

Estimation of modulation index of pulsar

1. Aim of the experiment

The aim of this experiment is to find out the pulse to pulse intensity modulation of the pulsar radio emission. ORT will be used to carry out observations of a select list of pulsars (given in Section ??). The data are analyzed with a pulsar pipeline using the procedure given in Section 4. The experiment also involves an interpretation of the results obtained, which the experimenter has to explain in the sheets provided at the end of this procedure.

2. Introduction

Pulsar is a source of radio waves which emits photons through the open field lines that will cross our line of sight as it rotates. So that we will observe a peak in the chart recorder as the pulsar beam crosses the line of sight of the observer. Is it possible that the Pulsar will emit radiation at the same intensity all the time during an observing session? The answer is No. These fluctuations in intensity is measured by a quantity called Modulation Index, m . The degree of Pulse modulation is represented by modulation index m . The modulation index is known to be a function of pulsar pulse phase. Hence, one can define a phase resolved modulation index as

$$m = \frac{\sqrt{I(\phi)^2 - (\overline{I(\phi)})^2}}{\overline{I(\phi)}}$$

where m is the modulation index, ϕ is the pulse phase, I is the pulsar intensity and angle braces represent averaging over a large ensemble of adjacent pulses. Exact functional dependence will be related to the region of pulse phase being studied. To be specific, it will depend on whether the phase region is classified as a "core" or "cone" component. The observed Pulsar radio emission is generated within a dense electron-positron plasma flowing through the open magnetic field lines of neutron star. The intrinsic pulse to pulse intensity modulations can arise from the time dependent lateral structure of this flow, probed once per Pulsar period by observer's line of sight. The observed values of m , after eliminating the interstellar scintillation effects for different Pulsars range from 0.5 to 2.5. The value of m usually decreases with increasing frequency, but some Pulsars of class St, the dependence $m(\nu)$ has a break and at higher frequencies, the modulation index begins to increase with ν .

3. Observational Log

Serial No.	Pulsar Name	HA	Time of Obs	Name of Recorded data file for he source
1.				
2.				
3.				
4.				
5.				
6.				
7.				
8.				
9.				
10.				

4. Analysis Procedure

The data recorded from the ORT is in plain binary. To make it useful for the analysis purpose, we have to convert it into a standard format through the pulsar pipeline, which is available at ORT. For finding the modulation index, one need the average intensity of an ensemble of pulses. Note down the intensity of the folded profile. Find the intensity of each pulses and note them down and find the standard deviation of each of the single pulses and average it. Now calculate the modulation index by dividing the mean deviation σ_s by the mean $\langle S \rangle$. Check the value of $m(v)$ by doing it for different data sets.

The step by step procedure of the analysis is given below.

1. Open a terminal and go to the folder where your data is saved. For example
`cd /scratch1/POS12 B4/27Dec2015/`
2. To analyse the data, change the source to 'tssh' by giving the following commands.
`$ tssh`
`$ source /scratch/soft/bin/path`
3. Get the time stamp in MJD. The timestamp file is recorded with the data and gives time in IST. Ignore the seconds and add 1 to the minutes. This is the start time of acquisition. Convert this to UTC and then MJD.
4. Convert the data to filterbank format
`acqch1fft input file -o output file.fil -nacc < > -mjd < >`
The value of `-nacc` will determine the sampling time of the data. A value of 16 will sample the data at 1 ms. `-mjd` is the Modified Julian Date (MJD) of the beginning of the observation. Find out the MJD of your observation, before analysing the data.
5. Use the command 'dedisperse' to dedisperse the data as given below.
`dedisperse input file.fil -d <DM> -nobaseline > outputfile.tim`
Where, `<DM>` is the DM of your pulsar.
6. For visualising the data as a timeseries, use the command reader as follows
`reader input file.tim > output file.asc`
7. You can plot the time series using GNUPLOT. Type 'gnuplot' in the command line, then use the following to plot the data.
`plot 'outputfile.asc' w l`
'w l' is the command for plotting the data with line.
8. Find the peak flux density of single pulses from the time series of your observations. Calculate the average value of it and determine the modulation index, m of the pulsar using (1) or with the method described at the beginning of this section.

5. Analysis Log and Plots

Intensity of the folded profile = mJy

Standard deviation =

Modulation index =

6. Results

The Modulation Index of pulsar PSR B =

7. Sources of Error in the Experiment

8 Discussions and Conclusions