The Metrewavelength Sky
ASI Conference Series, 2014, Vol. 13, pp 69 – 72
Edited by J. N. Chengalur & Y. Gupta

Detection of giant component from pulsar PSR J0653+8051

V. M. Malofeev*, D. A. Teplykh, O. I. Malov and S. V. Logvinenko
Pushchino Radio Astronomy Observatory of the Lebedev Physical Institute, Moscow, Russia

Abstract. We present the investigation of PSR J0653+8051 at frequency 111 MHz using Large Phase Array. This pulsar shows three components in the range 102-4850 MHz. We detected a few dozen of very strong pulses exceeding the amplitude of the mean profile more 110. Usually this pulsar demonstrates very weak signal on the level 3 sigma in mean profile. The detail analysis showed that all strong pulses with S/n ratio 4-20 sigma arrived on the longitude of the central component only. This effect is very seldom, because we detected such giant components only one day from more than two hundred days of observations.

Keywords : radio pulsar – giant pulses – radio transients

1. Introduction

The pulsar B0643+80 (J0653+8051) has been discovered by Arzoumanian et al. (1994). This object has $P = 1.214$ s, $\dot{P} = 3.8 \cdot 10^{-15}$, the mean age is about $5 \cdot 10^6$ years, $B = 2 \cdot 10^{12}$ G and $DM = 32.5\ pc\ cm^{-3}$. Pulsar has the three-component pulse profile. This profile form keeps from high to low frequencies and the pulse profile became more broad with decreasing of the frequency. In addition, the central component (C2) has more steep spectrum than the other components (Malofeev et al. 1998). The bursts activity of this pulsar was detected in 1996 for the first time. B0643+80 had displayed a burst in the central component (C2) with a flux increase with the factor of nine over its mean value. This event has been detected in one session from 23 days of observations (Malofeev et al. 1998).

*email: malofeev@prao.ru

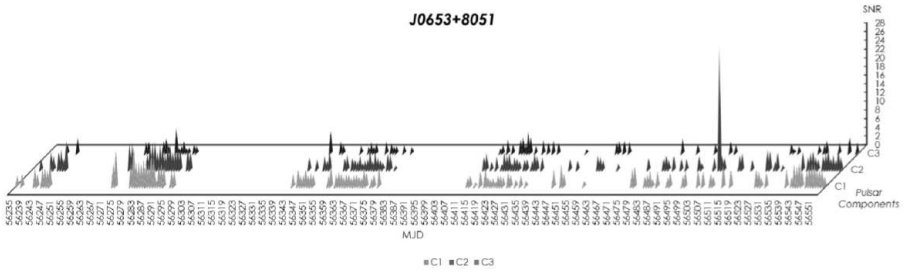

Figure 1. The fluctuations of the component intensity for B0643+80 at 111MHz. Signal to noise ratio of pulse components versus time.

2. Observations

The observations of the pulsar B0643+80 were carried out on Large Phased Array of Lebedev Physical Institute at 111 MHz, using digital pulsar receiver (Malofeev et al. 2012). The operation frequency bandwidth of LPA is 2.5 MHz. It is separated using the FFT into 512 spectral channels with the bandwidths of single channel equals to 4.88 kHz. The time resolution was 2.45 ms or 5.12 ms. The 255 observing sessions were carried out during the period from October 2012 to October 2013. The observing session contains about 900 pulsar periods.

3. Results

In present observations (series of 2012-2013) we also registered one case of the bursts activity of central component on 1 August 2013. Figure 1 illustrates the signal to noise ratio for all three pulse components versus time. Intensity fluctuations are presented in all three components of the pulse. The pulsar weakly emits in ordinary state (62% of the observational time) and in this case pulses have signal to noise (S/n) ratio in range 3-5 (Fig.2b). During about 26% of the observations pulsar was practically invisible ($S/n < 3$) (Fig.2a). In 12% of events pulsar demonstrates the increasing of emission activity ($S/n \geq 5$)(Fig.2c) including one "burst" day during 13 months of the observations (255 days), when the S/n increased 28 times more than the average amplitude of the central component in the integrated profile (Fig.3). Outbursts (1.08.2013) continued for about 300 periods or 6 min (Fig.4). It corresponds to 0.13% of total observing time (255 days, $2.3 \cdot 10^5$ periods)(Fig.2d). During this time we detected 21 individual pulses with $5 \leq s/n < 10$ and 19 ones with $s/n \geq 10$. It means that intensity of highest pulse can be 170 times higher than its mean value. All of these strong pulses were at the phase of the central component.

At the moment there are several effects can explain the changes in the amplitude

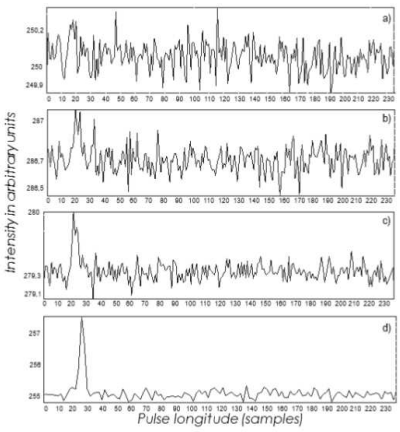

Figure 2. The examples of integrated pulse profiles of B0643+80 at 111 MHz: (a) - 22.03.2013, (b) - 31.12.2012 (c) - 12.12.2012, (d) - 01.08.2013. Sampling interval is equal to 5.12 ms.

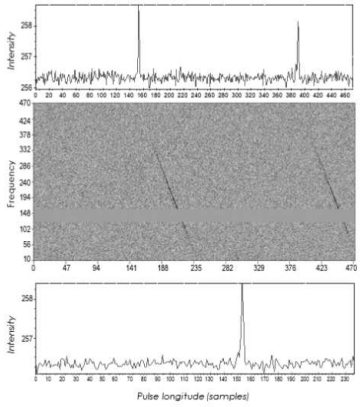

Figure 3. The observations of B0643+80 at 111 MHz on the 1 of August 2013: (a) - the pulse profile obtained by integrating of the 408 groups (double periods), (b) - the dynamic spectrum, (c) - the pulse profile obtained by integrating of the 816 pulses (folding with one period). Sampling interval is equal to 5.12 ms.

or the integral pulse shape: **1) Mode switching.** The effect is concerned with changes in all characteristics of the pulsar (pulse shape, polarization, emission intensity, etc.) and it is hardly responsible for the burst activity of pulsar B0643+80, as this object has too rare activity events (0.13% of the total observation time). **2) Giant pulses.** This phenomenon also does not explain the “burst" effect of B 0643+80, because pulse widths are much more than ones for the giant pulses. In the first case, we have pulse width approximately 10 ms, whereas giant pulses have nanosecond widths. **3) Radio transients.** In many ways, this is similar to the behavior of RRAT (McLaughlin et al. 2006), taking into account that they are more distant in comparison with the object under study, and weaker pulses are invisible. Duration of RRAT pulses is 2-30 ms and pulse rate is in the range of $0.01 - 0.4\%$. The extreme pulses of B0643+80 are in agreement with these values. One more object with similar bright radio bursts is known, B0656+14 (Weltevrede et al. 2006). But this pulsar has a wider emission window ($\sim 40^\circ$), while the B0643+80 has one equals to $\sim 5^\circ$ only. **4) “Core emission".** This may be one of the possible explanations of the central component bursts (Rankin 1983). **5)** It is likely this is a quite new effect - a giant component or pulse component burst.

4. Conclusions

We confirmed the presence of the bursts in second component of three components profile (Malofeev et al. 1998).

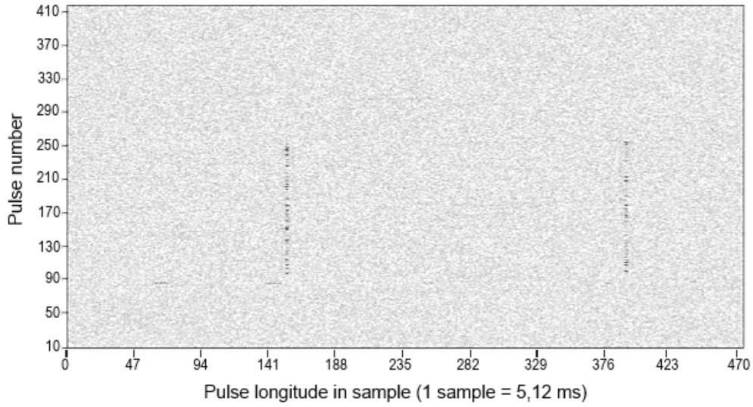

Figure 4. The intensity variations of pulses during the session on the 1.08.2013. The observation of B0643+80 have been carried out at 111 MHz using double period. The duration of the outburst is about 300 periods or 6 min.

We detected that intensity of this component can be a factor 170 higher than its mean value. The duration of the bursts is about 300 periods ($\sim$ 6 min) and such event is extremely rare (about 0.13% of the total observing time).

Acknowledgements

This work was partly supported by the Russian Foundation for Basic Research (project code 12-02-00661).

References

Arzoumanian Z., Nice D. J., Taylor J. H., Thorsett S. E., 1994, ApJ, 422, 671
Malofeev V. M., Malov O. I., Shchegoleva N. V., 1998, Astr. Rep., 75, 2
Malofeev V. M., Teplykh D. A., Logvinenko S. V., 2012, Astr. Rep., 56, 35
Rankin J., 1983, ApJ, 274, 333
Weltevrede P. et al., 2006, ApJ, 645, 2