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Pulsar work with the upgraded Ooty radio telescope

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Abstract. Recent upgradation of the Ooty radio telescope has been discussed along with the current pulsar observations.

Key words : radio observations—Ooty radio telescope—pulsar observations

1. Introduction

In 1992 Ooty Radio Telescope (ORT) was fitted with a pre-amplifier for each of its 1056 dipoles; this enhanced its sensitivity by at least a factor of three. A digital hardware was installed for setting ORT's declination under computer control, making the process faster and more reliable. Along with other modifications in the available hardware as well as software, ORT has now become a powerful instrument, particularly for pulsar observations. Described below are three of the major pulsar activities that are currently underway at ORT.

2. Upgradation of ORT

In 1992 ORT underwent a major upgradation. Each of its 1056 dipoles was fitted with a low noise GaAs FET amplifier. This reduced the receiver temperature of ORT to $\approx 100°$ K, and resulted in a system temperature of $\approx 150°$ K away from the galactic plane. The current sensitivity of ORT is 25, defined as the signal to noise ratio of a 1 Jy continuum source that is observed for 1 second with a bandwidth of 4 MHz; this is more than three times better than before.

A new digital system has been installed for setting the declination of ORT. Previously, ORT's declination was set by manually switching diode-controlled phase shifters into the electrical paths of the dipoles (since ORT has to be steered electrically in declination, whereas it can be steered mechanically in hour angle). This was a time consuming and cumbersome process, prone to human error. Now the diode switches are set by the new digital hardware, upon command from a computer. This has enhanced the rapidity and reliability of the declination setting procedure at ORT.

A new digital hardware, made by RRI, is dedicated for searching for milli-second pulsars. It has been installed at ORT, and is being used for an all sky survey for milli second pulsars.

The existing 512 channel correlator, that was meant for spectral line work, has been modified for observing pulsars, by significantly reducing the read time of the first 64 channels. This allows observations with a 32 channel frequency resolution and sampling intervals as small as three milli seconds.

The old PDP and VAX computers, that were used both for data acquisition as well as data analysis, are replaced by the newer PCs and SUN work stations. New software (both on-line as well as off-line) has been developed for using the 512 channel correlator through these machines.

3. Astronomy with upgraded ORT

ORT is currently being used for observations of inter planetary scintillations, spectral (recombination) lines, and pulsars. I will briefly describe the pulsar work that is currently being carried out at ORT using the 512 channel correlator. For these observations ORT is being used in the correlation mode, i.e., signals from the north and south halves of ORT are correlated and integrated for three to six milli seconds, depending upon the requirement. Using 64 of the 512 correlators, one obtains a spectral resolution of 32 channels within the ORT passband of 9 MHz, which is sufficient for de-dispersing the pulsars of interest.

3.1. *Targeted search for low period pulsars*

It is well known that there is a relative deficiency of low period pulsars (with periods between 10 and 100 ms) (see Lyne & Smith 1990), and it is not yet entirely clear whether this is due to selection effects or due to an intrinsic deficiency. Therefore various groups have been searching for low period pulsars, particularly towards objects in the sky where they are most expected, like supernova remnants and so on (see Manchester 1992). Using ORT we have started a search for low period pulsars towards eight objects in the sky that have shown inter planetary scintillations at low frequencies (102 MHz), but are absent from high frequency catalogs (Pynzar & Udalstov 1989). Such objects are suspected to be low period pulsars. We are able to obtain search data with a sampling interval of 3 ms, enabling us to look for pulsars with periods as low as 12 ms. With a spectral resolution of about 300 KHz we are limited to a dispersion measure of 100 $pc.cm^{-3}$ for full sensitivity. We plan to observe each region for 65 minutes, in 5 stretches of 13 minutes each, which should make our limiting sensitivity to be about 2 mJy. Five of the eight regions have been observed so far, and preliminary analysis has been done on three of them. Figure 1 shows the amplitude spectrum for the source G58.0-1.8, where the dispersion measure was not searched for (power spectra of the 32 frequency channels were integrated). Further analysis is in progress for the rest of the regions.

3.2. *Dynamic spectra*

It is by now reasonably established that pulsar intensity variations on time scales of days or months, are due to refractive scintillations in the interstellar medium (Ricket 1990). This points to large scale irregularities ($\geq 10^{10}$ m) in the ISM. Some pulsars show interesting refractive effects such as 'multiple images' and sloping bands in the dynamic spectra (which is the pulsar intensity as a function of time and frequency). We have started a program of monitoring the dynamic spectra of a few strong pulsars that are expected to show interesting

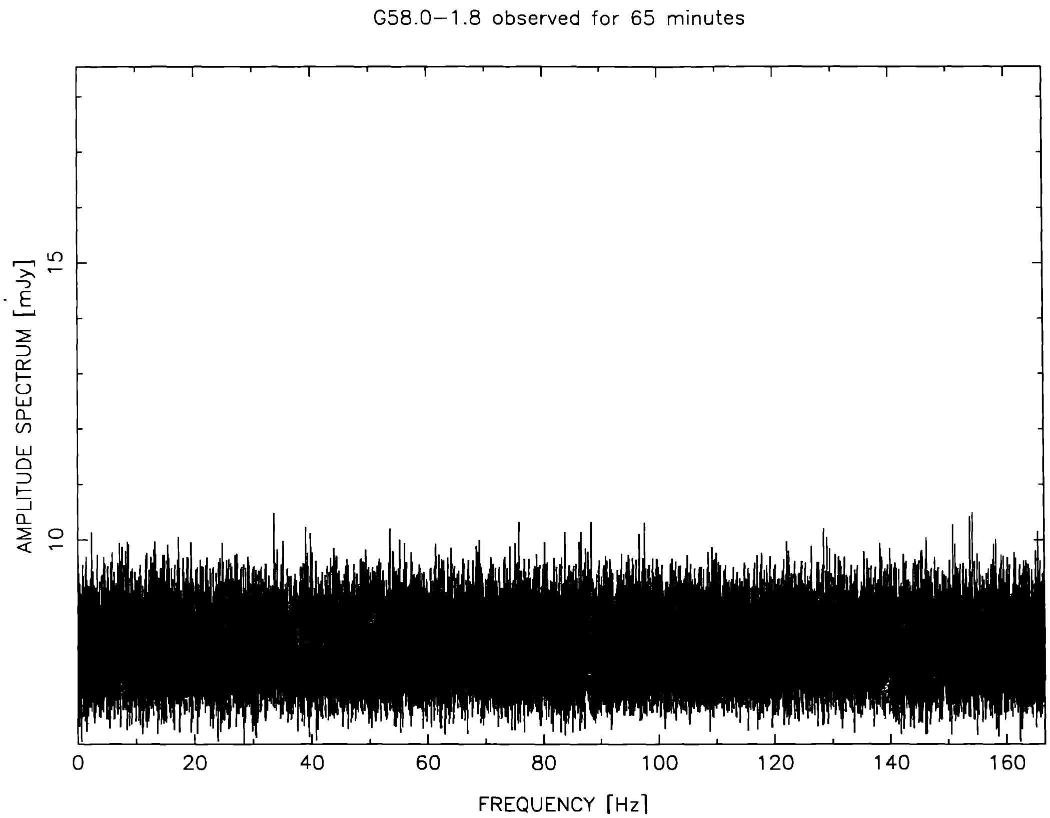

Figure 1

refractive effects. Figure 2 is a sample dynamic spectra of PSR 0834 + 06, shown as a gray scale plot. Each data point in the figure refers to the mean energy within the pulse (averaged over several pulses to eliminate pulse to pulse fluctuations) in each of the 32 frequency channels. Worthy of note are the sloping bands due to refractive interstellar scintillations.

3.3. *Pulse nulling phenomenon*

The phenomenon of pulse nulling in pulsars is not yet understood. About a third of all pulsars are supposed to show this phenomenon (Michel 1991), some nulling for less than 1 percent of the time, some for 5 to 10 percent of the time; one pulsar (PSR 0826-34) spends almost 70 percent of its time in the nulled state. Nulling has shown interesting correlations with the phenomenon of drifting of the sub-pulses (Lyne and Ashworth 1993). We have started investigating the percentage of nulling in some weak pulsars, that are available within the declination range of ORT, and that have not been studied before for this effect. PSRs 0149-16 and 0942-13 show a negligible amount of nulling ($\leq 1\%$). Figure 3 shows the histogram of normalized pulse energies (corrected for ISS) for 10000 pulses from PSR 0942-13; there is no additional peak at zero energy, which is the typical signature of nulling.

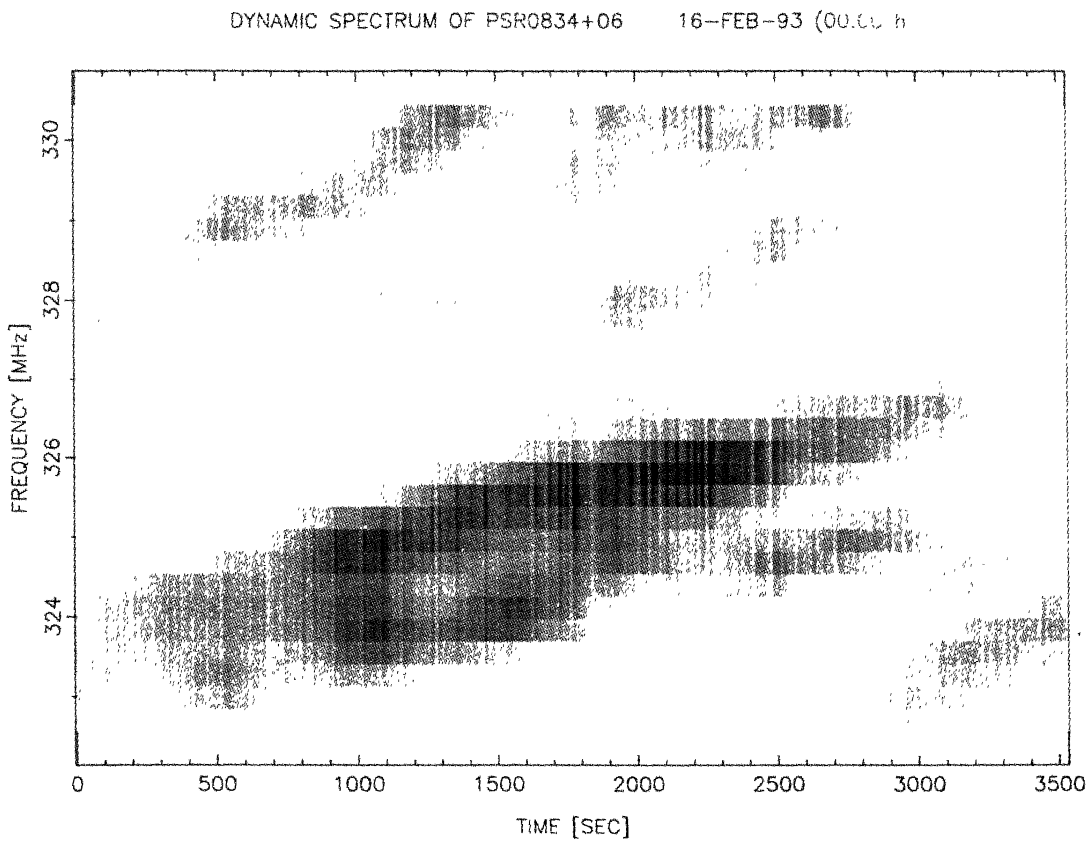

Figure 2

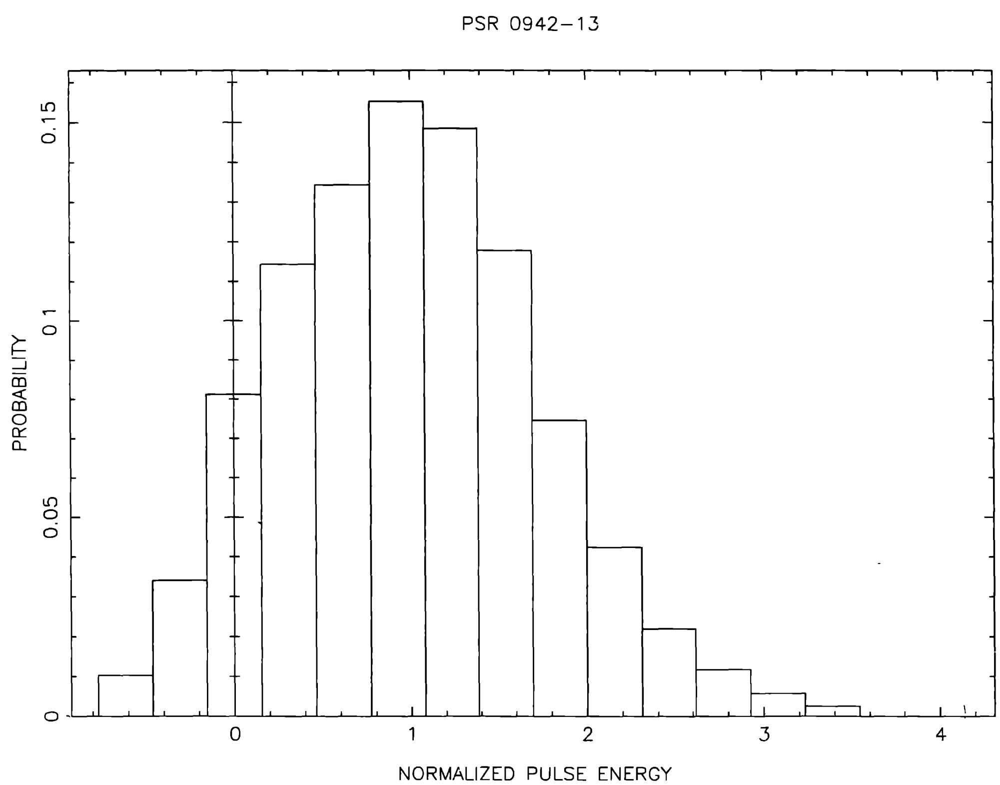

Figure 3

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