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Statistics of occurrence of giant pulses from PSR 0950+08

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Triggered by the observations of a large number of giant pulses from the extremely variable pulsar PSR 0950+08 on August 8, 1997, we have undertaken a long-term monitoring programme of this object, by observing it daily for half an hour with the Rajkot radio telescope, at 103 MHz. We have obtained a total of about 130 days of successful observations during 1997-98. With daily 32 minutes of observing, data for close to a million pulses (P=253 ms) have thus been recorded, yielding a mean pulse intensity of ~ 3 Jy. While most individual pulses will be too weak to be detected (signal to noise < 0.2), single giant pulses may greatly exceed the noise level. We have chosen 20 times the above mean intensity as the threshold for a pulse to be called giant. This makes sure that the individual giant pulse will at least be above a 4σ noise level, thus safeguarding against the inclusion of any significant number of spurious cases. Though we did not identify individual giant pulses by their phase, effects of the radio interference were minimized by rejecting all records with a certain amount of discernible radio interference.

From our data for about one million pulses, roughly one percent were found to be giant pulses, and at least one in 10,000 crossed the mean pulse level by a factor of 100, with some individual pulses as large as 300 times the mean. During the half an hour of our daily observations, the giant pulses, whenever seen, seem to occur randomly. Though sometimes a few giant pulses may follow each other in quick succession, more likely they appear alone followed or preceded by large gaps extending to many pulse periods (20-30 pulse periods) when no giant pulse may be seen. Figure 1 shows a sample of our observations of a quiet day, with hardly any detectable giant pulses, and followed a few days later by a day of extreme giant pulse emission activity.

There is a wide fluctuation in the daily giant pulse occurrence rate. In fact almost all (~ 99%) of the total giant pulses seen by us have been observed during 30 to 35 "active" days, about one fourth fraction of the total 130 days of observations. There were about 10 to 11 particularly active days where as much as 10 percent of the total pulses observed were giants. There are large fluctuations in the daily averages of pulse intensity which have one to one correspondence with the daily giant pulse rate. Both the large percentage of giant pulses (~10%) on some days and the frequent switching between days of extreme quietness and of giant-pulse activity certainly makes PSR 0950+08 as the most violently variable among the known pulsars.

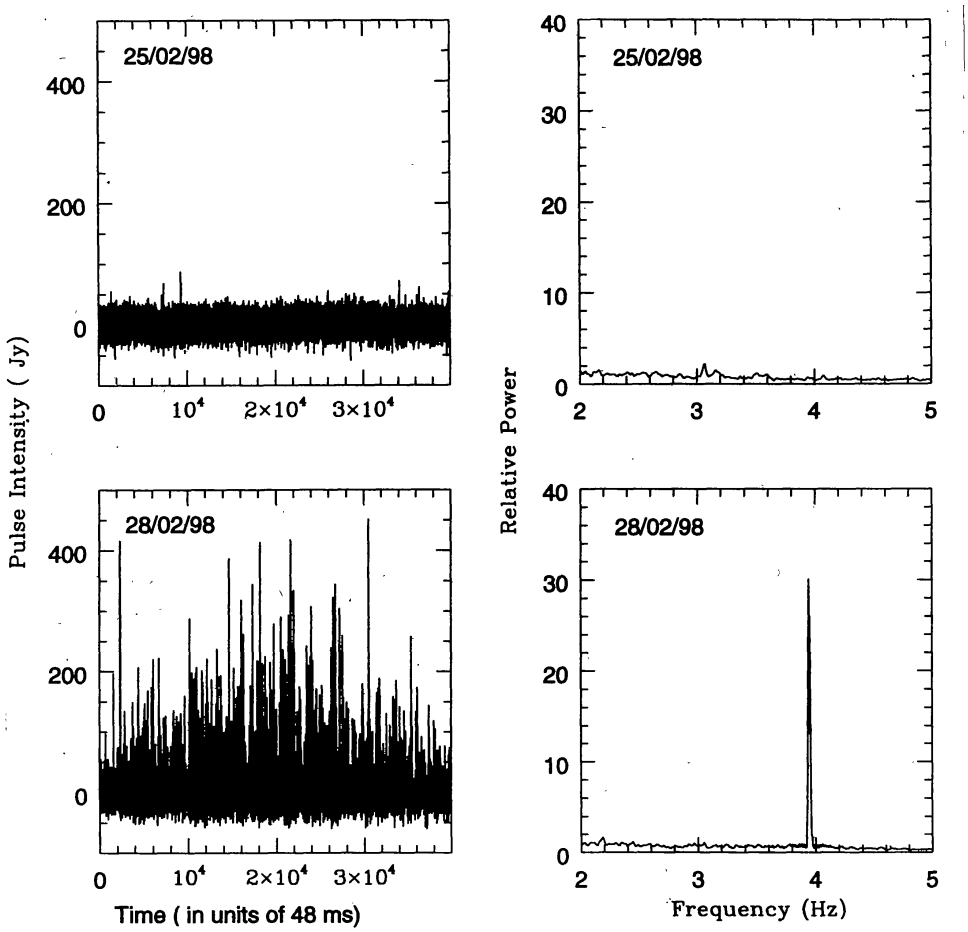

Figure 1. A plot of the observed data for two days of vastly different giant pulse emission activity from PSR 0950+08, showing a total of 40,000 data points in each case. With sampling interval of 48 ms, each record amounts to an observation time of 32 minutes.A running average of 1000 data points has throughout been subtracted to remove any slow baseline drifts. On the right are shown the corresponding power spectrum plots of these data records.

The origin of these giant pulses can be traced to the pulsar itself. One can unambiguously rule out any instrumental effects, like large gain fluctuations of the receiver system, masquerading as giant pulses. The calibration and the observed noise level in our records do not fluctuate by any appreciable amount from one day to the other, irrespective of the level of the giant pulse emission seen. One can also rule out any ionospheric or interplanetary scintillation effects as our observations have been carried out both during day and night times, depending upon the time of transit of the source during different months of observations, and no systematic differences in the giant pulse emission rate are found in the records. The long term variations in pulsar intensities (on time scales of days and longer) have generally been explained in terms of the interstellar refractive effects. The time scale of such variations for PSR 0950+08 at 103 MHz is expected to be around 47 days. This is an order of magnitude higher value than the actually observed period of ~ 4 days. Additionally, many times the daily average from one day to the next rises from about < 0.3 to ~ 20 Jy (a factor of > 50) within a single day's time, which does not fit with the expected refractive time scales at all. Therefore we conclude that these variations are something intrinsic to the pulsar radiation process.