SIMULTANEOUS MULTI-FREQUENCY PULSAR OBSERVATIONS

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INTRODUCTION

To investigate the frequency dependence of single pulse properties it is necessary to make simultaneous multi-frequency observations. This is because although some of the investigations are of a statistical nature, these should be carried out on the same pulses at the different frequencies. Further, detailed study of pulse shape, time of arrival and spectra can only be carried out on simultaneous data.

OBSERVATIONS

The observations were made in 1975 using the Mk IA radio telescope at Jodrell Bank operating simultaneously at 1420, 408 and 151 MHz. Dispersion removing receivers were used at the lower two frequencies. Data taking limitations meant that the pulses were inspected in real-time and only suitably strong sequences were recorded. It was not possible to record every pulse in a sequence because the counters had to be time shared between the three frequencies. All four Stokes parameters were recorded but only total intensity results are discussed here. Twelve of the strongest pulsars were observed and useful data obtained on six. The best data were obtained from PSR 0329+54 and results from this pulsar are presented below.

RESULTS

Main Pulse Shape

Pulses are more sharply defined and narrower at low frequencies. At 1420 MHz the main pulse often sits on a plateau of radiation sometimes identifiable as individual components but at others resembling noisy wings. High frequency pulses are broader and this is well demonstrated when multiple component main pulses occur. The

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1420 MHz components overlap while the low frequency ones are separate. Fine structure (∿ six components) is occasionally seen in the 408 MHz main pulse but not at 1420 MHz.

Pulse Width

This is complicated by the multiple structure of the main pulse but groups of pulses consisting of a single component were selected and pulse width histograms constructed. These show the 1420 MHz pulses to be significantly broader than the 408 MHz. The 151 MHz pulses were not present in all cases and were slightly dispersion broadened but appear to be similar in width to the 408 MHz pulses.

Time of Arrival

Again care had to be exercised to avoid the multi-component structure confusing the results. Histograms of time of arrival show a slight tendency for the lower frequencies to have a more variable time of arrival. Studies of individual cases suggest this is not a dispersion measure effect.

Component Spectra

Absolute intensity measurements were not made and so it is only possible to consider the relative spectra of the various components. The outriders have a much flatter spectrum than the main component, the leading outrider particularly so. The intensity of the leading outrider can exceed that of the main pulse at 1420 MHz. This was not observed to happen at 408 MHz except on one occasion when the leading outrider was the only component present, there being no main pulse. The 408 MHz outriders are sometimes unusually strong but the 151 MHz outriders are not similarly enhanced. Indeed they are seldom seen at the lowest frequency.

Pulse Intensity

Peak pulse intensity histograms have been constructed. At 151 MHz the distribution is narrow and symmetrical. At 408 MHz there is a slight skew towards higher intensities and at 1420 MHz there is a pronounced tail of strong pulses (strong compared with the mean intensity)

Pulse to Pulse Variability

Only 1420 MHz and 408 MHz data were considered because of the possibility of narrow band scintillation at the lowest frequency. The log of the ratio of peak intensity at 1420 and 408 MHz was plotted for a sequence of pulses. In general pulse to pulse variability is well correlated but with two interesting exceptions. The intensity at both frequencies was observed to go down to nearly zero but the higher frequency recovered more quickly. The next recorded 1420 MHz pulse was of average intensity whereas the 408 MHz was still less than the noise thus making the ratio extremely large. The other exception was when two 'giant' 1420 MHz pulses occurred accompanied by 408 MHz pulses of only moderate intensity.

DISCUSSION

BARTEL: You mentioned that subpulses in PSR 0329+54 overlap as is the case for components II and III in the average profile. How can you then determine the unblended subpulse width at the longitudes of components II and III?

THORNE: By selecting pulses where only component III was present. I do not have a width for component II as this rarely appears in isolation.

STINEBRING: Do you find that the subpulses in PSR 0329+54 and the integrated profile rise more rapidly than they decay?

THORNE: Yes. However, this type of pulses (with a quasi-exponential tail) only occurs occasionally, so the effect is diluted in the integrated profile, but I believe it can be seen. The lack of frequency dependence means it is not λ^4-scattering.