Young Neutron Stars and Their Environments
IAU Symposium, Vol. 218, 2004
F. Camilo and B. M. Gaensler, eds.

The Radio Pulsar J0205+6449 in the SNR 3C 58

V. M. Malofeev, I. F. Malov, O. I. Malov, A. P. Glushak

Lebedev Physical Institute, Moscow, Russia

Abstract. Pulsed radio emission has been detected from the X-ray pulsar J0205+6449 in the SNR 3C 58 at 111 and 88 MHz on radio telescopes of the Pushchino Radio Astronomy Observatory. The dispersion measure DM = 141 pc cm^{-3} has been confirmed. The synchrotron mechanism is proposed for the radio and X-ray emission to explain the lower X-ray and radio luminosities of this pulsar compared to the Crab pulsar.

1. Results

Murray et al. (2002) reported the detection of an X-ray pulsar J0205+6449 with a period of 65.68 ms in the SNR 3C 58. Estimates of the distance to the SNR range from 1.5 kpc (Losinskaya 1986) to more than 6.5 kpc (Williams 1973).

Using the pulsar search program and the sensitive Pushchino Large Phased Array we detected pulsed signals from PSR J0205+6449 at 111 MHz (Malofeev et al. 2001). Later similar signals were registered by the other Pushchino radio telescope DKR-1000 at 88 MHz. Camilo et al. (2002) detected PSR J0205+6449 at 820 and 1375 MHz and measured its dispersion measure DM = 140.7 ± 0.3 pc cm^{-3}. Our data confirmed that the best profile can be obtained if DM = 141 ± 10 pc cm^{-3} (Malofeev et al. 2003 and Fig. 1). This value of DM gives the distance to the pulsar of 6.4 kpc. Figure 2 shows the integrated profile of PSR J0205+6449 at 111.23 MHz. The measured parameters of this pulsar are listed in Table 1. Using a longer MJD interval (52164–52779) we obtained more precise values of P and $\dot{P}$ than Camilo et al. (2002) and Malofeev et al. (2003).

The synchrotron model is proposed to explain the difference between the luminosities of PSR J0205+6449 and the Crab pulsar. In this model the radio luminosity L_R is proportional to B_{LC} (Malov 1999) and since this radio emission is coherent, $L_R \propto n^2 B_{LC}$. We can use the Goldreich-Julian formula for the density of relativistic particles:

$$n = \frac{B}{Pce} = \frac{8\pi^3 R_*^3 B_s}{c^4 e P^4} \tag{1}$$

The period of PSR J0205+6449 is two times more than the Crab pulsar's period. This means that the radio emission of PSR J0205+6449 should be a factor of ~ 2000 weaker than from PSR B0531+21, in agreement with observations. The X-ray radiation is not coherent and $L_x \propto nB^{(\alpha+1)/2}$ (Pacholczyk 1970). For the spectral index $\alpha = 2.8$ the ratio of the X-ray luminosities of the Crab pulsar and of PSR J0205+6449 should be ~ 1000, also in good agreement with observations.

The correlation between the optical bolometric luminosities and the values of B_{LC} and the similar correlation for the hard radiation (X-rays & γ-rays),

https://doi.org/10.1017/S0074180900181628 Published online by Cambridge University Press

namely $\log L_{opt} = (1.85 \pm 0.47) \log B_{LC} + (21.00 \pm 2.32)$ and $\log L_{x+\gamma} = (0.83 \pm 0.14) \log B_{LC} + (31.20 \pm 0.70)$, enable us to predict for PSR J0205+6449 $L_{opt} \sim 10^{31}$ ergs s^{-1} and $L_{x+\gamma} = 7 \times 10^{35}$ ergs s^{-1}, making searches for optical emission and gamma-rays from this pulsar promising.

Acknowledgments. This work was partly supported by RFBR (PrNo. 03-02-16509), INTAS (Grant No. 00-00849), an IAU Travel Grant and by the NSF (Grant No. 00-098685).

Table 1. The measured parameters of PSR J0205+6449.

P (ms)	$\dot{P}$	MJD	DM (pc cm^{-3})
65.67895013(6)	1.93498(1) $\times 10^{-13}$	51901.330	141 $\pm$ 10

S_{111} (mJy)	S_{88} (mJy)	w_{50} (111 MHz) (ms)	w_{10} (111 MHz) (ms)	α
40	< 150	$\sim$ 25	$\sim$ 40	2.8

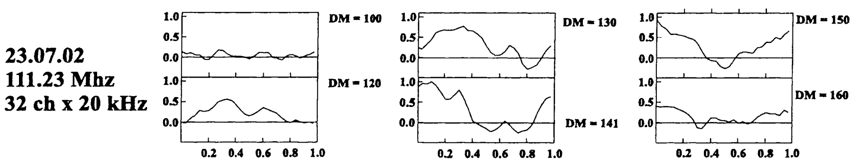

Figure 1. Sample of integrated pulsar profiles of PSR J0205+6449 for various dispersion measures.

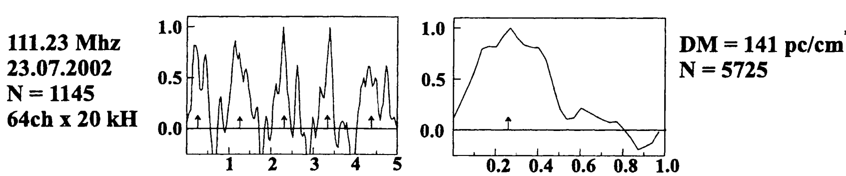

Figure 2. The integrated profiles of PSR J0205+6449: the observing window (P_0) equals five apparent periods ($P = 65.68$ ms), this profile is obtained by the integration over 1145 P_0 (left); integrated profile obtained by the folding with 5725 apparent periods (right).

References

Camilo, F. et al. 2002, ApJ, 571, L41

Losinskaya, T. A. 1986, Supernovae and Stellar Winds, (Moscow: Nauka)

Malofeev, V. M., Malov, O. I., & Glushak, A. P. 2001, IAU Circ. No. 7775

Malofeev, V. M. et al. 2003, Astron. Reports, 47, 413

Malov, I. F. 1999, Astron. Reports, 43, 727

Murray, S. et al. 2002, ApJ, 568, 226

Pacholczyk, A. G. 1970, Radio Astrophysics, (San Francisco: Freeman)

Williams, D. R. W. 1973, A&A, 28, 309

https://doi.org/10.1017/S0074180900181628 Published online by Cambridge University Press