Hard X-ray Modulation Telescope

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The Hard X-ray Modulation Telescope (HXMT) will be China's first astronomical satellite. On board HXMT there are three kinds of slat-collimated telescopes, the High Energy X-ray Telescope (HE, 20-250 keV, 5000 cm^2), the Medium Energy X-ray Telescope (ME, 5-30 keV, 952 cm^2), and the Low Energy X-ray Telescope (LE, 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 X-ray background and the particle induced local X-ray background. The 3σ continuum sensitivity of HXMT is about 0.5 mCrab (10^5s) for all the three telescopes. HXMT will perform an X-ray sky survey and do pointed observations of X-ray sources to study their broad band spectra and the multi-wavelength temporal properties. The planned launch date of HXMT is around 2014/2015. It will run in a low earth orbit with an inclination angle of 43°, and the designed lifespan is four years.

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:

- To conduct 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 nature of the cosmic X-ray background and the statistical properties of AGNs.
- To study the quasi-periodic oscillation and other temporal phenomena of black hole and neutron star X-ray binaries. Especially, with its large detection 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.
- To scan the Galactic plane to monitor transient sources.
- To study the cyclotron resonance features and the magnetic field strengths of neutron stars.
- To observe supernova remnants to study their non-thermal X-ray emission properties and the related particle acceleration mechanism.

Satellite and payloads

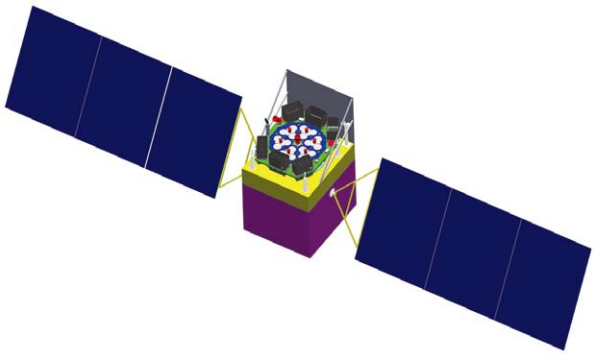

Fig.1 Shown is the illustration of the HXMT satellite. The payloads are on the top of the satellite, and there installs a sunshading board in one side so that the payloads will not be exposed directly in the sunlight, which will keep the detectors to work at low temperature. The satellite is three-axis stabilized, with an attitude control precision of 0.1°and measurement accuracy of 0.01°. Considering the locations of the remote control stations, and 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 550km 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 their 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

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Fig.2 The payload assembly of HXMT. The 18 cylindric detector units of HE are in the center of the assembly and are 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 three star trackers, three charged particle monitors, and an antena.

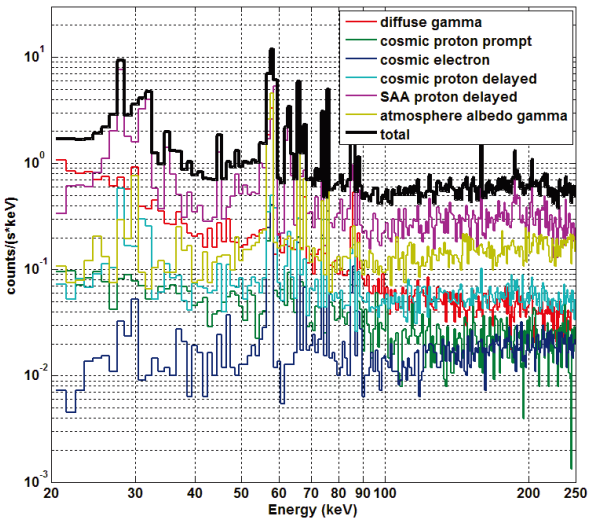

Fig.3 The simulated in-orbit background induced by various components at the time 10 minutes from the Southearn Atlantic Abnormal (SAA) region and 100 days after launch.

a reliable estimation of the aperture incident and particle induced backgrounds, respectively. On the top of and surrounding the NaI/CsI modules there are scintillation plastic plates used as veto to depress the particle background of the main detectors. As shown in Fig. 3, the simulated in-orbit background of HE is about 200 cts/s, corresponding to a continuum sensitivity of about 3×10^{-7} cts cm^{-2} s^{-1} keV^{-1}, or 0.5 mCrab (3σ,10^5 s, @100 keV). The energy coverage is 20-250 keV, and the energy resolution is better than 19% (@ 60 keV).

ME uses 1728 Si-PIN detectors that are integrated in three modules. The energy coverage of ME is 5-30 keV, and the total detection area is 952 cm^2. At the working temperature (-40 ~ -20°C), the energy resolution of ME is better than 15%. Similar to HE, ME also has three kinds of FOVs, 1°×4°(main FOV), 4°×4°, and the fully blocked one.

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 -80~ -50°C. In this temperature range, the energy resolution of LE is about 2.5% (@ 6keV). LE is sensitive in 1-15 keV with a total detection area of 384 cm^2. The FOVs of LE are 1.6°×6°(main FOV), 4°×6°, fully blocked, and 60°×2°, with the last big FOV to monitor the bright and bursting sources.

Project status

HXMT will be China's first dedicated astronomy satellite. The project was proposed in 1994 and officially approved in March, 2011. The scheduled launch time will be around 2014/2015.