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Outline

MAXI mission
 X-ray Detectors (GSC, SSC)
 Current status
 Nova/Burst Search & Alert Systems

Latest results (Atel, GCN)
 BHC state transition (XTE J1752-223, Cyg X-3)
 Outbursts of Be transient pulsars
 Orbital, Super orbital periods
 GRBs, short X-ray transients, X-ray bursts
 Preliminary results of SSC (all sky map, spectra)

Data release plan (alert mail, on-demand, etc.)



MAXI mission

(Monitor of All-sky X-ray Image)

- MAXI is the first astronomical payload on JEM (Japanese Experimental Module) - EF (Exposed Facility) on ISS.
- All sky monitor covering 0.5-30 keV
- Synchronized with the ISS orbital motion, MAXI scan the 80~95% sky every ~92 min.



Objectives of MAXI mission

- Detection and monitor of transient X-ray sources
 - X-ray binaries (BH, NS, WD, accreting or shocked winds)
 - other Galactic transients (AXPs, SGRs, flare stars, novae, ...)
 - AGNs (long-term variability)
 - GRBs (2~3 events/year)
 - □ Nova alerts (GRBs, new sources, and outbursts of known sources)
- Long-term light curves of X-ray sources in the whole sky
 - □ "An X-ray movie of the entire sky"
- Census of X-ray sources
 - □ 0.5—30 keV, down to <1 mCrab in 2 years
- Diffuse source mapping
 - with SSC (X-ray CCD camera) using soft X-ray lines

Overview of MAXI



	GSC (X-ray Gas Camera)	SSC (X-ray CCD Camera)
Detector	Xe-filled prop. counter x12	CCD 16 chips x 2 camera
Energy range (Q.E.>10%)	2-30 keV	0.5—12 keV
Energy resolution (FWHM)	15.7%(at 8.0keV)	< 2.5%(150eV) (at 5.9keV)
Time resolution & accuracy	< 200 µ sec	~6 sec
Instantaneous sky coverage	2.4 % of the whole sky (160 deg x 3 deg x 2 sets)	1.4% of whole sky (90 deg × 3 deg × 2 sets)
Point Spread Function	1.5 degree	1.5 degree
sensitivity	10~20 mCrab (day)	50 mCrab (day)

collimator



SSC





Sky views from MAXI Zenithal

View



- FOV crossing time for each source is >45 sec
- FOV crossing intervals are 20 min. for horizon to zenith, 70 min. for zenith to horizon.
- One-orbit (92 minutes) Coverage 85
 95 % (GSC)





1 scan all sky image (GSC)



No exposure correction is applied.

Current status of GSC operation

- The high BGD induced the discharge problems.
- 4 cameras were out of operation since Sep 23.
- 8 cameras in the low latitudes
 Effective area 8cam/12 (=2/3)
 Exposure time 50%
- Current sensitivity (5 sigma) 10-20 mCrab/day (2-10 keV) 3-4 mCrab/week (2-10 keV)
- 1-day sky coverage remains
 96% (all-sky except the sun)



2009.9.30.



Current status of SSC

- 32 CCDs are operational.
- Performance is as expected :
 - energy resolution is about 150eV@5.9keV (FWHM)
- Problem on data transfer
 - □ low speed (MIL-STD-1553B: 20-40kbps) : Good
 - med speed (Ethernet:200-600kbps): lost 50% data ... essential for the spectrum analysis of SSC
 - => This delays the calibration and data distribution.
 - => Japanese astronaut installed a new computer to solve this problem.
 - Performance is under verification.
- Light leak from the side of CCD

SSC one-day image



- The light leak limits the SSC observation
 SSC covers about a half of the entire sky every day.
- observation efficiency in time is ~40 %.
- Sensitivity is 50 mCrab for one day observation.

Nova/Burst Search & Alert Systems (Negoro+2010)

(internal testing!!)

- The Nova /Burst Search System looks for transient event candidates using the photon accumulation time widths (= time bin sizes) ranging from one second to one day.
- The Alert System receives transient event candidates from the Nova/Burst Search System.
- The Alert System automatically verifies the transient events, and automatically transmit Nova/Burst Alerts to the Internet through the MAXI alert mailing list, the MAXI Homepage (http://maxi.riken.jp). We also plan to use existing route, such as GCN and ATel.
- We plan to start the transmission of the automatic alerts in this spring.



Three Nova/Burst Search systems and one Alert System @Tsukuba TSKC/JAXA.

Latest Results



GSC All-sky map in 7 months

2009/8/15 - 2010/3/15



Atel and GCN with MAXI/GSC Astronomer's Telegram 23

<2010> Mar 12 Short X-ray Transient Mar 3 4U1608-522 Flare Feb 18 Mrk 421 Flare Recurrent outburst Feb 10 V0332+53 Feb 6 4U 1711-34 Flare Feb 3 Short X-ray Transient Jan 26 Cyg X-3 State Transition Jan 24 HR 1099 Flare Jan 23 4U 1323-619 Flare Jan 23 XTE J1752-223 State Transition Jan 10 GX 339-4 Flare Jan 9 H 1743-322 State Transition Jan 5 V0332+53 **Recurrent** outburst Jan 5 Mrk 421 Flare

<2009>

Dec 31 H 1743-322 Flare Dec 31 4U 1630-47 Flare Dec 28 NGC6440 Outburst Dec 9 Swift J1753.5-0127 Soft X-ray Dec 2 Short X-ray Transient Nov 15 GX 304-1 Outburst Oct 31 A0535+26 Recur.outburst Oct 29 4U 2206+54 Flare Oct 25 XTE J1752-223 New source

<u>GCN</u>

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 2010 Mar 16
 XRF 100315A

 2010 Feb 3
 Short X-ray Transient

 2009 Dec 2
 Short X-ray Transient

 2009 Nov 24
 GRB 091120

 2009 Sep 27
 GRB 090926B

 2009 Aug 31
 GRB 090831A

Black Hole Candidates 2009/8/15 - 2010/2/9



red: 2-4 keV, green: 4-8 keV, blue: 8-16 keV

(no exposure correction)

XTE J1752-223 with MAXI/GSC

MAXI light curve Crab XTEJ1752-223 Sun avoidance 1.5 - 20.0 keV 5-20 keV - - - -.5-4 keV 0.6 4.0 - 10.0 keV 4-10 keV المحاوم بسعودهم ا 0.3 - AN THOMAS 0.4 0.14 10-20 keV 140.04 55100 55160 55180 55200 55220 02/25 UT 08/14 2009 © JAXA/RIKEN/MAXI-Team 2010

- New BHC XTE J1752-223 was first detected by the galactic bulge scan with the RXTE/PCA on 2009 Oct. 23.
- There are 2 initial plateau phase which lasted for ~25 days, and ~40 days. -> implying a very slow increase in the accretion rate.
- The rapid increase in the soft band was observed from 2010 Jan 20. ->a sudden appearance of the accretion disk
- Flux in 1.5-4 keV and higher bands are anti-correlated with a lag of 3 days. ->The co-existence of the disk and the hot corona.

Those anti-correlation is clearly seen in the intensity-hardness diagram.

XTE J1752-223 with MAXI/GSC

hardness-intensity diagram



The state change is visible in the hardness-intensity diagram as "q-type curve".

- The difference between 2 plateau (low/hard state) is clearly seen.
- After the increased radio emission was detected (ATCA: Brocksopp+2010), the source change to the high/soft state. MAXI/GSC can clearly observe the overall state change.



Cyg X-3

- Cyg X-3 exhibits a few state § transitions in a year.
- MAXI/GSC detected the LHS to HSS transition issued in Atel #2404.



Cyg X-3 Spectral fitting (Kotani+2010)

analyzed with the preliminary GSC rmf.





kotaní 20-Feb-2010 02:04

wa(pl) + narrow line N_H=(2.8±0.3)×10²² cm⁻² Γ =0.66±0.03 lineE=(6.78±0.03) keV χ²=1.5 MJD=55160.0-55170.0 Expos. = 947 s



13 are shown out of monitored 23. red: 2-4 keV, green: 4-8 keV, blue: 8-16 keV

(no exposure correction)



- MAXI/GSC detected the recurrent outbursts from 7 Be transients.
 (4 events were issued in ATel.)
- MAXI nova alert system noticed several outburst events. (under internal testing)
- MAXI triggered the Suzaku ToO observation of V0332+53.
- GX 304-1 appeared after the 30 years quiescent state.
- The flux dependent change of the spectral parameters are interesting field. MAXI will help these studies.

GSC light curve of A0535+262 (1.5-20 keV)



- >1Crab outburst was observed on 2009 Dec.
- Before the burst, the precursor was observed.
- On March 3-9, INTEGRAL/MAXI detected the brightening. (ATel#2496)
- Large outburst will occur shortly ?

- Binary pulsars: orbital, super-orbital period is also clearly observed.
- Except for the unobservable duration, MAXI is consecutively able to monitor those sources.
- Powerful tool for searching for the orbital/super-orbital period.



ATEL#2360



- The X-ray flux had increased from <20 mCrab to 160mCrab since at least a week before.
- Follow up observation with XTE/PCA found a 2.26 ms pulsation, which identified this source to the LMXB, SAX J1748.9-2021. (Atel #2407)
- Radio follow-up was also carried out.



Short transient, XRF

- Detected only a fraction of a scan.
- No known source. No GRB reported.
- 2009.12.1. MAXI J0754+166
- 2010. 2. 2. MAXI J1724-329 <u>ATEL#2415</u>
 Lasted for 20 s. -> XRF 100202A <u>GCN#10359</u>

Large absorption -> X-ray burst beyond GC ?





ATFL#2321







Exposure (cm²x sec) is corrected
 Background (NXB and CXB) is NOT subtracted
 First all-sky-image taken with X-ray CCD

0.05

spectrum with SSC



Further calibration is required!!

current Suzaku/XIS

SSC spectra of celestial objects







Public Data Release Plan

- Nova alerts (this spring)
 MAXI e-mail (+GCN, ATEL etc).
- Periodical release
 - 🗆 science data
 - ~120 sources, pre-selected
 - light curves (every day)
 - □ GSC: 1.5-4/4-10/10-20 keV,
 - □ SSC: 0.5-2/2-5/5-10 keV (this summer)
 - Spectra (this summer)
 - all sky image (daily/weekly/monthly)
 - Recommendation of additional targets is welcome.
- On-demand release (end of this year)
 any sky and time region specified
 light curve, spectrum, and image





MAXI Public User Portal (at RIKEN) http://maxi.riken.jp/

Summary

- Operation
 - □ 8 GSC cameras are operating in low latitudes.
 - □ All of 32 CCDs(SSC) are operational at night side.
- Early results (ATel, GCN, proceedings)
 - □ State-change of XTE J1752-223
 - Outbursts of Be transient pulsars, orbital and super orbital periods
 - □ GRB, XRF, short transients, (hidden X-ray burster?)
 - □ Flare alerts of Mrk421, HR 1099 etc.
- 7-months All-sky map (300 sources detected) MAXI 1-year catalog will be compiled.
- Light curves and news are available at MAXI homepage <u>http://maxi.riken.jp</u>
- Data public
 - Transmission of transient alerts (in this spring)
 - Public release of light curves (SSC) and spectra (GSC/SSC) of about 120 pre-selected sources.
 - Suggestion for additional sources to the list is appreciated.
 - End of this year, release of on-demand data (any sky and time regions)