



A Chandra Successor in the 2030s

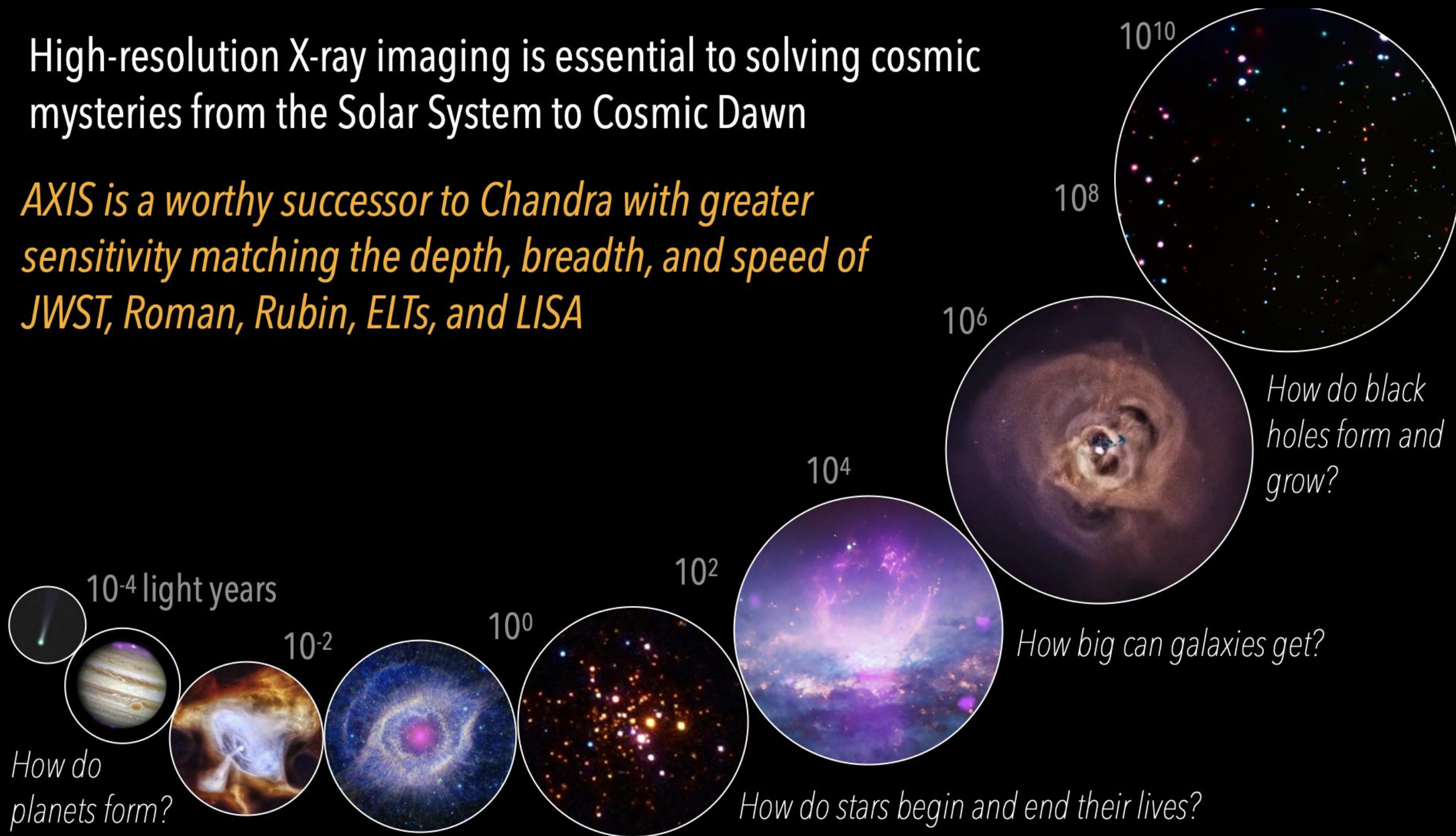
Michael Koss

Eureka Scientific

On Behalf of AXIS Science Proposal Team
(C. Reynolds, E. Kara, E. Hodges-Kluck, B.
Williams, A. Ptak, science leads, and 500+
community science members)

High-resolution X-ray imaging is essential to solving cosmic mysteries from the Solar System to Cosmic Dawn

AXIS is a worthy successor to Chandra with greater sensitivity matching the depth, breadth, and speed of JWST, Roman, Rubin, ELTs, and LISA



AXIS VS...

Chandra

- 5-10x larger effective area
- 6x better FoV-ave PSF

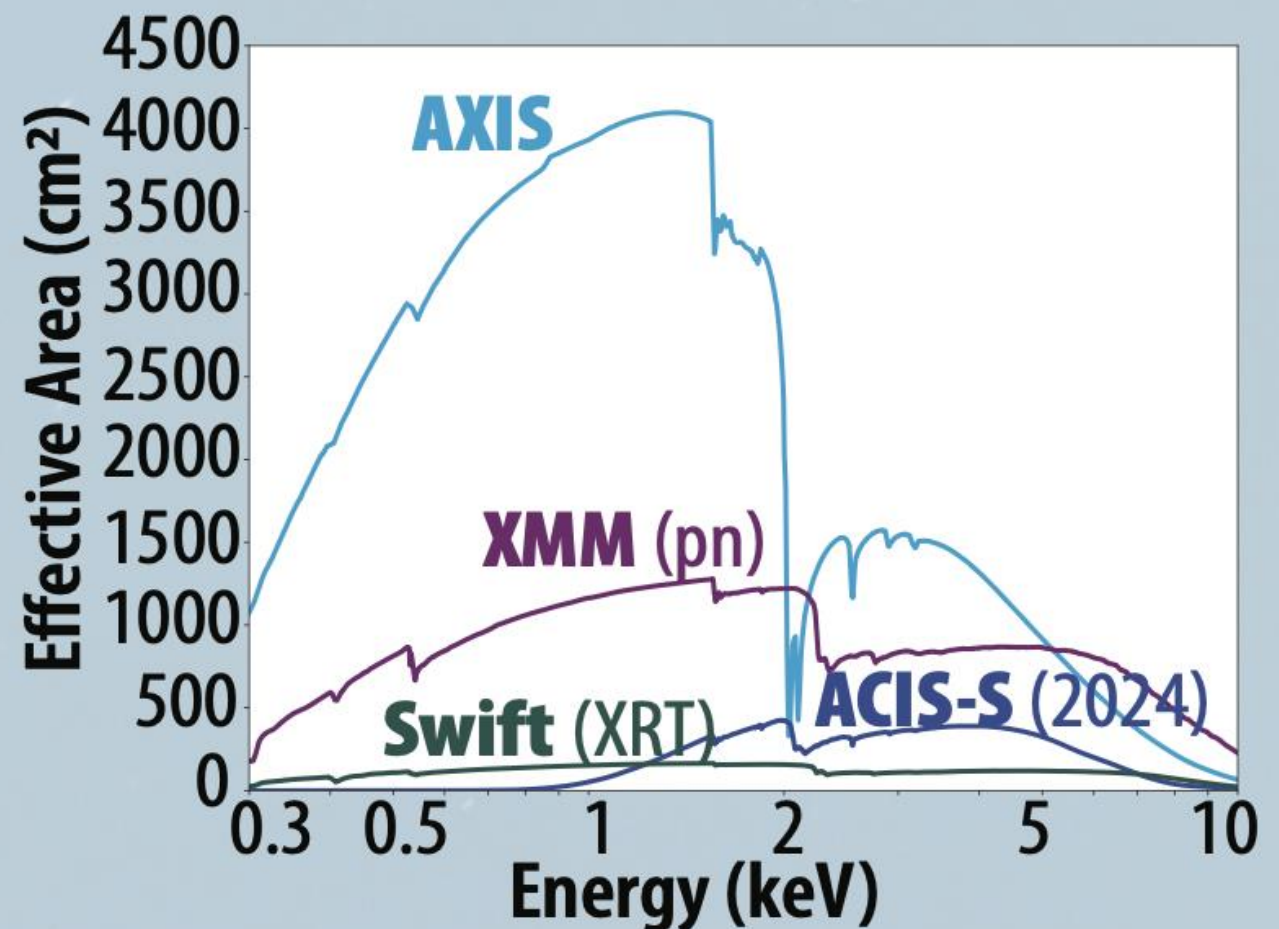
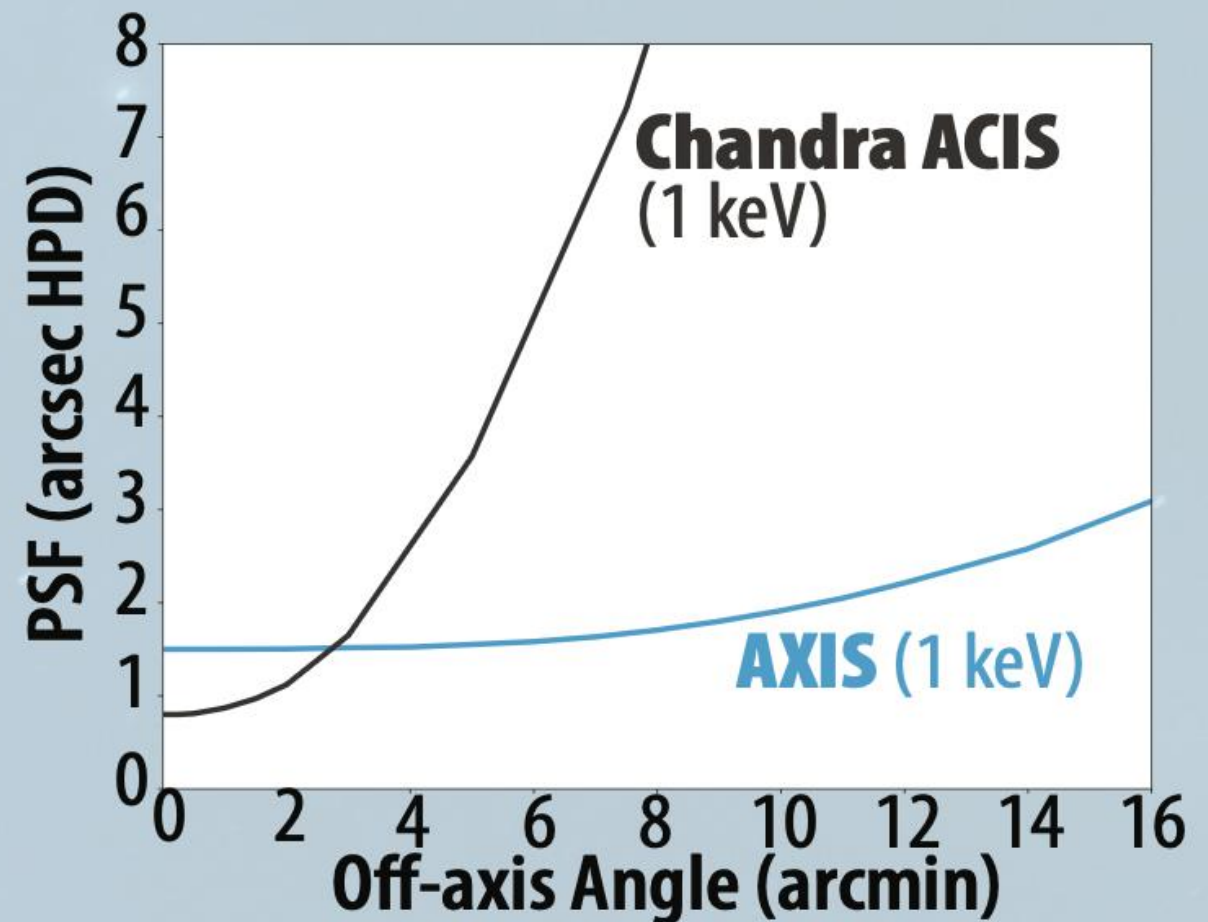
AXIS has 70x the survey grasp (FoV x area) at 1.5" than Chandra.

XMM-Newton

- 4x larger area below 2 keV
- 10x better PSF

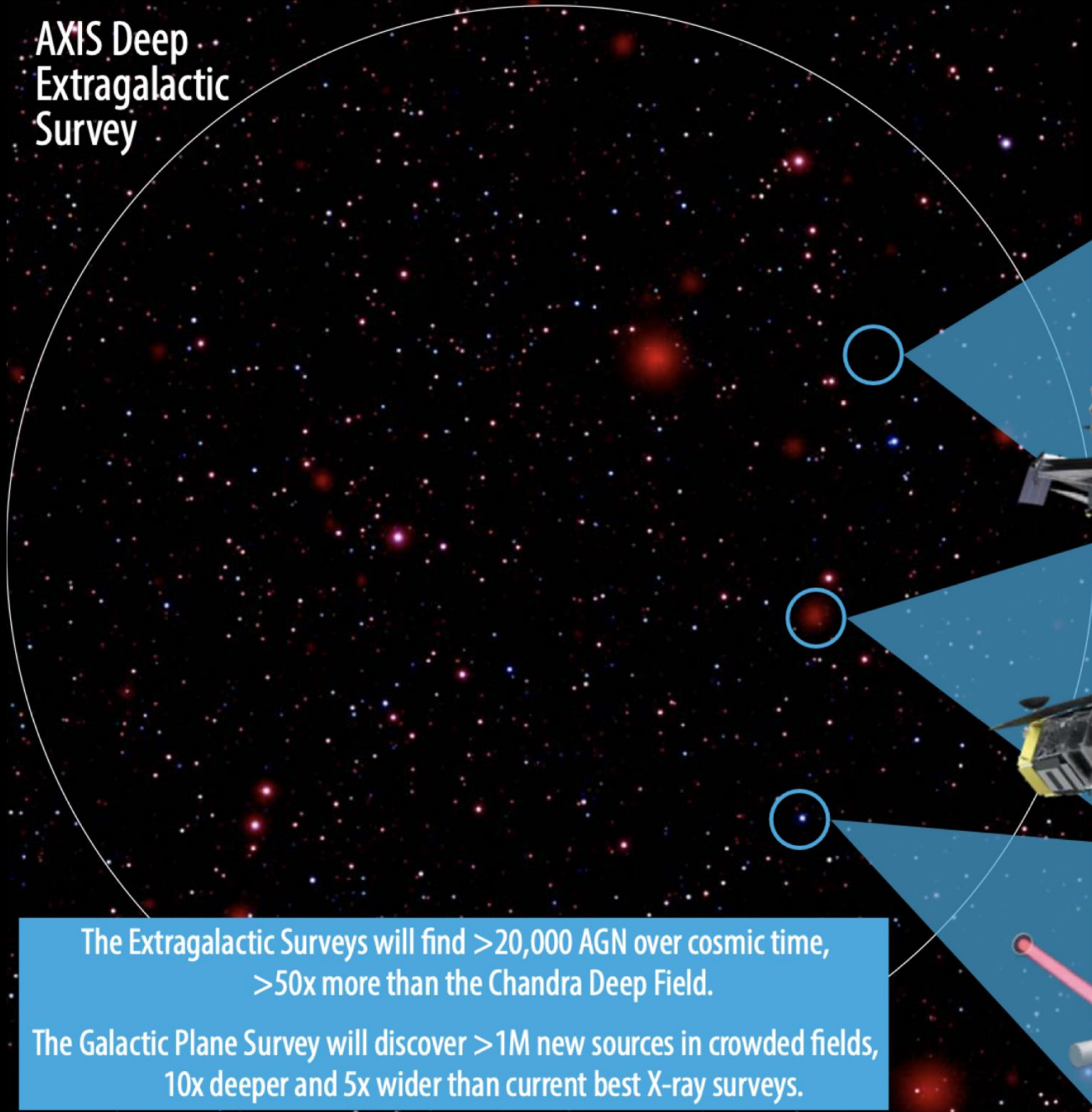
Swift

- Same fast ToO Response Time
- 60x better sensitivity

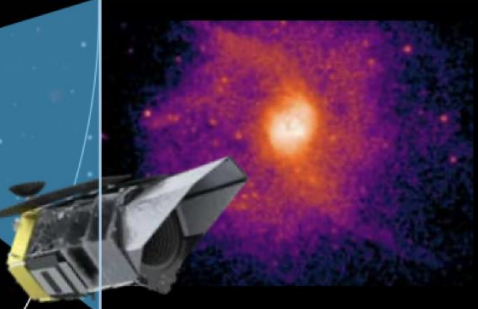


AXIS Deep
Extragalactic
Survey

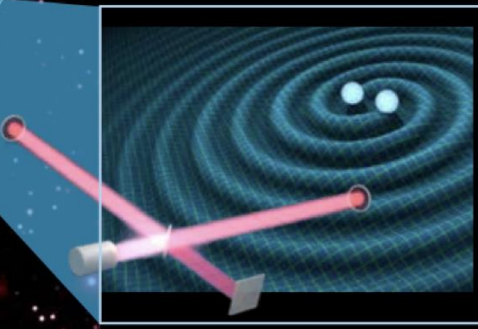
Science Pillars



What seeds supermassive black holes and how do they grow?



How do gas, metals, and dust flow into, through and out of galaxies?



What powers the diversity of explosive phenomena?

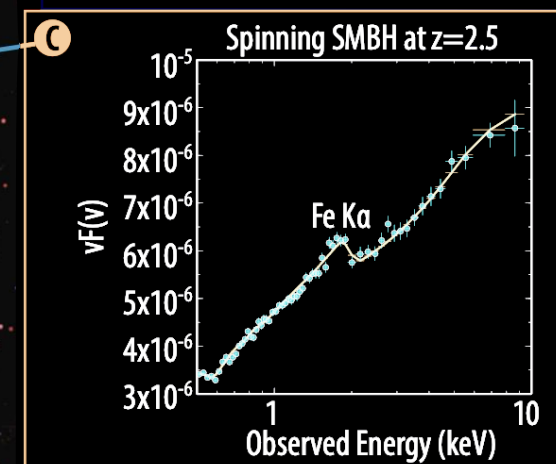
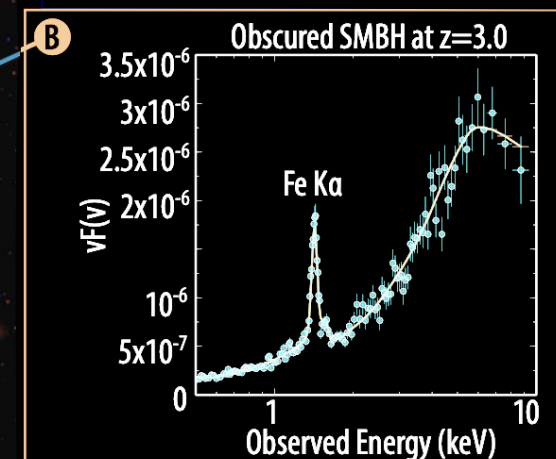
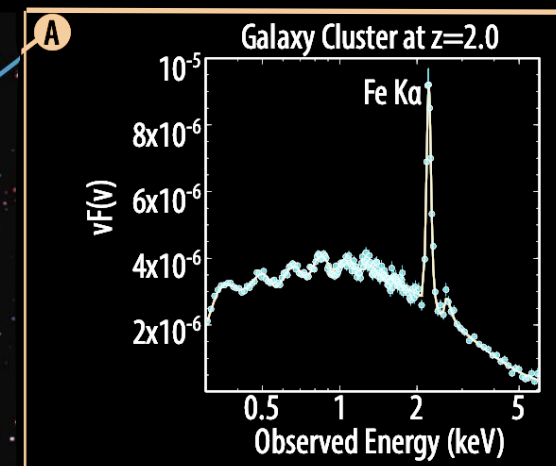
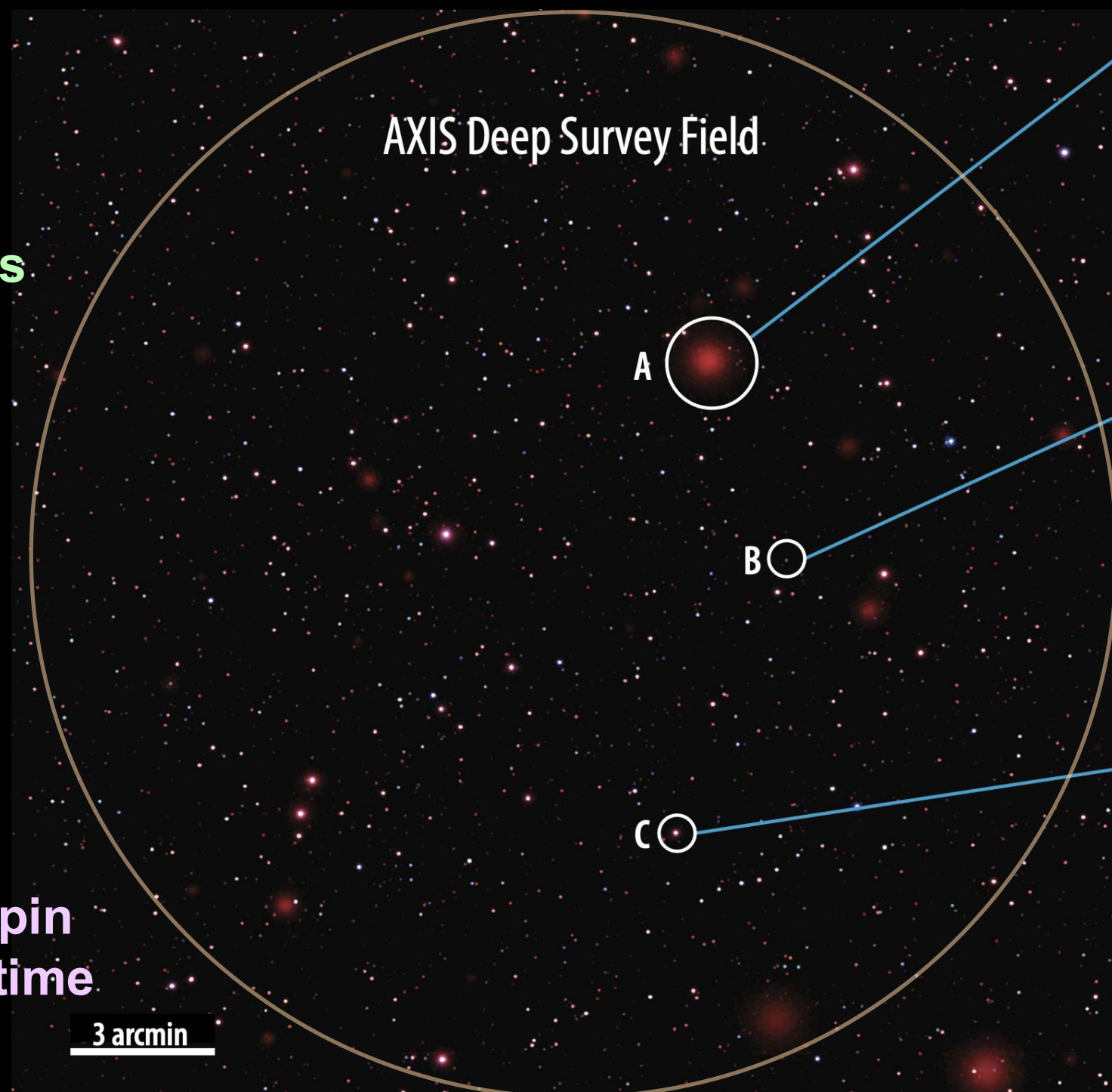
The Extragalactic Surveys will find >20,000 AGN over cosmic time,
>50x more than the Chandra Deep Field.

The Galactic Plane Survey will discover >1M new sources in crowded fields,
10x deeper and 5x wider than current best X-ray surveys.

High- z clusters

AGN obscuration
fraction

Black hole spin
over cosmic time

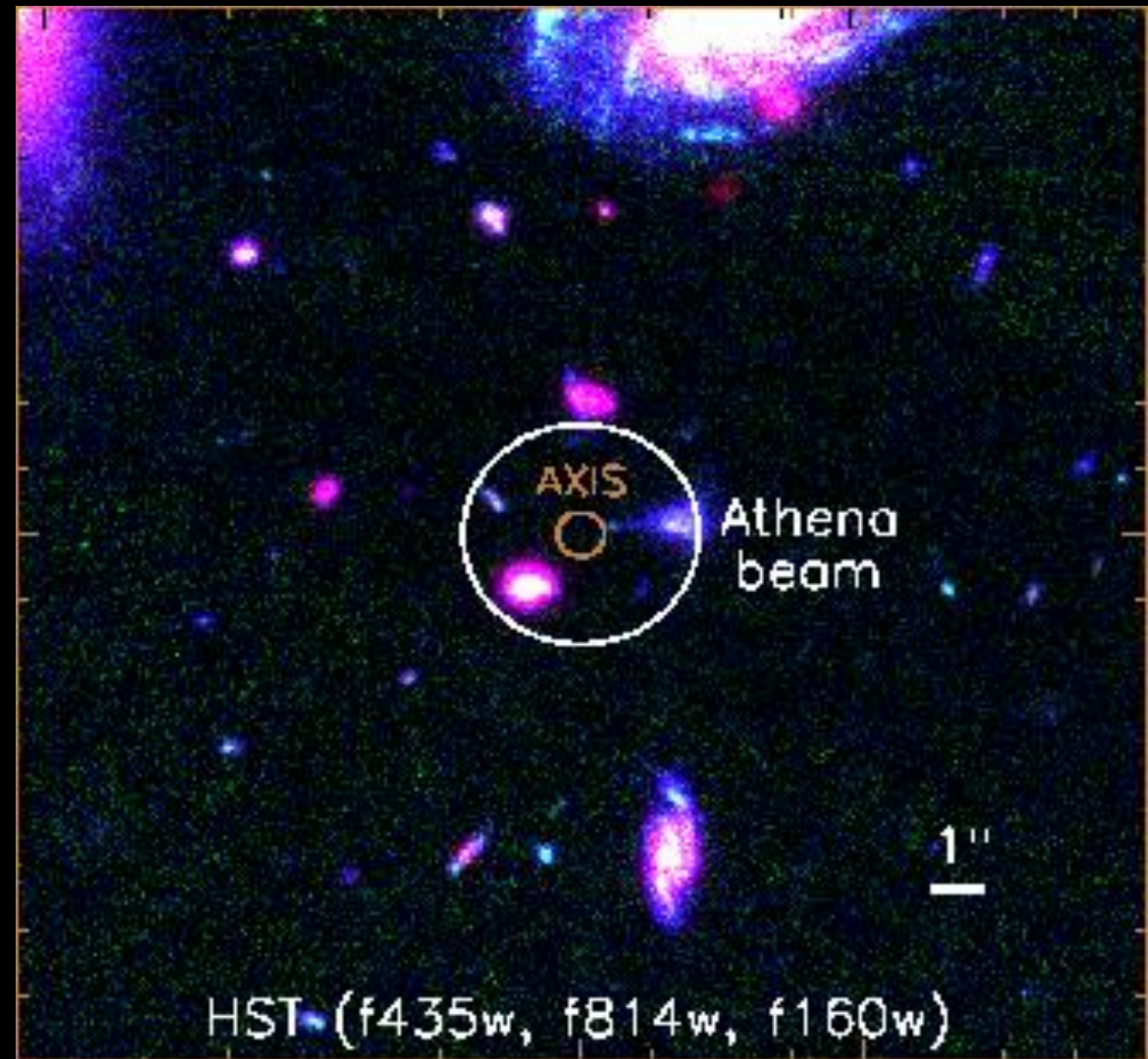


Deep Extragalactic Surveys

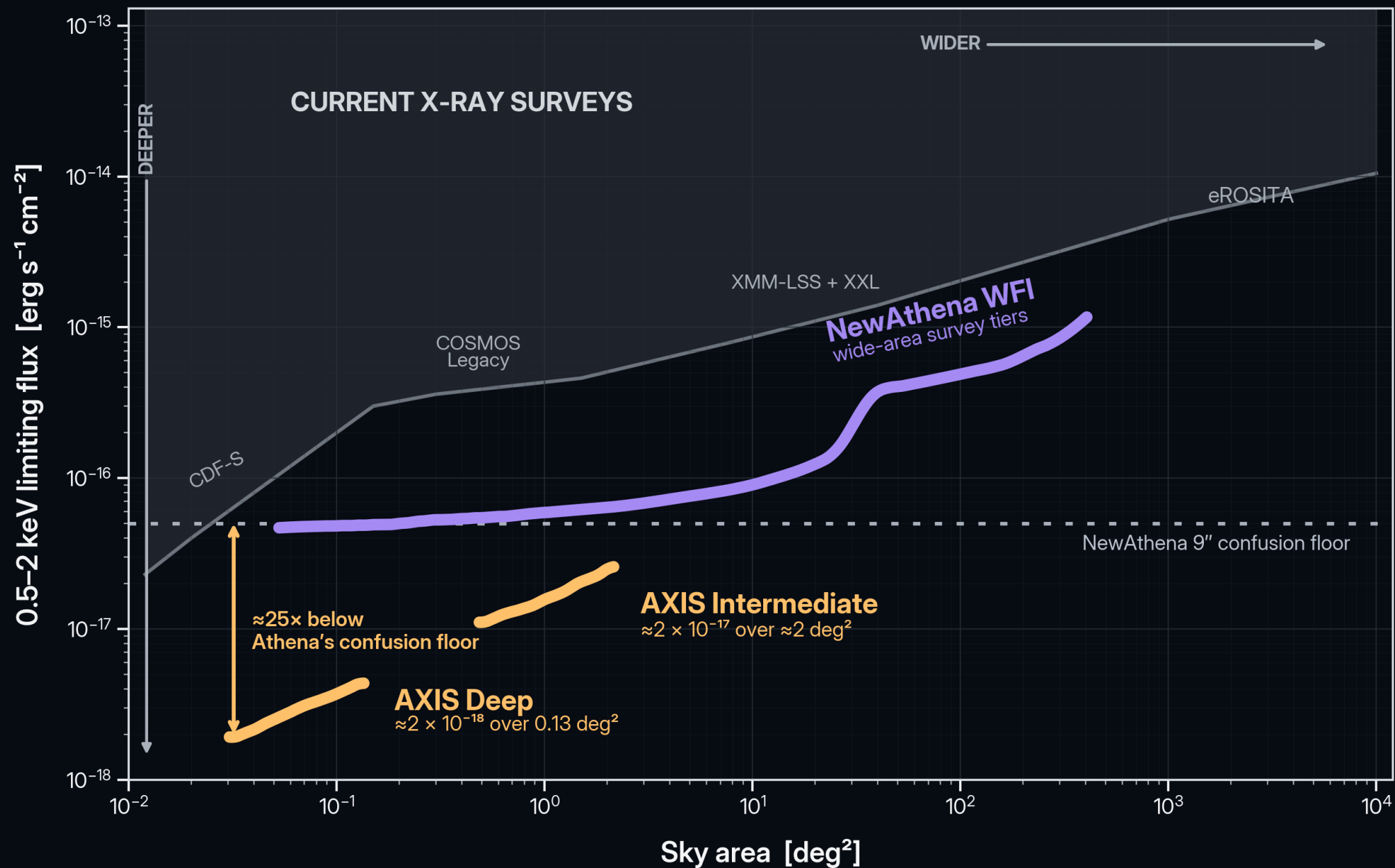
Further, Wider, Faster

AXIS Deep
Extragalactic
Survey

3 arcmin



Deep Extragalactic Surveys Further, Wider, Faster



ATHENA

WIDE + HIGH THROUGHPUT

Large samples of rare, luminous AGN
WFI discovery; X-IFU physics

+

AXIS

DEEP + SHARP

$\approx 1.5''$ imaging below the confusion floor
Deblending + secure host counterparts

TOGETHER

A complete AGN census:

rare luminous quasars → faint SMBH seeds
demographics + resolved environments + spectra



Astro2020 asks: “What seeds supermassive black holes, and how do they grow?”

400Myr

500Myr

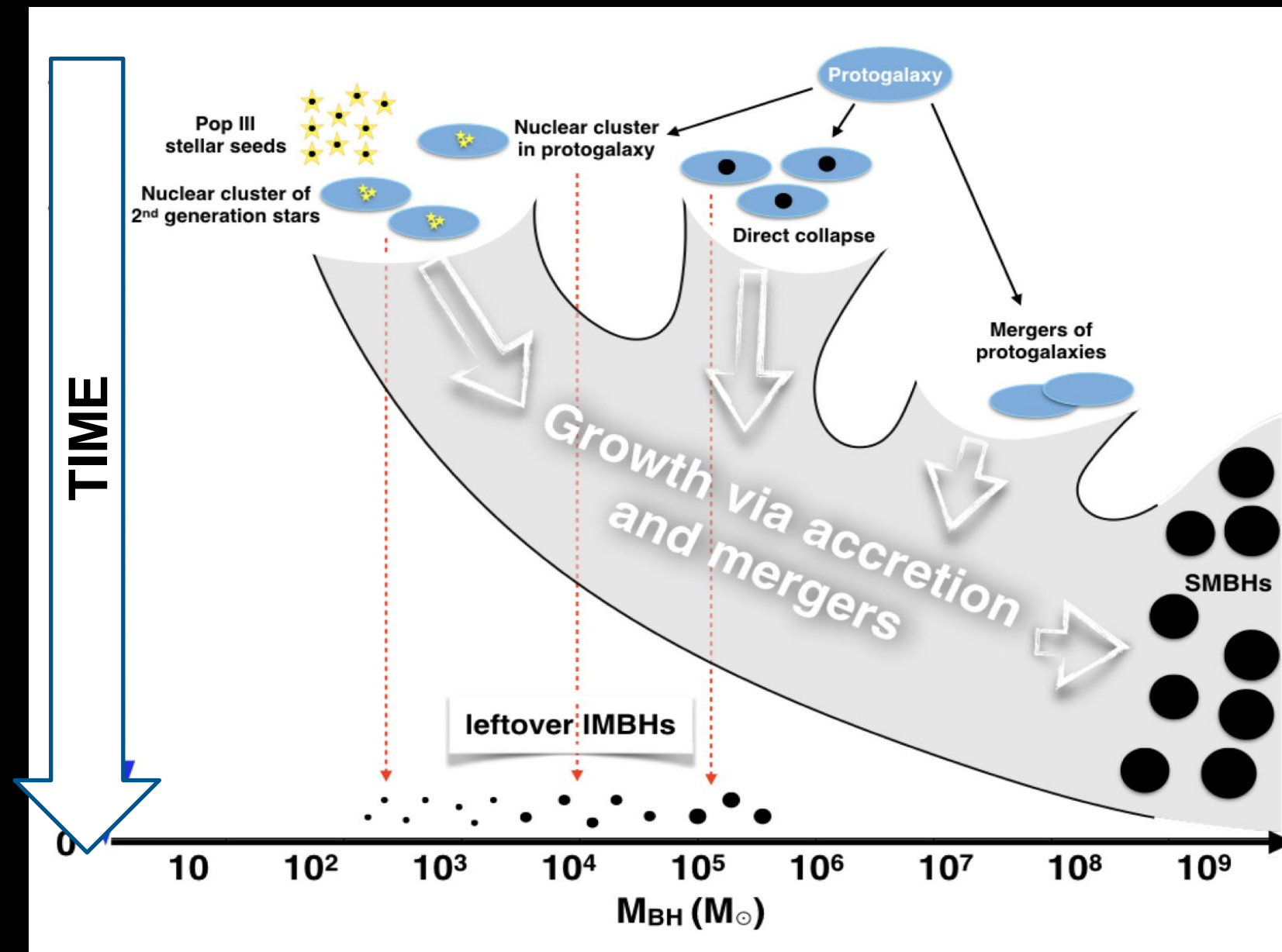
600Myr

1Gyr

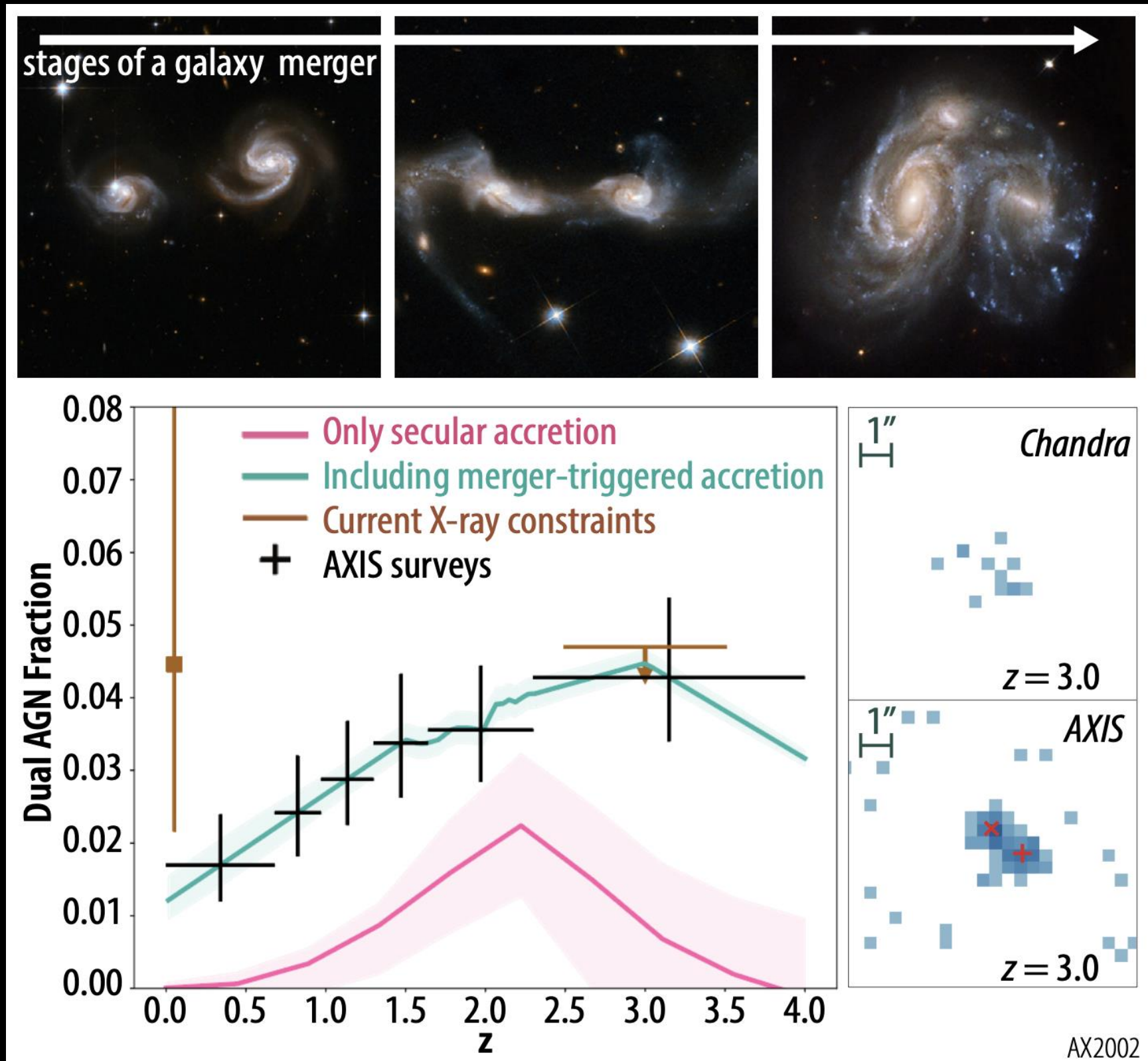
2Gyr

6Gyr

13.6Gyr



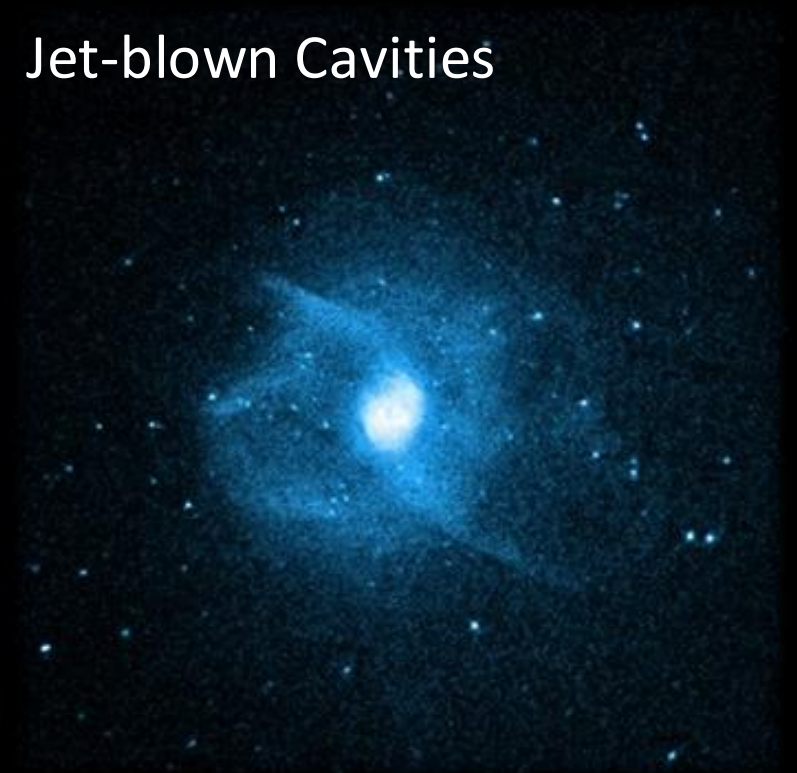
What is Role of Mergers in Growing Black Holes?



AGNs in Starbursts



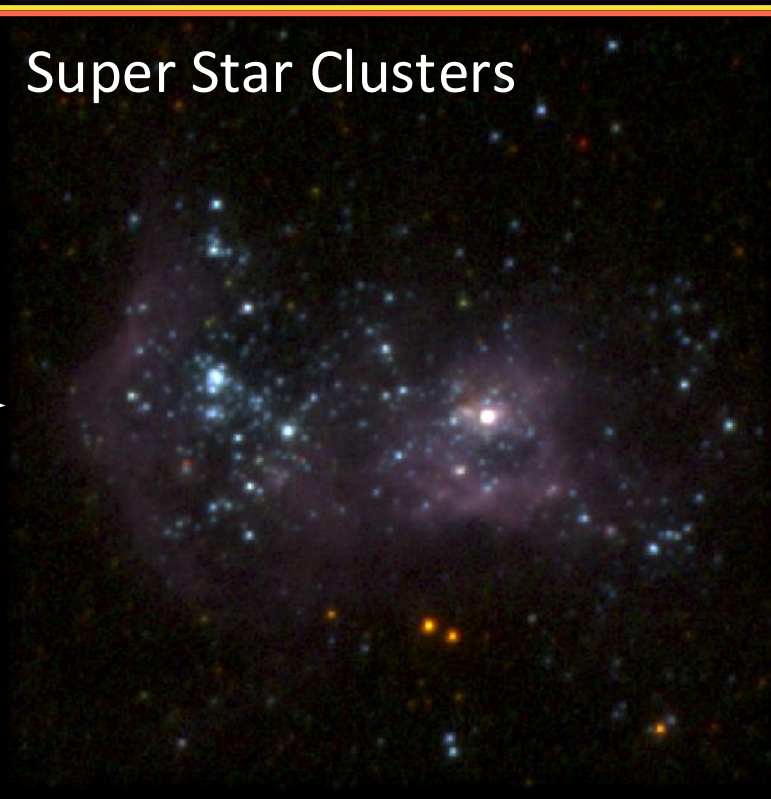
Jet-blown Cavities



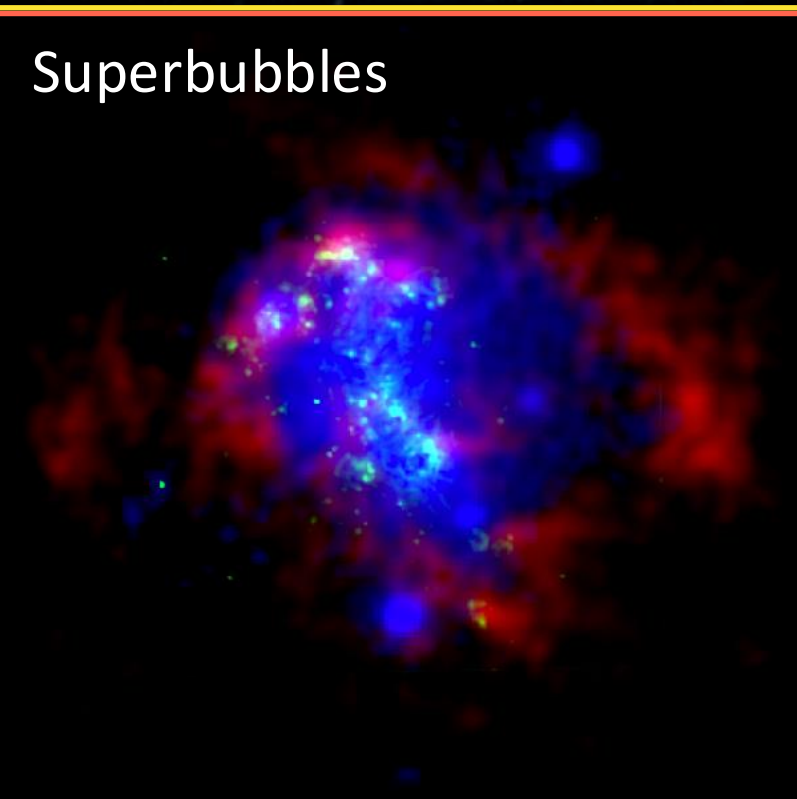
Feedback in the ISM



Super Star Clusters



Superbubbles



Starburst Winds



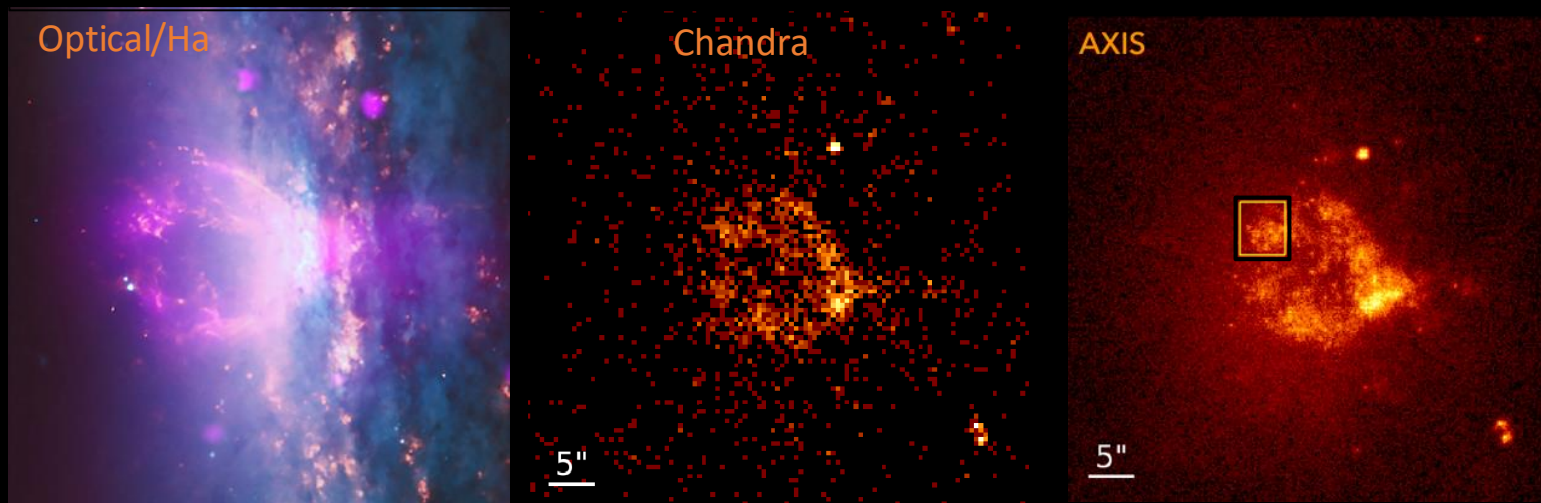
X-rays trace key “hidden drivers of galaxy growth”

Astro2020 asks :

“How do gas, metals and dust flow into, through, and out of galaxies?”

“How is the growth of black holes coupled to the evolution of their host galaxies?”

SUPERBUBBLE IN NGC 3079 (20Mpc)



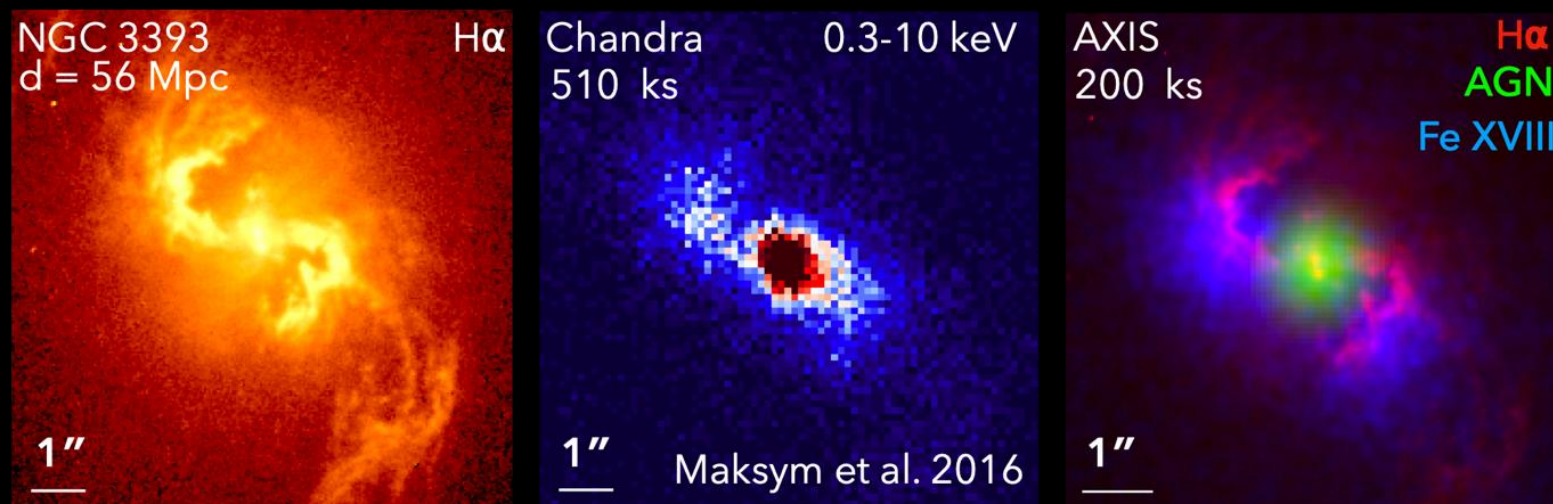
AXIS+Athena probes mass, metal and energy content of galactic-scale wind.

AXIS resolves fine wind structure out to 50Mpc; resolves galactic scales at all redshifts.

AXIS fast readout permits study of structure close to bright AGN

AXIS low background allows us to push to low-surface brightness emission in early-type galaxies

AGN WIND-GALAXY INTERACTION IN NGC 3393



Galactic Plane Surveys

Chandra Surveys
AXIS Galactic Plane Footprint
Roman Galactic Plane Footprint

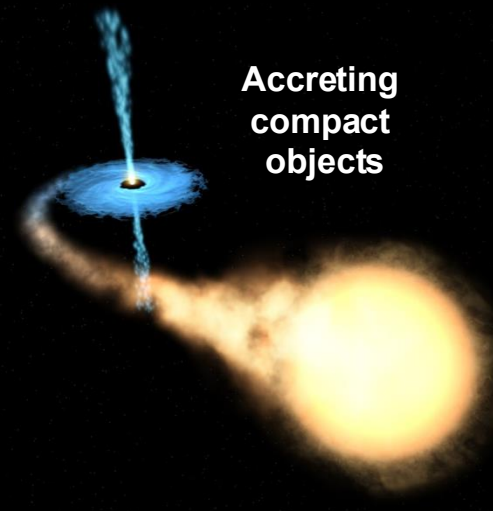
10x deeper +
5x larger area =
1 million new objects!



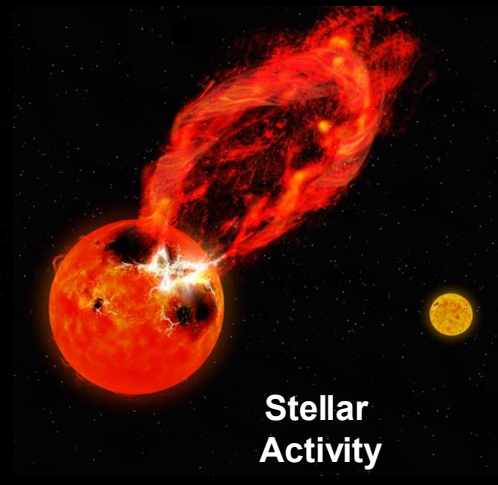
Supernova Remnants



Pulsar Wind Nebulae



Accreting
compact
objects



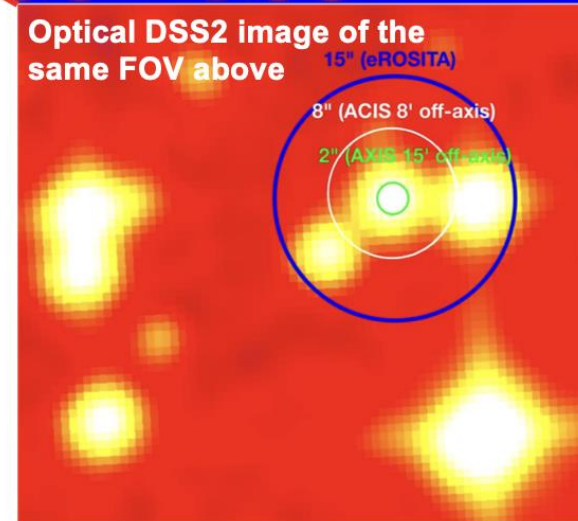
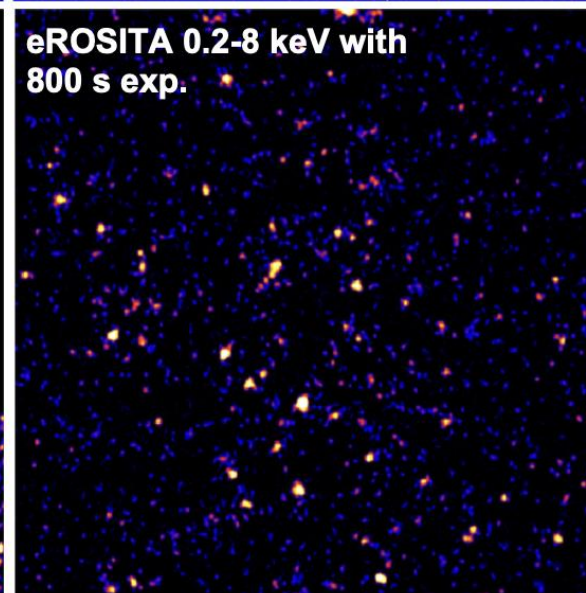
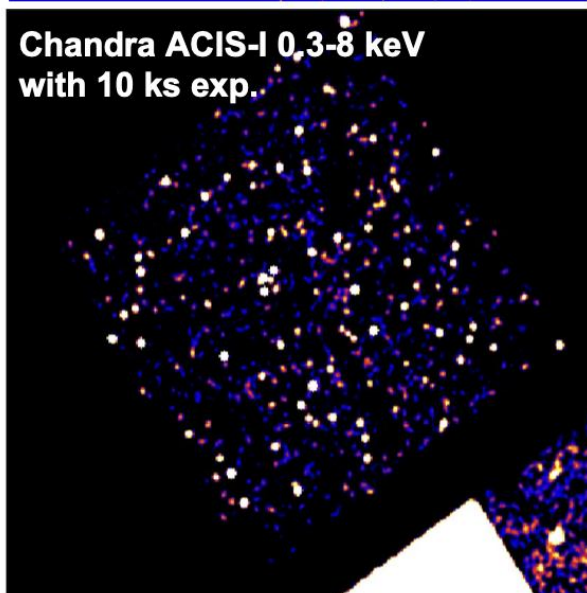
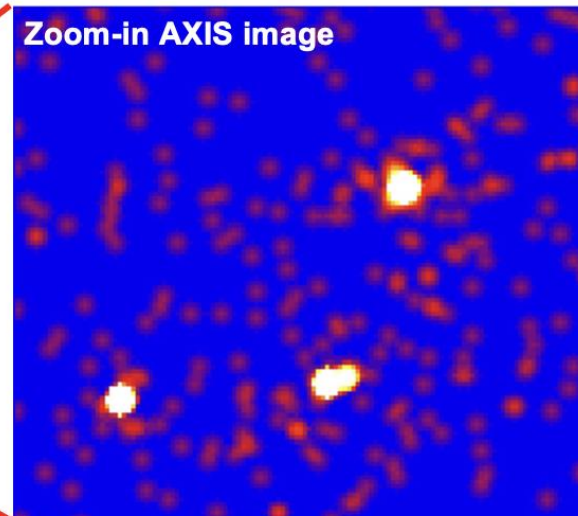
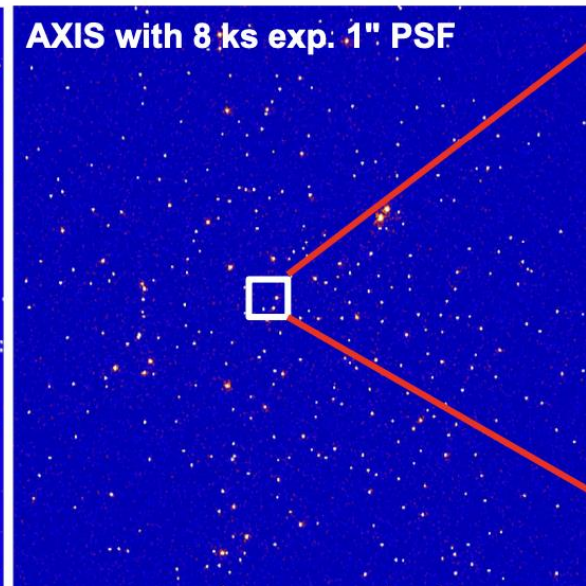
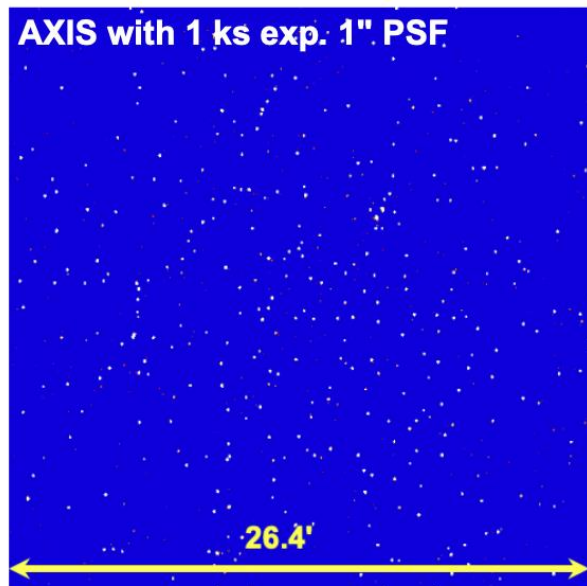
Stellar
Activity



Galactic Center

1 million+ New Objects

Galactic Plane Survey



Typical angular resolutions for AXIS, Chandra-ACIS at large off-axis angles, eROSITA are overlaid.

Simulated NGC 2516 Images

eROSITA will survey the plane, but has poor angular resolution

High angular resolution necessary for localizing sources to ensure accurate MW counterparts

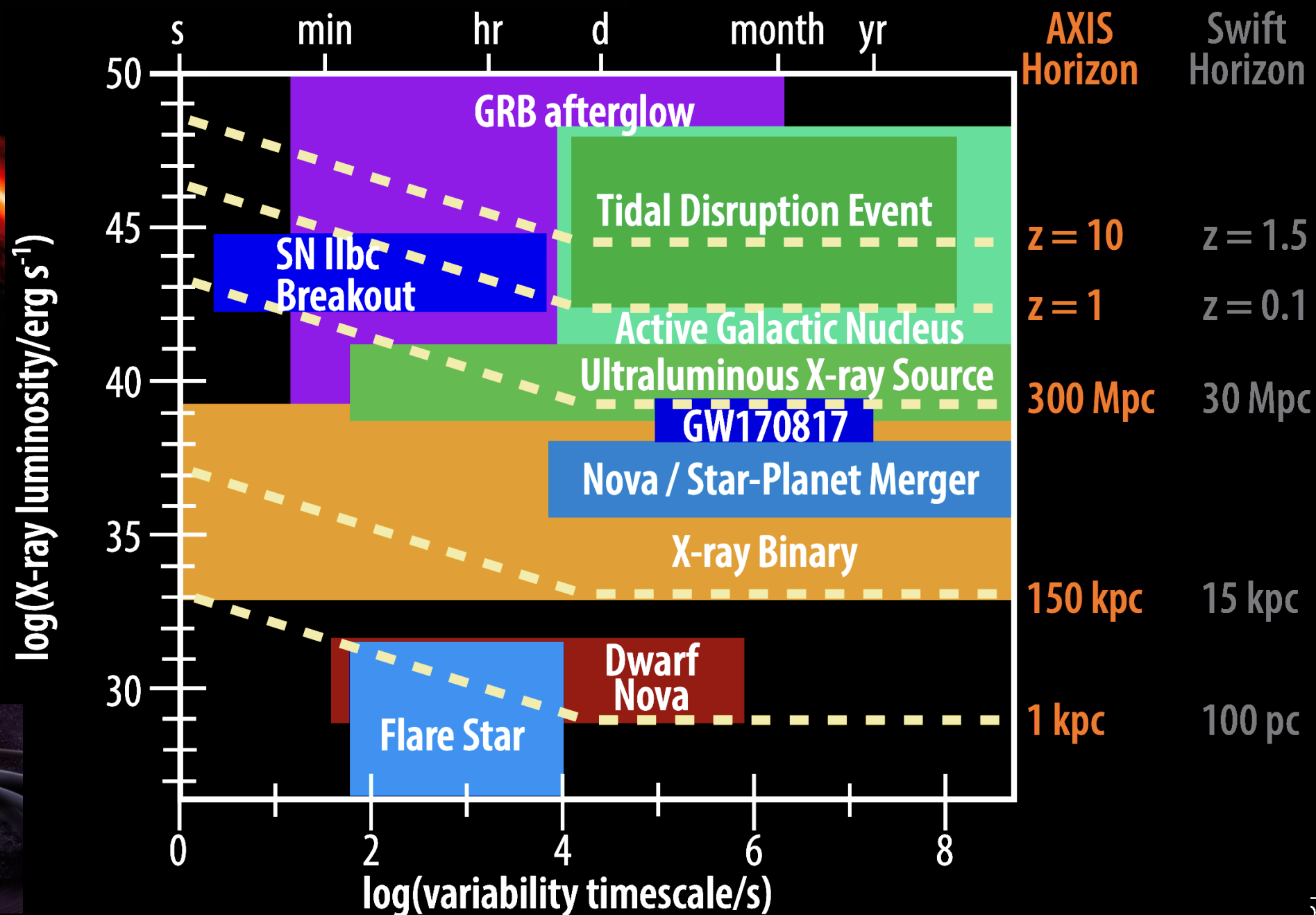
Joint X-ray + MW properties lead to more robust source classifications

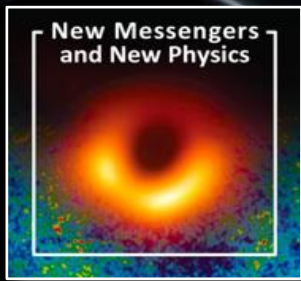
High angular resolution also leads to more sensitivity (lower background for point sources)

AXIS in the Panchromatic Time Domain Landscape

AXIS TDAMM Capabilities

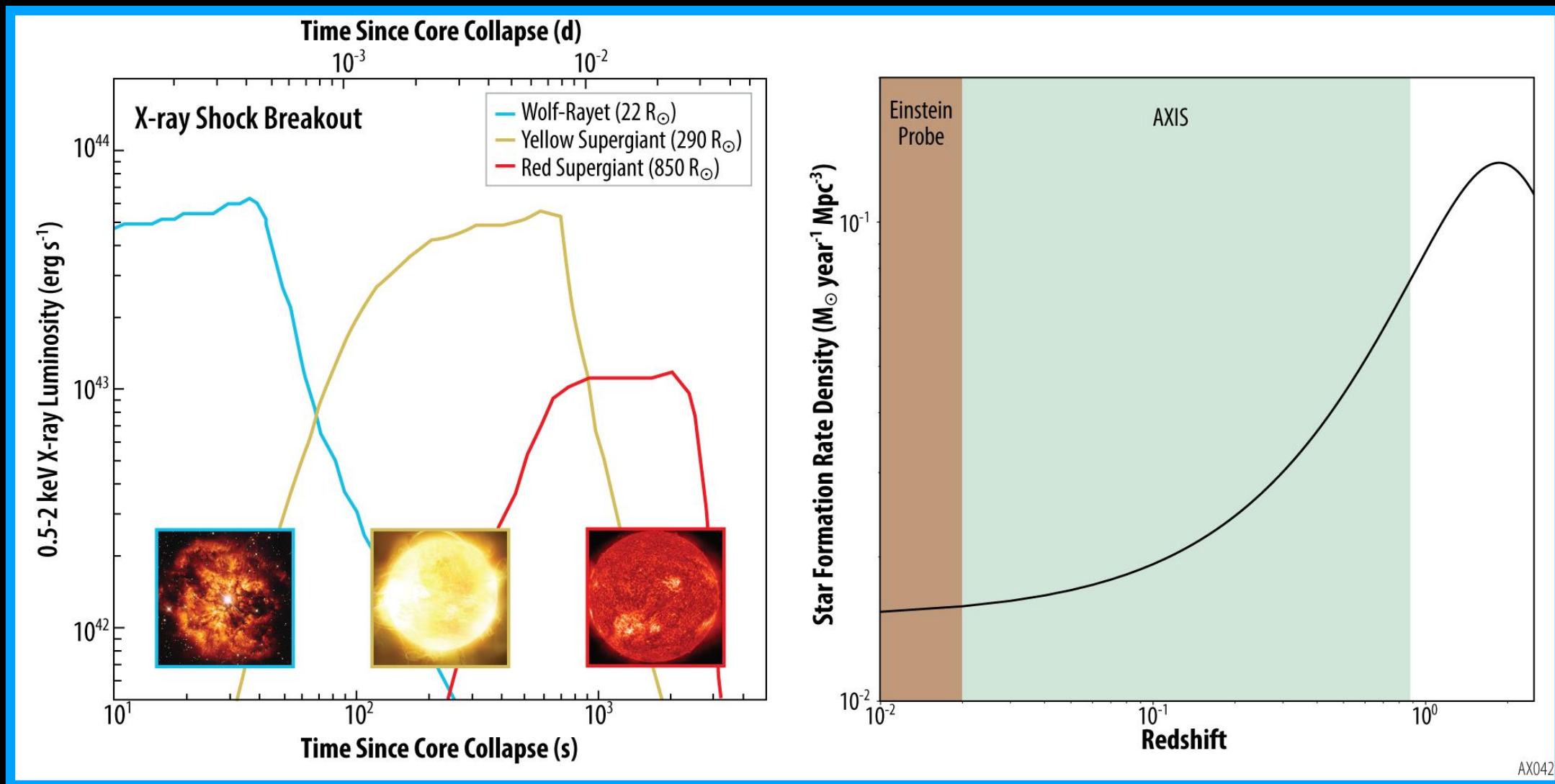
- <1 hr ToO Response Time
- Data Downlink in <12hrs for rapid characterization
- On-board Transient Alerts to community in 10 min





Astro2020 asks: “How do stars live and die?”

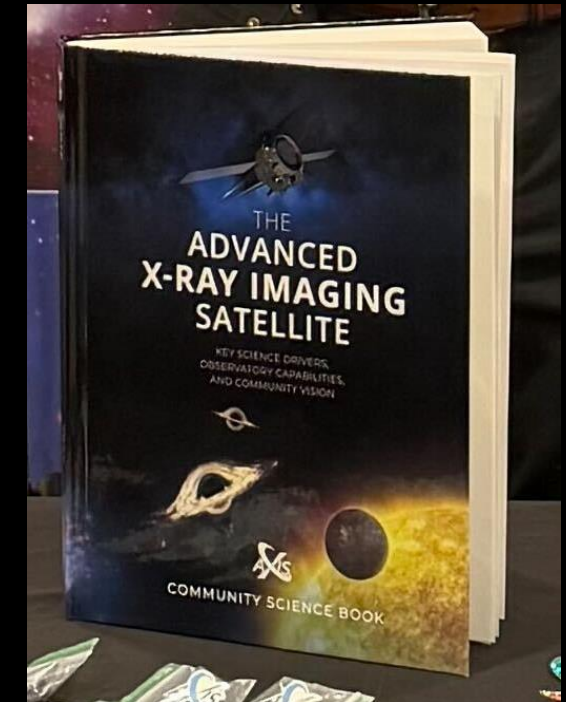
What are the progenitors of core-collapse supernovae? Real-time detection of shock breakout

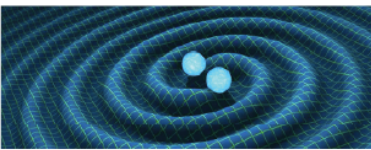
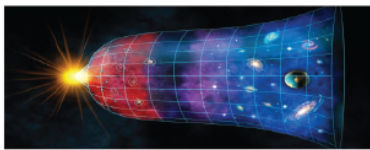
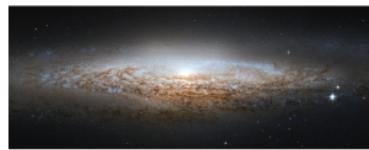
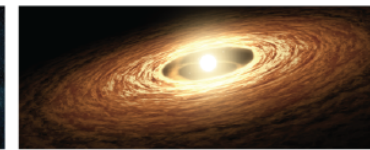
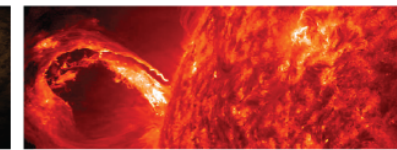


AX042

Community Science

- 500+ scientists
- 138 science cases
- ~600-page reference volume
- arxiv.org/abs/2511.00253



Astro2020 Science Panel Questions					
					
Compact Objects	Cosmology	Galaxies	Exoplanets & Solar System Science	ISM & Planet Formation	Stars
Q1: BH/NS Spins ADES, AWES Add. Sci., D.2.1.1, G0-7	Q1: Big Bang AXIS: N/A	Q1: Reionization ADES Add. Sci., D.2.1.1 G0-3, G0-5	Q1: Planet formation G0-10, G0-11, G0-13, G0-17	Q1: Star-formation ISM impact D.2.2.1, G0-9	Q1: Extreme Stars GPS Add. Sci., D.2.3.2, G0-15
Q2: Explosive Transients D.2.3.1, D.2.3.2, D.2.3.3, G0-18, G0-21, G0-23	Q2: Dark Matter D.2.2.3 Add. Sci., G0-8	Q2: Feeding/Feedback D.2.2.1, D.2.2.2, D.2.2.3 G0-1, G0-2, G0-6, G0-9	Q2: Planet properties G0-12, G0-14	Q2: Molecular clouds AXIS: N/A	Q2: Binary evolution GPS Add. Sci., D.2.3.1, D.2.3.2, D.2.3.3 G0-23
Q3: Relativistic Jets D.2.2.2, D.2.3.3, G0-7, G0-9	Q3: Structure Formation D.2.2.3 G0-4, G0-6	Q3: SMBH form./growth D.2.1.1, D.2.1.2, G0-1, G0-5, G0-19, G0-20	Q3: Habitability OCS, D.2.4 G0-15, G0-16	Q3: Protoplanetary disks G0-10, G0-11, G0-13	Q3: Stars up close GPS Add. Sci., OCS D.2.3.2, D.2.4, G0-15
Q4: BH seeds D.2.1.1, D.2.1.2 G0-5, G0-19, G0-24	Q4: GW cosmology D.2.3.3	Q4: DM Haloes AXIS: N/A	Q4: Bio-signatures AXIS: N/A	Q4: Planet Formation Rate G0-10, G0-11, G0-13	Q4: Space Weather GPS Add. Sci., OCS, D.2.4, G0-14, G0-17, APM

Summary

- **Chandra successor:** arcsecond imaging, wider, faster.
- **Black hole growth:** obscured AGN; BH spin.
- **Mergers:** separates close dual-AGN pairs.
- **Feedback:** >10x more cavities; ~500 pc winds.
- **Surveys:** 10x deeper, 5x wider - ~1M new objects.
- **Time domain:** <1 hr ToO; alerts in 10 min.
- **Stellar deaths:** real-time shock breakout.
- **Community-built:** 500+ scientists, 138 cases.