# Extragalactic Survey with MAXI

Yoshihiro Ueda[1], Kazuo Hiroi[1], Satoshi Eguchi[1], and the MAXI team

[1] Department of Astronomy, Kyoto University, Kyoto 606-8502, Japan
*E-mail(YU): ueda@kusastro.kyoto-u.ac.jp*

Abstract

We summarize the prospects for extragalactic survey with the MAXI mission. By integrating all the data taken for $> 0.5$ years, we estimate that about 1,300 Active Galactic Nuclei (AGNs) will be detected in the 3–20 keV band with the Gas Slit Cameras from extragalactic sky at Galactic latitudes higher than 15°. The MAXI survey will achieve the best sensitivity for populations of moderately absorbed AGNs among any all sky X-ray missions, and is complementary to *ROSAT* all sky survey and hard X-ray (>10 keV) surveys by the *Swift* and *INTEGRAL* satellites. Many "transient" AGNs could be newly detected with MAXI. In this paper, we discuss the scientific significance of the MAXI survey.

Key words: catalogs — galaxies: active — X-rays: galaxies — X-rays: general

## 1. Introduction

X-ray surveys at high Galactic latitude are powerful approach for studying the nature of extragalactic populations, mainly Active Galactic Nuclei (AGNs). While the X-ray background below 10 keV has been mostly resolved into discrete sources in ultra deep surveys with *Chandra*, surveys with a much larger area that cover a brighter flux range are indispensable for the global understanding of the cosmological evolution of AGNs. In particular, all sky surveys above 2 keV with sensitivities of $\sim 10^{-12}$ erg cm$^{-2}$ s$^{-1}$ (2–10 keV) bridging the *HEAO1* all-sky survey (Piccinotti et al. 1982) and *ASCA* / *XMM-Newton* serendipitous surveys (Ueda et al. 2005, Watson et al. 2008) are still missing, which are important to trace AGN evolution in the low to intermediate redshift universe.

With its unprecedented sensitivity from the whole sky in the hard band above 2 keV, MAXI will provide a new X-ray source catalog that becomes the basis of all scientific studies of the mission. In this paper, we summarize the prospects for the extragalactic survey performed with the Gas Slit Cameras. Details on source detection method and estimates of the sensitivity are given in Hiroi et al. (2008, this conference).

## 2. Sensitivity of MAXI

The ultimate sensitivity of MAXI is determined by the source confusion limit, constrained by the angular resolution of the imager. By assuming a beam size of $1.5° \times 1.5°$, the cumulative number density of one source per 10 beams is calulated to be $N(> S) = 0.044$ deg$^{-2}$. Figure 1 shows an expected log $N$ - log $S$ relation of

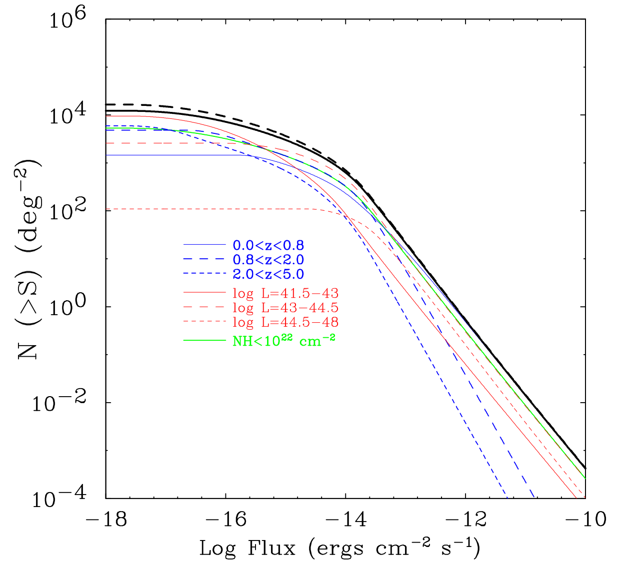


Fig. 1. Expected log $N$ - log $S$ relation of AGNs in the 3–20 keV band from the population synthesis model by Ueda et al. (2003).

AGNs in the 3–20 keV band, based on the population synthesis model by Ueda et al. (2003). It can be seen that the confusion limit of MAXI corresponds to $\approx 5 \times 10^{-12}$ erg cm$^{-2}$ s$^{-1}$ (3–20 keV), i.e., 0.2 mCrab, as an optimistic estimate.

To achieve the best sensitivity from the MAXI survey, we develop an analysis method utilizing maximum likelihood fit to a projected image (Hiroi et al. 2008). Using the MAXI simulator developed by Eguchi et al. (2008, this conference), we estimate a realistic sensitivity of $\approx 1$ mCrab from 1 week operation for a point source with $5\sigma$

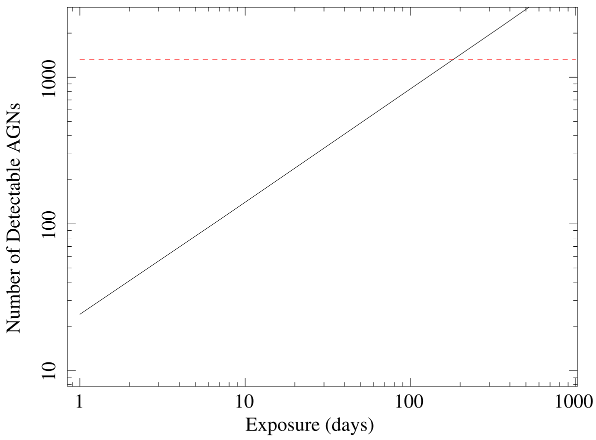


Fig. 2. Total number of AGNs from the MAXI extragalactic survey as a function of exposure (operation time). The horizontal line is the maximum number corresponding to the confusion limit.

detection, and hence $\approx 0.2$ mCrab (confusion limit) from half year operation. Figure 2 shows the expected number of detectable AGNs from an area of 30,000 deg$^2$ at $|b| > 15^\circ$, based on the Ueda et al. (2003) model. We expect about 100, 320, and 1300 sources from an exposure of 1 week, 1 month, and 6 months, respectively.

## 3. Content of the MAXI Catalog

The MAXI AGN catalog will contain many heavily obscured AGNs with absorption column densities of $N_\mathrm{H} \sim 10^{23-24}$ cm$^{-2}$ thanks to the large effective area above 5 keV. At the confusion limit, we estimate the number ratio between unabsorbed AGNs (log $N_\mathrm{H} < 22$) and absorbed ones (log $N_\mathrm{H} > 22$) to be about 800 : 500. The fraction of Compton-thick AGNs with log $N_\mathrm{H} > 24$ is expected to be a few percents in the total. This estimate is quite uncertain, however, depending on the $N_\mathrm{H}$ distribution of AGNs and its evolution.

The variability of AGNs can have significant impacts on the content of the catalog produced every half year, in particular at fluxes near the sensitivity limit. Also, we may detect many "transient" AGNs that are observable only during their flare phase. For instance, the timescale of "shots" seen in Galactic black holes in the low/hard state (Negoro et al. 1994) will become $\sim 10^6$ sec for a black hole mass of $10^8$ M$_\odot$.

## 4. Summary

We have shown from simulation studies that the fluxes of about 100 AGNs can be determined every week with an accuracy of 20% from the MAXI mission. We will have a new extragalactic catalog of about 1300 AGNs every half year, which is the largest one as an all-sky survey that covers energies above 2 keV. This catalog will be deeper than the *ROSAT* all sky survey for objects with absorptions of log $N_\mathrm{H} \gtrsim 21.5$, and deeper than the *Swift*/BAT survey for log $N_\mathrm{H} \lesssim 23.5$. In addition, the catalog will include many transient AGNs. These properties of the catalog will make the scientific outputs of MAXI unique among any other missions.

## References

Eguchi, S. et al. 2008, this volume
Hiroi, K., Ueda, Y., Eguchi, S. 2008, this volume
Negoro, H., Miyamoto, S., Kitamoto, S. 1994, ApJ, 423, L127
Piccinotti, G., et al. 1982, ApJ, 253, 485
Ueda, Y., Akiyama, M., Ohta, K., Miyaji, T. 2003, ApJ, 598, 886
Ueda, Y. et al. 2005, ApJS, 161, 185
Watson, M.G. et al. 2008, submitted (arXiv:0807.1067)