The first year result of MAXI/SSC

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Abstract

Solid-state Slit Camera (SSC) is CCD camera installed on MAXI. The SSC consists of two CCD cameras: each contains 16 CCD chips. The CCD chip has 1024 x 1024 pixels and area of 25mm square. These CCD chips are cooled down to -60 degree using a combination of the radiator and the peltier cooler. In one year of operation, MAXI/SSC has detected over 70 X-ray sources and several bursts from known X-ray sources. In this presentation we report the status of MAXI/SSC as well as the preliminary result of monitoring X-ray transients obtained from the operation of the first year

Key words: SSC

1. All sky map

Fig1 shows the all-sky map obtain by SSC. The colors red, green, blue show the energy band of 0.7-2.0keV, 2.0-4.0keV 4.0-7.0keV, respectively. After 16 months of observation, the map shows more then 100 point sources and few diffuse structure in low energy are detected. The most noticeable diffuse structure in this map is obviously the Vela SNR. On the rim of the Vela SNR, there is Pup-A SNR and the Vela pulser can also be seen in the middle of Vela SNR. In the Cygnus region, Cyg X-1,2,3 and Cygnus Loop is very bright, furthermore, Cygnus Superbubble is also detected. Finally, the north polar spur is detected near the galactic center. But due to its faintness and luck of statistics, we were unable to extract meaningful spectrum from the Cygnus superbubble and the north polar spur.

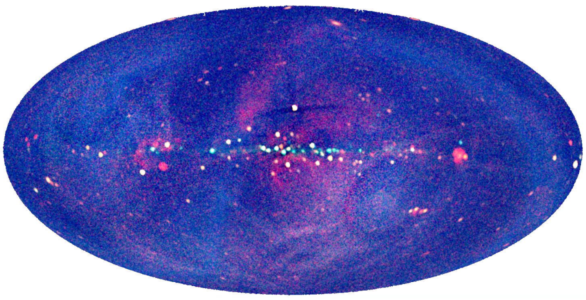

Fig. 1. SSC all-sky map.

1.1. Vela region

Vela SNR is a nearby (500pc) object which is one of the largest galactic SNR with radius of about 7°.5. Fig2 is the zoomed image of Vela SNR, SSC is the first X-ray CCD to map the entire Vela SNR. This image clearly shows that emission from Pup-A and Vela SNR itself can be separated. The green emission next to the Pup-A SNR come from Vela pulser. Since most of emission from Vela SNR is in low energy, the high energy from Vela pulser stands out. Lastly, glimpse of Vela Jr can be seen in top left corner of Vela SNR. The emission from Vela Jr is harder than Vela, it is shown in green color in Fig2.

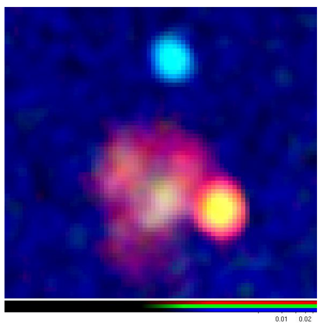

Fig. 2. The zoomed SSC all sky map around the Vela region. The bright blue source on the top is Vela X-1.

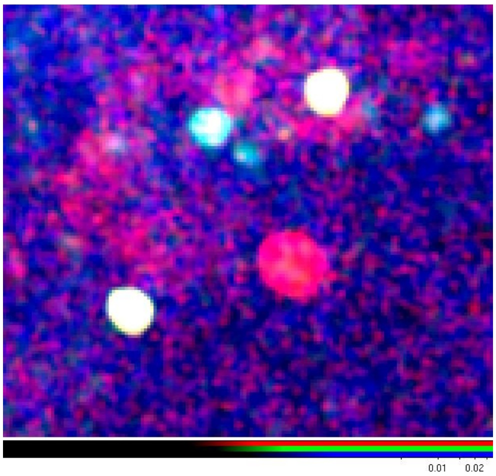

Fig. 3. Cygnus region of the SSC all-sky map. Cygnus X-1,2,3, cygnus loop and few other sources are detected.

1.2. Cygnus region

Fig.3 shows the zoomed image of SSC all-sky map around Cygnus region. In this map Cygnus X-1,2,3 shines very bright and also Cygnus Loop emits very soft X-ray. The horseshoe shaped emission of soft X-ray is called Cygnus Superbubble (CSB). This structure can be also seen in ROSAT all-sky survey. CSB is known for its strong X-ray emission and its large size, which is about $16° \times 13°$ along Galactic longtitude and latitude,repectively. Numerious OB associations at different distances are located in its direction, but the physical connection to the CSB is still unclear. Uyaniker et al suggested that the CSB is a combination of several diffuse sources in different distances and its origins are difference in each sources. The spectrum of this is still unknown. although SSC uses X-ray CCD's and it can produce spectra, due to luck statistics, we were unable to produce meaningful spectrum.

2. Observation of Sco X-1

Sco X-1 is the brightest object in X-ray sky. Due to its high X-ray flux, it had not been observed as a scientific target in most recent mission. Since SSC is slit camera, it allows us to observe this high flux target without pile-up. Fig4 shows the spectrum of Sco X-1. The spectrum is fitted by bbody+powerlaw model. Although MAXI/SSC's calibration is still ongoing, it shows very similar results from white et al. 1985. Only difference was that residual did not show any discrepancy around Fe-K line. We cannot conclude that Fe-K line does not exist, but there was no obvious line feature in the spectrum. For future work, since the brightness of Sco X-1 is vastly changing, there might be correlation between its brighness and equilavant length of Fe-K line.

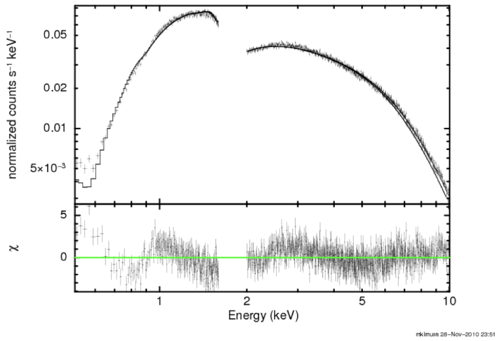

Fig. 4. Spectrum of Sco X-1 obtained by MAXI/SSC. Si-K edge is not used because of calibration issue.

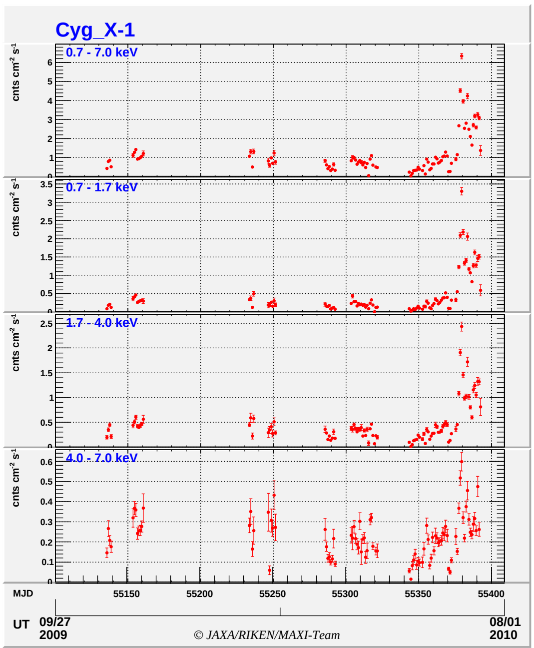

Fig. 5. SSC lightcurve of Cygnus X-1. The 4 panels shows the lightcurves in difference energy band.

3. The state change of Cygnus X-1

On July 2010, MAXI detected the brightening of Cygnus X-1. Fig5 shows the lightcurves obtained by SSC. The time were there is no data point are the time when Cygnus X-1 was out of SSC's FOV. Each panels shows the lightcurve of different energy ranges, 0.7-7.0keV, 0.7-1.7keV, 1.7-4.0keV, 4.0-7.0keV from the top panels Fig5 clearly shows that the Cyg X-1 is getting brighter around mjd=55350, and brightness peaks around mjd=55380 and changed to intermediate/high state.

Fig6 shows the spectrum of Cygnus X-1 obtained by SSC (red) and GSC (black). The top panel is the spectra when Cyg X-1 is in hard/low state and bottom panel is in the intermediate/high state. The spectrum is fitted by powerlaw+diskbb model, each component is shown in dotted line of blue and orange respectively. The fitting of the hard state showed the T_{in} = 0.19keV and Γ = 1.66, while the intermediate state showed T_{in} = 0.43keV and Γ = 2.35. which is fairly consistent with previous results in Makishima et al. and Dotani et al. This fit shows that the flux of low energy is mainly caused by the diskbb component in intermediate/high state. But since this intermediate state spectrum is integration of 2 weeks of data, in which the flux is vastly changing, so more detailed spectrum analysis such as fitting of daily spectrum is needed.

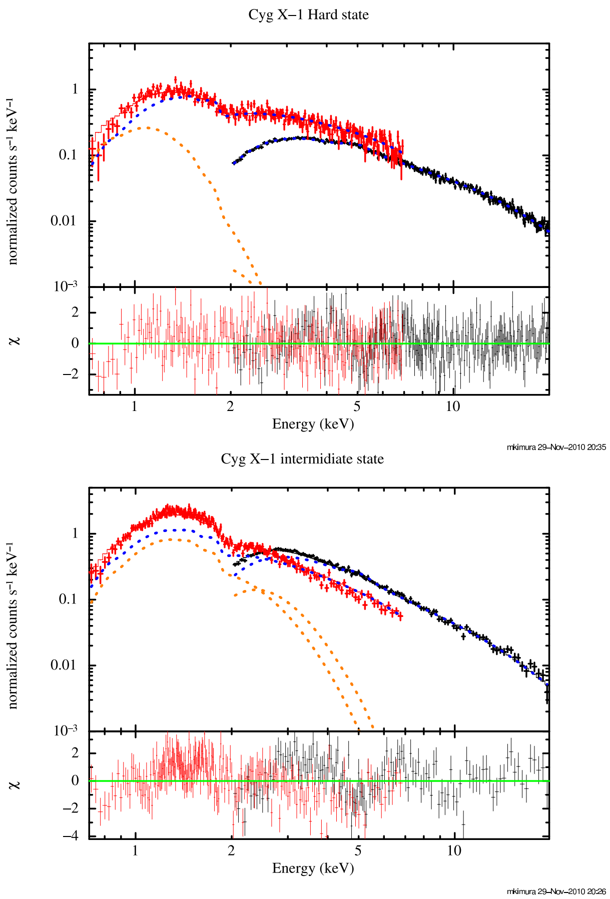

Fig. 6. The top panel shows the SSC spectrum of the Cygnus X-1 during the hard state while the bottom panels shows the soft state.

4. References

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