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1,000,000 Giant Pulses from the Crab Pulsar

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Abstract. The Crab pulsar was first detected soon after the discovery of pulsars, and has long been studied for its unique traits. One of these traits, giant pulses that can be upwards of 1000 times brighter than the average pulse, was key to the Crab's initial detection. Giant pulses are only seen in a few pulsars, and their energy distributions distinguish them from normal pulsed emission. There have been many studies over a period of decades to measure the power-law slope of these energy distributions, which provide insight into the possible emission mechanism of these giant pulses.

The 42-foot telescope at Jodrell Bank Observatory monitors the Crab pulsar on a daily basis. We have single-pulse data dating back to 2012, containing roughly 1,000,000 giant pulses, the largest sample of Crab giant pulses to date. This large set of giant pulses allows us to do a range of science, including pulse-width studies and in-depth studies of giant-pulse energy distributions. The latter are particularly interesting, as close inspection of the high-energy tail of the energy distribution allows us to investigate the detectability of extragalactic giant-pulsing pulsars. Also, by calculating rates from these energy distributions, we may be able to shed light on a possible link between Fast Radio Bursts and giant pulses.

Keywords. pulsars: general, radiation mechanisms: nonthermal

1. Energy Distributions

In order to determine if extragalactic giant pulses (GPs) are the sources of FRBs, as proposed by Cordes & Wasserman (2016), we created pulse-energy distributions and measured their power-law tails to determine the theoretical rates of supergiant pulses. Pulse energies for the main pulse (MP) and interpulse (IP) were both measured using PSRSALSA (Weltevrede 2016). Initial power-law fits resulted in poor χ^2 values, and upon inspection we noted that the energy distributions were best fit by three separate power-laws (see Fig. 1). The three different power-law slopes could possibly be attributed to separate classes of GPs, each having distinct energies.

2. Event Rates

From our GP energy distributions, we were able to calculate rates of occurrence for GPs of certain energies (Fig. 2). This allowed us to compare the rates of the highest energy GPs with those of FRBs to determine if GPs are likely candidates for FRBs. We found that the average time between GPs is 62 s, while the times to reobserve the brightest events from the MP and IP are 36 days and 60 days, respectively.

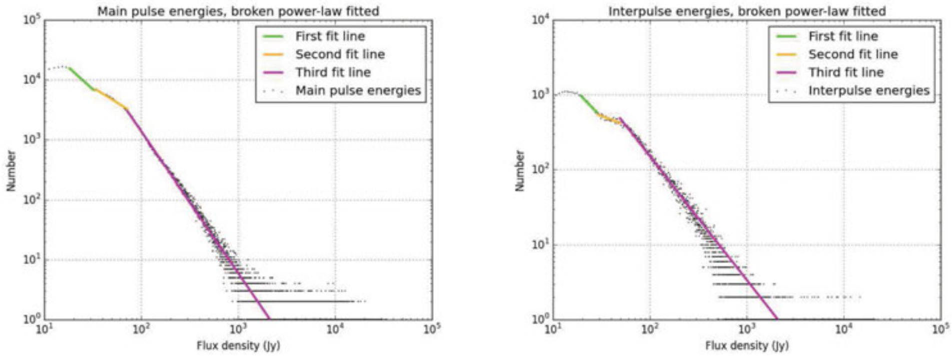

Figure 1. Triple power-law fits to the MP energy distribution (left) and the IP energy distribution (right). The power-law indices of the fits are 1.46±0.02, 1.00±0.06, 2.37±0.08 (MP) and 1.36±0.01, 0.49±0.05, 1.65±0.06 (IP).

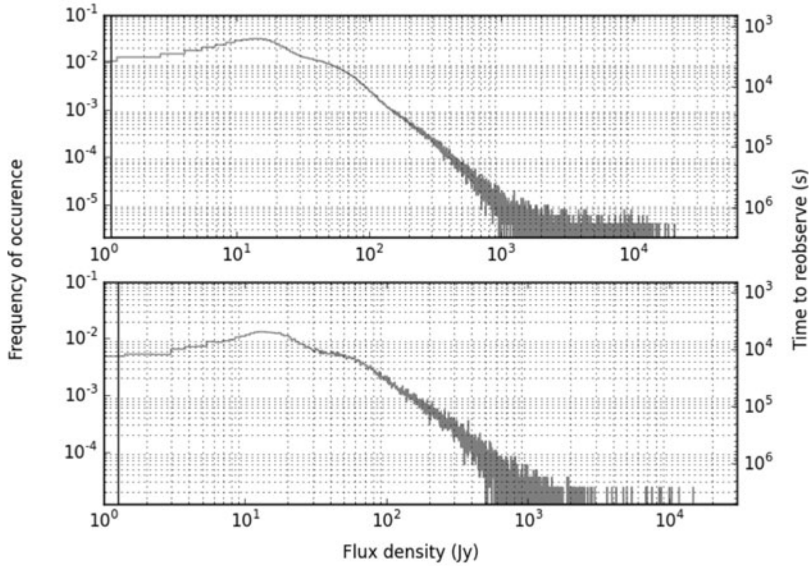

Figure 2. Energy distributions for the main pulse (top) and interpulse (bottom) and the rates at which events of a given energy reoccur.

3. Future Work

We continue to collect Crab GPs on a daily basis, and the addition of these new GPs will make our measurements of the power-law indices more precise. The increased observing time will also allow us to record more high-energy events, allowing us to better constrain the high-energy tail of the distribution and thereby determine a more accurate value for the rates of supergiant pulses.

References

Cordes, J. M. & Wasserman, I. 2016, *MNRAS*, 457, 232
Weltevrede, P. 2016, *A&A*, 590, A109