THE LYNX X-RAY MICROCALORIMETER

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One of the Lynx X-ray telescope’s three instruments is an imaging spectrometer called the Lynx X-ray Microcalorimeter (LXM), an X-ray microcalorimeter behind an X-ray optic with an angular resolution of 0.5 arc-seconds and approximately 2 m² of area at 1 keV. The LXM will provide unparalleled diagnostics of distant extended structures and in particular will allow the detailed study of the role of cosmic feedback in the evolution of the Universe.

The Lynx LXM provides high spectral resolution and high spatial resolution non-dispersive imaging spectroscopy over a broad energy range (0.2–10 keV). LXM is composed of a large array of X-ray sensors that determine the energy of individual incident photons by precisely measuring the temperature rise caused by each. It will meet the many different science-driven performance requirements of Lynx with different sub-regions of the detector array. These arrays are identified as the “Main Array” the “Enhanced Main Array” and the “Ultra-High-Resolution Array”. These arrays offer a range of solutions, trading spatial and spectral resolution, along with FOV and high count rate capability.

The “Main Array” has a field-of-view equivalent to the Athena X-ray Integral Field Unit instrument, but with a substantially smaller pixel size, necessary to exploit the X-ray Mirror Assembly half power diameter of 0.5 arc-seconds. This fine resolution will permit Lynx to observe sub-arcsecond-scale features in clusters and jets, and minimize source confusion in crowded fields. The “Main Array” will provide an energy resolution of better than 3 eV (FWHM) over the energy range of 0.2 to 7 keV with pixels sizes that vary in scale from 0.5 arc-seconds in the innermost 1-arc-minute “Enhanced Main Array” to pixels that are 1.0 arc-seconds extending out to a 5 arc-minute field-of-view. The “Enhanced Main Array” will provide 2 eV energy resolution (FWHM) as well as the better angular resolution.

A different sub-array called the “Ultra-High-Resolution Array (UHR)” will provide an energy resolution of 0.3 eV up to ~ 0.8 keV and ~ 2 eV resolution up to ~ 2 keV in a 1 arc-minute region off to the side with 1 arc-second pixels. This region will allow the measurement of turbulence in winds of individual galaxies, and is also used in a variety of other measurements of hot gases around galaxy halos.

Figure 1 Photograph of a prototype LXM array.

We will describe the baseline design of LXM and the results of recent progress in the development of these technologies. The baseline sensor technology uses transition-edge sensors (TES), but we also consider an alternative approach using versus metallic magnetic calorimeters (MMC). Both approaches utilize multi-absorber pixels designs known as “Hydron”, to dramatically increase the number of pixels beyond the previous state-of-the-art. We will describe a TES array that has been fabricated and is shown in Figure 1, that consists of over 48 thousand pixels, and similar MMC array with over 55 thousand pixels in which every single pixel is wired up within the array. Preliminary test results from the three sub-array pixel types from the TES prototype have demonstrated 0.3 eV energy resolution in UHR pixels at low energies. Preliminary tests of the “Main Array” and “Enhanced Main Array” pixel types also show that the performance requirements can be met, and the technical readiness level is advancing rapidly. We also briefly discuss the baseline readout design, the preliminary focal plane assembly design, and the preliminary cooling system design.