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Letter to the Editor

Swift monitoring of the new accreting millisecond X-ray pulsar IGR J17511−3057 in outburst

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ABSTRACT

Context. A new accreting millisecond X-ray pulsar, IGR J17511−3057, was discovered in outburst on 2009 September 12 during the *INTEGRAL* Galactic bulge monitoring programme.
Aims. To study the evolution of the source X-ray flux and spectral properties during the outburst, we requested a *Swift* monitoring of IGR J17511−3057.
Methods. In this paper we report on the results of the first two weeks of monitoring the source.
Results. The persistent emission of IGR J17511−3057 during the outburst is modelled well with an absorbed blackbody ($kT \sim$ 0.9 keV) and a power-law component ($\Gamma \sim$ 1–2), similar to what has been observed from other previously known millisecond pulsars. *Swift* also detected three type-I Xray bursts from this source. By assuming that the peak luminosity of these bursts is equal to the Eddington value for a pure helium type-I X-ray burst, we derived an upper limit to the source distance of ~10 kpc. The theoretically expected recurrence time of the bursts according to the helium burst hypothesis is 0.2–0.9 days, in agreement with the observations.

Key words. X-rays: binaries – pulsars: individual: IGR J17511−3057

1. Introduction

Accreting millisecond pulsars (AMSP) are neutron stars (NS) that accrete mass from a low-mass ($\ll 1\ M_\odot$) companion star and that show coherent pulsations at their millisecond spin period (Bhattacharya & van den Heuvel 1991). Since the discovery of the first AMSP in 1998, SAX J1808.4−3658 (Wijnands & van der Klis 1998), 11 other AMSPs were discovered (see e.g.; Altamirano et al. 2009; Casella et al. 2008; Altamirano et al. 2008; Wijnands 2006, for reviews). All the AMSP are hosted in low-mass X-ray binaries (LMXBs) with typical orbital periods of either about 40 min or a few hours, and exhibit a transient X-ray emission with bright outbursts (10^{36}–10^{37} erg/s) occurring on a time scale from two to more than ten years, and a typical duration of a few weeks (see e.g., Wijnands 2006). However, longer activity episodes have also been recorded (XTE J1807-294, see e.g., Falanga et al. 2005a), and one source, HETE J1900.1-3455, has never returned in quiescence since its discovery in 2005 (Kaaret et al. 2006; Galloway 2007). So far, only AMSP with orbital periods of a few hours have exhibited type-I X-ray bursts (the only exception being IGR J00291+5934). This is believed to stem from the composition of the material that is accreted onto the NS that in turns depend on the nature of the donor star (see e.g., Galloway & Cumming 2006, and references therein). The broad band X-ray (0.5–200 keV) spectra of AMSPs are generally fit by a model consisting of one or two soft thermal components and a comptonized hard component. The two soft components are associated with the radiation from the accretion disk and from the heated hot spots on the NS surface. The hard emission is likely to be produced by thermal Comptonization of the soft photons emitted by the NS surface in the hot accretion column above the NS hot spots (Gierlinski et al. 2002; Poutanen & Gierlinski 2003; Gierlinski & Poutanen 2005; Falanga et al. 2005a; Falanga et al. 2005b, 2007; Papitto et al. 2009; Patruno et al. 2009; Ibragimov & Poutanen 2003).

In this letter we report on the first ~2 weeks of monitoring with *Swift* of the 12th newly discovered AMSP in outburst, IGR J17511−3057. We discuss the evolution of the source X-ray flux and spectrum from the onset of the outburst, when the source was discovered, up to the beginning of the outburst decay. We also detected and analysed three type-I X-ray bursts.

1.1. The source IGR J17511−3057

IGR J17511−3057 was discovered on 2009 September 12 during the *INTEGRAL* Galactic bulge monitoring program (Baldovin et al. 2009; Kuulkers et al. 2007). The source was detected in both the *IBIS/ISGRI* and *JEM-X* mosaics, and its 3–100 keV energy spectrum was modelled by using a power law with index 2.0 ± 0.2. The corresponding flux was 1.1×10^{-9} erg s^{-1} cm^{-2}. A position within 2′ was determined, which allowed identification of IGR J17511−3057 as a new 245 Hz accreting pulsar by means of the *RXTE PCA* bulge scan data (Markwardt et al. 2009). Using this instrument, the source was initially detected on 2009 September 11, but not recognized as a new object due to the proximity of two previously known sources, XTE J1751−305 and GRS 1747−312, the first of which is a 435 Hz X-ray

Table 1. *Swift* observation log of IGR J17511-3057.

OBS ID	Instr.	Start time	Stop time	Exp[a] (s)	N_H (10^{22} cm^{-2})	Γ	kT_{BB} keV	R_{BB}[b] km	F^c_{obs} (erg/cm^2/s)	χ^2_{red}/d.o.f. (C-stat/d.o.f.)
00031492001	XRT/WT	2009-09-13 19:52:24	2009-09-14 00:53:31	2.2E+03	0.6±0.1	$1.3^{+0.2}_{-0.3}$	1.0 ± 0.1	4.6 ± 0.8	$4.9^{+0.1}_{-0.4}$	1.2/447
	XRT/PC	2009-09-13 21:29:48	2009-09-14 01:00:49	1.5E+03	1.0 ± 0.2	1.5 ± 0.1	–	–	4.8 ± 0.3	0.9/81
00031492002	XRT/WT (1)	2009-09-14 13:45:33	2009-09-14 13:49:50	2.5E+02	0.9±0.2	1.5 ± 0.1	–	–	4.8±0.3	1.2/74
	XRT/WT (2)	2009-09-14 15:26:34	2009-09-14 15:29:01	1.5E+02	$0.4^{+0.3}_{-0.2}$	1.0 ± 0.3	–	–	4.5 ± 0.8	1.0/19
	XRT/PC	2009-09-14 13:49:45	2009-09-14 15:37:21	1.6E+03	1.0 ± 0.2	1.5 ± 0.2	–	–	4.5 ± 0.5	1.2/50
00031492003	XRT/WT (1)	2009-09-15 15:31:43	2009-09-15 15:41:25	5.8E+02	0.4 ± 0.2	$0.9^{+0.5}_{-1.4}$	0.9 ± 0.1	$6.0^{+1.4}_{-1.8}$	$4.8^{+0.1}_{-2.3}$	1.1/174
	XRT/WT (2)	2009-09-15 17:12:27	2009-09-15 17:26:00	6.1E+02	$0.4^{+0.2}_{-0.1}$	$0.8^{+0.6}_{-1.5}$	0.9 ± 0.1	$6.3^{+0.9}_{-1.5}$	$4.8^{+0.1}_{-2.1}$	1.2/183
	XRT/PC	2009-09-15 15:41:27	2009-09-15 15:49:56	5.0E+02	0.5 ± 0.3	1.2 ± 0.2	–	–	$5.0^{+0.4}_{-0.6}$	0.9/36
00031492004	XRT/WT (1)	2009-09-16 17:16:29	2009-09-16 17:26:54	6.2E+02	0.3 ± 0.2	$0.5^{+0.7}_{-2.2}$	0.9 ± 0.1	$5.5^{+0.8}_{-1.8}$	$4.5^{+0.1}_{-2.2}$	1.1/170
	XRT/WT (2)	2009-09-16 18:57:28	2009-09-16 19:12:00	8.7E+02	0.7 ± 0.2	1.6 ± 0.4	1.0 ± 0.2	$3.9^{+1.0}_{-0.9}$	$4.0^{+0.2}_{-0.6}$	1.0/221
	XRT/PC	2009-09-16 17:26:57	2009-09-16 17:34:28	4.2E+02	$0.9^{+0.4}_{-0.3}$	1.5 ± 0.3	–	–	$4.2^{+0.2}_{-0.6}$	1.2/32
00031492005	XRT/WT (1)	2009-09-18 20:21:26	2009-09-18 20:24:14	1.7E+02	0.9 ± 0.2	1.4 ± 0.2	–	–	4.8 ± 0.4	0.9/48
	XRT/WT (2)	2009-09-18 23:34:25	2009-09-18 23:39:20	3.0E+02	$0.9^{+0.2}_{-0.1}$	1.5±0.1	–	–	4.6 ± 0.3	0.8/81
	XRT/PC	2009-09-18 20:24:16	2009-09-18 23:43:57	1.1E+03	1.0 ± 0.2	1.6 ± 0.2	–	–	$3.9^{+0.2}_{-0.3}$	1.1/67
00031492006	XRT/WT	2009-09-19 20:27:26	2009-09-19 22:25:50	1.4E+03	0.6 ± 0.2	$1.2^{+0.3}_{-0.5}$	0.9 ± 0.1	$4.6^{+1.4}_{-1.3}$	$4.0^{+0.1}_{-1.4}$	1.0/296
	XRT/PC	2009-09-19 20:27:38	2009-09-19 22:26:57	3.0E+02	$0.6^{+0.5}_{-0.4}$	$1.2^{+0.4}_{-0.3}$	–	–	$4.6^{+0.4}_{-1.0}$	0.9/17
00031492007	XRT/WT (1)	2009-09-20 09:18:13	2009-09-20 09:25:39	4.5E+02	$0.8^{+0.6}_{-0.3}$	$1.9^{+2.5}_{-0.8}$	1.1 ± 0.2	$3.6^{+1.4}_{-0.8}$	$3.6^{+0.4}_{-1.7}$	0.9/110
	XRT/WT (2)	2009-09-20 10:58:54	2009-09-20 11:01:28	1.5E+02	$0.9^{+0.3}_{-0.2}$	1.5±0.2	–	–	$4.0^{+0.3}_{-0.6}$	1.2/38
	XRT/PC	2009-09-20 09:25:42	2009-09-20 11:07:55	6.8E+02	0.9±0.2	1.5 ± 0.2	–	–	$3.6^{+0.2}_{-0.4}$	1.1/47
00031492008	XRT/WT (1)	2009-09-20 20:31:54	2009-09-20 20:34:14	2.0E+02	0.9±0.2	1.6±0.2	–	–	3.6 ± 0.3	1.2/49
	XRT/WT (2)	2009-09-20 22:08:54	2009-09-20 22:09:27	3.2E+01	$1.0^{+0.5}_{-0.4}$	1.9 ± 0.5	–	–	$3.3^{+0.5}_{-1.3}$	(23.0/29)
	XRT/PC	2009-09-20 20:35:18	2009-09-20 22:14:57	5.2E+02	$1.1^{+0.4}_{-0.3}$	1.5 ± 0.3	–	–	$3.5^{+0.3}_{-0.6}$	1.1/34
00031492009	XRT/WT (1)	2009-09-21 06:10:54	2009-09-21 06:16:49	3.6E+02	0.9 ± 0.2	1.6±0.2	–	–	3.7 ± 0.2	1.3/87
	XRT/WT (2)	2009-09-21 07:46:53	2009-09-21 07:52:37	3.4E+02	1.0 ± 0.2	1.7 ± 0.2	–	–	3.5 ± 0.2	1.1/80
	XRT/WT (3)	2009-09-21 09:23:06	2009-09-21 11:04:42	3.9E+02	0.8 ± 0.2	1.4±0.1	–	–	3.9 ± 0.2	1.1/93
	XRT/PC	2009-09-21 06:16:50	2009-09-21 11:40:02	2.9E+03	1.1±0.2	1.7 ± 0.1	–	–	3.2 ± 0.2	0.9/113
00031492010	XRT/WT	2009-09-28 10:16:53	2009-09-28 19:42:14	2.0E+02	1.1 ± 0.3	1.8±0.3	–	–	2.3 ± 0.3	1.1/31
	XRT/PC	2009-09-28 10:17:20	2009-09-28 19:50:57	4.6E+03	1.0 ± 0.2	1.5 ± 0.1	–	–	$2.4^{+0.2}_{-0.1}$	0.9/101
00031492011	XRT/PC	2009-09-30 18:23:35	2009-09-30 23:37:56	5.1E+03	1.1 ± 0.1	1.7±0.1	–	–	2.0±0.1	1.2/204
00371210000	XRT/PC	2009-09-30 18:35:26	2009-09-30 18:57:18	1.3E+03	1.1 ± 0.2	1.7±0.2	–	–	2.2 ± 0.1	0.9/70

a: the total exposure time of each observation; b: calculated by assuming a distance of 10 kpc; c: the (absorbed) flux in the 0.5–10 keV energy band in units of 10^{-10}.

millisecond pulsar. The *RXTE* spectrum could be described by an absorbed power-law model with photon index 1.8 and a 2–10 keV flux of 4×10^{-10} erg s^{-1} cm^{-2}. A *Swift* ToO observation was carried out on 2009 September 13, and it allowed for a preliminary characterization of the soft (0.5–10 keV) X-ray spectrum and the discovery of the first thermonuclear type-I X-ray burst from the source (Bozzo et al. 2009). Burst oscillations at ~245 Hz in other type-I X-ray bursts from this source were reported by Watts et al. (2009). Further follow-up observations of IGR J17511-3057 were carried out later with *XMM-Newton* (Papitto et al. 2009b) and *RXTE* (Riggio et al. 2009). The latter provided the most precise ephemeris of the source and yielded a pulse frequency of 244.83395157(7) Hz, an orbital period of 12487.5126(9) s, and an $a\sin(i)/c$ value of 275.194(3) lt-ms. The mass function of the system is thus 0.00107025(4) $M_\odot$, giving a minimum companion mass of 0.13 $M_\odot$ (assuming an NS mass of 1.4 $M_\odot$ and errors at 1σ c.l. in the last digit). The first accurate source position was determined through a *Chandra* observation at $\alpha_{J2000} = 17^h51^m08\overset{s}{.}66$ and $\delta_{J2000} = -30°57'41\overset{''}{.}0$ (1 σ error of ~0.6″, Nowak et al. 2009), and allowed for identifying its infrared counterpart (Torres et al. 2009). Radio observations at this position did not result in any detection (Miller-Jones et al. 2009).

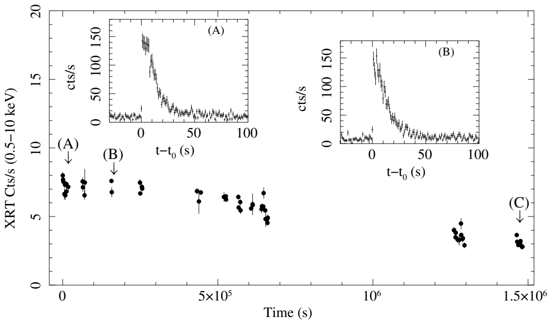

Fig. 1. *Swift*/XRT long-term light curve of the outburst of IGR J17511−3057 (time bin 1000 s, start time 2009 Sept. 13 at 20:00:41 UTC). The arrows in the plot mark the time of the type-I X-ray bursts observed with *Swift*. The two inserts show a zoom of the first two type-I X-ray bursts (time bin is 1 s). The time on the X-axes of these inserts is measured from the t_0 of the bursts. These are 2009 Sept. 14 00:50:27 and 2009 Sept. 15 at 17:17:19 (UTC), respectively. The third type-I X-ray burst (C) is reported in Fig. 2.

2. Data analysis and results

To monitor the X-ray flux of IGR J17511−3057 in outburst, we requested a 2 ks daily observation for the first week, and then two other observations of 5 ks were scheduled during the second week when we noticed that the source X-ray flux was already decreasing after the beginning of the outburst (see Fig. 1). A complete log of the observations is provided in Table 1. We processed all the *Swift* data by using standard procedures (Burrows et al. 2005) and the latest calibration files available (caldb v. 20090407). The *Swift*/XRT data were analysed both in window-timing (WT) and photon-counting (PC) modes (processed with the XRTPIPELINE v.0.12.3). We used *Swift*/BAT data accumulated only in EVENT mode, as the statistics of the data in SURVEY mode were too poor to provide any significant constraint on the source high-energy emission (15–150 keV).

Filtering and screening criteria were applied by using FTOOLS (Heasoft v.6.6.3). We extracted source and background

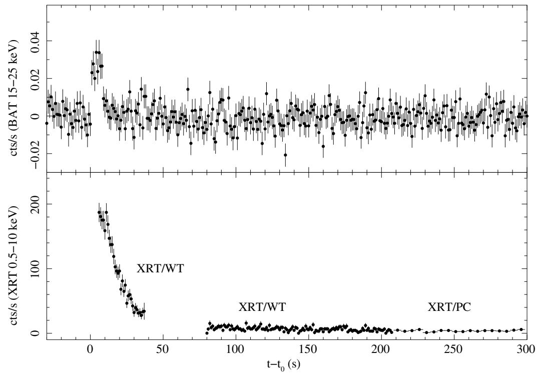

Fig. 2. The brightest type-I X-ray burst observed with *Swift*. The *upper panel* shows the BAT light curve (15–25 keV), whereas in the *lower panel* we reported the XRT light curve (0.5–10 keV). The time bin of the BAT and XRT/WT (XRT/PC) light curves is 1 s (5 s). The start time of the burst is 2009 Sept. 30 18:31:57 (UTC).

light curves and spectra by selecting event grades of 0–2 and 0–12, respectively, for the WT and PC modes. Exposure maps were created through the XRTEXPOMAP task, and we used the latest spectral redistribution matrices in the HEASARC calibration database (v.011). Ancillary response files, accounting for different extraction regions, vignetting, and PSF corrections, were generated by using the XRTMKARF task. All PC data were affected by a strong pile-up, and corrected according to the technique developed by Vaughan (2006). We used the XRTLCCORR task to account for this correction in the background-subtracted light curves.

During the three type-I X-ray bursts we also checked a possible pile-up of the XRT/WT data, caused by the high source count rate. We extracted the source spectrum during the brightest part (6 s) of the three events by adopting a box-shaped extraction region in which we progressively excluded the first and then two, three, and four inner central pixels[1]. These spectra were then fit with an absorbed black body model. We did not notice any significant pile-up in the spectral properties of the source at the peaks of the first two bursts. Only in the third burst (burst "C", see Fig. 2), we noticed that the XRT/WT data of the first two seconds of the burst were affected by a relatively strong pile-up. However, the time interval over which these data were accumulated is too short to apply the correction method described above and obtain a usable spectrum. Therefore, we discarded these first two seconds of observation. The peak luminosity we derive below for the third burst might thus have been somewhat higher than the value we reported, yielding a conservative upper limit on the distance we provide in Sect. 3.

We performed a Fourier analysis of the persistent emission and of the type I X-ray burst emission of IGR J17511-3057 in order to search for the known 245 Hz periodicity of the source. We corrected the photons' arrival times for the orbital motion of the source according to the solution given by Riggio et al. (2009). During the type-I X-ray bursts, we could not detect any periodicity up to 283 Hz given a detection threshold of 5σ. This translates into an upper limit on any fractional amplitude of the pulsed signal of 0.23 (at 3σ confidence level), where the binning effect of the temporal resolution of *Swift*/XRT in WT mode (1.8 ms) has been taken into account (van der Klis 1989). A similar analysis carried out on the persistent emission of the source only led to a marginal 5σ detection of pulsations, corresponding to an amplitude $\gtrsim 0.07$ (3 sigma c.l.). We note that the sensitivity to

[1] see also http://www.swift.ac.uk/pileup.shtml

Table 2. The three type-I X-ray bursts parameters.

Burst	A	B	C
$\tau_{\rm lc}$ (s)^a	11.2 ± 0.8	12.5 ± 0.8	14.3 ± 0.9
$F_{\rm peak}$ (10^{-8} erg cm^{-2} s^{-1})^b	3.0 ± 0.6	2.4 ± 0.5	3.1 ± 0.3
f_b (10^{-7} erg cm^{-2})^c	2.7 ± 0.2	2.8 ± 0.2	4.8 ± 0.3
$F_{\rm pers}$ (10^{-9} erg cm^{-2} s^{-1})^d	3.1 ± 0.4	3.5 ± 0.3	0.95 ± 0.09
$\gamma \equiv F_{\rm pers}/F_{\rm peak}$ (10^{-2})	10 ± 3	14 ± 4	3.1 ± 0.6
τ (s) $\equiv f_b/F_{\rm peak}$	9 ± 3	12 ± 3	16 ± 3

a: burst *e*-folding decay time. The $\chi^2_{\rm red}$/d.o.f. of the fits are 1.4/98, 1.2/86, and 1.3/29, respectively, for the burst A, B, and C; *b*: net unabsorbed peak flux; *c*: net unabsorbed burst fluence; and *d*: Unabsorbed persistent flux (all given in 0.1–100 keV).

periodic signals is hampered here by the lower number of photons collected by *Swift*/XRT than by, e.g. RXTE/PCA, with which the pulsations and the burst oscillations were detected from this source (see Sect. 1). In Fig. 1 we show the source light curve during about two weeks of monitoring.

2.1. Persistent emission

We extracted the source spectrum in the 0.5–10 keV energy band for each observation in Table 1 excluding the time intervals in which a type I X-ray burst was detected. We excluded about ~100 s before and after the bursts in the observations 00031492001 and 003. In those observations in which the XRT/WT data were accumulated during two or three different revolutions of the satellite, we extracted the X-ray spectrum separately to search for spectral variations. We indicated these different spectra in Table 1 by using the notation "1", "2", and "3". The XRT/WT spectra with the higher statistics (observation ID: 00031492001, 003, 004, 006, 007) could not be fit by only using a simple absorbed power-law ($\Gamma \sim 1$–2) model (reduced $\chi^2 \sim 1.5$–1.9, d.o.f. in the range 112–447), and the addition of a second component was required by the data. According to previous studies of AMSPs in outburst, we tried a model comprising an absorbed power law (PL) plus a black body (BBODYRAD in XSPEC, hereafter BB) or a disk black body (DISKBB in XSPEC) component. We found that the latter choice would need a highly improbable physical explanation to account for the large, inner accretion radius (a few hundred km) implied by the DISKBB model. As the spectra collected at higher statistics for this and similar sources show two soft components arising from the disk and the NS surface (see Sect. 1), we interpret the soft component detected with *Swift* as originating in the NS hotspots. Our interpretation is strengthened as it provides an area for the BB-emitting region that is fully compatible with the NS surface. This is shown in Table 1 (errors at 90% c.l.). We checked that the fits to the *Swift*/XRT spectra cannot be improved significantly by introducing a Comptonization model instead of a simple power law above ~2 keV. We tried a COMPTT model in XSPEC with different values of the seed photon temperature. The estimated column density is ~0.5–1×10^{22} cm^{-2}, compatible with the Galactic absorption in the direction of the source (Dickey & Lockman 1990). The 0.5–10 keV X-ray flux of the source decreased slowly from 5.0×10^{-10} erg cm^{-2} s to 2.0×10^{-10} erg cm^{-2} s during the first two weeks of observation.

2.2. Type I X-ray bursts

We also detected in the *Swift* observations three type-I X-ray bursts. The light curves of these bursts are reported in Figs. 1 and 2. The start time of the third burst was determined by *Swift*/BAT (XRT started observing the source only about ~5 s later). We performed a time-resolved spectral analysis of the three bursts by accumulating the XRT/WT spectra in intervals of different durations (from 1 to 10 s), depending on the source count rate. This time-resolved analysis did not reveal a clear signature of a photospheric radius expansion (PRE) in any of the three bursts (Lewin et al. 1993). The relevant parameters for each burst are reported in Table 2. Here the peak flux of each burst was determined from a BB fit to the spectrum of the initial 6 s of each burst (fixing the $N_{\rm H}$ at 0.6, see Table 1). The persistent spectrum determined from the closest XRT/WT observation to each of the burst was used as a background in the fit. We indicated with $\tau_{\rm lc}$ the decay time of the burst measured by fitting the observed light curve with an exponential function, and τ is the duration of the burst (see e.g. Lewin et al. 1993).

3. Discussion and conclusions

In this letter we reported on the results of the first ~2 weeks of the *Swift* monitoring of the newly discovered AMSP IGR J17511−3057 in outburst. Regarding the persistent emission of this source, the higher statistics spectra measured with XRT/WT showed that two different components were required to fit the data. These comprise a BB emission that we interpreted as being produced onto the NS surface (as suggested by the size of the measured radius compatible with a hotspot origin), and a power-law component that is most likely caused by the comptonization of the soft emission in the NS accretion column (see Sect. 1). This spectrum qualitatively agrees with observations of other AMSPs in outburst and with the preliminary results of the *XMM-Newton* observation of IGR J17511−3057 reported by Papitto et al. (2009b). At odds with their analysis, we could not detect the softest component of the spectrum that was modelled with a multicolor disk blackbody (temperature of 0.13 ± 0.1 keV). This most likely stems from the lower statistics and the short exposure time of the XRT spectra compared to what is obtained with *XMM-Newton* (exposure time ~71 ks).

From the analysis of the type-I X-ray bursts, we can estimate an upper limit on the source distance. In principle, determination of the distance can be obtained only when a burst undergoes a PRE; in this case, it is assumed that the bolometric peak luminosity of the source is saturated at the Eddington limit, $L_{\rm Edd} \approx 3.8\times10^{38}$ erg s^{-1} (as empirically derived by Kuulkers et al. 2003). Unfortunately, in the case of IGR J17511−3057, our time-resolved analysis of the bursts could not detect any evidence of a PRE. From the measured orbital period (several hours) and the mass function of IGR J17511−3057, we can argue that the companion star in this system is most likely a hydrogen-rich brown dwarf, as suggested in the case of SAX J1808.4−3658 (Bildsten & Chakrabarty 2001).

Similar to the case for this source, we thus expect that the time elapsed between different bursts is long enough to allow the hot CNO burning to deplete the accreted hydrogen. Therefore, the type I X-ray bursts of IGR J17511−3057 are most likely produced by the ignition of pure helium. Under the above assumptions, the peak luminosity of the brightest burst (C) can then be considered to be (at most) the Eddington value $L_{\rm Edd} \approx 3.8\times10^{38}$ erg^{-1}, and the resulting upper limit on the source distance is d = 10.1 ± 0.5 kpc. For comparison, the theoretical value of this distance found by assuming an helium atmosphere and canonical NS parameters (1.4 solar mass, and a radius of 10 km; see e.g., Lewin et al. 1993), is 8.9 ± 0.4 kpc. By using the above results, we can also evaluate the theoretically expected recurrence time of the bursts. With a distance of d=10 kpc, the persistent unabsorbed 0.1–100 keV flux of the source at the time of the bursts (A), (B), and (C) would translate into a bolometric luminosity of $L_{\rm pers} \approx 3.7, 4.2, 1.1\times10^{37}$ erg s^{-1}, respectively.

With these values at hand, we can estimate the local accretion rate per unit area, $\dot{m}$, through the relation $L_{\rm pers} = 4\pi R^2\dot{m}(GM/R)/(1+z)$ (with z = 0.31 the NS gravitational redshift; see e.g., Lewin et al. 1993). The ignition depths, $y_{\rm ign}$ for the three bursts can be calculated by using the equation $E_{\rm burst} = 4\pi R^2 y_{\rm ign} Q_{\rm nuc}/(1+z)$, where $E_{\rm burst} = 4\pi d^2 f_{\rm b}$, $f_{\rm b}$ is the fluence of the burst (see Table 2), and $Q_{\rm nuc} \approx 1.6$ MeV corresponds to the nuclear energy release per nucleon for complete burning of helium to iron group elements (Wallace & Woosley 1981). We obtain $y_{\rm ign}$ = 2.2,2.4, 4.0×10^8 g cm^{-2} for the bursts (A), (B), and (C), respectively. For the above values of the local accretion rates and ignition depths, the expected recurrence time of the bursts is about $\Delta t = (y_{\rm ign}/\dot{m})(1+z) \simeq 0.2$–0.9 days. This agrees with the recurrence time measured from the *XMM-Newton* (two bursts in ~71 ks, Papitto et al. 2009b) and *INTEGRAL* observations (4 bursts in ~200 ks carried out from 2009 September 16 to 2009 September 19, Falanga et al. 2009, in preparation).

Several more *Swift* observations of IGR J17511−3057 have already been planned. The results of this long-term monitoring campaign will be reported elsewhere (Campana et al. 2009, in preparation).

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References

Altamirano, D., Casella, P., Patruno, et al. 2008, ApJ, 674, L45
Altamirano, D., Strohmayer, T. E., Heinke, C. O., et al. 2009, Astr. Tel., 2182
Baldovin, C., Kuulkers, E., Ferrigno, C., et al. 2009, Astr. Tel. 2196
Bhattacharya, D., & van den Heuvel, E. P. J. 1991, Ph.R., 203, 1
Bildsten, L., & Chakrabarty, D. 2001, ApJ, 557, 292
Bozzo, E., Ferrigno, C., Kuulkers, E., et al. 2009, Astr. Tel. 2198
Burrows, D. N., Hill, J. E., Nousek, et al. 2005, SSRv, 120, 165
Casella, P., Altamirano, D., Patruno, A., et al. 2008, ApJ, 674, L41
Dickey, J. M., & Lockman, F. J. 1990, ARA&A, 28, 215
Falanga, M., Bonnet-Bidaud, J. M., Poutanen, J., et al. 2005a, A&A, 436, 647
Falanga, M., Kuiper, L., Poutanen, J., et al. 2005b, A&A, 444, 15
Falanga, M., Poutanen, J., Bonning, et al. 2007, A&A, 464, 1069
Galloway, D. K., & Cumming, A. 2006, ApJ, 652, 559
Galloway, D. K., Morgan, E. H., Krauss, M. I., et al. 2007, ApJ, 654, L73
Gierlinski, M., & Poutanen, J. 2005, MNRAS, 359, 1261
Gierlinski, M., Done, C., & Barret, D. 2002, MNRAS, 331, 141
Kaaret, P., Morgan, E. H., Vanderspek, R., et al. 2006, ApJ, 638, 963
van der Klis, M., 198, proceedings of the NATO Advanced Study Institute on Timing Neutron Stars, 27
Kuulkers, E., den Hartog, P. R., in't Zand, J. J. M., et al. 2003, A&A, 399, 663
Kuulkers, E., Shaw, S. E., & Paizis, A. 2007, A&A, 466, 595
Ibragimov, A., & Poutanen, J. 2009, MNRAS, 400, 492
Lewin, W. H. G., van Paradijs, J., & Taam, R. E. 1993, SSRv, 62, 223
Markwardt, C. B., Altamirano, D., Swank, J. K., et al. 2009, Astr. Tel., 2197
Miller-Jones, J. C. A., Russell, D. M., & Migliari, S. 2009, Astr. Tel., 2232
Nowak, M. A., Paizis, A., Wilms, J., et al. 2009, Astr. Tel. 2215
Papitto, A., Di Salvo, T., DÁi, A., et al. 2009a, MNRAS, 493, 39
Papitto, A., Riggio, A., Burderi, L., et al. 2009b, Astr. Tel. 2220
Patruno, A., Rea, N., Altamirano, D., et al. 2009, MNRAS, 396, 51
Poutanen, J., & Gierlinski, M. 2003, MNRAS, 343, 1301
Riggio, A., Papitto, A., Burderi, L., et al. 2009, Astr. Tel. 2221
Torres, M. A. P., Jonker, P. G., Steeghs, D., et al. 2009, Astr. Tel., 2233
Vaughan, S., Goad, M. R., Beardmore, A. P., et al. 2006, ApJ, 638, 920
Wallace, R. K., & Woosley, S. E. 1981, ApJS, 45, 389
Watts, A. L., Altamirano, D., Markwardt, C. B., et al. 2009, Astr. Tel. 2199
Wijnands, R., & van der Klis, M. 1998, Nature, 344, 346
Wijnands R., 2006, in Trends in Pulsar Research, Nova Science Publishers, ed. J. A. Lowry, New York, 53