OBSERVATIONS OF THE MILLISECOND PULSAR PSR 1855+09 AT 102 MHz

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Introduction

The study of millisecond pulsars is of great astrophysical interest. One may expect that the rotation effect on the structure of the magnetosphere should be very significant. In view of the short duration of the pulses they are very suitable for investigations of the interstellar medium; at least they hold the promise for the pulsar time scale.

Millisecond pulsars were discovered and have been studied on the basis of their radio emission at decimeter wavelengths. At longer wavelengths scattering of the radio emission in the interstellar medium is the principal limitation of millisecond pulsar observations.

We have observed PSR 1855+09 (Kuz'min *et al.* 1990) which has the lowest dispersion measure, 13.2952 pc cm^{-3} (Segelstein *et al.* 1986) of the known millisecond pulsars. The expected interstellar scintillation (ISS) broadening is 1.2 ms, which is smaller its 5.362 ms period. The observed period was calculated from the binary system orbital elements (Segelstein *et al.* 1986).

Observations

We observed PSR 1855+09 during 1989-1990 at the BSA array of the Pushchino Radioastronomical Observatory (Vitkevitch *et al.* 1976, Alekseev and Dobysh 1989). The 32×5-kHz multichannel receiver was used. The time constant was 0.3 ms. The number of integrated pulses was defined by time of pulsar passage through the the antenna beamwidth by earth rotation, about 42000 periods. The rubidium station clock was synchronized by the USSR Time Standard received by broadcast television (Vdovin *et al.* 1989).

Figure 1 gives the mean profile of PSR 1855+09 at 102 MHz as well as its 1400-MHz counterpart (Segelstein *et al.* 1986). One can see that the 102 MHz and 1400 MHz profiles are similar. The main pulse and interpulse are visible in both. The separation between the interpulse and main pulse is about 140° at 102 MHz and is not substantially different than at 1400 MHz. The profiles of the interpulse and main pulse and the ratio of their energies $E_{\rm IP}/E_{\rm MP} = 0.25$ are nearly the same at both frequencies. The observed pulse widths of the main pulse and interpulse are about the same at 0.9 ms. The width of the emitted pulse was evaluated to be nearly 0.7 ms after a correction for the dispersion smoothing of 0.5 ms and detector time constant of 0.3 ms.

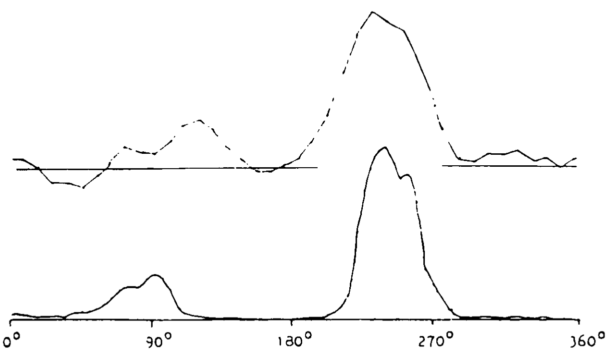

Figure 1 The mean profiles of PSR 1855+09 at 102 MHz *upper plot*, and 1400 MHz *lower plot*.

The pulse energies were estimated by comparison with reference sources PSR 1508+55 and PSR 2217+47 having energy 780×10^{-29} J m^{-2} Hz^{-1} (Izvekova *et al.* 1981). The energy of PSR 1855+09 was found to be 3×10^{-29} J m^{-2} Hz^{-1}. The mean flux density is about 500 mJy. The energy spectral index as compared with measurements at 430 MHz and 1400 MHz (Segelstein *et al.* 1986) is −2.2.

The dispersion measure DM was obtained by measuring the time delay of pulses at frequencies 101.379 and 103.699 MHz. Our value of DM is 13.298 ± 0.005 pc cm^{-3}.

Discussion

The value of DM obtained at 102 MHz, 13.298 ± 0.005 pc cm^{-3}, is within the uncertainty of the value 13.2952 ± 0.0012 pc cm^{-3} obtained at higher frequencies by Segelstein *et al.* (1986). Therefore, one can conclude that twisting of the magnetic field (Shitov 1983) at 102 MHz for this pulsar does not exceed 10°.

The scattering broadening of the observed pulse (figure 1) is less than 0.5 ms. This value is only half the expected 1.2 ms (Kuz'min *et al.* 1988) given by a $(DM)_{sc} = DM^2$ dependence of scattering broadening on the dispersion measure. This difference may indicate that the power-law index of the $(DM)_{sc}$ dependence is smaller than 2.

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