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Lynx X-Ray Observatory

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One of the most exciting challenges of human discovery is understanding the complexities of the Universe. We have entered an era when a multi-wavelength and multi-messenger approach with powerful new observatories is required to address the origins and physics of the cosmos. Sensitive x-ray measurements are a central part of this quest. Their great power stems from the fact that much of the baryonic matter, as well as the settings for some of the most active energy releases in the Universe, are primarily observable in the x-ray band. A powerful x-ray observatory can be a discovery engine for exploring the Universe near and far.

The James Webb Space Telescope (JWST) and other upcoming major space- and ground-based facilities are expected to greatly expand science frontiers in the next decade. This presents both a great opportunity and a challenge for a future x-ray observatory. In many areas, such as understanding black holes during the Cosmic Dawn or formation and evolution of galaxies, an x-ray observatory is a logical next step after JWST and WFIRST. The challenge is that the x-ray science at these new frontiers requires expansion of capabilities by orders of magnitude beyond the current state of the art or anything already planned. Until recently, such gains were not technologically possible. This has changed thanks to recent breakthroughs in key technologies for x-ray mirrors and detectors. We are reaping the fruits of very significant US investments in these areas over the past 10 to 15 years. Lynx, an x-ray observatory that will fly revolutionary instrumentation aboard a proven, tested, and simple spacecraft, is now totally feasible.

By orders of magnitude, across multiple dimensions, Lynx will be the most powerful x-ray observatory ever designed and flown. In all aspects, Lynx will be a Great Observatory that will open a new era in our understanding of nature. It will provide an unprecedented view of the otherwise “Invisible Universe” and push outward upon every frontier of the scientific landscape. It will provide the depth and breadth to answer those questions which confront us today; just as importantly, it will have capabilities to address those questions we have yet to even ask.

Lynx’s transformational scientific power is entirely enabled by its payload — the mirror assembly and a suite of three highly capable science instruments. Each of the payload elements features state-of-the art technologies but at the same time represents a natural evolution of an existing instrument or technology, with each already having years of funded technology development. All key technologies are currently in the Technology Readiness Level (TRL) range between 3 and 5. With three years of targeted pre-phase A development in early 2020s, all but one enabling technology will be matured to TRL5 and it will reach TRL4 by start of Phase~A and achieve TRL5 shortly thereafter.

Lynx science goals require a set of capabilities that go orders of magnitude beyond any existing or planned x-ray mission. These capabilities can be implemented within a proven mission architecture derived from Chandra.

This special section presents contributions emphasizing technology specific to achieving Lynx science objectives. The collection includes articles on technology development for each payload element and on alternative technologies deemed capable of meeting Lynx scientific needs. This includes an imaging component that provides a factor of 50x higher throughput, 20x the field-of-view with sub-arcsec imaging, and a factor of 1000x greater speed for surveys compared to the current state of the art (Chandra). Turning to spectroscopy, several articles describe the many components of the Lynx x-ray microcalorimeter, which will provide a fully spatially resolved spectroscopic x-ray capability. Other contributions cover Lynx’s soft x-ray dispersive grating spectrometer and large-format, fine angular resolution imager.

Combined, the Lynx payload elements will provide performance gains of historical magnitude synergistic with current cutting-edge and major future astronomical facilities — the Extremely Large Telescopes on the ground, JWST, WFIRST, Advanced LIGO, LISA, ALMA, SKA — all making great leaps in sensitivity in their respective wavebands.