The Lynx Observatory:
A Concept for a Next Generation X-ray Telescope

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“Light, Light, The visible reminder of invisible light” – T.S. Eliot
Each wavelength provides different information.
We are surrounded by naturally-occurring radioactive elements in the soil and stones.

Uranium

Radium

We have radioactive elements (Potassium 40, Carbon 14, Radium 226) in our blood or bones.
Staying Alive!
If our atmosphere blocks out X-Rays, how can we see them?
• Most of the matter that we “see” in the universe is via its X-ray emission
• The bulk of this matter is the hot, X-ray-emitting gas in the great galaxy clusters
• Every known class of astronomical object, from comets to quasars, is also an X-ray source
CHANDRA X-RAY OBSERVATORY

Chandra can detect and image X-ray sources that are billions of light years away.

This focusing power is equivalent to the ability to read a newspaper at a distance of half a mile!
The Chandra data shows how 10-million-degree gas is expanding outward after the explosion that destroyed the star. The movie spans 2000-2013.
[credit: NASA/CXC/SAO]
What's Next?

What Mysteries Still Need to be solved?
A symbol of great insight in many cultures - with the ability to see through solid objects to reveal the true nature of things.

Academy of the ‘Lynx-Eyed’ was founded in 1603 by Federico Cesi. Perform incisive and penetrating investigations of the natural world.
A NEW GREAT OBSERVATORY

HIGH DEFINITION X-RAY IMAGER
Designed for exquisite imaging and wide surveys, the HDXI is an active pixel array covering a 20° x 20° field of view with subarcsecond imaging.

LYNX X-RAY MICROCALORIMETER
Spatially resolved 3 eV spectroscopy across a 5′x5′ field of view, sampled with 1′ pixels. Two subarrays optimized for finer imaging and higher spectral resolution.

X-RAY GRATINGS SPECTROMETER
Spectral resolving power of \( R > 5000 \) with \(~4000 \) cm\(^2\) of effective area across the critical X-ray emission and absorption lines of C, O, Mg, Ne, and Fe-L.

EINSTEIN

CHANDRA
50x higher throughput while maintaining Chandra’s angular resolution.

Like going from your 8” backyard telescope to a 10-m Keck.

What takes Chandra 8 weeks, Lynx can do in ~1 day for deep surveys.
Like skipping stones off of a (calm) body of water
Lynx Mirror Assembly has a 3m diameter

JWST Primary Mirror: 6.5 m
Lynx Mirror: 25 m
to 3 m diameter assembly
The Lynx mission is designed to pursue three science pillars:

1. There are ample resources for many other programs, including those unexpected today.
2. It will be a discovery platform for all.

www.hiddenicosmos.org
BLACK HOLE DAWN

New Record Breaking Quasars
J1342+0928; z=7.54; 800 million Msun!

Supermassive Black Holes in the Early Universe

Time Since Big Bang
(in billions of years)

Black Hole Mass
(in millions of solar masses)

Image credit: Jinyi Yang/UA; Reidar Hahn/Fermilab; M. Newhouse/NOAO/AURA/NSF
ENGINES OF CHANGE

Illustris

Illustris TNG

Same Numerics, Different Physics

Indistinguishable Galaxies

Stellar Mass Galaxies

Metals

$T_{\text{gas}}$

$\rho_{\text{gas}}$

Gas Column Density (log M$_{\odot}$ kpc$^{-2}$)

Temperature (K)

Gas Metallicity (log Z$_{\odot}$)

Stellar Column Density (log M$_{\odot}$ kpc$^{-2}$)
HIDDEN LIGHT OF SUNS

Where do planets form? Where do they migrate?

- X-ray spectra of young stars show more than accretion plus magnetic activity
- X-rays implicated in rapid heating of protoplanetary disks
- After stars lose their disks X-ray surveys are the only way to find young stellar objects

How do the characteristics of flares change with time and what impact does this have on exoplanet conditions?

- Systematic change of $T_{\text{max}}$, $E_{\text{flare}}$, $L_{x,\text{max}}$ on flares of stars with varying mass, age, magnetic configuration as input to evolution of planetary irradiation
- Influence of energetic particles inferred from line profiles

The star’s magnetic field creates an ecosystem which helps to set the environment that planets (and life) experience (Lingam & Loeb 2018) Stellar magnetospheres influence the inner edge of the traditional habitable zone (Garaffo et al. 2016, 2017).

Credit: R. Osten
ASTROPHYSICS

Decadal Survey Missions

- UV-Visible-Near IR
- Visible-IR
- X-Rays

Launch in 2030s!

Lynx X-ray Observatory

Lynx?
THE MILKY WAY
<table>
<thead>
<tr>
<th>Gravitational Waves</th>
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<tr>
<td>Gamma-rays (magenta)</td>
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<tr>
<td>Ultraviolet (violet)</td>
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<tr>
<td>Optical &amp; Infrared (blue-white to red)</td>
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<tr>
<td>X-Ray Jet (blue)</td>
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The right answer is seldom as important as the right question.
– K. Thorne

The Renaissance of Multi-wavelength Astronomy has Begun!
Are Cats Spies Sent by Aliens?

If you hold a cat’s ears back and describe what you see, it is a perfect match to the classic "grey alien," with its almond-shaped eyes, small mouth, and small nose.

Obviously true. See below.

THANK YOU!

Dr. Jessica A. Gaskin

https://wwwastro.msfc.nasa.gov/lynx/

https://www.lynxobservatory.com

https://chandra.harvard.edu/
All Things Big and Small

40 km Above the Earth!

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BACKUP SLIDES