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Letter to the Editor

A remarkable recurrent nova in M 31 - The X-ray observations

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ABSTRACT

Context. Another outburst of the recurrent M 31 nova M31N 2008-12a was announced in late November 2013. Optical data suggest an unprecedentedly short recurrence time of approximately one year.
Aims. In this Letter we address the X-ray properties of M31N 2008-12a.
Methods. We requested *Swift* monitoring observations shortly after the optical discovery. We estimated source count rates and extracted X-ray spectra from the resulting data. The corresponding ultraviolet (UV) data was also analysed.
Results. M31N 2008-12a was clearly detected as a bright supersoft X-ray source (SSS) only six days after the well-constrained optical discovery. It displayed a short SSS phase of two weeks duration and an exceptionally hot X-ray spectrum with an effective blackbody temperature of $\sim$ 97 eV. During the SSS phase the X-ray light curve displayed significant variability that might have been accompanied by spectral variations. The very early X-ray variability was found to be anti-correlated with simultaneous variations in the UV flux.
Conclusions. The X-ray properties of M31N 2008-12a coherently point towards a high-mass white dwarf in the nova system. This object might be a promising Type Ia supernova progenitor. We re-discovered additional X-ray detections of M31N 2008-12a that are consistent with our data and increase the number of known nova outbursts to seven. This nova is an exceptional object that merits further attention in the future.

Key words. Galaxies: individual: M 31 – novae, cataclysmic variables – X-rays: binaries – stars: individual: M31N 2008-12a

1. Introduction

Recurrent Novae (RNe) are those for which more than one nova outburst has been observed. As in the case for Classical Novae, the outburst is caused by a thermonuclear runaway in an accreted envelope of matter on top of a white dwarf (WD) in a close binary system (see Bode & Evans 2008, for recent reviews). A proportion of the accreted matter is ejected during the outburst and forms a drastically enlarged pseudo-photosphere, thereby leading to the optical nova. The matter remaining on the WD hosts stable hydrogen burning soon after the outburst. This process powers a supersoft X-ray source (SSS; photon energies below 1 keV, see Parmar et al. 1998) that can be observed once the ejected matter becomes optically thin to soft X-rays.

While the optical characteristics of a nova depend on the properties of the ejected envelope, only X-ray measurements allow us to observe the WD directly and study its physics. Novae with a short SSS phase are expected to host a massive WD (e.g. Hachisu & Kato 2006, 2010). Also, a high effective temperature of the SSS indicates a high-mass WD (Sala & Hernanz 2005). A massive WD is required to produce recurrence times that are short enough to be observed (Truran & Livio 1986; Yaron et al. 2005). The shortest time between two confirmed nova outbursts was eight years for the Galactic RN U Sco (Schaefer 2010). In the single-degenerate scenario of Type Ia supernova (SN Ia) progenitors, RNe correspond to the final stage of the binary evolution (see Hachisu et al. 1999b,a).

Novae in our neighbour galaxy M 31 (distance 780 kpc; Holland 1998; Stanek & Garnavich 1998) have been observed for almost a century. Currently, almost a thousand nova outbursts are known in M 31 (see the online catalogue[1] of Pietsch et al. 2007). Dedicated X-ray monitoring observations of M 31 novae together with archival studies compiled a sample of 79 novae with SSS counterparts (see Henze et al. 2013c, hereafter HPH2013, and references therein). A statistical analysis of this sample revealed strong correlations between optical and X-ray parameters, showing that novae that decline fast in the optical are hot in X-rays with short SSS durations (HPH2013).

Nova M31N 2008-12a was first discovered in Dec 2008 by F. Kabashima & K. Nishiyama[2]. Two additional eruptions were found in Oct 2011 and Oct 2012, with the latter being classified as the outburst of a He/N nova by Shafter et al. (2012). For a comprehensive description of the optical properties and the identification of the latter outbursts with M31N 2008-12a see the accompanying Letter by Darnley et al. (2014, hereafter DWB2014). In Nov 2013, another outburst was detected by Tang et al. (2013) and this Letter focusses on the results from the subsequent X-ray monitoring.

[1] http://www.mpe.mpg.de/~m31novae/opt/m31/index.php
[2] http://www.cbat.eps.harvard.edu/CBAT_M31.html#2008-12a

2. Observations and data analysis

Soon after the announcement of the Nov 2013 outburst of M31N 2008-12a we requested a target of opportunity (ToO) X-ray monitoring with *Swift* (Gehrels et al. 2004). The extremely short recurrence time suggested a high-mass WD, the SSS phase of which we aimed successfully to detect and characterise. All observations are summarised in Table 1. Additionally, in Table 2 we list all observations of a *Swift* monitoring programme after the 2012 outburst that did not detect any X-ray source.

The *Swift* X-ray telescope (XRT; Burrows et al. 2005) data analysis was based on the cleaned event files. We derived the count rates given in Table 1 using the source statistics (`sosta`) tool within the HEAsoft XIMAGE package (version 4.5.1.). This method takes into account the background, estimated in a source-free region around the object, as well as corrections for sampling dead time, vignetting and point spread function (PSF). The upper limits in Tables 1 and 2 were computed assuming a PSF constructed from the merged data of all detections.

The source and background photons were extracted from the event files within the HEAsoft Xselect environment (version v2.4c). The spectral analysis used XSPEC (Arnaud 1996, version 12.8.1g) with the Tübingen-Boulder ISM absorption model (`TBabs` in XSPEC), the photoelectric absorption cross-sections from Balucinska-Church & McCammon (1992) and the ISM abundances from Wilms et al. (2000). All spectra were binned to include at least one photon per bin and fitted in XSPEC assuming Poisson statistics according to Cash (1979).

The ultraviolet (UV) magnitudes are given in the Vega system and were determined using the `uvotsource` tool. All magnitudes assume the *Swift* UV/optical telescope (UVOT, Roming et al. 2005) photometric system (Poole et al. 2008) and have not been corrected for extinction.

All upper limits correspond to 3σ confidence and all error ranges to 1σ confidence unless otherwise noted.

3. Results

Nova M31N 2008-12a was clearly detected by *Swift* as a bright X-ray source following its 2013 outburst (first announced by Henze et al. 2013a). Based on the unprecedentedly short recurrence time we had expected a massive WD that should display a fast SSS appearance (according to Hachisu & Kato 2010, HPH2013). Consequently, the *Swift* monitoring was designed to start as soon as possible to constrain the beginning of the SSS phase. Surprisingly, the SSS turned on even faster than expected and the first observation, approximately six days after discovery, detected a bright SSS. The source was monitored with *Swift* until the SSS turned off two weeks later (see Table 1).

The source position, as determined from the merged XRT event files of all detections, is RA = 00h45m29.29s, Dec = +41°54′08″.5 (J2000; 90% confidence error 3″.6). Although this is 4″.8 away from the optical coordinates reported by Tang et al. (2013) (RA = 00h45m28.89s, Dec = +41°54′10″.2) both positions are consistent ($\sim 2\sigma$ level) due to the large uncertainties. Moreover, the appearance of the X-ray source soon after the optical nova outburst as well as its characteristics (see below) leave little doubt that both events are related. Therefore, we identify the transient X-ray source as the counterpart of M31N 2008-12a.

The best-fit parameters for a simultaneous fit of all X-ray spectra with a black body model are $kT = (97^{+5}_{-4})$ eV and $N_{\rm H} = (1.4^{+0.2}_{-0.3}) \times 10^{21}$ cm^{-2}. A χ^2 test statistic for this fit gave a reduced χ^2 of 1.19 for 574 degrees of freedom. The estimated kT is exceptionally high for an M 31 nova (cf. HPH2013). From the M 31 reddening maps of Montalto et al. (2009) we derived an approximate E(B-V) ~ 0.26 for the position of M31N 2008-12a. This corresponds to $N_{\rm H} \sim 1.8 \times 10^{21}$ cm^{-2} (using the relation of Güver & Özel 2009), which is consistent with the best-fit value.

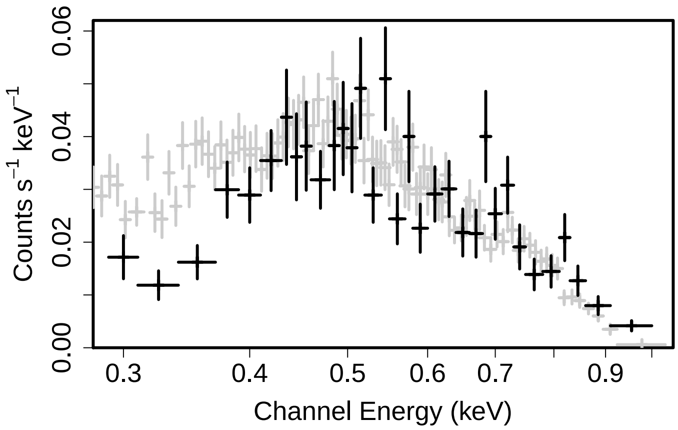

Fig. 1. *Swift* XRT spectrum extracted from merged event files. This is shown only for visualising the high effective temperature. Model fitting was performed on the individual spectra. In grey we show for comparison a scaled spectrum of the bright and hot nova M31N 2007-12b (Pietsch et al. 2011) which is a suspected RN (Bode et al. 2009).

A spectrum extracted from the combined event files of all detections is shown in Fig. 1. This spectrum was grouped to include at least 20 counts per bin and is only used for visualisation. Practically all source photons have energies below 1 keV. This source is clearly a SSS. Because the Wien tail of the spectrum extends to (relatively) high energies we can infer that the SSS is unusually hot even without the use of specific spectral models (which are controversial, see e.g. Ness et al. 2013).

In Fig. 2a we show the X-ray light curve of the nova during the 2013 outburst. This plot and Table 1 assume that the optical outburst occurred between the last upper limit and the first detection reported by Tang et al. (2013), i.e on Nov 26.6 2013 (with an uncertainty of ±0.5 d). Following the first detection of the SSS on day six after the outburst its count rate increased and subsequently showed significant variability (see Fig. 2a). This variation was not due to instrumental vignetting or bad columns. The count rate started dropping on day 16 and the source disappeared a few days later. The last detection in an individual observation on day 18 showed a count rate that was approximately an order of magnitude below the peak level (see also Table 1).

The SSS might still have been detected at the 2σ level in the merged 14.3 ks of the last five upper limit observations. However, with $(7.7 \pm 3.4) \times 10^{-4}$ ct s^{-1} its count rate would have been more than an order of magnitude below the bright phase. Therefore, this bright SSS phase which indicates stable hydrogen burning (see e.g. Sala & Hernanz 2005), was definitely over at this point. Consequently, we assume a SSS turn-off time ($t_{\rm off}$) of (19 ± 1) d. This is consistent with the results of the low-cadence *Swift* monitoring following the 2012 eruption that failed to detect a SSS ~ 20 d after outburst (see Table 2 and Fig. 2a).

The X-ray variability might have been accompanied by spectral variation. In Fig. 2b we show the results of a simultaneous fitting (with $N_{\rm H}$ fixed to the global best fit) of separate groups of consecutive observations with similar count rate. Figure 2b shows indications for lower effective temperatures at the very beginning and end of the SSS phase. We also fitted the second and sixth temperature bin (low count rates) and the third and fifth bin (high count rates) in Fig. 2b simultaneously with fixed

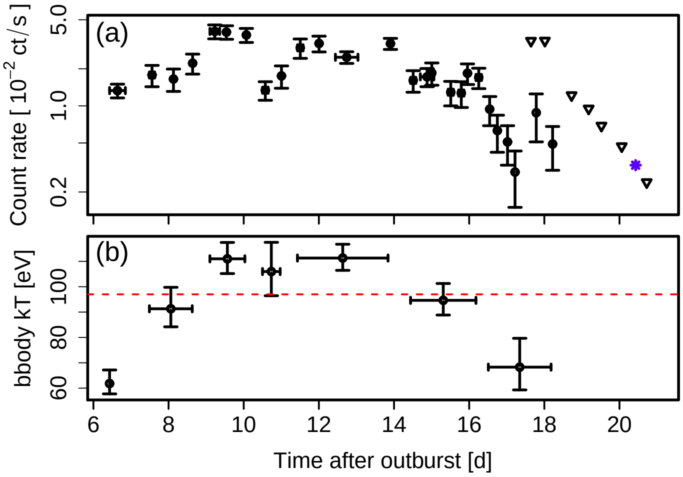

Fig. 2. Evolution of X-ray count rate (a) and effective black body temperature (b) of M31N 2008-12a during the 2013 *Swift* monitoring. This assumes an outburst on 2013-11-26.60 UT (see also Table 1). The error bars in time represent the duration of the individual observation (a) or the time between the grouped observations (b). *Panel a:* Upper limits are indicated by black open triangles. A blue asterisk marks the first upper limit estimated from the *Swift* monitoring after the 2012 outburst (see Table 2). *Panel b:* Groups of observations have been fitted simultaneously with the N_H fixed to the global best fit. The red dashed line shows the overall best-fit temperature derived in Sect. 3.

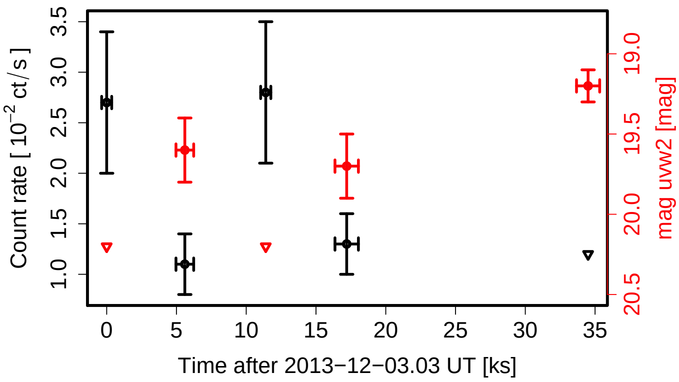

Fig. 3. Short-term X-ray and UV light curves for the five snapshots of *Swift* observation 00032613005 on day six after outburst (see Table 1).

absorption. These groups of observations represent the high- and low-luminosity states of M31N 2008-12a, with the forth temperature bin possibly belonging to a transitory stage. The resulting best-fit temperatures were found to be different, albeit with weak significance: $kT = (105 \pm 3)$ eV (high) vs (91 ± 4) eV (low).

Furthermore, we found significant X-ray variability within the first (6 ks) *Swift* observation of the 2013 outburst (see also Henze et al. 2013b). This count rate variation was accompanied by variability in the UV. Subsequently, no significant UV variations were found against a gradual decline (see Table 1). In Fig. 3 we show both short-term light curves based on the individual *Swift* snapshots during the first detection. They appear to be anti-correlated. This process could indicate the gradual emergence of the SSS. Therefore, we estimate a SSS turn-on time (t_{on}) of (6 ± 1) d.

4. Discussion

4.1. Variability

Significant X-ray variability during the early stages of the SSS phase has been observed in several Galactic novae (e.g. KT Eri, RS Oph; Bode et al. 2010; Osborne et al. 2011). One interpretation of this effect is a variable absorption column during the emergence of the SSS from the expanding ejecta and/or optically thick wind (see e.g. Hachisu & Kato 2006). Short-term X-ray variability of various kinds has been observed in the M 31 nova sample (see HPH2013).

The anti-correlation between X-ray and UV flux during the early SSS phase (Fig.3) and the later possible temperature variations (Fig. 2b) might point towards intrinsic variations in the WD temperature. Schwarz et al. (2011) suggested a similar scenario to explain the anti-correlated X-ray and UV variability during the SSS phase of the Galactic nova V458 Vul (see also Ness et al. 2009). They drew an interesting parallel to the variability in persistent SSSs which might originate in accretion-rate variations that cause the WD photosphere to expand or shrink (see Reinsch et al. 2000; Greiner & Di Stefano 2002). Based on its frequent outbursts and evidence from the optical data (DWB2014) M31N 2008-12a is likely to have a high accretion rate. The observed variability might indicate that accretion had been re-established as early as six days after outburst.

4.2. Theoretical implications of the short recurrence time

Theoretically, a recurrence period (τ_r) of order one year is only expected for extremely massive WDs ($\gtrsim 1.35 M_\odot$) with a high mass accretion rate exceeding 10^{-7} $M_\odot$ yr^{-1} (Wolf et al. 2013, Saio et al. 2014, in prep.). A massive WD is consistent with the high temperature suggested in our X-ray spectra (Sect. 3, Fig. 1). For such a short τ_r, however, the accreted mass is too small (several 10^{-7} $M_\odot$) for the pseudo-photosphere to bloat to a red-giant size. Therefore, we would expect a relatively high effective surface temperature even at the optical maximum that results in a faint peak magnitude. The shorter the τ_r, the fainter the peak magnitude.

The low peak brightness of M31N 2008-12a (never above 18th mag, see DWB2014) seems consistent with this scenario. While high accretion rates can also trigger hydrogen shell flashes on less massive WDs without causing a nova (see Jose et al. 1993), the observed evidence suggests that M31N 2008-12a was experiencing actual nova outbursts. Optically faint novae with fast and hot SSS phase might generally be good RN candidates.

An extremely massive WD can be born as an ONe WD in the final stage of stellar evolution for a narrow range of zero-age main-sequence mass ($\sim$ 8–10 $M_\odot$). Another possibility is mass-accretion onto an initially less massive WD in a binary system. If a (CO) WD was born with $M_{WD} < 1.07$ $M_\odot$ and accumulates mass until reaching the Chandrasekhar mass it will explode as a SN Ia. RNe with short τ_r correspond to immediate progenitors of SNe Ia in the single degenerate scenario (Hachisu et al. 1999b,a).

4.3. Population picture

In Fig. 4 we show the position of M31N 2008-12a in the five-parameter space of the correlations presented by HPH2013 for the M 31 nova sample. The SSS time scales were unprecedentedly short, also compared to Galactic novae where e.g. the fastest t_{on} was displayed by the RN U Sco ($\gtrsim$ 8 d; Schlegel et al. 2010). The average SSS temperature seems considerably higher than measured for any other M 31 nova and

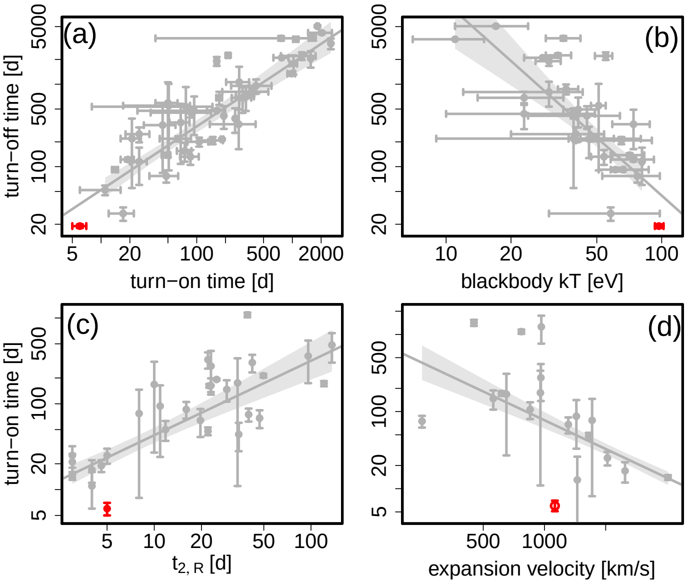

Fig. 4. Double-logarithmic plots of the nova parameter correlations from HPH2013. The solid grey lines indicate a robust powerlaw fit with corresponding 95% confidence regions in light grey. The correlations displayed are: (a) $t_{\rm on}$ vs $t_{\rm off}$, (b) black body kT vs $t_{\rm off}$, (c) R band optical decay time $t_{2,R}$ vs $t_{\rm on}$, and (d) expansion velocity vs $t_{\rm on}$. All time scales are in units of days after outburst. Overplotted in red are the parameters of M31N 2008-12a as derived in Sect. 3 or by DWB2014.

might have been even hotter during the high-count rate observations (see Sect. 3 and Fig. 2b). Overall, the X-ray parameter relations (Figs. 4a and b) are broadly consistent with the population trends. M31N 2008-12a therefore provides an important extension of these relations into previously unpopulated regions of the parameter space.

The two optical parameters, $t_{2,R}$ and $v_{\rm exp}$ (see DWB2014), show stronger deviations from the rest of the nova sample. Such a behaviour might be consistent with a fainter nova outburst as suggested by theoretical models (Sect. 4.2). However, for the two correlations in Figs. 4c and d the scatter is generally larger. At this stage, it is difficult to determine whether the connection between the optical and X-ray parameters of M31N 2008-12a is significantly different from the overall population trend.

4.4. Previous X-ray outbursts

During a literature search we found that M31N 2008-12a had actually been detected in X-rays before the first optical outburst was reported. It was initially discovered as the "recurrent supersoft X-ray transient" RX J0045.4+4154 by White et al. (1995) based on archival ROSAT data. Because no optical nova was known before 2008, this source was not recognised as a nova counterpart by Pietsch et al. (2005) in the course of their archival analysis. White et al. (1995) reported two X-ray outbursts in Feb 1992 and Jan 1993. The recurrence time of approximately one year as well as the short duration of the outbursts and the high black body temperature ($\sim$ 90 eV) estimated by White et al. (1995) are well in agreement with the results reported here.

Furthermore, another outburst of this "known recurrent transient" was reported by Williams et al. (2004) in *Chandra* data taken in Sep 2001. Because this observation used the HRC detector no X-ray spectrum exists. The outburst was shorter than five months. Overall, there is strong evidence that M31N 2008-12a had at least three outbursts before 2008. A follow-up paper will study the optical and X-ray archives in more detail.

5. Conclusions

The X-ray properties of M31N 2008-12a suggest coherently that the binary system hosts a high-mass WD. The fast recurrence times and optical evidence indicate a high accretion rate the re-establishing of which could explain the observed early X-ray and UV variability. M 31 remains a treasure island for nova science and might hold the key to the understanding of the (potentially numerous) optically faint RNe and their impact on SN Ia progenitor theories. The position of M31N 2008-12a will be watched closely (in particular) in late 2014.

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Table 1. *Swift* observations of nova M31N 2008-12a.

ObsID	Exp[a] [ks]	Date[b] [UT]	MJD[b] [d]	Δt^c [d]	UV[d] [mag] uvm2	uvw1	uvw2	Rate [10^{-2} ct s^{-1}]	$L_{0.2-1.0}$ [e] 10^{38} erg s^{-1}]
00032613005	6.0	2013-12-03.03	56629.03	6.43	-	-	19.4 ± 0.1	1.3 ± 0.2	1.0 ± 0.1
00032613006	2.0	2013-12-04.09	56630.09	7.49	19.8 ± 0.3	> 19.5	19.7 ± 0.2	1.8 ± 0.4	1.3 ± 0.3
00032613007	2.0	2013-12-04.70	56630.70	8.10	19.4 ± 0.2	19.4 ± 0.2	19.3 ± 0.2	1.7 ± 0.3	1.2 ± 0.3
00032613008	1.7	2013-12-05.23	56631.23	8.63	20.0 ± 0.4	19.6 ± 0.2	19.8 ± 0.3	2.2 ± 0.4	1.7 ± 0.3
00032613009	1.9	2013-12-05.70	56631.70	9.10	19.8 ± 0.3	> 19.9	19.9 ± 0.3	4.0 ± 0.5	3.0 ± 0.4
00032613010	2.0	2013-12-06.10	56632.10	9.50	19.9 ± 0.3	19.8 ± 0.3	19.5 ± 0.2	4.0 ± 0.5	3.0 ± 0.4
00032613011	2.0	2013-12-06.63	56632.63	10.03	> 20.2	19.7 ± 0.3	20.0 ± 0.3	3.8 ± 0.5	2.8 ± 0.4
00032613012	3.3	2013-12-07.10	56633.10	10.50	20.1 ± 0.2	> 19.8	20.2 ± 0.3	1.3 ± 0.2	1.0 ± 0.2
00032613013	1.8	2013-12-07.57	56633.57	10.97	20.1 ± 0.4	19.4 ± 0.2	19.6 ± 0.2	1.7 ± 0.4	1.3 ± 0.3
00032613014	1.5	2013-12-08.03	56634.03	11.43	19.6 ± 0.3	> 20.0	19.9 ± 0.3	3.0 ± 0.5	2.2 ± 0.4
00032613015	1.8	2013-12-08.57	56634.57	11.97	19.9 ± 0.4	20.0 ± 0.3	> 20.3	3.2 ± 0.5	2.4 ± 0.4
00032613016	4.4	2013-12-09.03	56635.04	12.44	19.8 ± 0.2	19.7 ± 0.3	20.0 ± 0.2	2.5 ± 0.3	1.9 ± 0.2
00032613017	3.8	2013-12-10.44	56636.44	13.84	> 20.6	19.9 ± 0.2	20.0 ± 0.2	3.2 ± 0.3	2.4 ± 0.2
00032613018	2.1	2013-12-11.04	56637.04	14.44	20.0 ± 0.4	> 20.2	> 20.4	1.6 ± 0.3	1.2 ± 0.2
00032613019	3.0	2013-12-11.31	56637.30	14.70	20.1 ± 0.3	19.6 ± 0.3	20.2 ± 0.3	1.7 ± 0.3	1.3 ± 0.2
00032613020	1.9	2013-12-11.57	56637.57	14.97	> 20.0	19.6 ± 0.3	19.9 ± 0.3	1.9 ± 0.4	1.4 ± 0.3
00032613021	1.9	2013-12-12.04	56638.04	15.44	19.9 ± 0.2	-	-	1.3 ± 0.3	1.0 ± 0.2
00032613022	1.9	2013-12-12.32	56638.32	15.72	20.4 ± 0.3	-	-	1.3 ± 0.3	1.0 ± 0.2
00032613023	1.9	2013-12-12.51	56638.52	15.92	20.2 ± 0.4	19.8 ± 0.3	20.0 ± 0.3	1.8 ± 0.4	1.4 ± 0.3
00032613024	2.1	2013-12-12.78	56638.78	16.18	> 20.9	-	-	1.7 ± 0.3	1.3 ± 0.2
00032613025	2.0	2013-12-13.10	56639.11	16.51	-	19.8 ± 0.2	-	0.9 ± 0.2	0.7 ± 0.2
00032613026	1.9	2013-12-13.31	56639.31	16.71	-	20.4 ± 0.3	-	0.6 ± 0.2	0.5 ± 0.2
00032613027	1.9	2013-12-13.58	56639.58	16.98	-	20.2 ± 0.2	-	0.5 ± 0.2	0.4 ± 0.1
00032613028	2.0	2013-12-13.78	56639.78	17.18	> 20.2	> 20.2	> 20.5	0.3 ± 0.1	0.2 ± 0.1
00032613029	0.3	2013-12-14.24	56640.24	17.64	-	-	-	< 3.4	< 2.5
00032613030	0.9	2013-12-14.38	56640.38	17.78	-	-	-	0.9 ± 0.4	0.7 ± 0.3
00032613031	1.9	2013-12-14.52	56640.52	17.92	-	-	-	< 3.4	< 2.5
00032613032	1.9	2013-12-14.78	56640.78	18.18	> 20.2	20.1 ± 0.4	20.3 ± 0.3	0.5 ± 0.2	0.4 ± 0.1
00032613036	1.6	2013-12-15.06	56641.06	18.46	> 20.1	> 20.0	> 20.3	< 1.2	< 0.9
00032613033	1.4	2013-12-15.64	56641.64	19.04	-	-	20.8 ± 0.3	< 0.9	< 0.7
00032613034	1.9	2013-12-16.05	56642.05	19.45	> 20.2	> 20.1	> 20.4	< 0.7	< 0.5
00032613035	1.7	2013-12-16.52	56642.52	19.92	20.7 ± 0.3	-	-	< 0.5	< 0.3
00032613037	7.6	2013-12-17.06	56643.06	20.46	> 19.9	20.4 ± 0.2	> 20.3	< 0.2	< 0.2
00032613038	7.8	2013-12-20.66	56646.66	24.06	20.4 ± 0.2	> 20.6	20.2 ± 0.3	< 0.1	< 0.1
00032613039	8.0	2013-12-23.26	56649.26	26.66	20.0 ± 0.4	> 19.6	20.5 ± 0.2	< 0.2	< 0.1
00032613040	3.8	2013-12-23.59	56649.59	26.99	-	-	-	< 0.2	< 0.2

Notes: [a]: Dead-time corrected exposure time; [b]: Start date of the observation; [c]: Time in days after the outburst of nova M31N 2008-12a in the optical on 2013-11-26.60 UT (MJD = 56622.60; see Tang et al. 2013); [d]: *Swift* UVOT filters were UVM2 (166-268nm), UVW1 (181-321nm) and UVW2 (112-264nm); [e]:X-ray luminosities (unabsorbed, blackbody fit, 0.2 - 1.0 keV) and upper limits were estimated according to Sect. 3.

Table 2. *Swift* observations of the 2012 outburst of nova M31N 2008-12a.

ObsID	Exp[a] [ks]	Date[b] [UT]	MJD[b] [d]	Δt^c [d]	UV[d] [mag] U	uvw1	uvw2	Rate [10^{-2} ct s^{-1}]	$L_{0.2-1.0}$ [e] 10^{38} erg s^{-1}]
00032613001	4.0	2012-11-06.45	56237.45	20.35	-	-	20.2 ± 0.2	< 0.3	< 0.2
00032613002	4.2	2012-11-16.34	56247.34	30.24	-	19.8 ± 0.1	-	< 0.3	< 0.2
00032613003	3.5	2012-12-16.13	56277.13	60.03	-	-	20.4 ± 0.2	< 0.3	< 0.2
00032613004	3.7	2013-02-05.36	56328.36	111.26	19.8 ± 0.2	-	-	< 0.4	< 0.3

Notes: As for Table 1. The time [c] is in days after the outburst of nova M31N 2008-12a in the optical on 2012-10-17.10 UT (MJD = 56217.10; see Sect. 3.