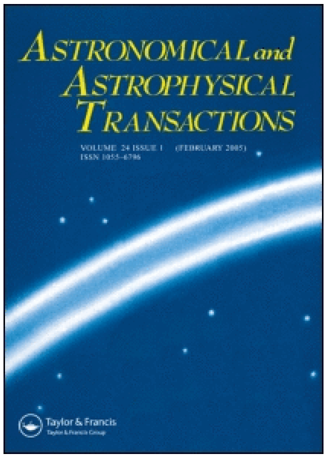

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POLARIZED RADIO EMISSION OF 12 PULSARS IN A MODEL WITH JOSEPHSON RADIATION

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The numerical comparison for the position angle of the polarization plain along the pulse profile in the model with observations has been carried out, using the χ^2 criteria. It is shown for 12 objects, that observed position angle dependence on longitude can be explained by the different sections the same polarization structure of a transverse electrical wave guide mode. Due to the Josephson effect inside the neutron star, this mode propagates continuously in the plasma jet along the magnetic field and forms the beam pattern of polarized radiation. Individual differences of observing curves were explained by the different values of sighting parameter.

KEY WORDS Pulsars: general, pulsars: polarization, pulsars: modelling

1 INTRODUCTION

It is generally believed that pulsar radiation is generated in the magnetosphere region, and that polarization of this radiation is determined by the geometry of open magnetic field lines in the hollow-cone beam model (Manchester and Taylor, 1979; Malov, 1980).

The radiation in the Josephson pulsar model originates inside the neutron star due to the Josephson effect (Kovalev, 1979, 1980). Oscillations generated in this case propagate along the magnetic field, like in a wave guide, inside the current of plasma, spreading out through cracks in the crust. Due to this current, the plasma wave guide with the longitudinal magnetic field easily penetrates from the crust of the neutron star to the magnetosphere and forms a beam pattern of radiation. According to this model, polarization of pulsar emission will be determined by the polarization of wave-guide types of oscillations (normal wave-guide modes). In particular, only oscillations with a transverse electrical TE mode propagate easy just

Table 1. Results of comparison of the calculated and observed curves. Columns 1–7 contain, respectively, the pulsar name, sighting parameter, symmetry center coordinates of the model curve, calculated significance χ^2_θ, theoretical significance χ^2_θ for the confidence level 0.95 and the number degrees of freedom

Pulsars	α	X_0 *degrees*	Y_0 *degrees*	χ^2_θ	χ^2_T	*The number of degrees of freedom*
0628–28	0.540	43.1	55.2	37.5	60.1	41
0740–28	0.860	44.6	60.7	10.9	23.7	14
0940–45	0.996	20.1	-53.8	1.5	18.3	10
1055–52	0.873	92.4	-20.3	9.0	21.0	12
1055–52	0.403	264.2	131.4	5.1	14.1	7
1133+16	0.548	22.4	2.2	12.3	31.4	20
1154–62	0.890	47.5	-35.1	8.5	25.0	15
1223–63	0.411	40.5	-118.4	3.5	15.5	8
1240–64	0.618	41.4	65.7	2.1	23.7	14
1449–64	0.841	45.5	36.5	1.8	22.4	13
1556–44	0.292	36.2	41.7	12.6	27.6	17
1700–32	0.124	44.9	18.0	31.0	32.7	21
1747–46	0.297	45.3	-22.8	4.8	21.0	12

as the corresponding type of oscillations in the vacuum wave guide. It is exactly the mode excited at the beginning of the plasma wave guide the Josephson effect.

An agreement between this picture and common polarization properties of pulsars was shown by Kovalev (1992). Our purpose is to show it for some individual pulsars. Some of the results for 6 pulsars were discussed by Larionov and Kovalev (1993).

2 THE FIT AND RESULTS

Observational data were loaded into computer from the figures of McCuloch *et al.* (1978) with the help of a digitizer. Then fitting of theoretical curves to the experimental data was made using a formula obtained for the TE_{01} mode (Kovalev, 1992):

$$\text{P.A.} = \arctan\left(\frac{x}{\alpha}\right),$$

where P. A. is the position angle, x is the longitude, α is the sighting parameter of the section of the polarized beam pattern by the line towards the observer (α is less than 1 and corresponds to the angular distance from the beam axis to the section by the line of sight, normalized by the width of the pattern diagram). It is known that in the general case the electric field distribution in the TE modes is deseribed by a Bessel cylindrical function. It was emphasized that such a simple dependence of P. A. is possible only for the TE_{01} mode.

The results of fitting are presented in Table 1. Optimization has been made with 3 parameters: α and symmetry point shifts of the model curve along the X

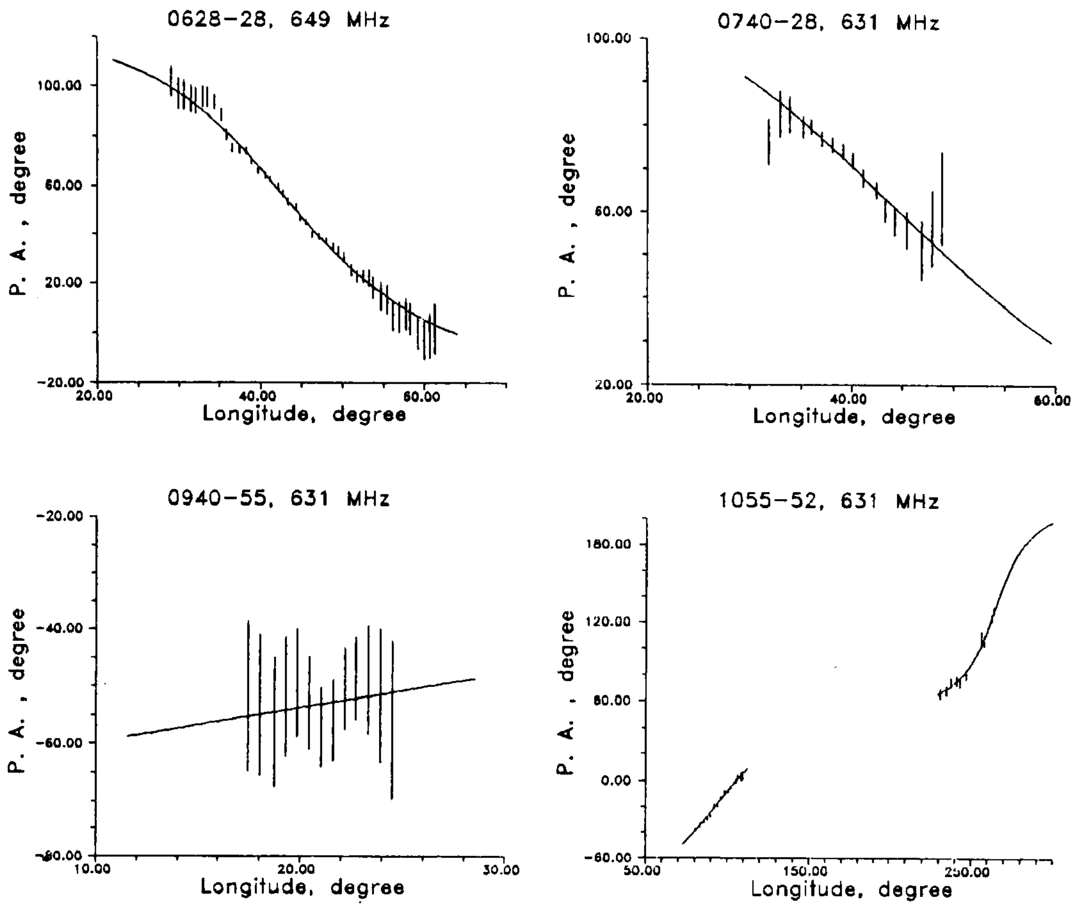

Figure 1 Variations in position angle throughout the integrated profiles (vertical lines) together with the best-fit curves based on the Josephson model (solid line).

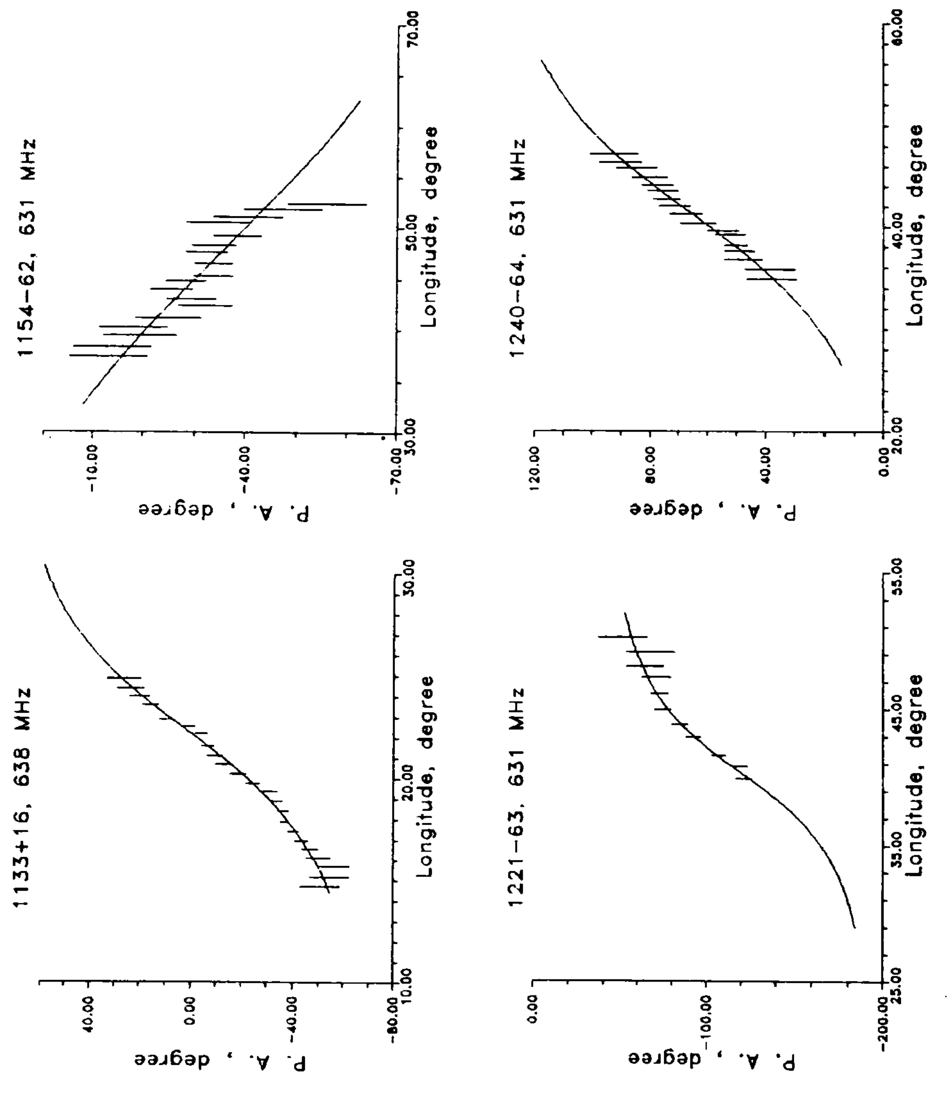

Figure 1 Continued.

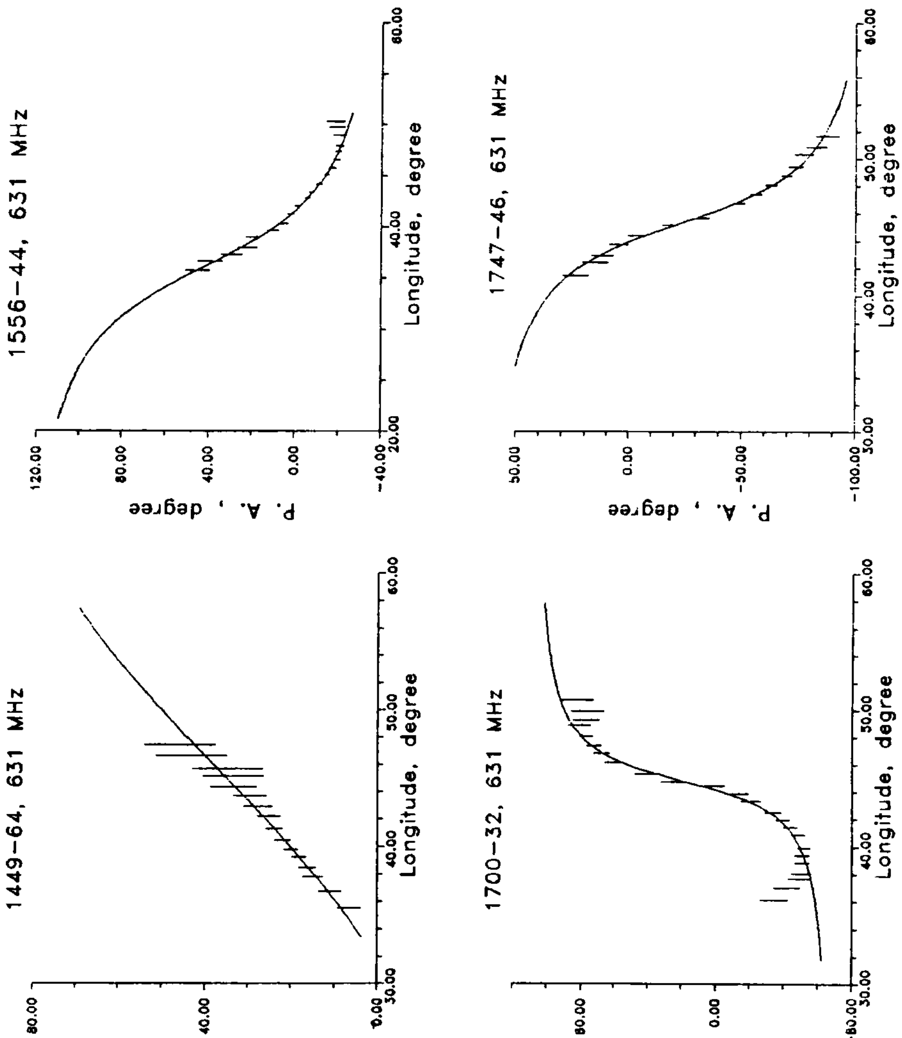

Figure 1 Continued.

and Y axes. Agreement between theoretical and experimental data was estimated using the χ^2 criterion with confidence level 0.95. This criterion is met for all the data presented in Figure 1.

3 CONCLUSION

With the limits of the given model, all the observational data can be explained as different longitude sections of the same angular polarized radiation structure, corresponding to the simple wave guide mode TE_{01} stucture. The difference between the curves is a consequence of one common reason: the angular distances from the pattern diagram axis to these sections are different for different pulsars.

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