Understanding very faint X-ray binaries from X-ray light curves

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Abstract

TODO

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1 Introduction

A special case of binary systems are X-ray binaries. These systems contain a donor star orbiting a neuron star (NS) or a black hole (BH). The huge gravitational forces from these compact objects causes accretion of matter from the donor star on to the compact object. During this accretion process X-rays are emitted and can be observed with X-ray telescopes. Observations have shown persistent sources which have a constant accretion rate and emit constant X-rays. But they also show transient sources that are most of the time in quiescence and occasionally show a rise in X-ray. These occasional events or outbursts typically last for a couple of days to several weeks and can have peak luminosity's up to 10^{39} erg s^{-1}. Currently roughly 200 X-ray binaries have been observed (Liu et al. 2007). Since the last 15 years evidence have grown for the existence of Very Faint X-ray Binaries (VFXB) that have outburst peak luminosity's of 10^{34-36} erg s^{-1}. Observations on this subclass were for a long time hard because the low luminosity's approach the instrumental limits. Currently about 30 X-ray binaries are classified as a VFXB.

It is yet not understood why VFXB's are so faint. So far research have been focusing only on individual sources. But to find out more about the origin of the faint character a systematic analysis on outburst light curves from multiple VFXB's is required. There have been already systematic studies of outbursts from bright X-ray binaries. Comparing outburst characteristics such as the duration and decay time of very faint X-ray binaries with those of bright sources can provide us more insight in the accretion process of these systems. Secondly it is interesting to test the disc instability model, the generally accepted description for bright outbursts, on very faint x-ray binaries too. So far this model has successfully described the decay shape of several outbursts from bright sources. Current observations from X-ray binaries predicts lower orbital periods for lower luminosity's. Still it is unkown if multiple VFXB's match with this hypothesis and the disc instability allows us to test this hypothesis.

To fulfill these needs in exploring the nature of very faint x-ray binaries, we aim to answer the following two questions. What are the typical duration and decay time of outbursts of VFXB's? Do VFXB's have shorter orbital periods?

2 X-ray binary classification

This section contains the required background knowledge in the classification of X-ray binaries. The classification of X-ray binaries involves three criteria: the type of the compact object, the mass of the companion star and the X-ray peak luminosity. The following sections will explain each criteria.

2.1 Type of the compact object

BH

The first classification criteria is the type of compact object; a BH or a NS. BH's can be identified by calculating their mass. When this mass exceeds the maximum mass of a NS, $\sim 2.5-3M_{\odot}$, we know the compact object should be a BH. Calculating the mass of the compact object can be a hard task. For this calculation the X-ray binary must be bright enough in quiescence in order to identify the spectra of the donor star. From this spectra the type of donor star and thereby the mass can by derived. The final step to derive the mass of the compact object is to find the orbital period of the binary system. The orbital period can also be derived from the Doppler shift in spectral analysis. If the orbital plane is aligned with our line of sight the spectral lines are red shifted when the donor star moves towards us and blue shifted when the donor star moves away from us. Knowing the orbital period and the mass of the donor star allows us to derive the mass of the compact object. This method resulted in the identification of *XTE J1118+480* and *TODO* as a BH.

NS

The other compact object type is a NS. NS's can be recognized by thermonuclear bursts. These bursts show a typical light curve shape of a fast rise and slow decay. And they show specific characteristics in their spectra.

This is because in contrast to a BH a NS has a solid surface and thermonuclear bursts only occur in NS.

2.2 Mass of companion star

High mass X-ray binaries

High mass transients can accrete material by a stellar wind or decretion disk of the companion star. Be/X-ray transients are the most common type for accretion via a decretion disk. Be stars are B or O type stars that can spin so fast that the rotation force overcomes the gravitational force and a decretion disk forms (Wijnands et al. 2006).

Low mass X-ray binaries

In low mass transients mass transfer happens via Roche Lobe overflow during which a accretion disk forms around the compact object. The disc instability model provides a generally accepted description of this accretion processes for bright sources (Lasota 2001). A more detailed description of this model can be found in section 3.

2.3 Luminosity

Bright to very bright

The third classification of X-ray transients is based on their X-ray peak luminosity when they are in outburst. Bright to very bright X-ray binaries have peak luminosity's of 10^{37-38} erg s^{-1} in X-ray. Currently the best description of the accretion behaviour of this class is given by the disc instability model explained in section 3.

Faint

Faint X-ray binaries have peak luminosities of 10^{36-37} erg s^{-1} in X-ray. The faint outbursts occur usually in series separated by the orbital period. This can be explained by the companion star moving in a wide eccentric orbit and accretes only matter at minimal distance (Okazaki and Negueruela 2001). There are two main characteristic for the faint X-ray transients. The first one is that a large fraction contains neutron star accretors. The second one is that the faint X-rays are more concentrated towards the galactic center (Cornelisse et al. 2002a). But this might be an artifact of observations mainly focussing on this region (Degenaar and Wijnands 2009).

Very Faint

Very Faint X-ray binaries have peak X-ray luminosity's of 10^{34-36} erg s^{-1}. There has been only one observation of a white dwarf system showing a outbursts above 10^{34} erg s^{-1} so VFXB's likely contains BH's and NS's (Watson et al. 1985). There have been several suggestions for explaining the very faint character. They could be intrinsically bright but appear as very faint due to their large distance (Wijnands et al. 2006). If these system are edge-on oriented the accretion disk can partly block X-rays (Muno et al. 2005). This way it appears as a very faint source but has a intrinsic luminosity that belongs to a bright source. Although it is more likely that these sources have a very faint intrinsic luminosity (Wijnands et al. 2006). As Wijnands et al. 2006 mentioned, different characteristics have been found in analysis of light curves and spectra from VFXB's and it seems to be a inhomogeneous class with the distinction between faint and very faint rather arbitrary. Although we currently know that most sources in this class are low mass X-ray binaries.

3 The disc instability model

For Low mass X-ray binaries accretion happens via Roche lobe overflow. While material from the outer layers of the companion star is transferred towards the compact object angular momentum must be conserved and a accretion disk forms (Frank et al. 2002). Instabilities in this accretion disc can trigger the rise of outbursts. The disc instability model is the accepted description of outbursts in X-ray binaries (King and Ritter 1998). This model describes the effects of the disc irradiation on the disc stability. In NS binaries the irradiated accretion disk is caused by emission from the NS itself. In BH binaries it is the inner disc that irradiates the outer disc.

The disc instability model provides predictions for the outburst decay shape depending on the ionization state of the accretion disk. The start of a outburst happens via the following steps. The accumulation of matter in the accretion disc is able to ionize the disc. This ionization raises the disc's viscosity which causes rapid rise in X-ray flux. When the accretion disk is fully ionized by irradiation from the central source it predicts a exponential decay. As soon as the outer edge of the disc cools down below the hydrogen ionization temperature the accretion disk becomes partly ionized. During this stage a linear decay is expected until it fades to quiescence. The transition from exponential to linear decay happens at a luminosity of

$$L_t(NS) = 3.7 \times 10^{36} R_{11}^2 \mathrm{erg\ s}^{-1} \tag{1}$$

for NS's and

$$L_t(BH) = 1.7 \times 10^{37} R_{11}^2 \mathrm{erg\ s}^{-1} \tag{2}$$

for BH's. With R the accretion disc radius in units of 10^{11} cm and L_t the transition luminosity. Section 4.4 provides a explanation of how physical parameters were extracted from this model.

4 Method

From the 30 known VFXB's we selected light curves that show at least a outburst and more importantly enough data points to reveal a outburst shape. The selected X-ray light curves cover data from two telescopes: the Rossi X-ray Timing Explorer (*RXTE*) and the Neil Gehrels Swift Observatory (*Swift*). All the light curves from *RXTE* exlcuding *XTE J1118* which is taken with the All Sky Monitor (*ASM*), are taken with the the Proportional Counter Array (*PCA*). The (*PCA*) and (*ASM*) have a energy range of 2–10keV (Swank and Markwardt 2001).

Six *Swift* light curves are from the galactic center observing campaign (Degenaar et al. 2015). The other *Swift* light curves are processed via the online tool from (Evans et al. 2007). The X-ray telescope on board of *Swift* has two observing modes with usage priority based on the incoming flux. Most of the time our sources are weak enough to be observed with the Photon Counting (*PC*) mode. But when the count rates reach the maximum of the *PC* mode *Swift* switches to Window Timing (*WT*) mode. In both modes the X-ray telescope on board *Swift* is sensitive to a energy range of 0.3-10keV. For the analysis on the *Swift* light curves we have used both observing modes.

4.1 Outburst detection

For each light curve potential outbursts are identified. The identification is done by eye on 10 days meridian binned light curves.

4.2 Outburst duration τ_{dur}

Based on the symmetry of most outburst shapes, each outburst is fitted to a Gaussian using the `astropy` package (Astropy Collaboration and Robitaille 2013). From each Gaussian fit the standard deviation (*std*) is used to derive the duration of the outburst

$$t_{dur} = 6std \tag{3}$$

with τ_{dur} the outburst duration and *std* the standard deviation from the Gaussian fit. Prior to the fitting process we have determined the average count rate and the standard deviation when to source was in quiescence:

1. **Fit-data selection**
   The standard deviation of the background is used as a tress hold for noise detection in the following way. For each outburst data points were selected until two adjacent observations have count rates below $2std$. This data selection is used as the input data for the Gaussian fit. For some *Swift* light curves containing solely the outburst region we used all data points as fit input data.

2. **Offset count rates**.
   A Gaussian function converges to zero at both sides but in the original light curves the quiescence level is not at zero. In order to get the best possible fit the light curve should also converge to zero in quiescence. Therefore all light curves count rates are subtracted by the average count rate of the quiescence. Light curves that show only the outburst region weren't corrected for the quiescence level.

In the case of outbursts containing a few data points (~ 4), the fit can converges to amplitudes bigger then ten times the peak count rate. To avoid this behaviour the amplitude is constraint to

$$\text{amplitude} < 1.3 \times \text{peak rate} \tag{4}$$

4.3 Outburst decay time τ_{dec}

The second outburst parameter that is determined is the decay time τ_{dec}, also referred to the e-folding timescale computed over the outburst decay region (Chen et al. 1997). The decay time is, such as τ_{dur}, unrelated to instrumental sensitivity which makes it suitably for comparison between different sources from different telescopes. In order to extract τ_{dec} from each outburst a exponential function was fitted, using the `astropy` package. The exponential fit function is defined as

$$F(t) = A \exp\left(-\frac{t}{\tau_{dec}}\right) \tag{5}$$

with $F(t)$ the count rate, A the amplitude, t the time after the start of the outburst decay and τ_{dec} is the decay time. As mentioned earlier we fitted this decay model to the outburst decay region. This region is determined similarly as for τ_{dur} but the start point is fixed at the time of the peak rate. In the case of some Swift light curves which are containing solely the decay region the whole data set was used.

The fit function 5 converges to zero moving forward in time. So the get the best fit the light curves should have a average count rate of zero when in quiescence. This correction is performed by subtracting the average of the background similar to τ_{dur}.

4.4 Decay model

At the beginning of the decay when the disc is completely ionized the outburst shows a exponential decay shape. At some time t_t the irradiation cannot maintain a fully ionized disc. When the disc becomes partially ionized the decay shape switch to linear. The exponential shape is described by

$$F(t) = (Ft - Fe)\exp\left(-\frac{t - t_t}{\tau_e}\right) + F_e \tag{6}$$

With $F(t)$ the count rate, F_t the count rate at the transition, F_e the exponential amplitude, t the time, τ_e the exponential decay time and t_t the time at the transition. The exponential amplitude is constraint to $0.4L_t \leqslant L_e \leqslant L_t$ The linear shape is described by

$$F(t) = F_t\left(1 - \frac{t - t_t}{\tau_l}\right) \tag{7}$$

with $F(t)$ the count rate, F_t the count rate at the transition, t the time, t_t the time at the transition and τ_l the linear decay time. The final model thus looks like:

$$F(t) = \begin{cases} (6), & t \leqslant t_t. \\ (7), & t > t_t. \end{cases} \tag{8}$$

The model is fitted using Markov Chain Monte Carlo (*MCMC*) sampling. This is an improved version of the basic Monte Carlo sampling that produces a probability distribution from random start variables. The *MCMC* gives a probability distribution for each of the five parameters. Each fit parameter is constraint by a reasonable range matching with the outburst count rates. The probability distribution thus lies between this range and the meridian of the distribution is taken as the best fit value.

Source selection
In order to fit this model to an outburst decay, the transition from a exponential to a linear decay must be clearly visible. In addition the number of data points at each side of the transition must be such that the difference between a totally exponential or linear decay is clear. For example some *Swift* light curves are having data points with intervals of one week which can't be used. But the *RXTE* light curves are have intervals of one day for which it is possible to distinct the exponential and linear part. The outbursts that meet these requirements are fitted with the decay model.

Accretion disk radius R_{circ}
With the fit parameters from this model several physical properties of the binary system can be derived. The first one is the radius of the accretion disk. This can be derived from

$$R_{disc} = 3.5 \times 10^7 \sqrt{\tau_e} \tag{9}$$

With R_{disc} the accretion disk radius and τ_e the exponential decay time

Orbital period P_{orb}
The second physical property that is determined is the orbital period P_{orb}. This orbital period is derived from the mass ratio q and the disc radius R_{disc} using

$$P_{orb} = 3\left(\frac{R_{disc}}{R_{\odot}}\right)^{3/2} \frac{1}{(1+q)^2} \frac{1}{[0.500 - 0.227\log(q)]^6} \mathrm{h} \tag{10}$$

Model validation
If a source has a known distance d with F_t we are able to check if the model is corresponding to the theory. By converting F_t into a luminosity L_t using d and compare that to the theoretical values of L_t given by equation

We can check if these values match and compute backwards at what distance the source must be assuming the model is correct. To do this calculation we need to convert the light curves in count rates to luminosity. The first step is the count rate to flux conversion with the Portable, Interactive Multi-Mission Simulator (*PIMMS*) tool . Then the accretion luminoscity L_{acc} is derived from the flux with

$$L_{acc} = 12\pi F_t d^2 \tag{11}$$

5 Results

5.1 Outburst detection

The outburst detection resulted in 41 outbursts in 21 out of 24 sources listed in table 1. For each source we noted their confirmed compact object type, BH or a NS, in column 2. Sources with unknown compact object type are labeled with '?'. For each outburst the telescope used for observation and the time at the peak of the outburst is noted in column 2 and 3 respectively.

We classified 5 outbursts as not suitable to determine the duration or decay time via fitting:

- Two outbursts, *GR J17597-2201* and *IGR J1744-230*, contain outbursts with variable count rates longer than one year, they are classified as quasi periodic (QP) outbursts. The high variability of QP outbursts makes them unsuitable to determine the duration or decay time.
- The light curve of *IGR J17451-3022* also shows high variability in outburst so estimating the duration and decay time via fitting is not a realistic approximation.
- The *Swift* light curve of *SAX J1828.5-1037* shows a clear outburst at 55875MJD. But this outburst contains only data points at the top of the outburst which would result in big errors on the fit parameters.
- *XTE J1719-356* shows one clear increased count rate at 55376MJD in the *RXTE* light curve. The *Swift* light curve contains increased activity around the same time, shown in figure 1, which indicates that the increased activity in the *RXTE* light curve is real. Despite this increased activity, in the *RXTE* light curves there is now outburst shape visible besides this single data point. Additionally the *Swift* light curve does not show a clear outburst shape also duo to few

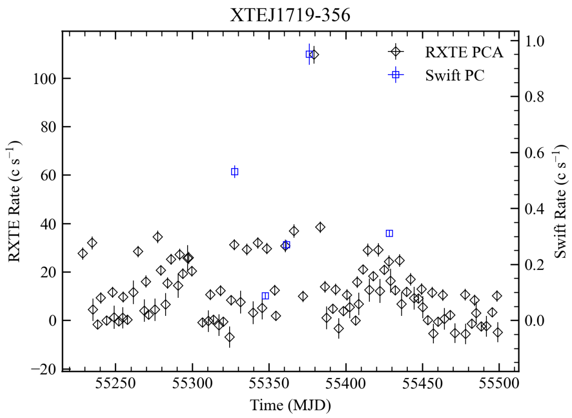

Fig. 1: The *RXTE* and *Swift* light curve of *XTE J1719-356* show increased activity around 55377MJD. This indicates that there is a outburst.

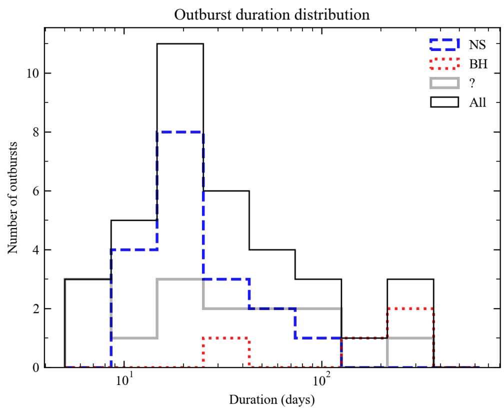

Fig. 2: Distribution of the duration of each outburst.

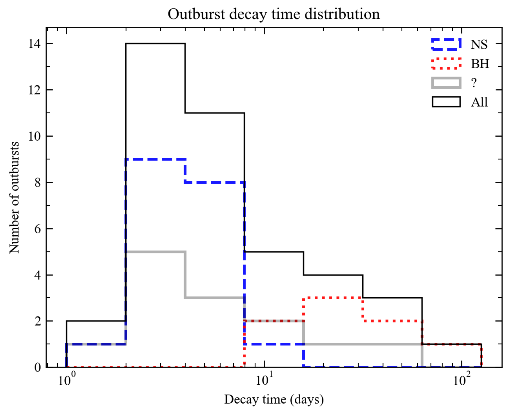

Fig. 3: Distribution of the duration of each outburst.

data points. This makes it too hard to conclude anything about the duration or decay time of this outburst.

5.2 Duration

On 36 outbursts we successfully fitted a Gaussian function. Five outbursts (58584MJD *XTE J1728-295*, 56010MJD *IGR J1817-3656*, 55595MJD *Swift J1357.2-0933*, 57868MJD *Swift J1357.2-0933* and 54644MJD *XMMJ174457-2850.3*) weren't fit to a Gaussian because they only contain the decay part. The duration extracted from the fits is shown in column 5 of table 1.

The distribution of the outburst's duration from all outbursts is show in figure **??**.

5.3 Decay time

Welke bronnen niet geschikt

1 Source	2 BH/NS	3 Telescope	4 t_{peak} (MJD)	5 τ_{dur} (days)	6 τ_{dec} (days)	7 Notes
XTE J1734-234	?	RXTE	51403	18.48	10.54	
IGR J17375-3022	?	RXTE	52466	5.940	0.01	
		RXTE	54750	7.380	2.41	
		RXTE	55043	7.440	1.89	
IGR J17597-2201	NS	RXTE	-	-	-	QP
		Swift	-	-	-	QP
SAX J1753.5-2349	NS	RXTE	51392	17.70	4.43	
		RXTE	54753	20.22	5.99	
		RXTE	55276	55.50	12.76	
WGA J1715.3-2635	?	RXTE	52501	113.72	26.86	
XTE J1118+480	BH	RXTE	51549	37.80	12.37	
	BH	RXTE	51693	321.51	76.31	
XTE J1637-498	?	RXTE	53215	17.70	2.73	
		RXTE	53818	29.90	3.28	
		RXTE	54707	30.20	5.67	
XTE J1719-291	NS	RXTE	54547	20.94	4.47	
XTE J1719-356	NS	RXTE	55376	-	-	U
		Swift	55379	-	-	U
XTE J1728-295	BH	RXTE	52927	261.45	22.21	
		RXTE	55440	135.62	59.77	
		Swift	58584	-	30.58	
XTE J1737-376	NS	RXTE	53053	15.33	3.05	
		RXTE	54714	21.09	7.09	
IGR J1744-230	?	RXTE	-	-	-	QP
IGR J1817-155	?	RXTE	54354	61.23	7.90	
IGR J1817-3656	BH	Swift	56010	-	11.26	
IGR J17451-3022	?	Swift	57056	-	-	HV
IGR J17494-3030	NS	Swift	56010	24.81	4.31	
SAX J1828.5-1037	?	Swift	55875	-	-	U
Swift J1357.2-0933	BH	Swift	55595	-	30.74	
		Swift	57868	-	35.86	
XMMJ174457-2850.3	NS	Swift	54644	-	2.53	
		Swift	55103	12.96	1.47	
		Swift	55408	10.09	2.24	
		Swift	56153	16.06	2.48	
		Swift	57659	13.89	2.77	
Swift J174553.7-290347	NS	Swift	53894	12.31	3.66	
Swift J174540.7-290015	?	Swift	57460	242.94	36.75	
Swift J174540.2-290037	?	Swift	57556	46.17	7.86	
		Swift		107.05	12.15	
Swift J174540.2-285921	?	Swift	55746	14.40	3.16	
		Swift	57578	16.61	2.93	
GRS 1741-2853	NS	Swift	54174	53.09	3.20	
		Swift	55112	40.76	5.02	
		Swift	55462	76.20	4.71	
		Swift	56517	33.19	2.21	
		Swift	57485	34.41	3.20	
		Swift	58045	24.39	7.77	

Tab. 1: All sources with their identified outbursts. Per source the type of objects BH, NS or unkown ? is specified. For each outburst we noted from which telescope the observation data comes from, the time at the peak of the outburst, the outburst duration, the outburst decay time and possible notifications. Notes explanation; QP: Quasi Periodic outburst, U: Unclear outburst shape due to few data points which make it unsuitable for fitting and HV: High Variability in outburst making it not suitable for fitting.

5.4 Decay model

1 Source	2 F_t $(c\ s^{-1})$	3 F_e $(c\ s^{-1})$	4 τ_e (days)	5 τ_l (days)	6 t_t (MJD)
SAXJ1753.5-2349	TODO	TODO	5.999±0.562	7.954±0.572	55298.3±1.101
XTEJ1118+480	TODO	TODO	15.801 ±6.357	30.735 ±4.681	51727.0 ±3.1
XTEJ1737-376	TODO	TODO	6.124 ±0.331	1.935 ±0.530	54728.4 ±0.5
XTEJ1728-295	TODO	TODO	20.216 ±0.685	92.049 ±1.850	58629.3 ±1.4
IGRJ17177-3656	TODO	TODO	10.863 ±0.250	15.877 ±1.376	55662.1 ±1.4
XMMJ174457-2850.3	TODO	TODO	2.242 ±0.238	3.975 ±0.831	54651.3 ±0.8

SAX J1753.5-2349

Equation 9 gives a disk radius of 2.520 10^{10} cm. This disc radius together with the mass ratio gives a orbital period of 3.656h TODO via equation 10. This source is known as a neutron star binary so we assumed that $q = 0.1$.

XTE J1118+480

There are two outbursts from *XTE J1118+480* visible in its light curve. The fit of the outburst at 51693 MJD gives a disk radius of 4.089 10^{10} cm by equation 9. This disc radius together with a mass ratio of TODO give a orbital period of 22.2h TODO via equation 10. Analysis on the outburst at 53215 MJD can be found in the discussion. The distance of this source has been calculated by period fluctuations due to a eclipsing donor star. There are several approximations from this method ranging from 3 to 8 kpc REF. Based on the transition flux F_t this source should be at a distance of 3.074 kpc. Therefore we used equation **??** TODO and set $n_h = 0.99\ 10^{22}$ based on Stoop et al. 2021.

XTEJ1737-376

Equation 9 gives a disk radius of 2.546 10^{10} cm. This disc radius together with a mass ratio of $q = 0.04$ gives a orbital period of 2.05h TODO via equation 10.

XTEJ1728-295

TODO

IGRJ17177-3656

TODO

XMMJ174457-2850.3

TODO

6 Discussion

7 Conclusion

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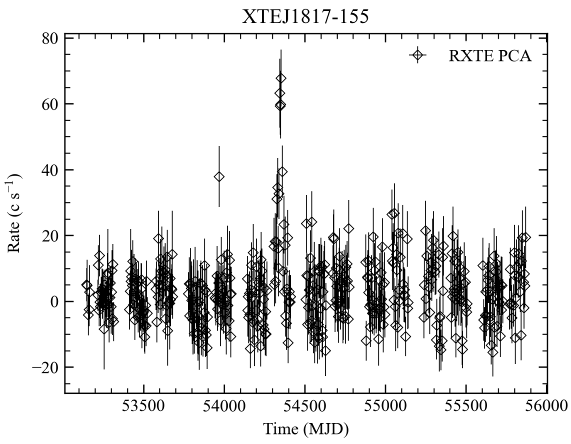
Apendix

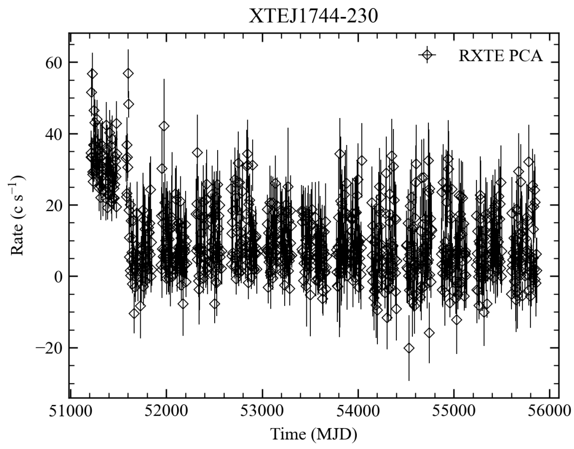
.1 Lightcurves

.2 Gaussian fits

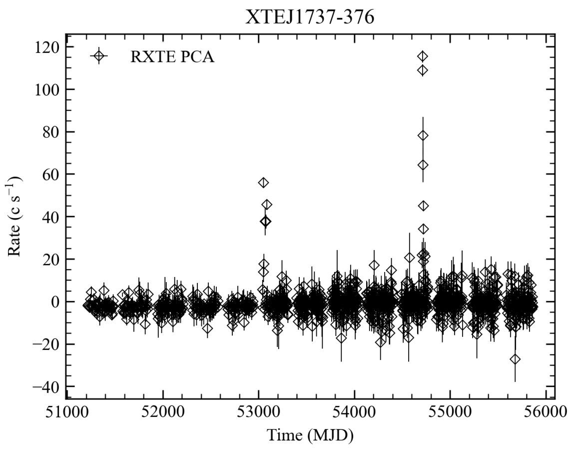
.3 Exponential fits


XTEJ1817-155
RXTE PCA
Rate (c s^{-1})
Time (MJD)

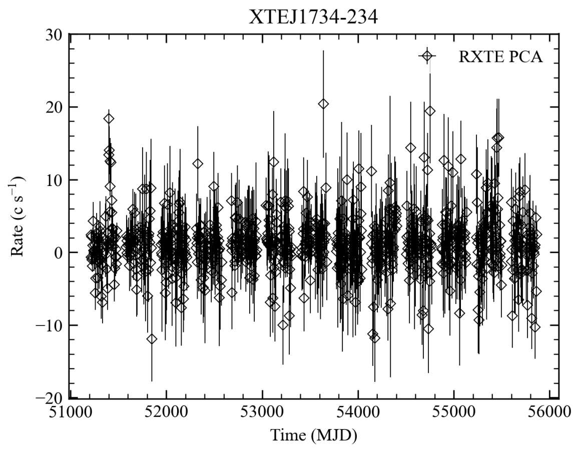
(a)


XTEJ1744-230
RXTE PCA
Rate (c s^{-1})
Time (MJD)

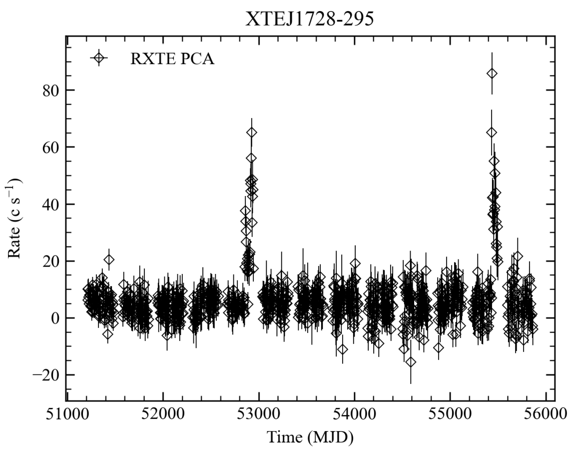
(b)


XTEJ1737-376
RXTE PCA
Rate (c s^{-1})
Time (MJD)

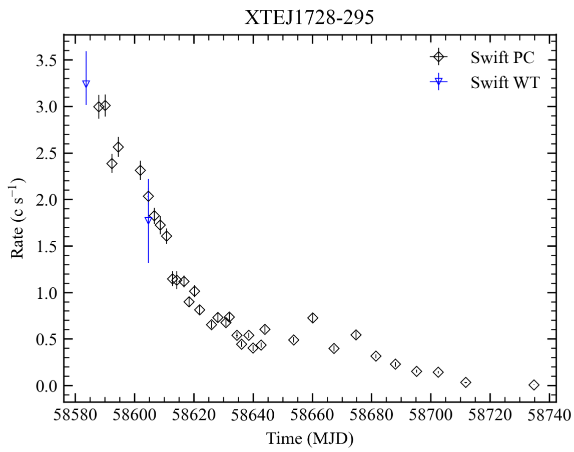
(c)


XTEJ1734-234
RXTE PCA
Rate (c s^{-1})
Time (MJD)

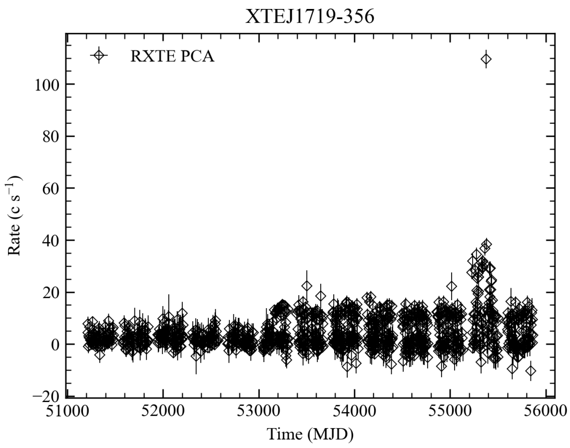
(d)


XTEJ1728-295
RXTE PCA
Rate (c s^{-1})
Time (MJD)

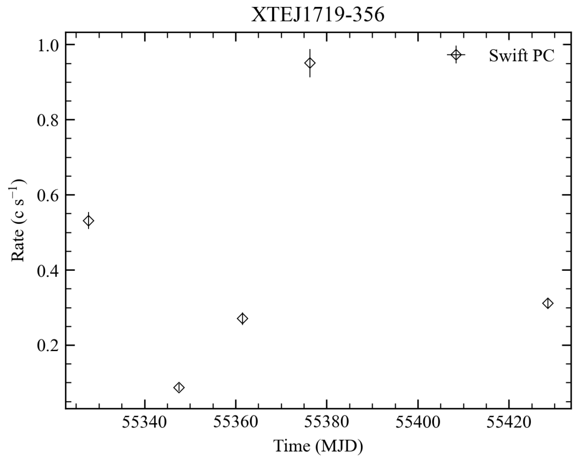
(e)


XTEJ1728-295
Swift PC
Swift WT
Rate (c s^{-1})
Time (MJD)

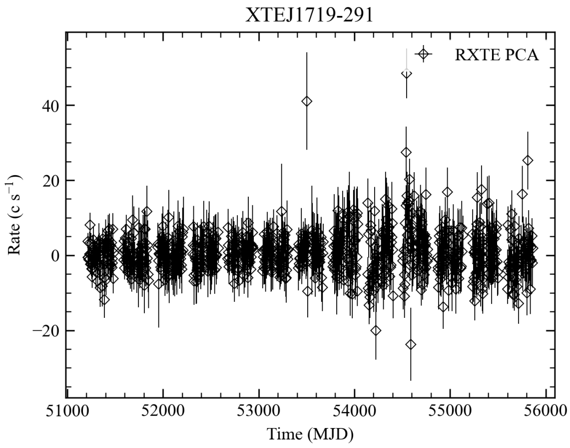
(f)


XTEJ1719-356
RXTE PCA
Rate (c s^{-1})
Time (MJD)

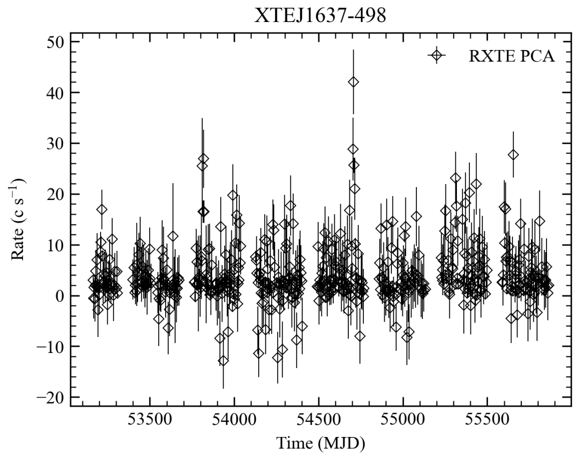
(g)


XTEJ1719-356
Swift PC
Rate (c s^{-1})
Time (MJD)

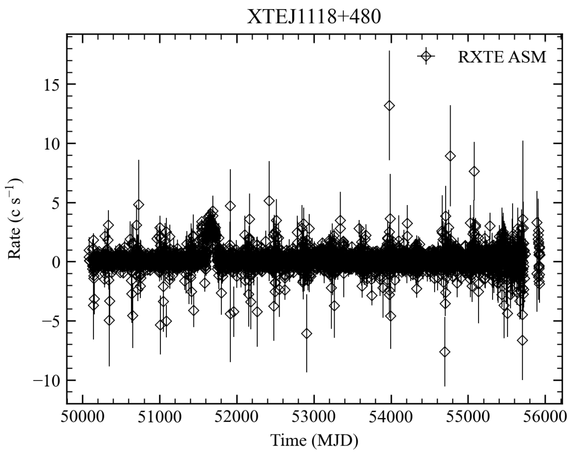
(h)


XTEJ1719-291
RXTE PCA
Rate (c s^{-1})
Time (MJD)

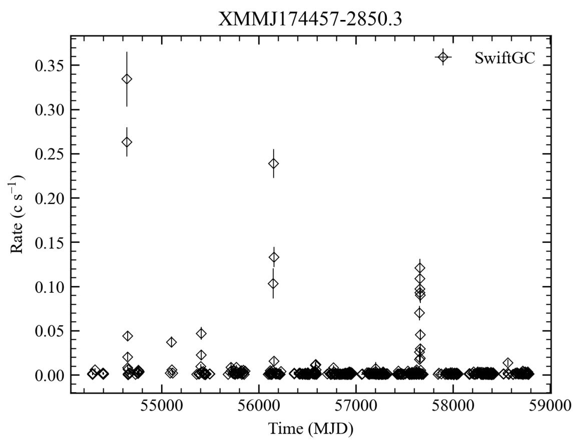
(i)


XTEJ1637-498
RXTE PCA
Rate (c s^{-1})
Time (MJD)

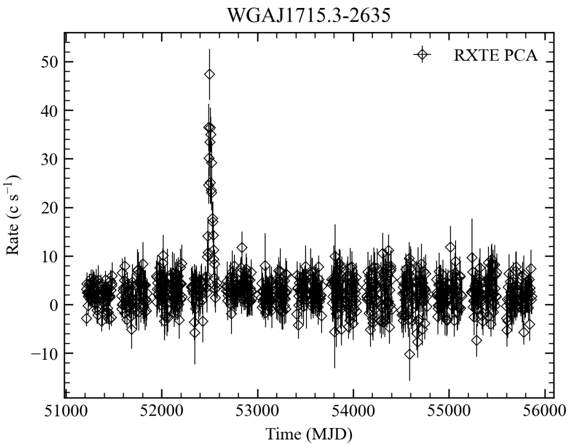
(j)


XTEJ1118+480
RXTE ASM
Rate (c s^{-1})
Time (MJD)

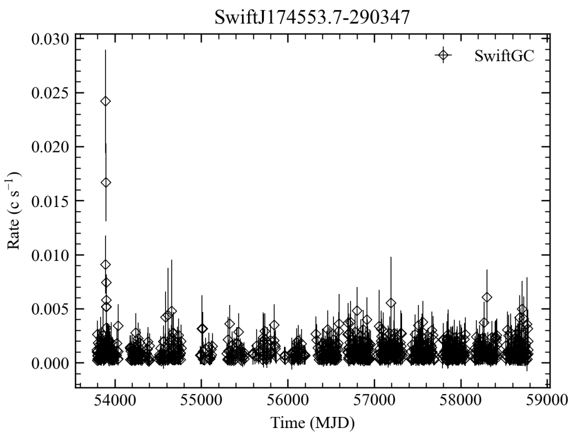
(k)


XMMJ174457-2850.3
SwiftGC
Rate (c s^{-1})
Time (MJD)

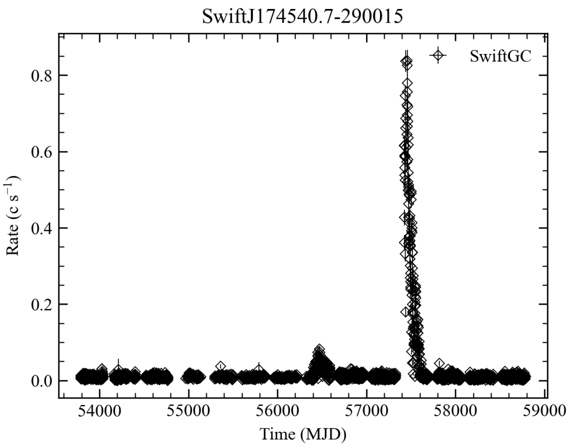
(l)


WGAJ1715.3-2635
RXTE PCA
Rate (c s^{-1})
Time (MJD)

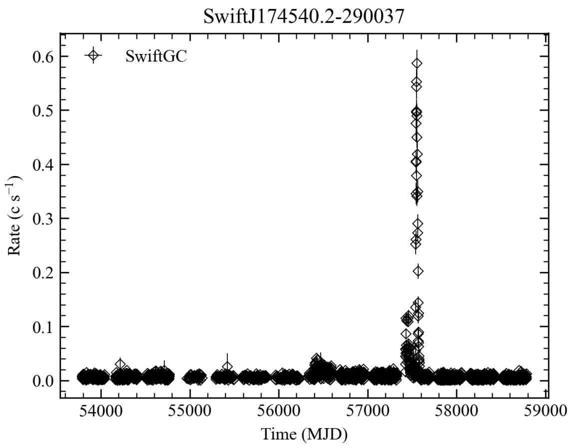
(m)


SwiftJ174553.7-290347
SwiftGC
Rate (c s^{-1})
Time (MJD)

(n)


SwiftJ174540.7-290015
SwiftGC
Rate (c s^{-1})
Time (MJD)

(o)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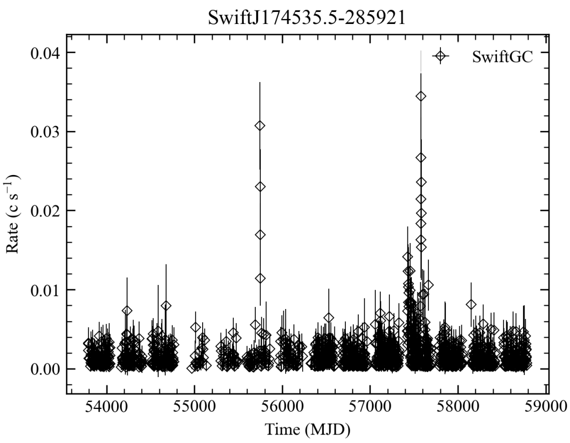
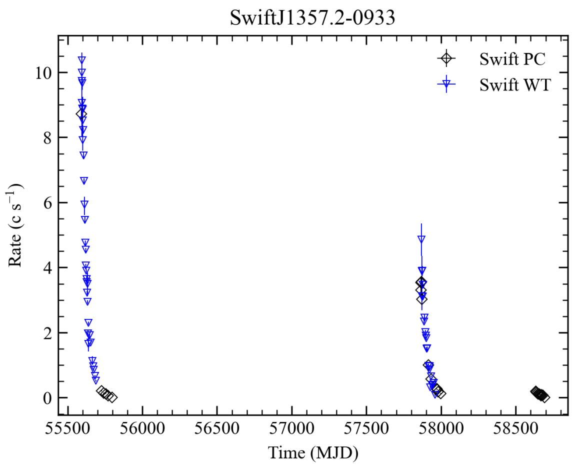
SwiftGC
Rate (c s^{-1})
Time (MJD)

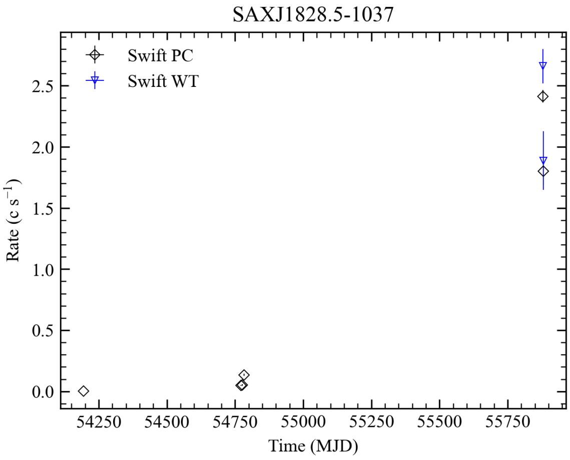
(p)


SwiftJ174535.5-285921
SwiftGC
Rate (c s^{-1})
Time (MJD)

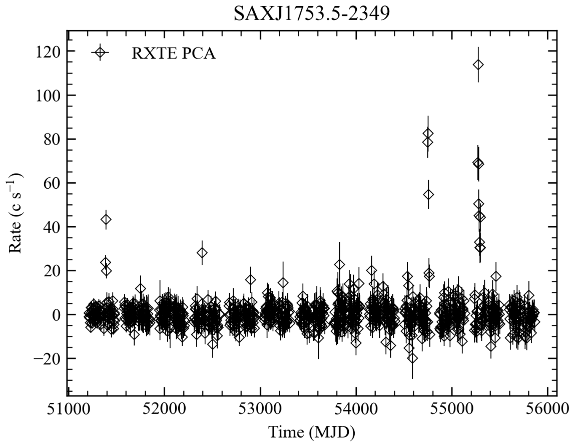
(q)


SwiftJ1357.2-0933
Swift PC
Swift WT
Rate (c s^{-1})
Time (MJD)

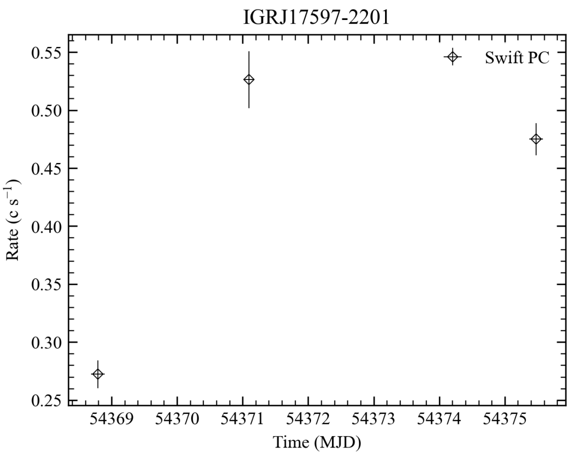
(r)


SAXJ1828.5-1037
Swift PC
Swift WT
Rate (c s^{-1})
Time (MJD)

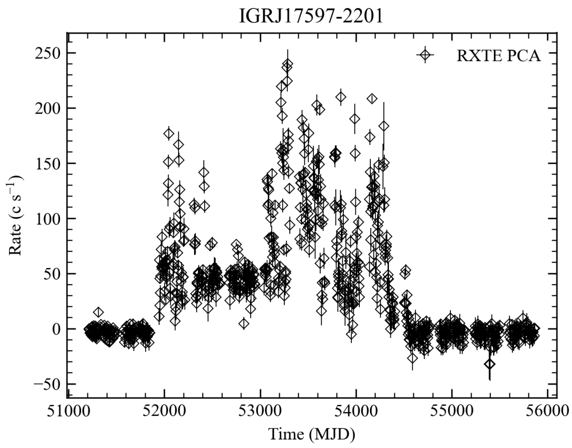
(s)


SAXJ1753.5-2349
RXTE PCA
Rate (c s^{-1})
Time (MJD)

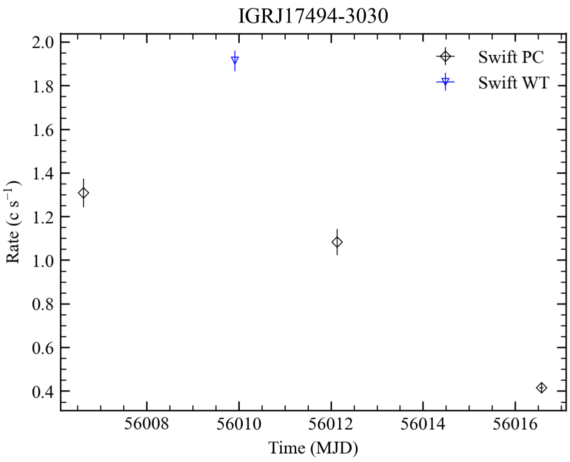
(t)


IGRJ17597-2201
Swift PC
Rate (c s^{-1})
Time (MJD)

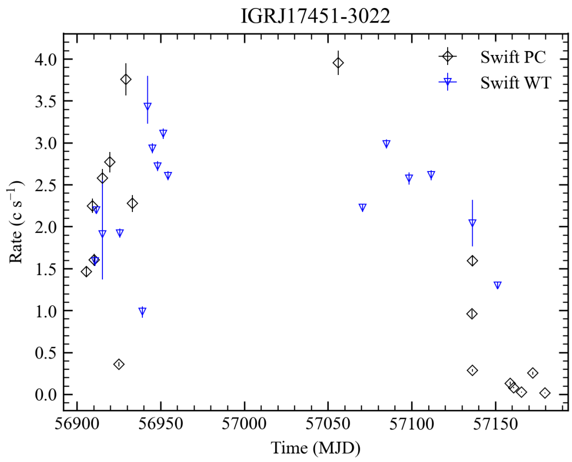
(u)


IGRJ17597-2201
RXTE PCA
Rate (c s^{-1})
Time (MJD)

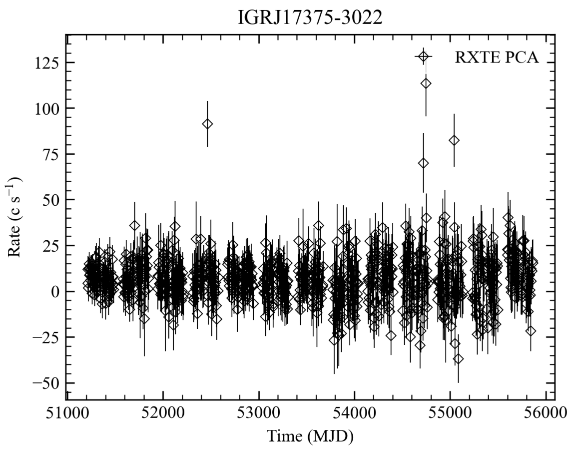
(v)


IGRJ17494-3030
Swift PC
Swift WT
Rate (c s^{-1})
Time (MJD)

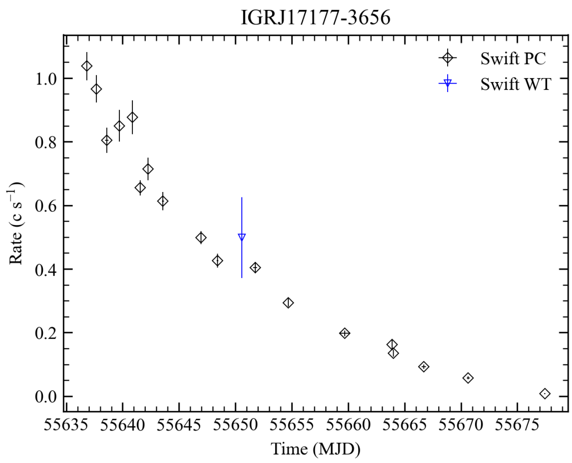
(w)


IGRJ17451-3022
Swift PC
Swift WT
Rate (c s^{-1})
Time (MJD)

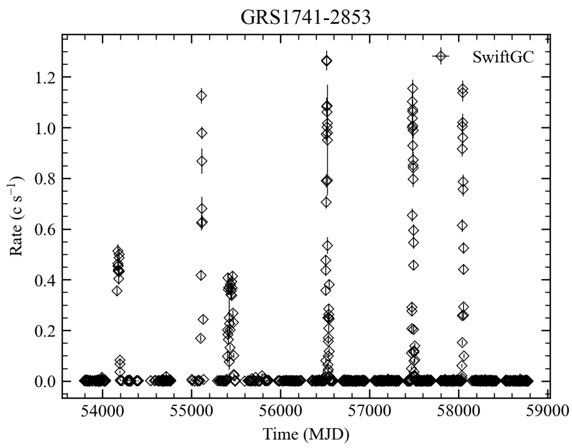
(x)


IGRJ17375-3022
RXTE PCA
Rate (c s^{-1})
Time (MJD)

(y)


IGRJ17177-3656
Swift PC
Swift WT
Rate (c s^{-1})
Time (MJD)

(z)


GRS1741-2853
SwiftGC
Rate (c s^{-1})
Time (MJD)

()