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New pulsar observations using the Gauribidanur Radio Telescope

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Abstract. Pulsar observations with improved sensitivity have been initiated at 34.5 MHz and a 1-MHz bandwidth using the Gauribidanur Radio Telescope. We describe our new procedure where the raw (2-bit) signal voltages are recorded and the data are processed optimally off-line. A few preliminary results from these observations are presented.

1. Introduction

Pulsar observations at low frequencies are severely limited due to increased sky brightness, enhanced scattering & dispersion effects, instrinsic luminosity reduction in the pulse energies, and terrestrial interference making it difficult to achieve high sensitivity. In an earlier attempt (Deshpande and Radha Krishnan 1992, 1994), 8 pulsars were studied at 34.5 MHz using the Gauribidanur Radio Telescope (Deshpande et al., 1989) (GEETEE). To enable a more detailed study of these pulsars, and to enlarge the sample of detectable pulsars, a new setup based on a Fast Data Aquisition System (FDAS) (Deshpande et al., 1997) is employed. This new setup is five times more sensitive than available earlier, and also offers higher time resolution. In this paper, we present a few preliminary results of the renewed pulsar observations at 35 MHz.

2. The pulsar sample, and observations

For the present observations, we have used the East-West arm of the GEETEE, with a fan beam of $0^\circ.5 \times 25^\circ$. A 1-MHz wide band centered at 34.5 MHz from the antenna is downconverted to get an IF of 10 MHz. The signal voltages are Nyquist sampled with a 2-BIT quantization, and the raw data are recorded for off-line processing.

Our pulsar sample, a subset of the known pulsar population, is selected such that the expected signal to noise ratio for each selected pulsar is ≥ 5. To estimate pulsar flux at 34.5 MHz, we assume that the spectrum of the pulsed energy has a turnover at 100 MHz, and the spectrum is symmetric around the turnover frequency. The spectral index above 100 MHz for each pulsar is estimated from the known values for pulsar fluxes at higher frequencies from the pulsar catalogue (Taylor et al., 1993). In case this was not possible, the spectral index was assumed to be 1.2 and the flux at 100 MHz was estimated. The background sky temperature is estimated based on the continuum survey at 34.5 MHz (Dwarakanath and Udaya Shankar 1990). Pulse scattering effects are also taken into account while estimating the expected pulse widths.

For an integration time of ~ 2500 seconds, 5σ detection criterion yielded a sample of ~ 40 pulsars, with a Dispersion Measure of ≤ 50 (distance ≤ 1.5*kpc*), and pulsar periods of ≥ 250 msec. All the pulsars in this sample were observed during March-July 1997 on three occasions.

3. Analysis and preliminary results

In the off-line processing, the recorded time sequence of the signal voltages is Fourier transformed in suitable blocks to produce an equivalent spectrometer output. The resultant matrix of data then corresponds to the intensity as a function of time for each of the narrow spectral channels. Provision is made to identify and mask certain 'noisy' channels from analysis, and to ignore time intervals that may be affected by interference. Terrestrial interference was seen in the observations made mainly during the day time, especially in the morning, and late evening. Strong and sporadic interference due to lightening discharges was also present in some data. The data are then incoherently dedispersed (Huguenin 1976) and "folded" with at the apparent period of a given pulsar. The processing also allows for Dispersion Measure (DM) tuning, and the DM corresponding to the best signal-to-noise ratio can be chosen for dedispersion.

The spectral resolution is chosen optimally such that the dispersion smearing across the narrow channel is comparable to the inverse of the channel width.

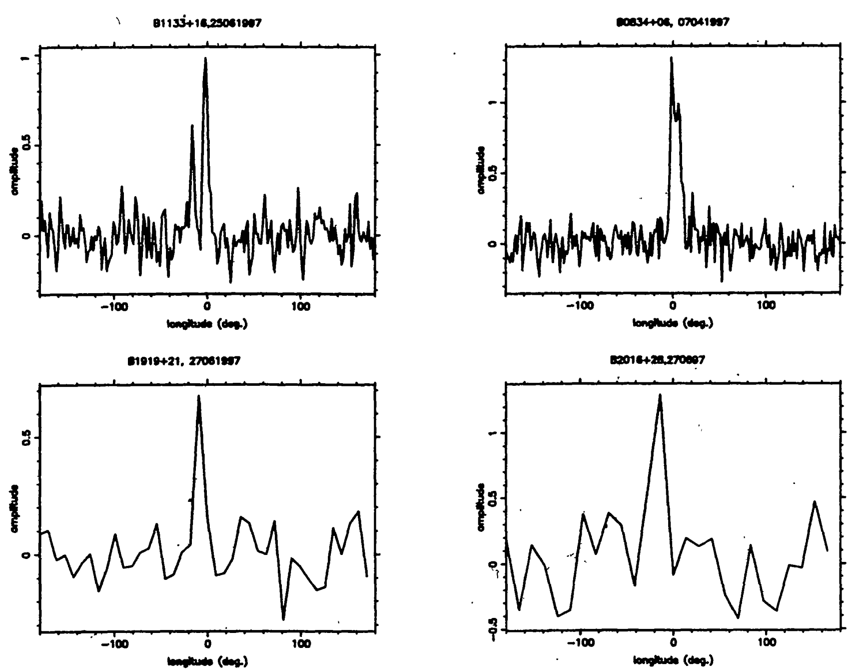

Figure 1. The pulse profiles; the integration time for B1133+16 is ~ 300s, for B0834+06 ~ 750 s, and that for B1919+21 & B2016+28 ~ 570 s, respectively. The amplitude scale is not calibrated.

From the preliminary analysis on 12 objects, seven pulsars were detected, six of which were studied earlier using the GEETEE. Pulse profiles of four of these, pulsars are shown above in Fig. 1. The pulsar B2016+28 had not been detected in the previous attempts from Gauribidanur. The double peaked pulse shape of B1133+16 stands out clearly resolved, whereas in the case of B0834+06 there is only a hint of being so.

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