Discovery of a Transient Source during a Suzaku/XIS Observation of 1E0102-72

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Abstract

A transient source is discovered in an observation in the Small Magellanic Cloud with Suzaku/XIS. The spectrum of the source can be fitted by a low temperature blackbody (kT ~71eV) with a luminosity of ~1.64x10^{37}erg/s. It is very likely to be accreting white dwarf which is a common model for Super Soft Source. Furthermore, an edge feature of oxygen was confirmed. Here we report a newly discovered transient source and discuss its nature.

1. Introduction & Observations

1E0102.2-7219 is the second brightest X-ray source in the Small Magellanic Cloud (SMC). It was found to be a shell-like supernova remnant (Seward & Mitchell 1981). It is a good calibration source for its line-dominated soft-band emission and constant flux. Suzaku also observed with the purpose of calibration for the XIS many times (see Table 1). Among the frequent observations, we discovered a transient source at the edge of the XIS images. We present the result of a Suzaku study of the source and discuss its nature.

Table 1. Suzaku Observation Log

Sequence number	Start date	Exposure 2x2	3x3	5x5
100001010	2005.08.11*	-	68.1	2.3
100001020	2005.08.13	-	-	4.0
100014010	2005.08.31	-	18.1	6.4
100044010	2005.12.16	-	97.2	14.2
100044020	2006.01.17	6.9	17.0	19.6
100044030	2006.02.02	-	11.3	10.3
101005010	2006.04.16	-	22.1	-
101005020	2006.05.21	-	19.4	-
101005030	2006.06.26	-	17.6	4.2
101005040	2006.07.17	-	12.8	7.8
101005050	2006.08.25†	-	-	-
101005030	2006.09.19†	-	-	-
101005070	2006.10.21†	-	-	-

Notes. 13 times of observation data (359.3+†ks).
* Disabled, because a cover of the XIS is not fully open.
† Data are not yet processed.

2. Results

2.1 Image

Figure 1 shows a XIS image obtained on 2005 August 31. Events taken with the four detectors are merged. XIS detected four sources and three of these sources were also detected in images taken at other epochs. The remaining one is a transient source, which is the main topic below.

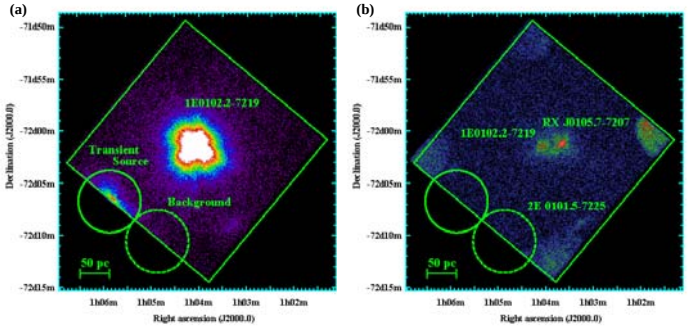

Fig. 1. X-ray image with XIS. This data were obtained on 2005 August 31, and four XIS events are merged. (a) 0.2-2.0 keV and (b) 2.0-12.0 keV. Solid circle is source region and dashed circle is background region.

When we search a point source from all data, transient source is detected only as for the observation of 2005 August 31. This source was not found in other datasets. The peak position of the source is (R.A., Decl.) = (01h05m47.5s, -72°06'35") but the true source position may not be determined with the XIS observation because it is located at the edge of CCDs. Therefore, in order to better constrain the position, we compared the observed intensity profile with simulated images; i.e. we simulated images assuming a point source is located at various positions outside of the XIS field (xissim; Ishisaki et al. 2006). The source position was derived as (R.A., Decl., Sta.err, Sys.err) = (01h05m51s, -72°07'25", ± 0.4", ± 1'). The positional error is so large that there are many possible candidates of the source. In particular, it may be RX J0105.7-7207 which is unknown X-ray source.

2.2 Time variation

Figure 2 is a XIS1 background-subtracted light curve with regions shown in Figure 1. A source or a background region is the circle of a radius of 3'. 90% photons are included in the regions when a point source was assumed. Figure 3 shows the result of periodic search with Lomb method (Lomb 1976). The period of 3000 and 6000 seconds is influence of a Suzaku satellite. The pulse of the source was not detected with the data.

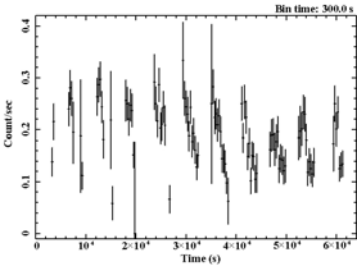

Fig. 2. An XIS1 background-subtracted light curve of 0.2-1.0 keV band with a bin time of 300 sec (Obs. 2005 August 31).

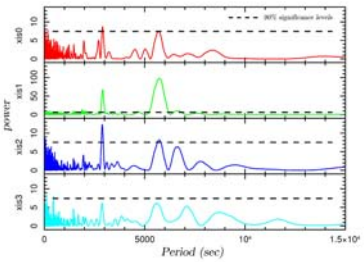

Fig. 3. The result of analysis with Lomb method. The period of 3000 and 6000 sec is influence of a Suzaku satellite. Dashed lines are 90% significance level.

2.3 Spectrum

The spectrum with the best fit model and parameters are shown to Figure 4 and Table 2. At first, we fitted the spectrum with a blackbody model, but the value of a chi-square showed the model is inconsistent. We added an edge model to reduce a residual error and tried to do the fitting again. As a result, the best fit parameter of the edge energy is ~0.73 keV, Ftest value for an model is 14.0, and probability is 2.61x10^{-6}. It is suggested the model of an edge from He-like oxygen is consistent. Furthermore, considering a CNO cycle, an upper limit of an edge from He-like carbon (0.39 keV) is 0.10 τ, and He-like nitrogen (0.55 keV) is 0.18 τ.

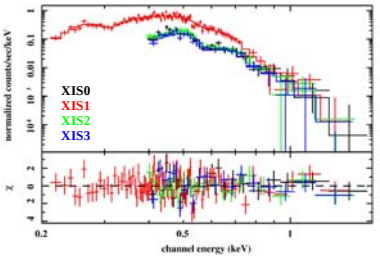

Fig. 4. XIS spectrum (Obs. 2005 August 31). (black; XIS0, red; XIS1, green; XIS2, blue; XIS3)

Table 2. The best fit parameters

Components	Parameter	Values	Unit
model : wabs×blackbody×edge×constant			
Absorption	N_H	$4.85^{+0.43}_{-0.43}\times10^{20}$	cm^{-2}
Blackbody	k_BT	$71.4^{+2.2}_{-2.2}$	eV
	Norm.	$3.61^{+0.47}_{-0.43}\times10^{-4}$	L_{39}/D_{10}^2*
	Flux	$3.80^{+0.06}_{-0.08}\times10^{-11}$	erg s^{-1} cm^{-2}
	Luminosity †	$1.64^{+0.03}_{-0.23}\times10^{37}$	erg s^{-1}
Edge	Energy	$0.73^{+0.02}_{-0.02}$	keV
	Max τ ‡	$1.02^{+0.40}_{-0.29}$	
Constant	XIS0	$0.97^{+0.07}_{-0.06}$	
	XIS1	1.00 (fixed)	
	XIS2	$0.81^{+0.05}_{-0.05}$	
	XIS3	$1.05^{+0.09}_{-0.08}$	
χ^2/dof (χ^2_{red})		179.73/154 (1.17)	

Notes. Values in the 0.2-1.8 keV band. Uncertainties indicate the 90% confidence level.
* L_{39} is the source luminosity in units of 10^{39} ergs^{-1}, D_{10} is the distance to the source in units of 10 kpc.
† Bolometric luminosities at 60kpc
‡ Absorption depth at the threshold.

3. Discussion

It seems very likely to be "Super Soft Source" (SSS) for its low temperature blackbody. A radius of the source is ~2x10^{8} cm and a bolometric luminosity is ~2x10^{37} erg/s when assumes spherically-symmetric and located in SMC. It suggests the source was accreting white dwarf which is the most extensively model for SSS (van den Heuvel et al. 1992). Furthermore, the edges mean that there is oxygen rich structure than the solar (Anders & Grevesse 1989). We have just proposed the Suzaku AO-2 observations to study it in detail.

References

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