MAXI Observations of Supergiant Fast X-ray Transients

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Abstract

About 20 supergiant fast X-ray transients (SFXTs) have been discovered mainly by INTEGRAL. The MAXI nova-alert system was often triggered by short X-ray flares or outbursts probably from SFXTs, for instance, IGR J18483−0311, AX J1841.0−0536, and AX 1739.1−3020 (aka XTE J1739−302/IGR J17391−3021) even though about half of SFXTs can not be spatially resolved from nearby bright X-ray sources. Thus, MAXI may discover new SFXTs in future (a present SFXT candidate is MAXI J1932+091). Here, we briefly summarize preliminary MAXI results of SFXTs, and present the capability to detect the orbital periodicity of IGR J18483−0311.

Key words: X-rays: transient — neutron star: SFXTs

1. Introduction

Supergaint Fast X-ray Transients, SFXTs, (e.g.,Sguera et al. 2005; Negueruela et al. 2006) are a sub-class of high mass X-ray binaries (HMXBs). SFXTs exhibit relatively short, and not-so-bright hard X-ray flares. The flare activities typically last less than one hour, and the peak flux of the flares are around 100 mCrab or less in the soft X-ray band, which are just below the detection limits of the previous all sky monitors, e.g., Gigna/ASM and RXTE/ASM. These characteristics of the sources had long hidden their nature until INTEGRAL discovered them.

The MAXI nova-alert system (Negoro et al. 2016) was often triggered by probable short transient activities of SFXTs in a single scan transit or 4 orbits ($\sim$ 6 h) time bin. If detected, we, the MAXI team, provide a prompt E-mail alert to the members of the x-ray-star MAXI mailing list. Here, we briefly summarize observational properties of SFXTs from MAXI/GSC observations.

2. MAXI detections of SFXTs

About half of SFXTs are so close to bright sources that MAXI can not resolve the sources. Such sources are shown in light green in figure 1 (see a color version on the website). Furthermore, X-ray properties of flares from SFXTs, "short and hard", make it difficult for MAXI to catch flares. Nevertheless, X-ray enhancements probably due to activities of SFXTs often triggered the MAXI nova-alert system, or were recognized on GSC images, e.g., AX J1841.0−0536 (Negoro et al. 2010) and XTE J1739−302/IGR 17391−3021 (Negoro et al. 2015). Usually, such enhancements were recognized only in a single scan orbit, except for outbursts from IGR J18483−0311. We, however, could not confirm that the activities were really due to SFXTs except for simultaneous detection with other observatories.

Such possible detections of SFXTs with MAXI/GSC are summarize in table 1. As shown in the table, the numbers of the MAXI detections are positively correlated with those of Swift/BAT detections, suggesting that MAXI actually detected the source activities. We are checking the significance of each detection and the source location more precisely by taking point spread functions of the cameras and nearby sources into account.

3. Periodicity

Periodicity search was performed for IGR J18483−0311 using GSC data over 7 years, and the orbital period of $\sim$ 18.5 days was clearly detected in the power spectrum density (figure 2). Sakakibara (2013) obtained a more precise period of 18.576 ± 0.016 days using 4 years MAXI/GSC data.

He also showed that a 2–20 keV folded light curve of GSC data had a profile very similar to a 15–50 keV light curve of Swift/BAT data, and that the soft X-rays tended to increase more gradually than the hard X-rays. Such gradual increase in the soft X-ray band was also recognized in RXTE/ASM data (Levine, et al. 2011).

4. Discussion and Future Works

As shown above, MAXI can detect SFXT activities. This implies that undiscovered SFXTs will be detected

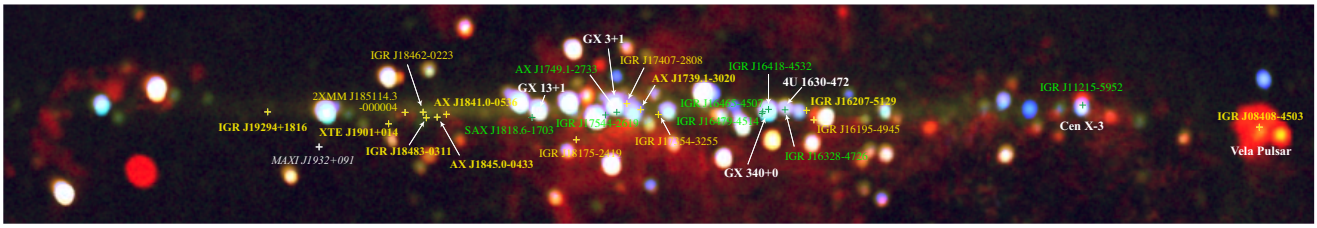

Fig. 1. Locations of known SFXTs and nearby bright sources shown on a MAXI GSC+SSC X-ray image.

Table 1. List of SFXTs spatially resolved by MAXI (shown in yellow in figure 1)

Object Name	(l, b)	MAXI Detection[1]	BAT Detection[1]	Nearby Source Name	f^2 [mCrab]	$\Delta\theta[d]$
IGR J08408−4503	(264.041, −1.950)	4	10	Vela Pulsar	∼ 10	0.54
IGR J16207−5129	(332.459, −1.050)	2?				
AX J1739.1−3020/XTE J1739 −302/IGR J17391−3021	(358.068, +0.445)	8?	27	IGR J1735−3022 XB 1732−304	∼20	0.35 0.74
AX J1841.0−0536	(26.764, −0.239)	10	26			
AX J1845.0−0433/ IGR J18450−0435	(28.138, −0.658)	3?	14	Swift J1843.5−0343	∼ 10	0.86
IGR J18483−0311 (+ IGR J18462−0223)	(29.750, −0.745)	35	57	GS 1843−02	∼ 10	0.75 (0.38)
2XMM J185114.3	(32.909, −0.043)	0				
XTE J1901+014	(35.381, −1.623)	3	2			
IGR J19294+1816	(53.540, +0.115)	2?				

1. All the numbers of the MAXI detections are preliminary. Those of the BAT detections are from Romano et al. (2014) except for XTE J1901+014 (Krimm et al. 2010). The numbers show total days, not the times of triggers or outbursts.
2. Steady 4-10 keV X-ray flux, including the galactic ridge X-ray emission, observed with GSC at the nearby source region.

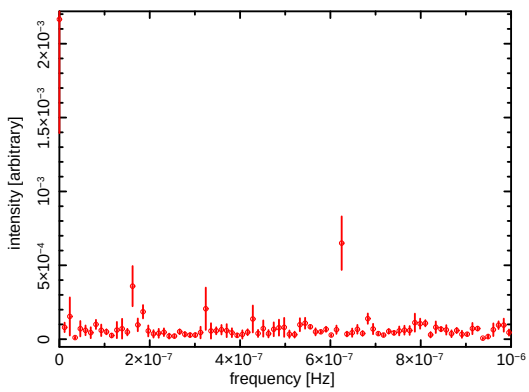

Fig. 2. PSD of IGR J18483−0311 (MJD55058-57692, 4.0-10.0 keV)

in future. In fact, MAXI J1932+091 (Yamaoka et al. 2014; Kennea et al. 2014), of which the companion is likely to be a Be star (Itoh et al. 2014), is a SFXT candidate though it locates at relatively high galactic latitude, $b \sim -5$ deg (see figure 1), and its emission lasted more than 9 hours (also see Negoro et al. 2016). Of course, other possibilities, for instance, a black hole binary, can not be excluded.

On the other hand, we have to carefully reanalyze MAXI data of known SFXTs as described above to evaluate long-term source activities or its recurrence in the soft X-ray band, which have not been extensively investigated after e.g., Levine, et al. (2011).

References

Itoh, A. et al. 2014, Astronomer's Telegram 6186
Kennea, J. et al. 2014, Astronomer's Telegram 6177
Krimm, H. et al. 2010, Astronomer's Telegram 2375
Levine, A. et al. 2011, ApJS, 196, 6
Matsuoka, M. et al. 2009, PASJ, 61, 999
Negoro, H. et al. 2010, Astronomer's Telegram 3018
Negoro, H. et al. 2015, Astronomer's Telegram 6900
Negoro, H. et al. 2016, PASJ, 68, S1
Negueruela, I. et al. 2006, ApJ, 638, 982
Romano, P. et al. 2014, A&A, 564, A2
Sakakibara, H. 2013, Master's thesis, Nihon university
Sguera, V. et al. 2005, A&A, 444, 221
Yamaoka, K. et al. 2014, Astronomer's Telegram 6174