1 Fast Radio Bursts

After Prof. Shriharsh Tendulkar's talk on FRBs last week, let's try to play around with some pulse data from Canadian Hydrogen Intensity Mapping Experiment (CHIME). So, as shown in the talk, the different frequencies of the pulse from the FRB comes at different times with the highest frequency coming first,

$$t_{\mathrm{arr}} \propto \mathrm{DM}\ \nu^{-2} \tag{1}$$

Ths constant for proportionality is 4.148808×10^3, if you want t_{arr} in seconds, when ν is in MHz and DM is in $\mathrm{pc\,cm^3}$ (pc - parsec is a unit of distance).

2 Activity

2.1 Finding the DM of a burst

We will be using some data of a pulsar B0011+47 from CHIME for this activity. The method is however the same for an FRB also.

- Start with the array dataset (`final_pulsar_data.npy`) in the drive. Load it using `numpy`. Plot the 2d waterfall plot.
- The x-axis of the plot should show time with each bin being **16 ms** long. The y-axis has **32 bins** of frequency going from **800 MHz on top to 400 MHz** in the bottom.
- Calculate the delay for each frequency channel given a DM value using the above equation.
- Using this delay, try to shift the frequency channels of the data so that the pulse lines up.
- Calculate the time series by summing over all frequency channels. You can define a signal-to-noise ratio (SNR) for this time series by taking the ratio of the maximum of the absolute value of the time series to the mean of the absolute value of the time series.
- Repeat this SNR calculation for many DMs and find the DM where SNR is maximum. This *de-disperses* the data and the best DM will give a nice peak in the time series.

The DM signifies how much matter the light from the FRB or pulsar interacted with on its way to our telescope and it is a proxy for the distance to the FRB or pulsar (with exceptions in highly dense regions of the sky).