X-ray Astronomy: Current Status and Future Plans

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Recent Results from Current Missions

Chandra
- Direct detection of cluster feedback

XMM-Newton
- Detection of intermediate mass black hole

Suzaku
- First view of infalling gas into galaxy clusters

Swift
- Discovered origin of ‘short-hard’ gamma-ray bursts.

Fermi
- Discovery of gamma-ray pulsars
Approved Future Missions

ASTROSAT
Large-area PC; soft XT, CZT coded mask; SSM; Launch in 2011

NuSTAR
Imaging hard X-ray satellite; Launch in 2012

SXG/eROSITA
All-sky survey with CCDs; Launch in 2013

GEMS
Efficient X-ray polarimetry; Launch in 2013

Astro-H
High-res. non-dispersive spectroscopy; HXT; Launch in 2014
Effective Area for Hard X-ray Timing

- ASTROSAT-LAXPC
- RXTE-PCA
- BeppoSAX-PDS
Effective Area for Imaging Hard X-rays

![Graph showing the effective area for imaging hard X-rays with different instruments: NuSTAR, XMM-Newton/PN, and Chandra/ACIS. The graph plots effective area (cm²) against energy (keV).]
Effective Area for High-Resolution Spectroscopy

![Graph showing effective area vs energy for different instruments: XMM RGS, Chandra MEG, Chandra HEG, Chandra LETG, and Astro-H SXS. The graph plots effective area (cm$^2$) on the y-axis and energy (keV) on the x-axis.]
Grasp for Large Area Surveys

Grasp: \( A_{\text{eff}} \times \text{FOV} \) (cm\(^2\) deg\(^2\))

- eROSITA 7 Tel
- XMM pn+MOS
- ROSAT PSPC

Energy (keV)
Future Science Arenas I

• High Spectral Resolution
  – Enables:
    • Probes of AGN feedback mechanisms / regulation of galaxy growth
    • Studies of metal formation/evolution over cosmic time
    • Probes of cosmology (DE and DM) via cluster evolution studies
    • Finding the ‘missing’ baryons
  – Requires:
    • Large effective areas with:
      – Transition Edge Sensor Microcalorimeters
      – Off-Plane or Critical Angle Transmission Gratings
Future Science Arenas II

• Very High Spatial Resolution
  – Enables:
    • Probes of the high-z universe – e.g., black hole evolution, constraints on accretion luminosity of the universe.
    • Surveys of SNR, XRB populations in galaxies
    • Probes/identification of obscured AGN
    • Trace the evolution of structure, black holes, and galaxies and the elements they produce
    • Probe the behavior of matter in extreme environments
  – Requires:
    • Piezoelectric-Adjusted Thin Mirrors
Future Science Arenas III

• High Timing Resolution
  – Enables:
    • Probes of physics of ultra-dense matter via studies of neutron star surfaces
    • Probes of accretion over all mass scales
    • Probes of strongly curved spacetime through studies of black hole event horizons
    • Probes of intense magnetic fields
  – Requires:
    • Large effective areas with
      – Active Pixel Sensors
      – Silicon Drift Diodes
IXO Capabilities

- Recommended in NWNH, but not 1\textsuperscript{st} priority
- ESA deferring L-Class selection; lower-cost options (e.g. Athena) being investigated.
Summary and Status

– The current picture for X-ray astronomy is good. Powerful tools are in place, breaking new ground and complementing telescopes at other wavelengths

– Near-term advances in key areas are on the horizon with hard X-ray imaging, high-resolution spectroscopy, polarimetry, and surveys

– The future is less certain, particularly for large missions. Clear definition of science needs, and creative plans for meeting goals with missions of different scales, are crucial for establishing the required science and technology roadmap.