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Confirmation of Pulsed Radio Emission from the Pulsar J1907+0919 (Shitov Radio Pulsar, SGR 1900+14)

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Abstract. Observations at a frequency of 111 MHz with the Large Phased Array at the Pushchino Radio Astronomy Observatory of the Astro Space Center of the P.N. Lebedev Physical Institute confirm the pulsed radio emission of the X-ray pulsar J1907+0919 that is a counterpart of the magnetar SGR 1900+14. Its pulsed radio emission was discovered earlier by Shitov (1999). A flux density periodogram is built. A new spin period $P = 5.22756(42)$ s and flux density 50 5 mJy are measured at the Epoch 56834.6 MJD. A value of the pulsar radio emission spectral index is estimated as < 4.3. This radio spectrum is one of the steepest among the spectra of known pulsars.

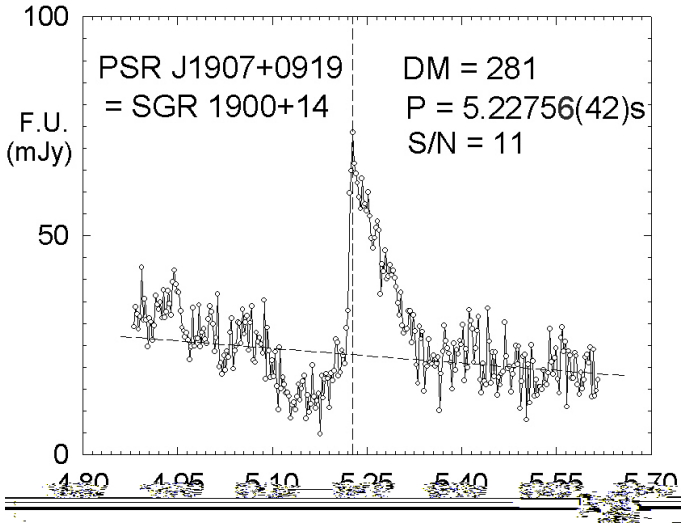
Introduction

The population of magnetars consists of AXP and SGR pulsars, many of which have steep radio spectra peaking at low frequencies [1]. In these cases, we expect success in the observations of magnetars at low radio frequencies, just as earlier for AXP 1E 2259+586 and 4U 0142+61 [2]. One more radio PSR J0418+5732, which is a counterpart of SGR 0418+5729, has recently been discovered at 111 MHz [3]. Long ago another (Shitov) radio PSR J1907+0919, the counterpart of the X-ray pulsar J1907+0919 and SGR 1900+14, was detected at 111 MHz [4, 5]. The request to confirm or refute the 111 MHz detection of PSR J1907+0919 was advanced in [6]. So, the present paper reports the new observations as well as confirms the radio detection of PSR J1907+0919 and measured parameters of its radio emission.

Obser ations and Results

The observations have been carried out at a frequency of 111 MHz with the Large Phased Array (LPA) at the Pushchino Radio Astronomy Observatory during the interval of 2014 April 2 -– 2014 October 8 (MJD 56749.1615–56938.6427) for 189.48 days. From this interval, 81 observational sessions were used for processing. Each observational session with the LPA lasted about 3 min, and the total exposure came to 243 min. The effective area was about 2.1 10^4 m^2, and HPBW was 48.0′ 33.5′. The sensitivity of the system came to 50 mJy

in a frequency band of 1 Hz and at a time constant of 1 s. A digital 512-channel receiver with a bandwidth of 2.560 MHz and sampling time of 2.5 ms was used. Each individual channel had a bandwidth of 5 kHz. The operation of the system was checked by observing some strong pulsars with well-known flux densities at 111 MHz. Impulsive RFI and bad channels were excluded from the observational data. To process the data, the Fast Folding Algorithm was applied [7], which significantly differs from the processing method used in [4, 5]. During the processing the dispersion measure was fixed to be the same as in Shitov's measurements, i.e., DM = 281.4 0.9 pc cm^{-3}.



Figur 1: Th PSR J1907+0919 av rag p riodogram for 189.5 days at 111 MHz as flux d nsity vs. p riod with a st p of 1.26 ms. P riod is giv n at MJD 56834.6. Th signal-to-nois ratio, S/N, is 11 0.5 in th maximum, wh r N is on standard rror.

The average periodogram of PSR J1907+0919 is shown in Fig. 1. There is broadening of the pulse profile, which is probably due to a quasi-periodic character of the radio emission.

We detect the period of PSR J1907+0919 to be 5.22756(42) s at MJD 56834.6, where 56834.6 is the averaged value in the total observational interval 56749.1615–56938.6427 (MJD), and an error was taken as 1/3 of the periodogram step (Fig. 1). The measured radio emission flux density is 50 5 mJy at the signal-to-noise ratio of 11 0.5. The comparison of the flux densities S_ν at ν = 111 MHz (50 mJy), 430 MHz (< 150 μJy), and 1410 MHz (< 30 μJy) [6] results in spectral index $\alpha <$ 4.3 and < 2.9, respectively. Here, S_ν / ν^α. This is one of the steepest spectra among well-known pulsars, like the one of the Geminga pulsar.

Note that at present a distance to SGR 1900+14 is often accepted to be 12.5 1.7 kpc (e.g. [8]), meanwhile the NE 2001 free electron distribution model [9] at DM = 281.4 pc cm^{-3} results in 6.7 kpc with an expected rough error of 30%. This large discrepancy probably indicates the NE 2001 model weakness, which was noted by its authors themselves.

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References

1. Malov I.F., ARep **58**, 139 (2014).
2. Malofeev V.M., Teplykh D.A., and Logvinenko, S.V., ARep **56**, 35 (2012).
3. Glushak A.P., Dumsky D.V., and Losovsky B.Ya., ATsir No. 1609 (2014).
4. Shitov Yu.P., IAU Circ. 7110 (1999).
5. Shitov Yu.P., Pugachev, V.D., and Kutuzov, S.M., ASPC **202**, 685 (2000).
6. Lorimer D.R. and Xilouris K.M., ApJ **545**, 385 (2000).
7. Kondratiev V.I., McLaughlin M.A., Lorimer D.R., et al., ApJ **702**, 692 (2009).
8. Davies B., Figer D.F., Kudritzki R.-P., et al., ApJ **707**, 844 (2009).
9. Cordes J.M. and Lazio T.J.W., astro-ph/0207156 (2002).

Подтверждение импульсного радиоизлучения пульсара J1907+0919 (радиопульсар Шитова, SGR 1900+14)

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Резюме. В наблюдениях на Пущинской радиоастрономической обсерватории с Большой Синфазной Антенной Астрокосмического центра Физического института имени П.Н. Лебедева на частоте 111 МГц подтверждено обнаруженное ранее Шитовым (1999) импульсное радиоизлучение пульсара J1907+0919, дубликата магнитара SGR 1900+14. Получена периодограмма плотности потока пульсара. Его новый период $P = 5.22756(42)$ с и плотность потока 50 5 мЯн были измерены на эпоху 56834.6 MJD. Оценена величина спектрального индекса радиоизлучения, 4.3. Этот радиоспектр – один из самых крутых среди спектров известных пульсаров.

Ключевые слова: радиоизлучение, пульсары, магнитары, J1907+0919 (Shitov), SGR 1900+14, SGR 0418+5729.