S. Sallmen, D.C. Backer, T. Hankins, D. Moffett, and S. Lundgren

Simultaneous Dual Frequency Observations of Giant Pulses

Abstract

Simultaneous data of Giant Pulses in the Crab Pulsar were taken at two widely spaced frequencies, using the detection of a giant pulse at 1.4 GHz at the VLA to trigger the observation of that same pulse period at 0.610 GHz at Green Bank. About 70% of these pulses are seen at both 1.4 and 0.6 GHz, implying they have a bandwidth of *at least* 0.8 GHz at 1 GHz. At both frequencies, the pulses are characterized by a fast rise and an exponential decay, consistent with scattering in the nebular filament zone only at 0.610 GHz.

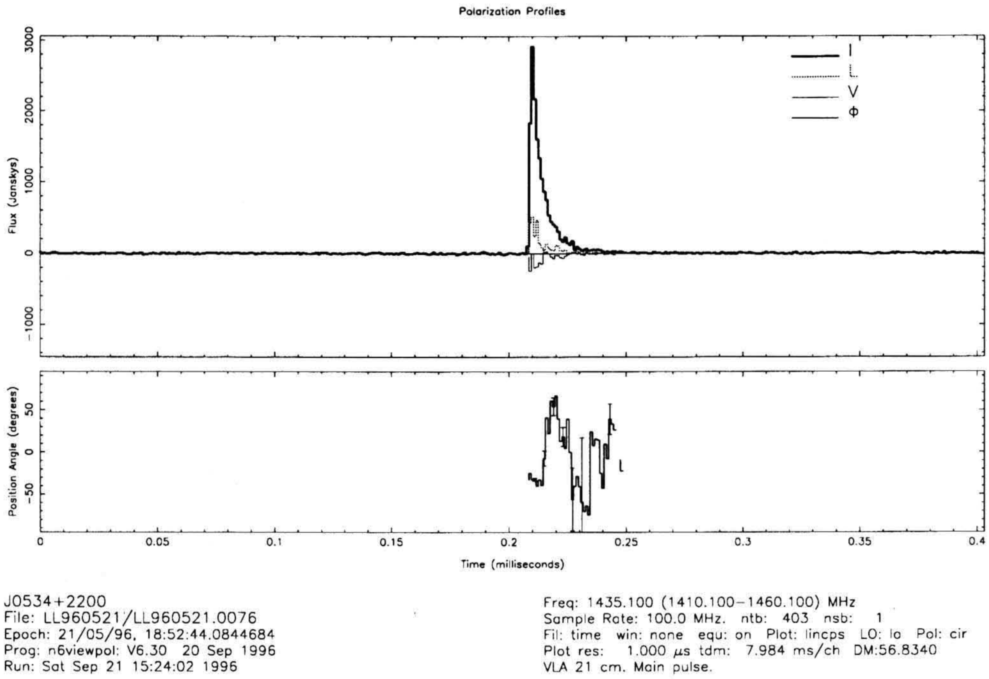
I Introduction

The Crab pulsar was first discovered by detection of its extremely strong giant pulses. These giant pulses occur only in the main pulse and interpulse, and never in the radio precursor. They are seen at all radio frequencies. Giant pulses contribute $\sim$ 5–7% of the pulse energy at 0.430 GHz. Essentially all the energy at 1.4 GHz comes from $< 1\%$ of the pulses.

II Experiment

The data shown here were all taken on 1996 May 21. The 1.4 GHz data were taken at the VLA, while the 0.610 GHz data were taken using the 85-3 telescope at Green Bank, West Virginia. The VLA resolves out the emission of the Crab Nebula, hence the exquisite signal to noise.

Using the phased array mode of the VLA, observers there were able to detect giant pulses in real time at 1.4 GHz and generate a trigger, the UTC time of which was sent over the internet, with a socket link between programs. A program written by Lundgren received the trigger, calculated the transit time of the trigger, and compared that to the difference in arrival time between 1.435 GHz and 0.618 GHz (the top of our 0.610 GHz band) due to interstellar dispersion. In this case, this time is $\delta t = 0.503$ s. In addition



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J0534+2200                                  Freq: 1435.100 (1410.100-1460.100) MHz
File: LL960521/LL960521.0076                Sample Rate: 100.0 MHz.  ntb: 403  nsb:  1
Epoch: 21/05/96, 18:52:44.0844684           Fil: time  win: none  equ: on  Plot: lincps  LO: lo  Pol: cir
Prog: n6viewpol: V6.30  20 Sep 1996         Plot res:  1.000 μs tdm:  7.984 ms/ch  DM:56.8340
Run: Sat Sep 21 15:24:02 1996               VLA 21 cm. Main pulse.
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Figure 1. Displays the data for a single giant pulse at 1.4 GHz. The top panel displays the total intensity I, along with linear and circular polarizations L and V. The vertical scale indicates that this pulse reached a peak flux of 3000 Janskys. The lower panel indicates the position angle of the linear polarization across the pulse.

to this delay, we included other factors such as the difference in arrival due to the separation between observing sites on the earth, and the latency in the GBPP (Green Bank Berkeley Pulsar Processor) hardware, which were of similar orders. If the trigger arrived in time for us to detect the pulse at 0.610 GHz, we signalled the GBPP to take data. Due to the slow rate of data dumped from the GBPP, it could only accept such a command approximately every 12 seconds. Some triggers were therefore missed.

III Discussion

A total of 77 triggers sent by the VLA observers reached Green Bank within the required time, and were accepted by the GBPP. For a variety of reasons, including a drifting clock used to identify the time at which the trigger was sent, we are currently only certain that we observed the correct period with the GBPP for 42 pulses. Of these, 29 were definitely detected at 0.610 GHz as well as at 1.4 GHz. Thus about 70% of the pulses must have a bandwidth of *at least* 0.8 GHz at 1 GHz. The emission is clearly wide band for these cases, as expected for models wherein the fundamental radiating unit has a scale of about a meter and emits a pulse of nanosecond width. The remaining pulses may be too weak to be seen with the 85′ telescope at Green Bank or they simply may not be present at this second frequency.

At 0.610 GHz, these pulses have profiles displaying a fast rise, and exponential decay. The decay time scale is about 90 μs and is consistent with that expected due to scattering in the nebular filament zone at the time of the observation. The fast rise indicates that the intrinsic time scale of the pulse is unresolved, $\lesssim$ 10 μs. At 1.4 GHz, the pulse shown (Figure 1) has a fast rise, $\lesssim$ 3 μs, and an exponential decay time scale of approximately 5 μs. Assuming $\tau_{\rm ISS} \sim \nu^{-4}$, we would expect 3 μs based on the 0.610 GHz measurement. Additionally, the position angle of the linear polarization does not remain constant during the decay at 1.4 GHz, so it is likely that the profile shape is not simply due to scattering by the nebular material.

The pulse displayed in Fig. 1 is also clearly polarized at 0.610 GHz, although some of the giant pulses are not polarized at the lower frequency. The relative arrival times of the detected pulses at the two frequencies are, however, highly correlated, and there is a weak amplitude correlation between the two frequencies as well.

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