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Discovery and study of the accreting pulsar 2RXP J130159.6-635806

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Abstract. We report on analysis of the poorly studied source 2RXP J130159.6-635806 at different epochs with *ASCA*, *Beppo*SAX, *XMM-Newton* and *INTEGRAL*. The source shows coherent X-ray pulsations at a period ∼700 s with $\dot{\nu} \sim 2 \times 10^{-13}$ Hz s^{-1}. A broad band (1–60 keV) spectral analysis of 2RXP J130159.6-635806 based on almost simultaneous *XMM-Newton* and *INTEGRAL* data demonstrates that the source spectrum is an absorbed power law with a photon index $\Gamma \sim 0.5 - 1.0$ and a cut-off energy of ∼25 keV. We also report on the identification of the likely infrared counterpart to 2RXP J130159.6-635806. The interstellar reddening does not allow us to strongly constrain the spectral type of the counterpart. The latter is, however, consistent with a Be star, the kind of which is often observed in accretion powered X-ray pulsars.

Keywords. pulsars: individual: 2RXP J130159.6-635806 – gamma rays: observations – X-rays: binaries – X-rays: individual: 2RXP J130159.6-635806.

On February 7, 2004 the *INTEGRAL* observatory detected a source which was not in the *INTEGRAL* reference catalog. This source was also clearly detected by *XMM-Newton* during its PSR B1259–63 monitoring programme (Chernyakova *et al.*, 2004). The best coordinates we derive for 2RXP J130159.6-635806 are $\mathrm{RA}_{J2000} = 13^h01^m58^s.8$, $\mathrm{DEC}_{J2000} = -63°58'10''$. This position is about $6''$ from the best *ROSAT* position of 2RXP J130159.6-635806. Taken into account the uncertainties of the localisation we conclude that most likely *XMM-Newton* source and the *ROSAT* one are the same.

The 1993–2004 time history of the 2–10 keV flux from 2RXP J130159.6-635806 as observed by *ASCA* and *XMM-Newton* is shown in the upper panel of Figure 1. While during the *ASCA* (1994–1995) and the first half of the *XMM-Newton* observations (2001–2003) the flux of the source was practically constant at a value $\sim 2.5 \times 10^{-11}$ ergs cm^2 s^{-1}, an outburst occurred between the end of January and the beginning of February 2004. During this period the source flux increased by a factor of more than 5. This outburst was also detected by *INTEGRAL* in the 20–60 keV energy range. While the *ASCA* and *XMM-Newton* data are well fitted with a simple power law modified by photo-absorption, *INTEGRAL* data show a presence of a high-energy cut-off at about ∼25 keV, typical for accreting X-ray pulsars. We fitted the *XMM-Newton* and *INTEGRAL* joint

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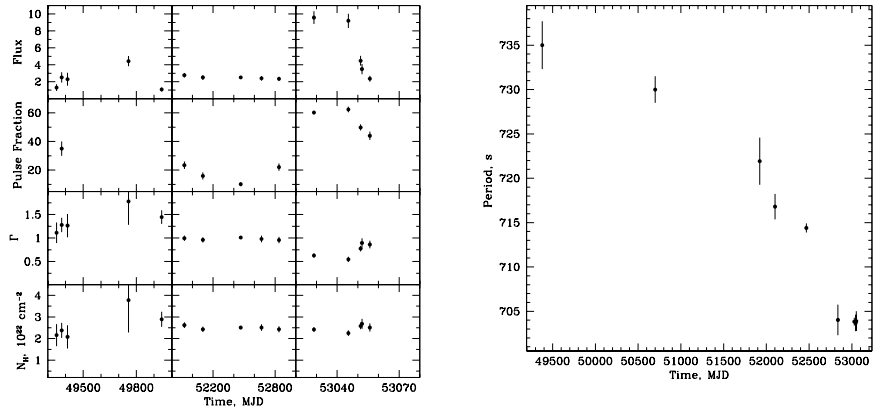

Figure 1. (*left*) Time evolution of the spectral parameters of 2RXP J130159.6-635806 and the 2−10 keV pulse fraction (in %). Flux is given in units of 10^{-11} erg/s/cm^2. (*right*) Time evolution of 2RXP J130159.6-635806 pulse period.

spectrum with an absorbed cut-off power law. The best fit parameters obtained are: $N_{\rm H} = (2.55 \pm 0.13) \times 10^{22}\,{\rm cm}^{-2}$, $\Gamma = 0.69 \pm 0.05$, $E_{cut} = 24.3 \pm 3.4\,{\rm keV}$, $E_f = 8.5 \pm 3.3\,{\rm keV}$.

Analyzing the light curve of 2RXP J130159.6-635806 we found that it demonstrates near coherent strong variations with a characteristic time about 700 s. The evolution of the pulse period is shown in right panel of Figure 1. An average spin up rate changes from $\dot{P} \simeq -6 \times 10^{-8}$s s^{-1} in 1994 – 2001, to $\dot{P} \simeq -2 \times 10^{-7}$s s^{-1} in 2001 – 2004.

The discussed above long term behaviour of the source, its spectral and timing properties, tend to indicate a high mass X-ray binary with a Be companion. It seems that this source belongs to a rather small group of persistent Be/X-rays binaries with rather low X-ray luminosity ($< 10^{35}$erg/s) and relatively long (> 200s) pulse periods (Reig & Roche, 1999). In order to check this we used the results of DSS and 2MASS surveys. In the 2MASS catalog we found a source with coordinates (equinox 2000) RA $= 13^h01^m58^s.7$, DEC $= -63°58'09''$ (at $\sim$1.1$''$ from the best *XMM-Newton* position) and magnitudes $J = 12.96 \pm 1.33$, $H = 12.05 \pm 0.03$, $K_s = 11.35 \pm 0.09$. The good agreement between both positions would tend to suggest that this source is the likely counterpart to 2RXP J130159.6-635806. Using the value of Galactic absorption $N_{\rm H} = 1.7 \times 10^{22}$ cm^{-2} we estimate the de-reddened magnitudes $J_{der} = 10.73 \pm 1.33$, $H_{der} = 10.72 \pm 0.03$, $K_{s\,der} = 10.51 \pm 0.09$. If the companion star is a Be main sequence star with surface temperature around 10000 K and the radius around 6-10 $R_\odot$ we can expect to see its infrared brightness $J, H, K \sim 10 - 11$ if the binary system is at the distance $\sim$4–7 kpc. An additional tentative argument in favour of such source distance is the source location in the direction to the Crux spiral arm tangent. At such a distance the unabsorbed intrinsic luminosity of 2RXP J130159.6-635806 is about $\sim 5 \times 10^{34}$–10^{35} erg/s, *i.e.* compatible with the typical luminosities of the persistent Be/X-ray binaries.

More detailed information on this source is given in Chernyakova *et al.* (2005).

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