# Status of the Hard X-ray Modulation Telescope (HXMT) Project

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**Key words**

Space astronomy,
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Scan,
Timing

**Abstract**

The Hard X-ray Modulation Telescope (HXMT) is China's first astronomical satellite. On board HXMT there will be three kinds of slat-collimated telescopes, the High Energy X-ray Telescope (HE, NaI(Tl)/CsI(Na), 20–250 keV, 5000 $cm^2$), the Medium Energy X-ray Telescope (ME, Si-PIN, 5–30 keV, 952 $cm^2$), and the Low Energy X-ray Telescope (LE, Swept Charge Device, 1–15 keV, 384 $cm^2$). The typical Field of View (FOV) of HXMT is 1°×6° (FWHM), with other FOVs so as to measure the cosmic and the local particle induced X-ray backgrounds. The 3-σ continuum sensitivity of HXMT is about 0.5 mCrab ($10^5$s) for all the three telescopes. HXMT will perform a broad band (1–250 keV) scan survey and do pointed observations of X-ray sources to study their spectra and multi-wavelength temporal properties. It will run in a low earth orbit with an inclination angle of 43°, and its designed lifetime is 4 years. HXMT is now in the pre-flight model phase (Phase-B) and is scheduled to be launched in late 2014.

## 1 Scientific Objectives

HXMT will perform a sky survey and do pointed observations in 1–250 keV. It is anticipated that in the survey a large number of X-ray sources will be detected, while with the pointed observations the multiwavelength X-ray variabilities and the broad band X-ray spectra of some bright sources can be studied in details. Specifically, HXMT has the following scientific objectives:

- Scan survey of the sky to detect various kinds of active galactic nuclei (AGNs, also known as supermassive black holes), which can be used to understand the natures of the cosmic X-ray background and the statistical properties of AGNs.
- Study the quasi-periodic oscillation phenomena in black hole binaries in 1–250 keV. Especially, with its large collection area, HXMT will be unique for studying the short timescale hard X-ray variability that reflects the dynamics near the black hole's event horizon.
- Scan the Galactic plane to monitor transient sources.
- Study the cyclotron resonance features and the magnetic field strengths of neutron stars.

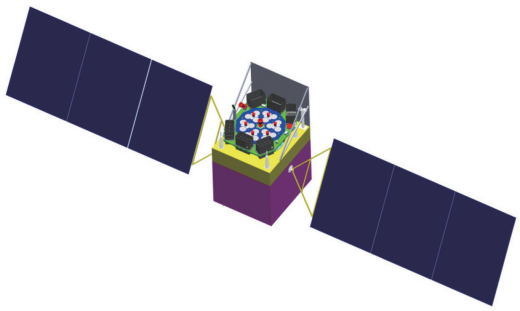

**Figure 1** An illustration of the HXMT satellite

## 2 Satellite and Payloads

Figure 1 shows the illustration of the HXMT satellite. The payloads are on the top of the satellite, and there is a sunshading board on one side so that the payloads will not be exposed directly in the sunlight to keep the low working temperature of the payloads. The satellite is three-axis stabilized, with an attitude control precision of 0.1° and measurement accuracy of 0.01°. Considering the locations

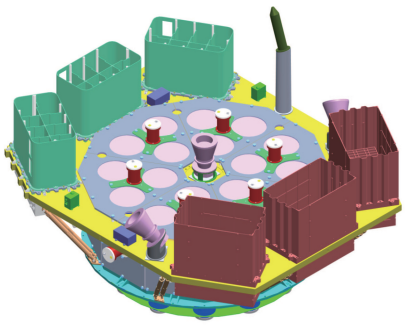

**Figure 2** Payload assembly of HXMT. In the centre there are 18 cylindric detector units of HE covered by veto plates. The three cyan detector boxes in the upper left belong to LE, and the three brown boxes in the lower right represent ME. On the payload assembly there are also three star trackers and three charged particle monitors

of the remote control stations and in order to avoid the high particle background environment such as the SAA region, the radiation belt, and the polar region, the orbit of the satellite has an altitude of 550 km and an inclination angle of 43°.

HXMT carries three slat-collimated instruments, the High Energy X-ray Telescope (HE), the Medium Energy X-ray Telescope (ME), and the Low Energy X-ray Telescope (LE).

HE has a cylindrical structure, consisting of 18 NaI/CsI phoswich modules (main detectors) with a detection area of 283.5 $cm^2$ each. In front of the detectors there are collimators to define the Field of Views (FOVs). 15 modules have FOVs of 1°×6°, 2 modules of 6°×6°, and 1 fully blocked. Such a combination of FOVs will permit a reliable estimation of the aperture incident and particle induced backgrounds, respectively. On the top and surrounding the NaI/CsI modules there are scintillation plastic plates used as veto to depress the particle background of the main detectors.

ME uses 1728 Si-PIN detectors read out by ASIC. The energy coverage of ME is 5–30 keV, and the total detection area is 952 $cm^2$. At the working temperature (from –40 to –20℃), the required energy resolution is 15% and the goal is 8% (at 20 keV).

LE uses swept charge device (SCD) as the detectors. The sun buffer on the top of LE is also the radiator to cool the detectors to from –80 to –45℃. In this temperature range, the energy resolution of LE is about 2.5% (at 6 keV). LE is sensitive in 1–15 keV with a total detection area of 384 $cm^2$.

## 3 In-orbit Background and Sensitivity

The in-orbit background of HXMT is simulated using the space particle environment measurements and GEANT4, the software package to simulate the interaction of matter and particles. As an example, Figure 3 shows the spectra of various components of the simulated in-orbit backgrounds of HE.

Using the effective areas of HE, ME and LE, and their simulated background spectra, we can get the sensitivities of these detectors respectively, which are illustrated in Figure 4.

## 4 Project Status

HXMT was proposed in 1994, and was officially approved in March, 2011. At the end of 2011, HXMT entered the pre-flight model phase. Now we are in the process to constrcut the electric model of the satellite. The scheduled launch time will be in late 2014.

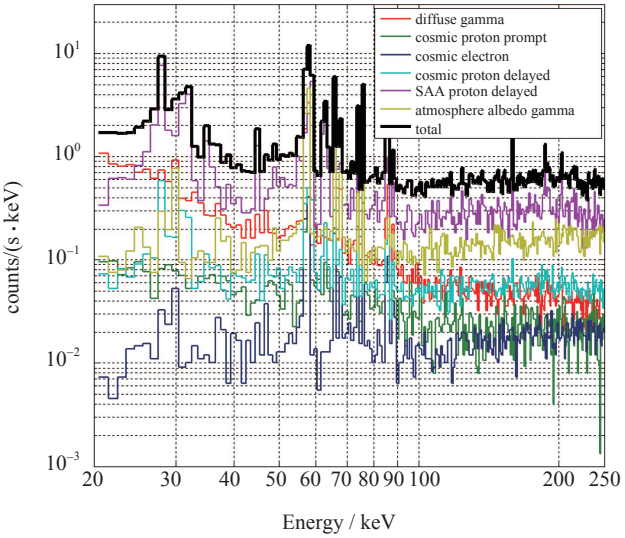


**Figure 3** Simulated in-orbit background induced by various components at the time 10 minutes from the Southearn Atlantic Abnormal (SAA) region and 100 days after launch

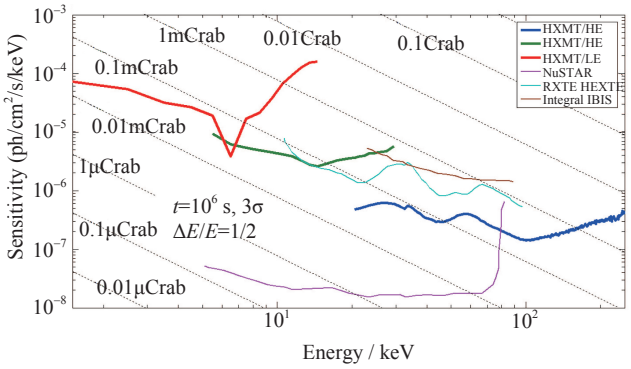


**Figure 4** The sensitivities of the three telescopes onboard HXMT. Also shown are the sensitivities of NuSTAR, RXTE/HEXTE and INTEGRAL/IBIS, which were reprinted from Koglinet al. 2005 (Proc. SPIE 5900, 266-275)