NEW OBSERVATIONS OF THE TIME ALIGNMENT OF PULSE PROFILES AT HIGH AND LOW FREQUENCIES

V. A. IZVEKOVA, A. D. KUZ'MIN, V. M. MALOFEEV
Radio Astronomy Department, Lebedev Physical Institute

W. SIEBER
Fachhochschule Niederrhein

A. JESSNER AND R. WIELEBINSKI
Max-Planck-Institut für Radioastronomie

Introduction

Exact timing measurements allow a determination of the phase shift between observations of a pulsar at different frequencies. It has become clear from these observations that a simple dipole magnetic field configuration can not explain the time lag observed for many pulsars between profiles at high frequencies (Kuz'min *et al.* 1986).

There are cases which might better be explained by a combination of dipole and quadrupole field components (Davies *et al.* 1984). We report in this paper on new pulsar time alignment observations of a number of pulsars at high and low frequencies which support the general picture outlined above.

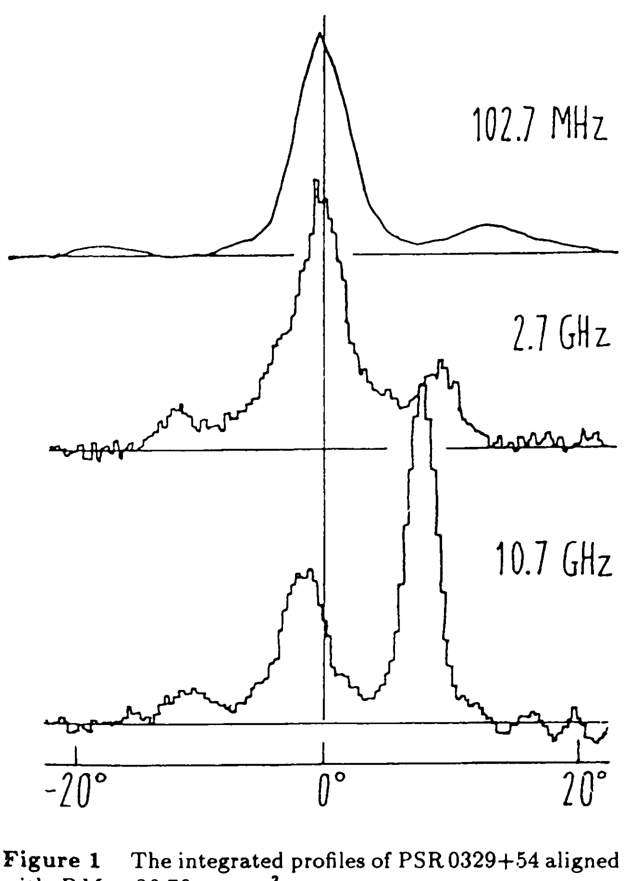

Figure 1 The integrated profiles of PSR 0329+54 aligned with $DM = 26.76\,\mathrm{pc\,cm^{-3}}$.

Observations

Our observations were performed 15-20 October 1988. At 2.7 and 10.7 GHz we used the 100-m radio telescope of the Max-Planck-Institut für Radioastronomie equipped with cooled FET-amplifiers. The receivers provided separate left and right-hand circular polarization channels. The total bandwidth was 40 MHz at 2.7 GHz and 50 MHz at 10.7 GHz. The full period was sampled at a resolution of 1024 samples per period. From 500 to 12000 successive pulses were added synchronously using a new pulsar data logger based on the observatory's computer system and dedicated hardware.

At 102 MHz the measurements were made with the BSA transit array of the Radio Astronomical Observatory of the Lebedev Physical Institute at Pushchino. The signal was divided into 32 channels by means of a 32 × 20 kHz filterbank (with a total bandwidth of 640 kHz) thus decreasing the ef-

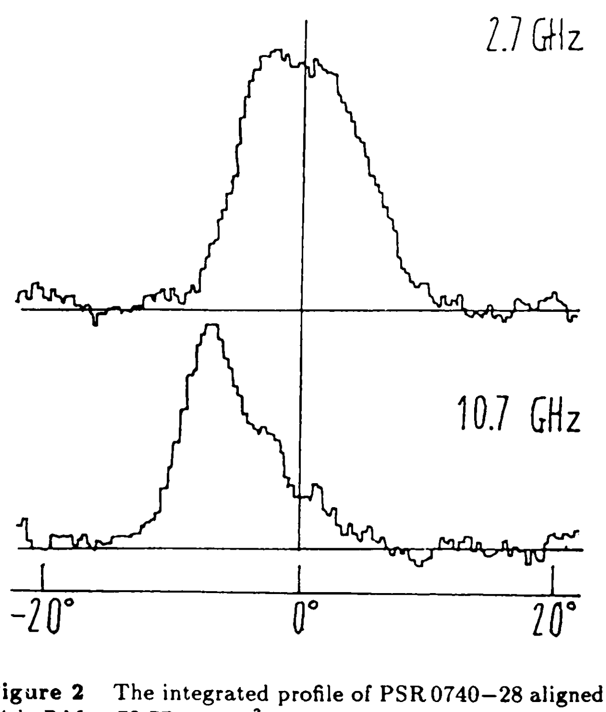

Figure 2 The integrated profile of PSR 0740−28 aligned with $DM = 73.77\,\mathrm{pc\,cm^{-3}}$.

https://doi.org/10.1017/S0002731600154630 Published online by Cambridge University Press

fects of dispersion and linear polarization. The time constant used was 3 ms, except for pulsars with high dispersion measure where the time constant was 10 ms. We used sampling intervals from 2.176 to 8.704 ms. Between 180 and 2400 pulses were integrated.

The total timing accuracy was better than 0.1 ms for all observations.

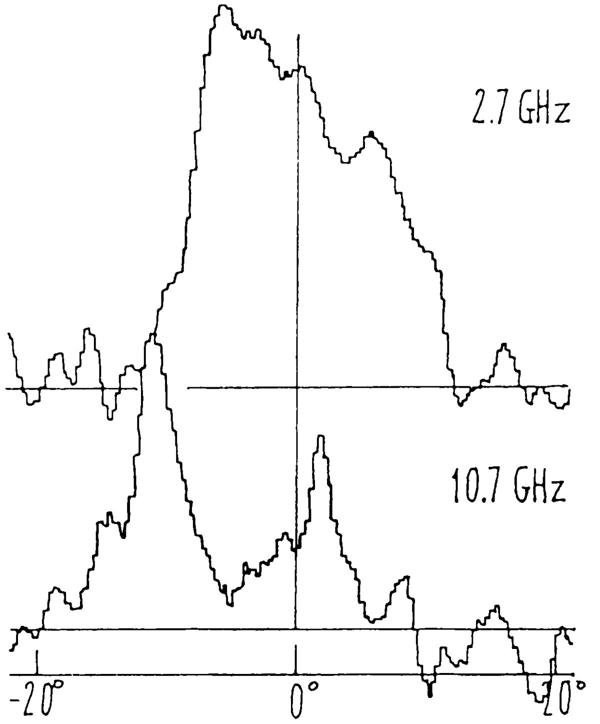

Figure 3 The integrated profile of PSR 1845−01 aligned with $DM = 159.1\,\mathrm{pc\,cm^{-3}}$.

Alignment of integrated profiles

The arrival times of all pulses were reduced to one epoch since the separation of observing times ranged up to 5 days. Furthermore, the difference in propagation times to the Effelsberg and Pushchino Observatories was accounted for by reducing the arrival times to the solar system barycenter and by adding integral numbers of barycentric periods. It is important to note that the dispersion delay between 2.7 and 10.7 GHz is very small. So the estimated error of the dispersion measure, DM, does not affect the time alignment between these two frequencies. Time alignment at two or three frequencies for about 20 pulsars was performed. Some examples are shown in figures 1 – 3.

There are pulsars with good alignment within the limits of the measurement errors (below 1σ), for example, PSR 0329+54 (figure 1). Significant time shifts have been detected for PSR 0740−28 and 1845−01 (figures 2 and 3).

A comparison between our 1984 (Kuz'min *et al.* 1986) and 1988 observations (see table 1) shows good agreement for most of the pulsars.

Table 1 High-frequency alignment

PSR	Time shift (in degrees) 2.7 - 10.7 GHz Oct. 1988	4.6 - 10.7 GHz Dec. 1984
0031−07		−4.3
0329+54	−1	< 1
0355+54	−3	
0450−18	+2.5	
0628−28	+1.5	
0740−28	−4.5	
0809+74		−5.5
0823+26	−0.8	
0919+06	−1	
0950+08		−2
1133+16	–	< 1
1604−00	−2	−2
1706−16		−1.5
1818−04	−2	
1822−09		< 1
1845−01	−5	
1911−04	0	
1929+10	−1	−1.5
2016+28		−2
2021+51	−1.5	−1.5
2310+42	−2	
2319+60	−1.5	

Our observations thus enlarge the group of pulsars which show visible non-dispersive shifts of the integrated pulse profile at high frequencies. This phenomenon seems to be rather common. Our observations may be considered also as a confirmation of a multipole magnetic field model.

https://doi.org/10.1017/S0002731600154630 Published online by Cambridge University Press