Vela Pulsar with Ooty Radio Telescope

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March 28, 2020

This report briefly describes some data analysis on the observations of the vela pulsar with Ooty radio telescope. Ooty performed the observations centred on 326.5 MHz with a bandwidth of 16 MHz. The raw voltage data consists of 1 s obseving time from the Northern and Southern half of the telescope. The time interval between each voltage is 1/33 microseconds.

1 Raw voltage

By taking 100,000 random samples from the raw data, we show in Figure 1 that the voltage distribution follows a gaussian shape as expected. The mean value of the voltage from the northern feed, however, deviates from zero due to small bias in the telescope backend.

2 Dynamic spectrum

The dynamic spectrum was obtained the same way as in Kishalay De report as follow:

- apply Fast Fourier Transform to 512 points at a time;
- compute the modulus square for half of the spectrum, corresponding to 256 frequency channels and a frequency resolution of about 64 KHz;
- average over 60 sets in time axis to get a time resolution of 1 ms.

The signals from the two halves of the array were then, added incoherently to improve the Signal to Noise Ratio (SNR). Figure 2 illustrates the correlated signal. We can observe 11 dispersed pulses from the vela pulsar within the 1 s observations.

3 Pulse properties

The channel width was increased to 257 KHz for a better SNR. Assuming a gaussian shape, we fit a single pulse from 3 different manually chosen channels and estimate their arrival time. The time delay of the pulse between two frequency f_1 and f_2 , with $f_1 > f_2$, is given by:

$$\Delta t \approx 4.15 \; (f_2^{-2} - f_1^{-2}) \; \mathrm{DM} \;\; \mathrm{ms} \qquad (1)$$

where DM is the dispersion measure in (pc/cc). Equation 1 holds when f_1 and f_2 are in units of GHz. A single line $\Delta t = \mathrm{DM}\delta f^{-2}$ was fitted with the data to calculate the DM where $\delta f^{-2} = 4.15 \; (f_2^{-2} - f_1^{-2})$. From the best linear fit (Figure 3d), the estimated DM is about 74.10 ± 10.2 pc/cc. The pulsar period is calculated by applying a linear fit to the arrival times of each pulse in the dedispersed time series (see Figure 5), resulting into a period $\mathrm{P} = 94.53 \pm 0.13$ ms.

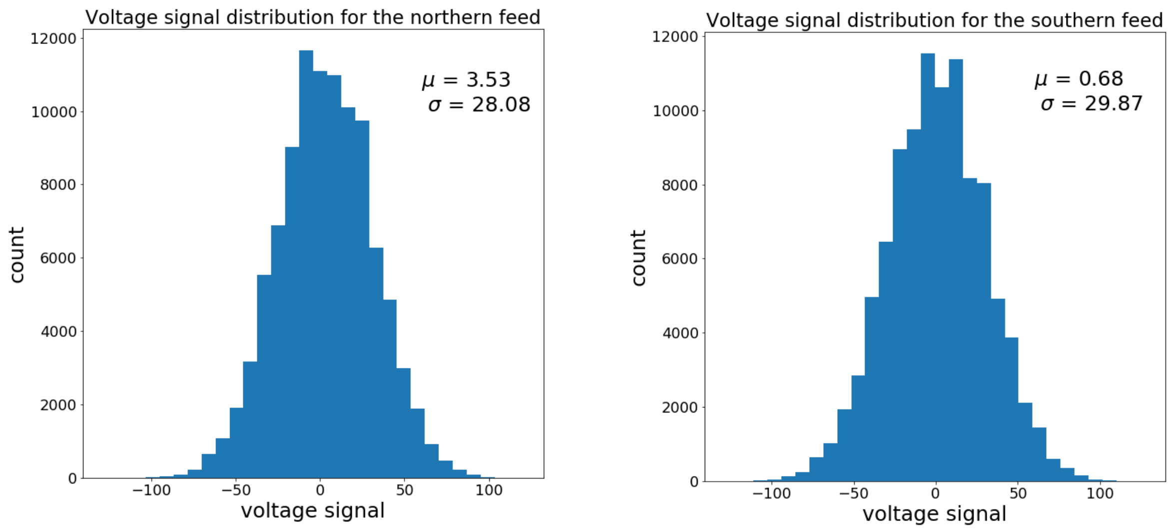


Figure 1: Voltage distributions of 100,000 randomly selected samples for both the northern (left) and southern (right) feed.

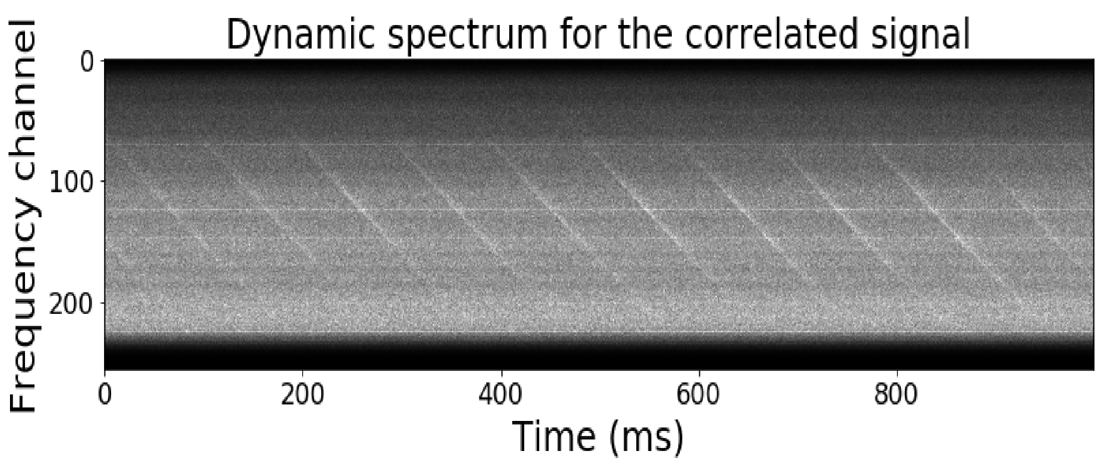
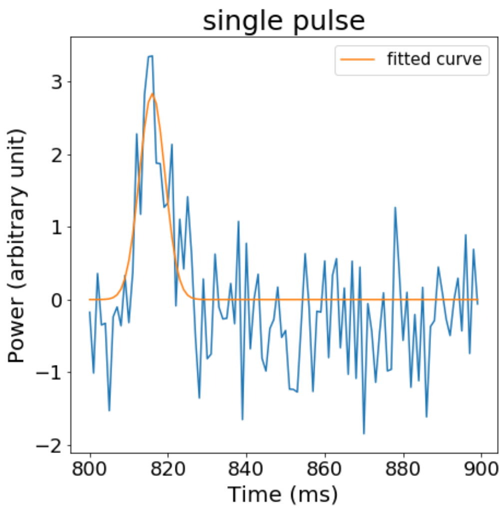
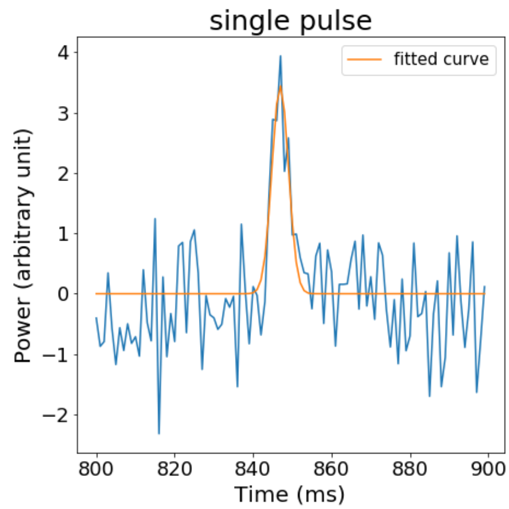


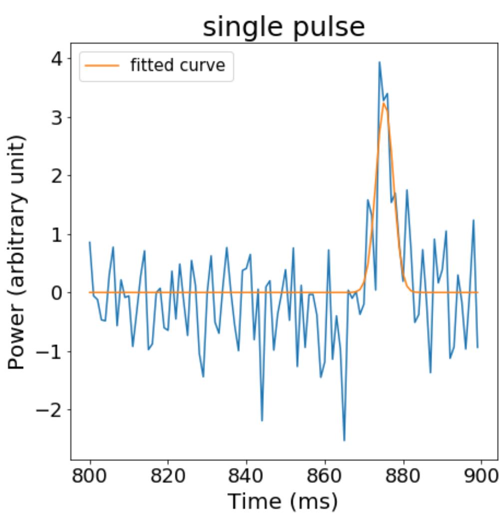
Figure 2: Dynamic spectrum of the correlated signal. The frequency resolution is 64 KHz with a time resolution of 1 ms.



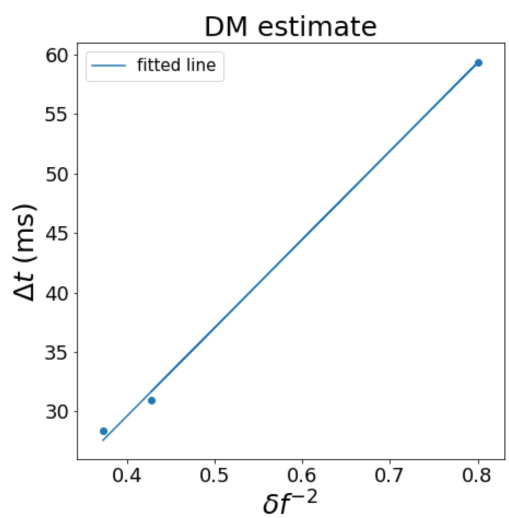
(a)



(b)



(c)



(d)

Figure 3: The single pulse and best fit gaussian at 328.04, 326.24 and 324.69 MHz are shown in figure a, b and c. The panel d is showing the best linear fit to estimate the dispersion measure.

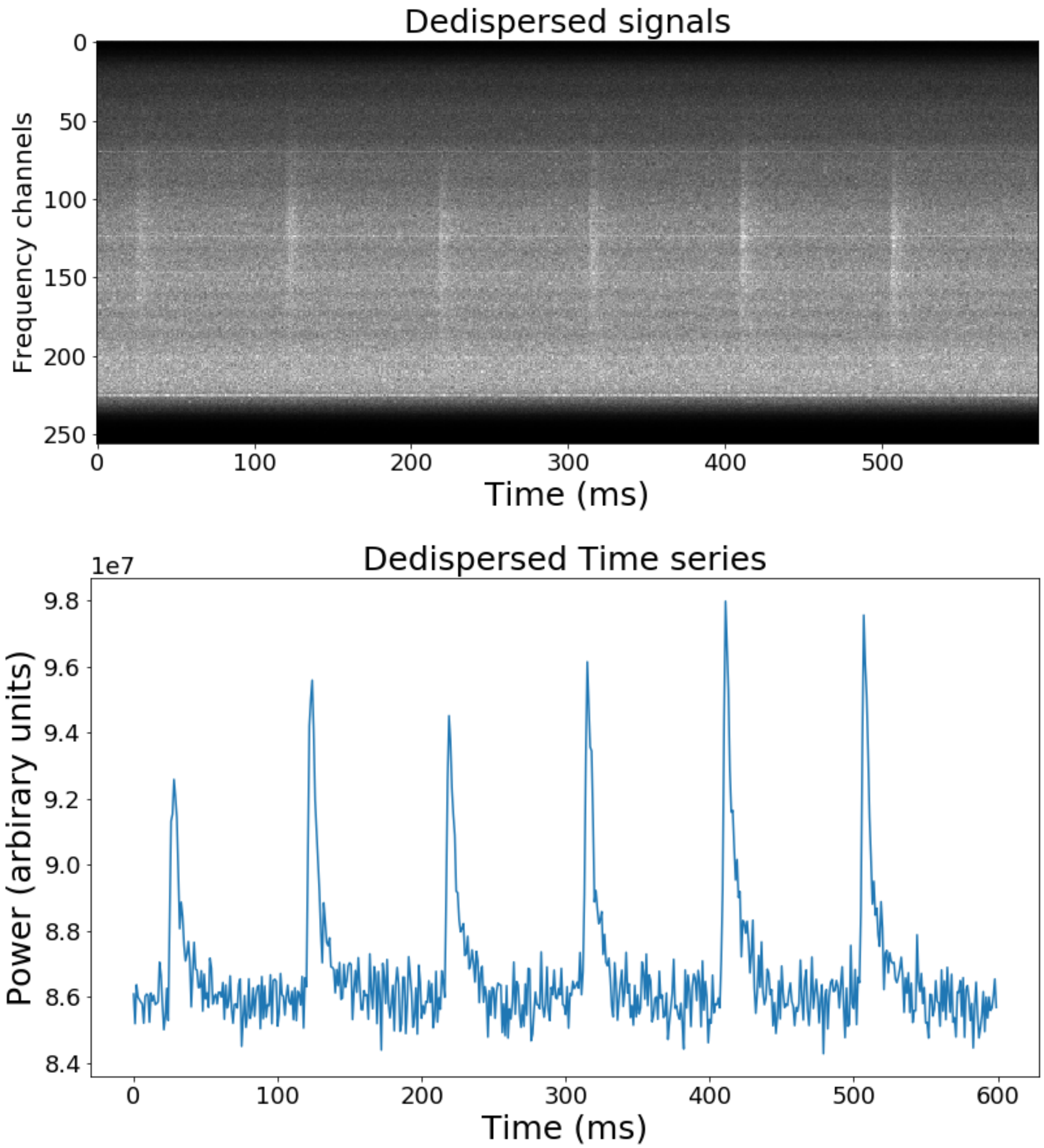


Figure 4: Top panel: Dynamic spectrum after a dispersive delay correction with DM value of 74.1 ± 10.2 pc/cc. Bottom panel: The total power of the signal summed across the frequency channels.

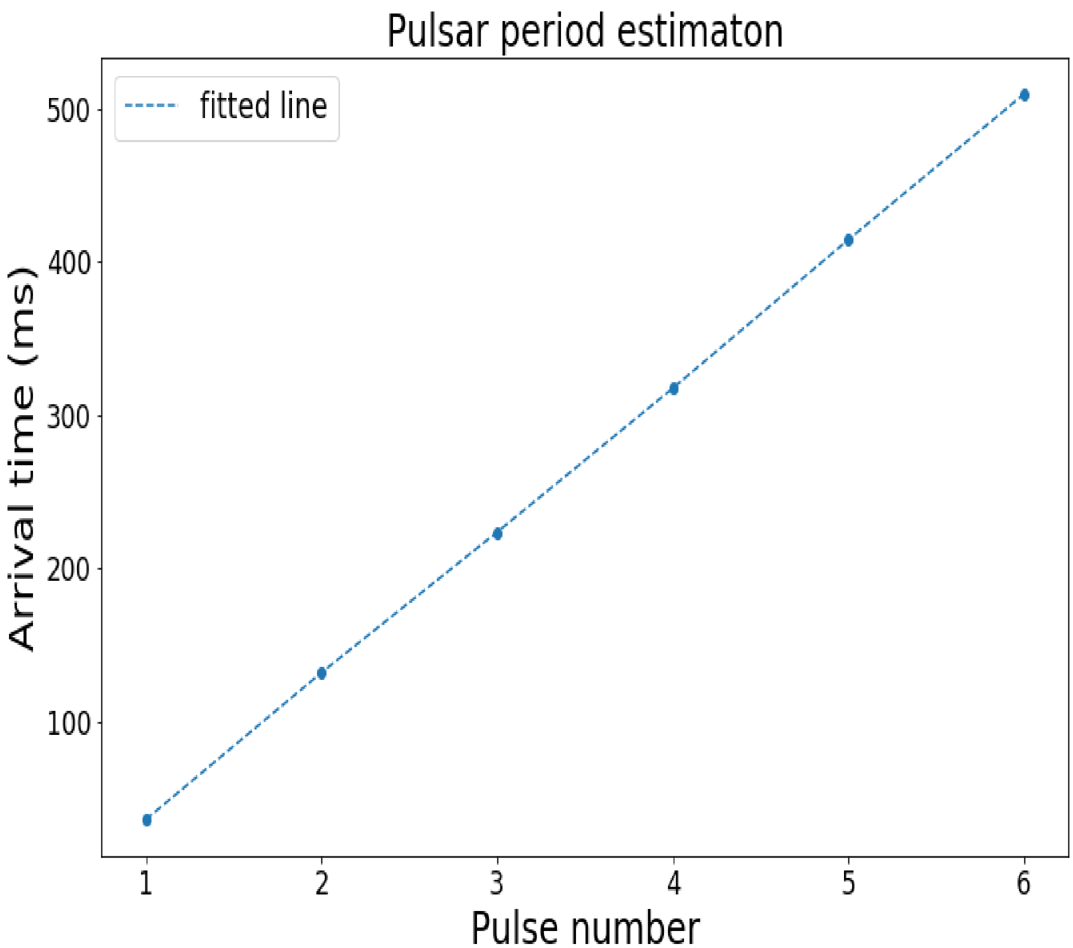


Figure 5: Linear fit to the pulse arrival times to estimate the rotation period.