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Status of the Hard X-ray Modulation Telescope Project

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ABSTRACT

The Hard X-ray Modulation Telescope (HXMT) is China's first astronomical satellite. It 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. The pre-flight models of the satellites have been finished, and the flight models are in production. The expected launch date of HXMT is in late 2015.

KEY WORDS

Hard X-ray Modulation Telescope (HXMT), Astronomical satellite, Black holes

1 Scientific Objectives

HXMT will perform a large scale 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, including transient events, and 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 main scientific objectives.

- To scan survey 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.
- To study the quasi-periodic oscillation phenomena in black hole binaries in 1−250 keV. Especially, with its large collection area, HXMT will be unique in 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, or study the X-ray counterparts of other burst events.
- To study the cyclotron resonance features and the magnetic field strengths of neutron stars.

2 Payloads Onboard HXMT

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

Telescope (LE). HE consists of 18 NaI/CsI phoswich modules (main detectors) with a total geometrical area of about 5000 cm^2 in 20−250 keV. ME uses 1728 Si-PIN detectors with an energy range of 5−30 keV and a total geometrical area of 952 cm^2. LE uses Swept Charge Device (SCD) as its detectors, which is sensitive in 1−15 keV with a total geometrical area of 384 cm^2.

3 Development of the Pre-flight Models

HXMT started the development of the pre-flight models at the beginning of 2012, after 9 months of design. In that year, we finished the electric, mechanical, and thermal models of the satellite as well as related tests. Figure 2 shows the electric model of the payload assembly and the mechanical model of the satellite in vibration tests, which were done in December 2012.

The space-qualification models of the platform components and most of the payloads were developed in 2013, and the rest of the payloads were in the first quarter of 2014. Figure 3 shows some of the space-qualification products of the payloads.

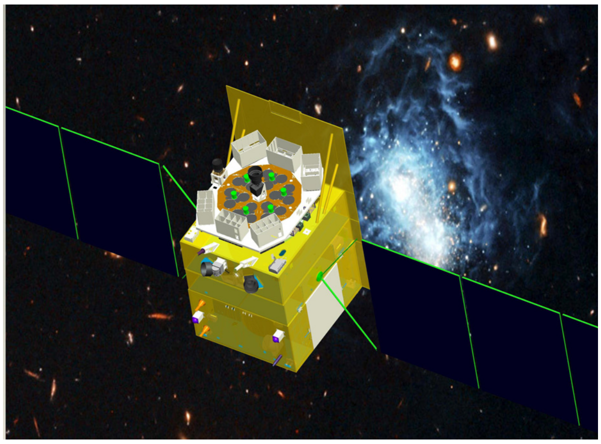

Fig.1 An artistic view of the HXMT satellite

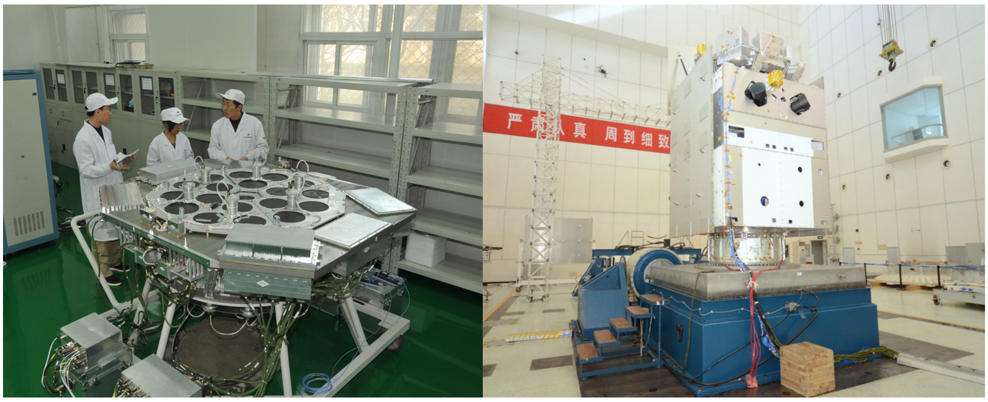

Fig.2 The electric model of the payload assembly (left) and the mechanical model of the satellite in vibration tests (right)

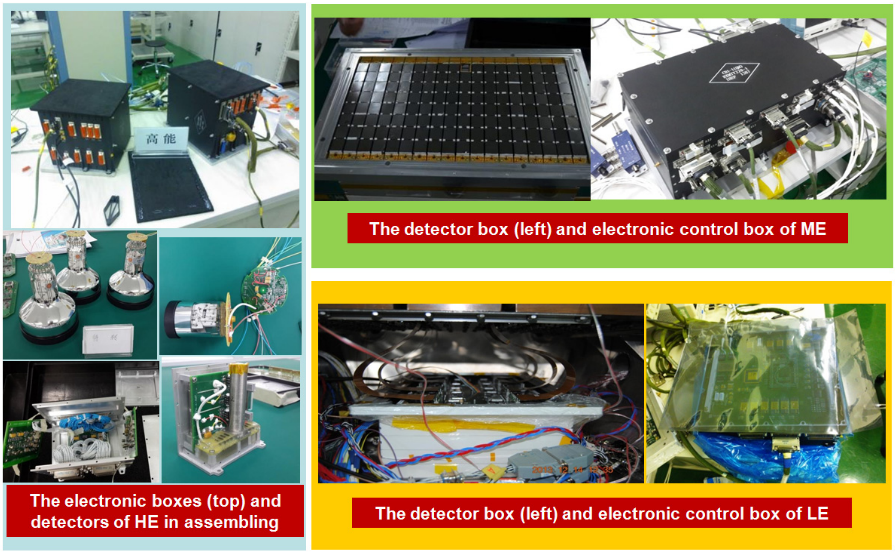

Fig.3 Some of the space-qualification products of the payloads

4 Calibration and Facility Building

Reliable and precise calibration is the basis for a space telescope to achieve its scientific goals. For HXMT, the performance of the detectors depends strongly on the working conditions. As shown in Figure 4, both the energy resolution and the signal amplitude of the LE detector are sensitive to the operating temperature. The HE and ME detectors have similar properties. The calibration is to obtain the response matrices of the telescopes under different working conditions.

There are two calibration facilities for the HXMT telescopes. One works in a laboratory environment and is for HE. It covers the energy range of about 15–110 keV. The other one covering 0.8–30 keV is for ME and LE, and operates in a vacuum chamber, because the air is not transparent to soft X-ray photons and the detectors need to be cooled to a temperature much below 0 ℃. The mono-energy X-ray beams of the two facilities are both produced with double crystal monochromators. The monochromaticity for the X-ray beam of the first facility is better than 1%, while the second one is designed as around 1‰. Both of them are about a magnitude better than the intrinsic energy resolutions of the detectors to be calibrated. Figure 5 shows the photos of the two facilities.

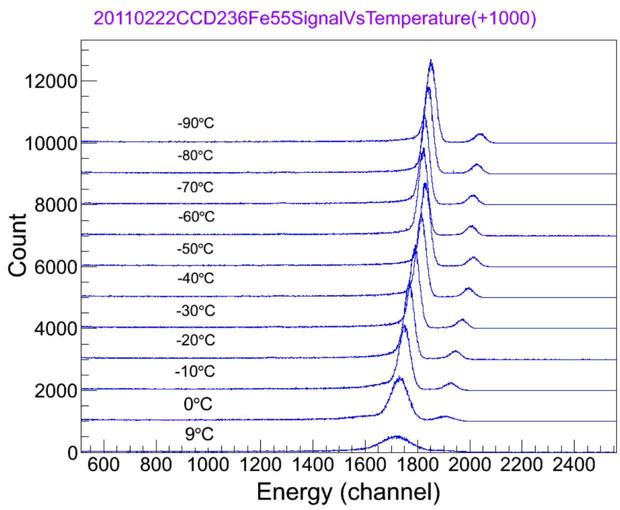

Fig.4 ^{55}Fe spectra measured by SCD detectors at different temperatures

Fig.5 The calibration facility for HE (left) and that for ME and LE. The one for HE is finished, and the other one will be finished in June 2014

In addition to the above two facilities, there are two other vacuum chambers for ME and LE respectively. In the chambers, we use X-ray tubes to illuminate metal targets to get florescent lines of iron, copper, molybdenum and tin. These florescent lines will be used to calibrate the variation of the energy response matrices of detectors at different operating temperatures, in supplement to the monochromatic X-ray beams.

5 Future Plan

It is expected that the flight models of the payloads will be finished in 2014. After about 6 months of calibration and testing, all the payloads will be delivered to the satellite in the first quarter of 2015. The scheduled launch time will be in late 2015.