

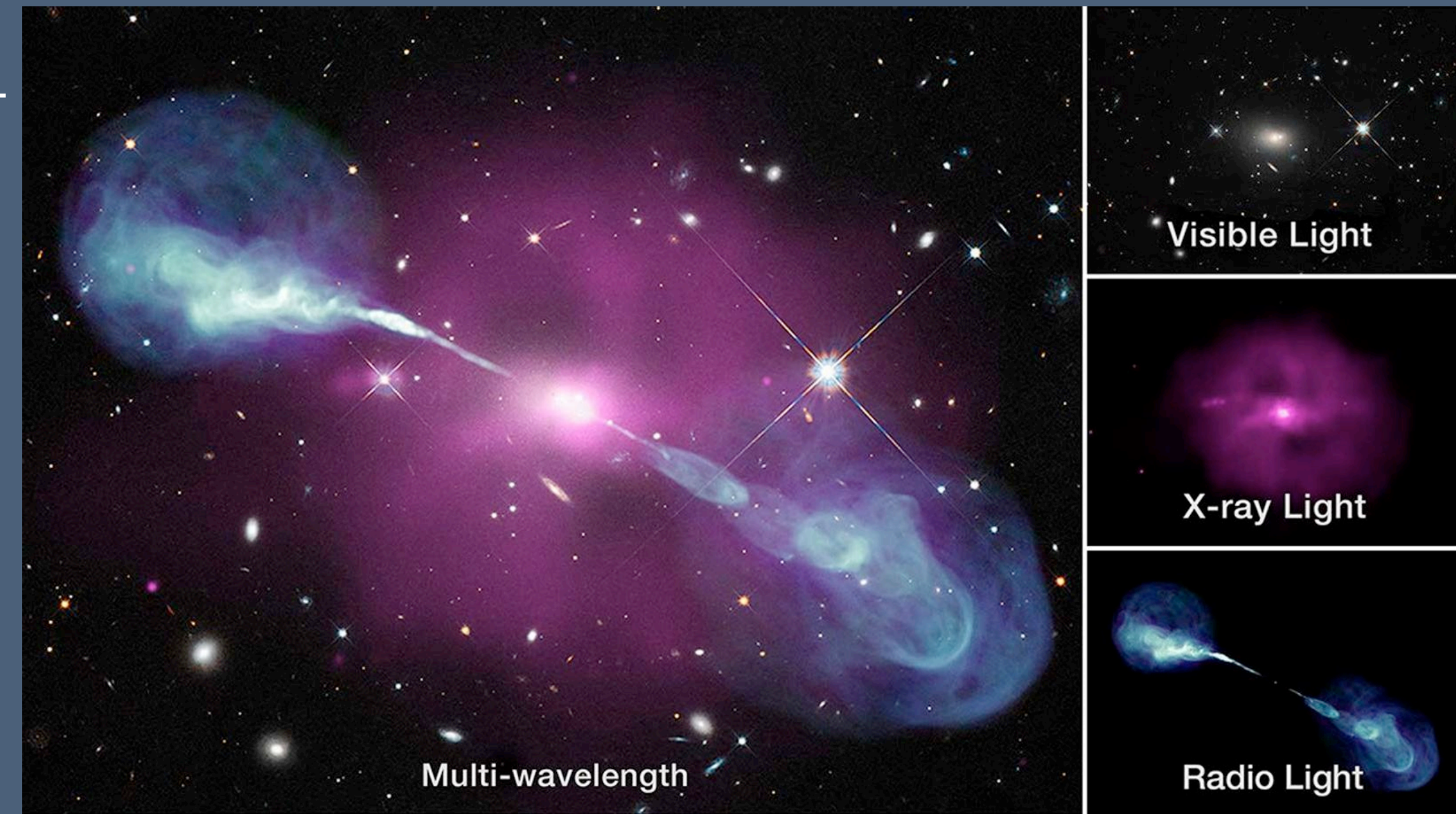
Resolving the Cosmic X-ray Background

with a Broad-Band X-ray Observatory

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and the Broad-Band X-ray Science Analysis Group.

Drivers of Galaxy Evolution

- Supermassive black hole growth is a main ingredient in all modern galaxy evolution frameworks
- Majority of SMBH growth happen in the dust-obscured phase
- Deep surveys placed some constraints on the AGN obscured fraction, but selection functions are complicated
- For individual AGN — many unanswered questions in accretion physics and how exactly AGN feedback works

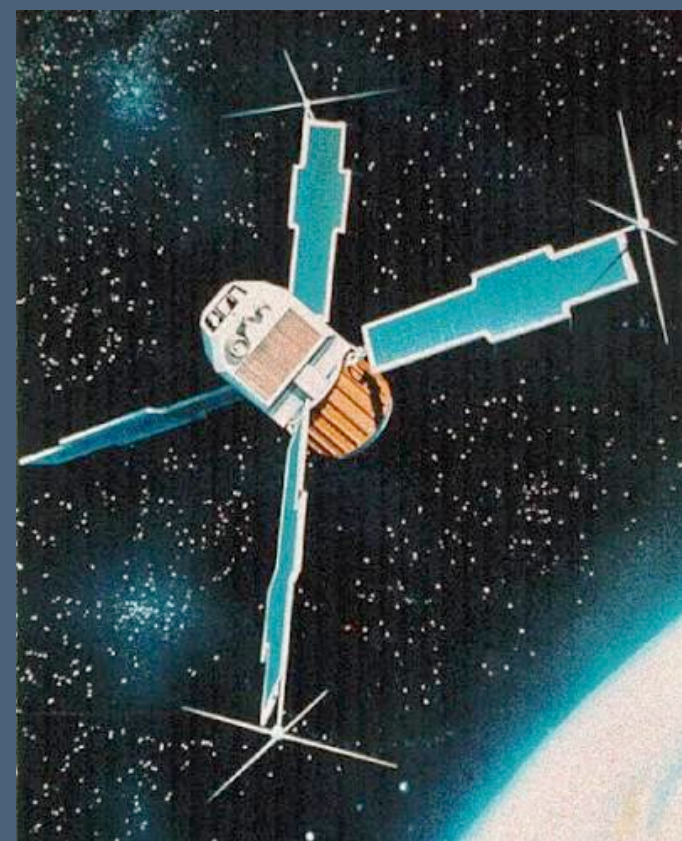
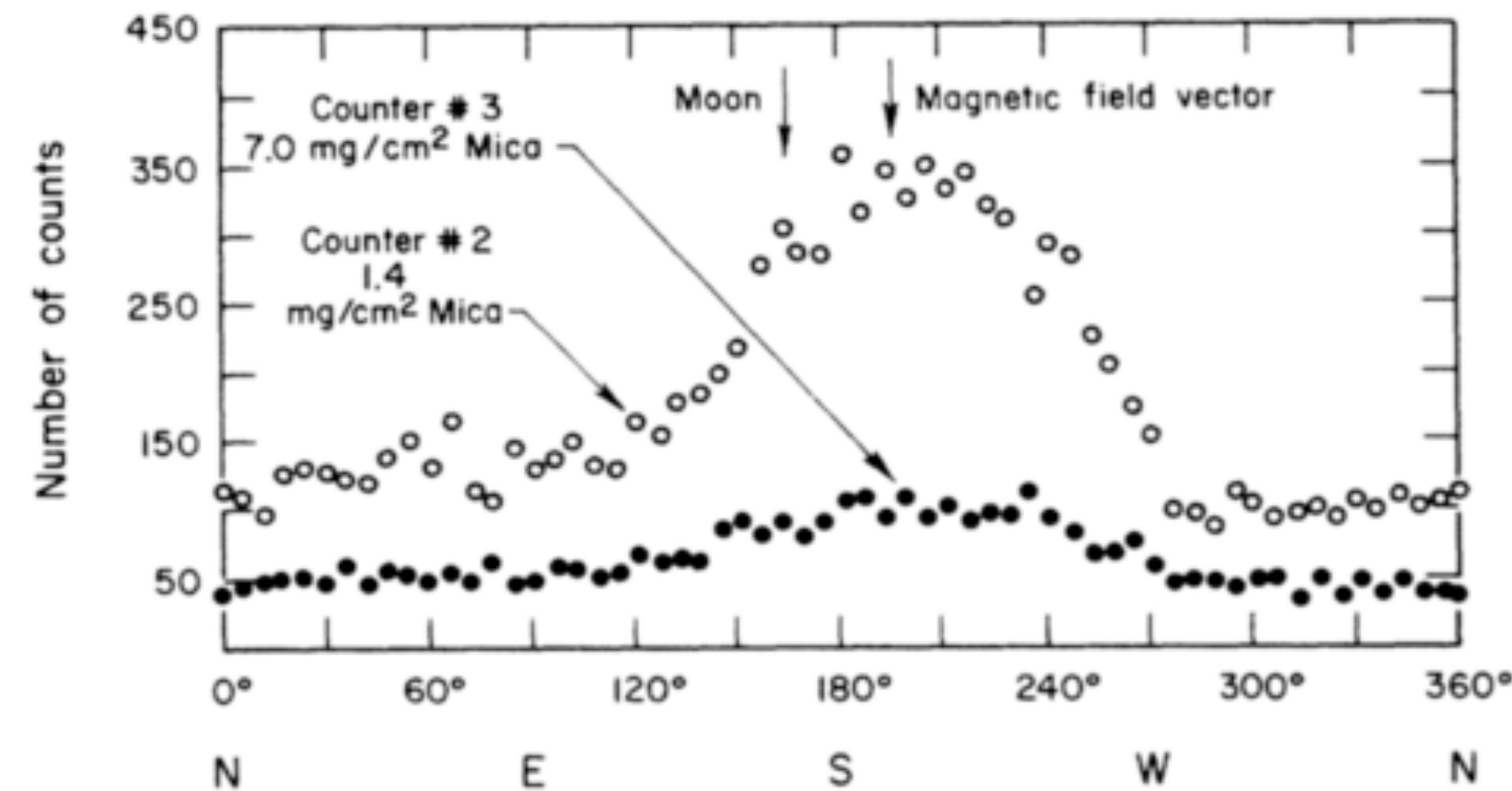


Credit: X-ray: NASA/CXC/SAO; visual: NASA/STScI; radio: NSF/NRAO/VLA.

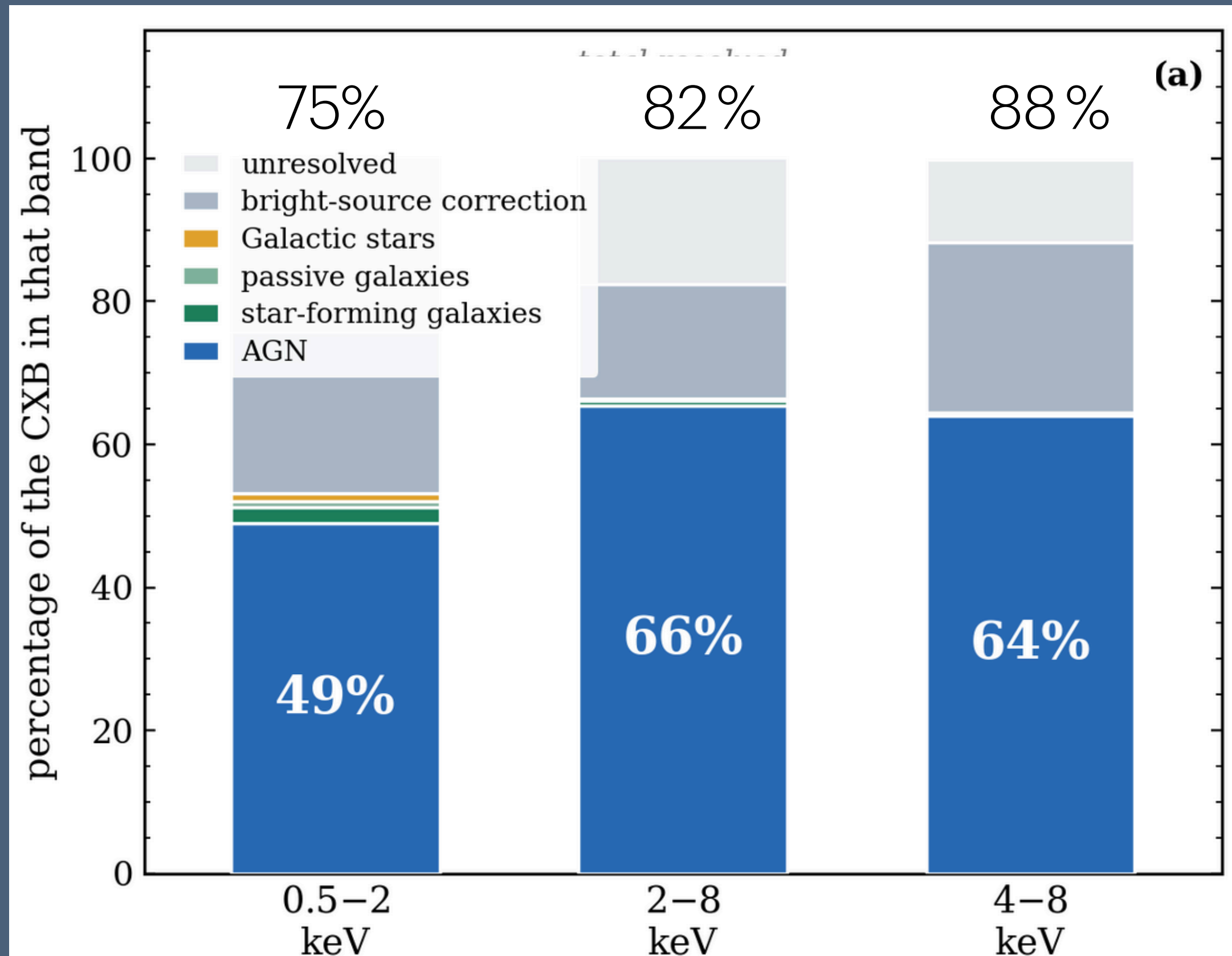
One of the three astro2020 priorities

The Cosmic X-ray Background

- We have known its existence for a long time — since 1960s
- We now think it's mostly comprised of point sources — accreting supermassive black holes



CXB as seen by Chandra

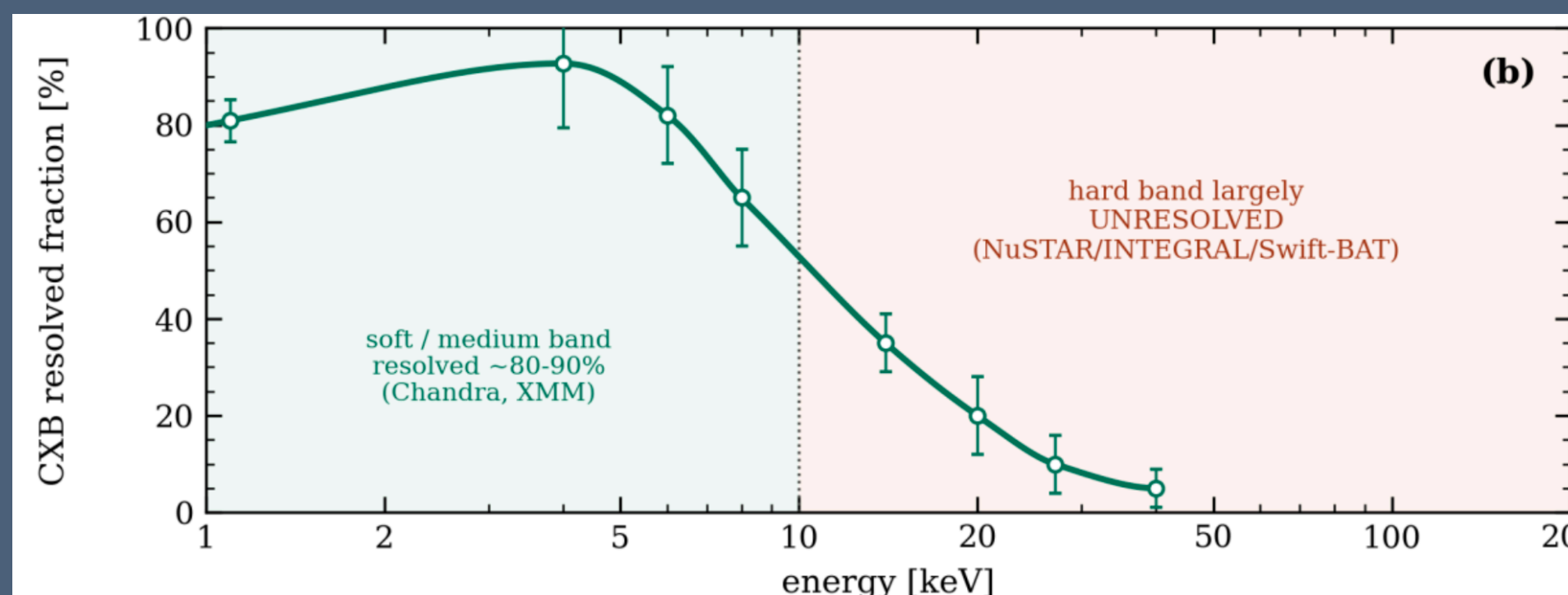
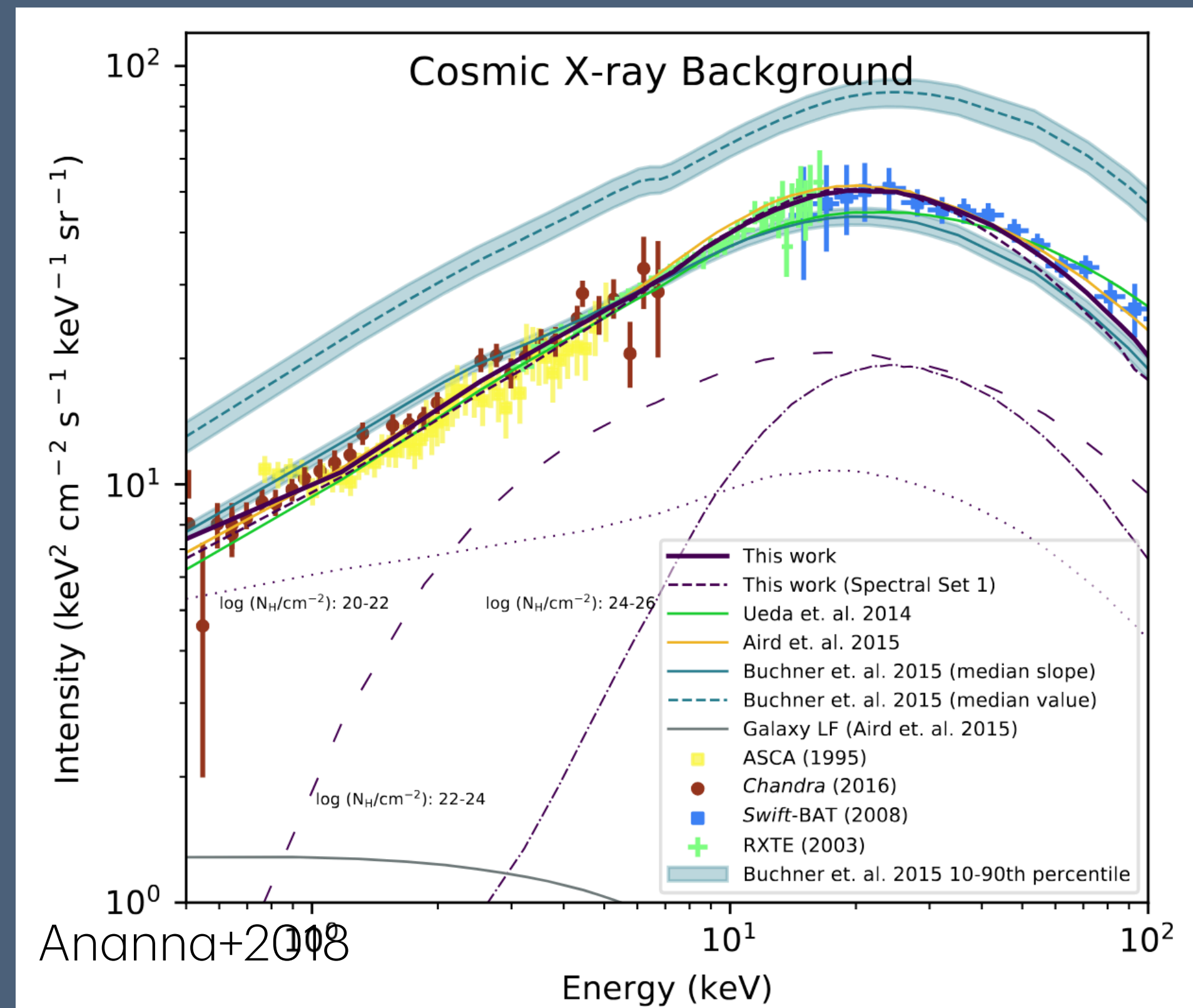


Lehmer+2012

- Chandra resolved ~ 80 to 90% of CXB to be point sources powered by AGN — primarily Compton-thin.
- A small percentage is comprised of galaxy X-ray emission.
- For the remaining, unresolved fraction, most can be accounted for by stacking HST/Spitzer source positions (Hickox & Markevitch 2007, Cappelluti+2016)

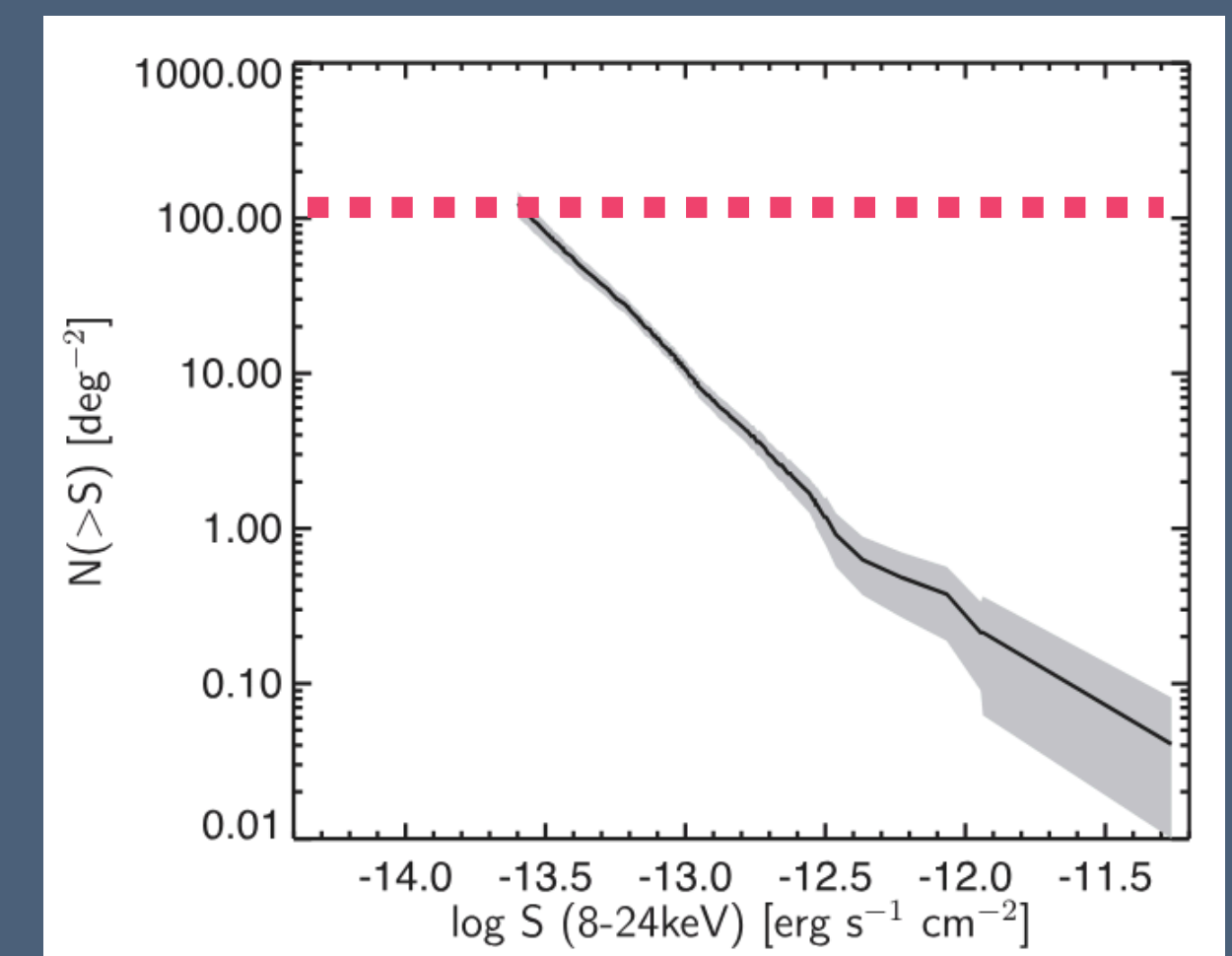
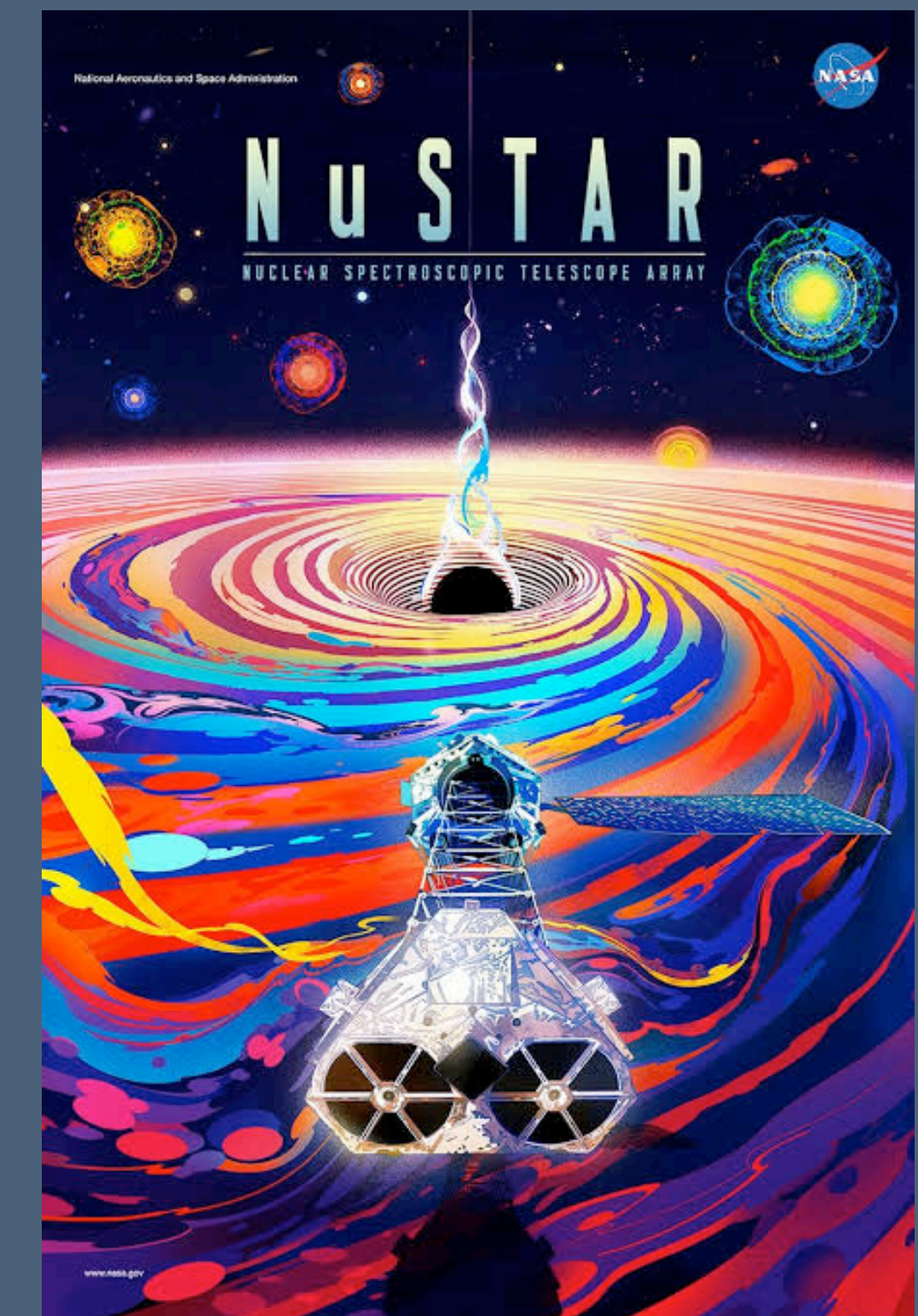
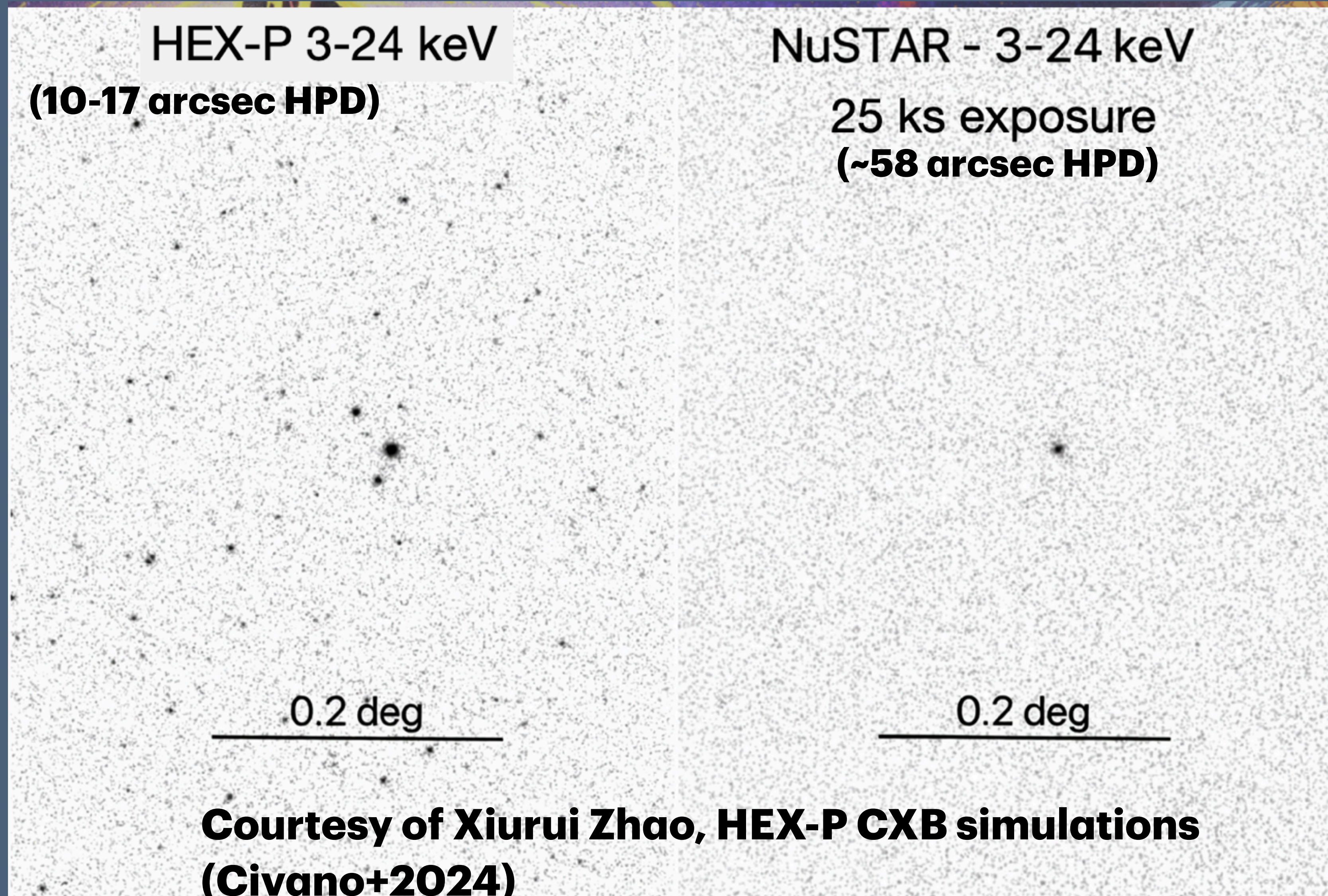
Luo+2017

CXB at higher energy: boundary condition for AGN population synthesis models



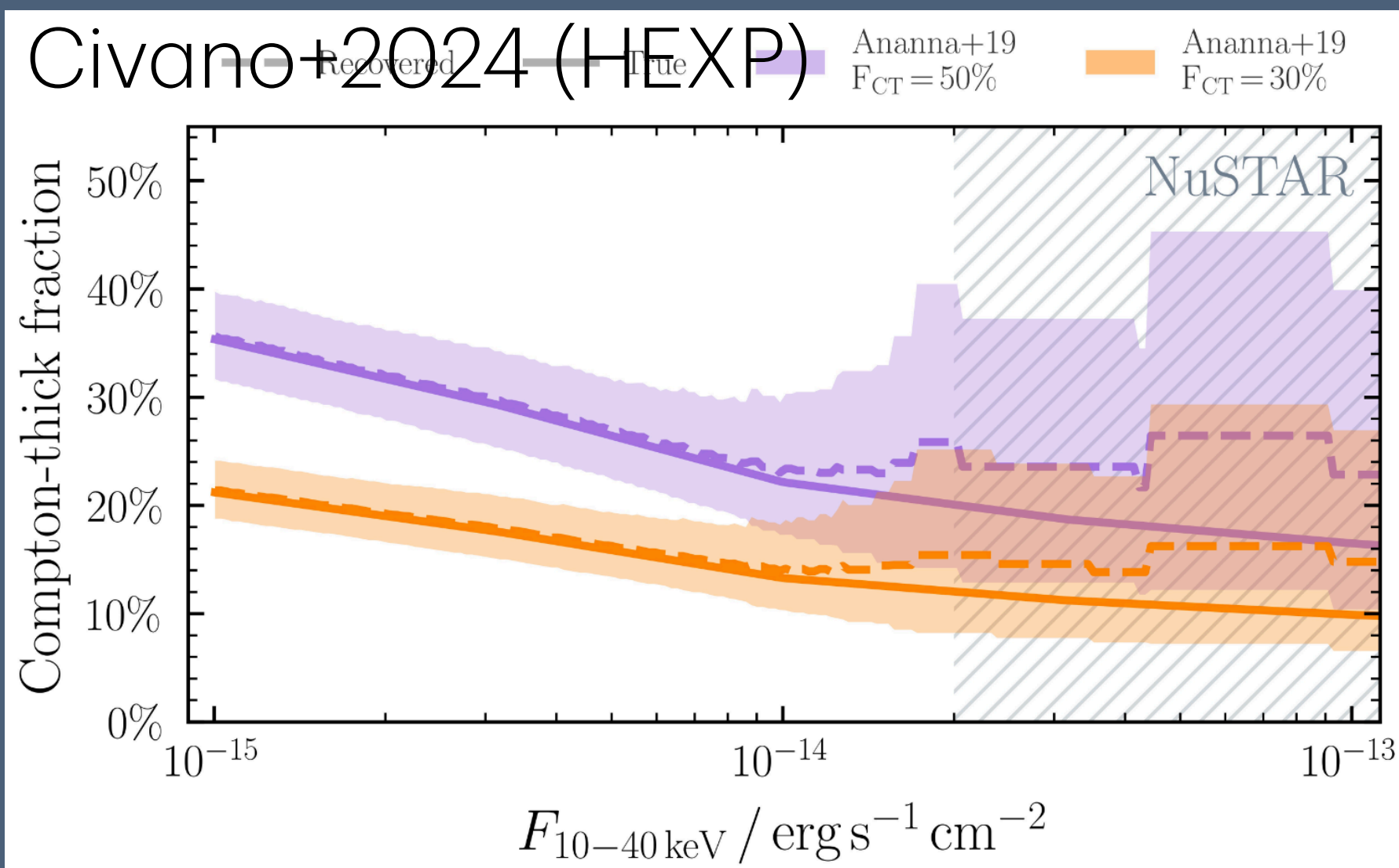
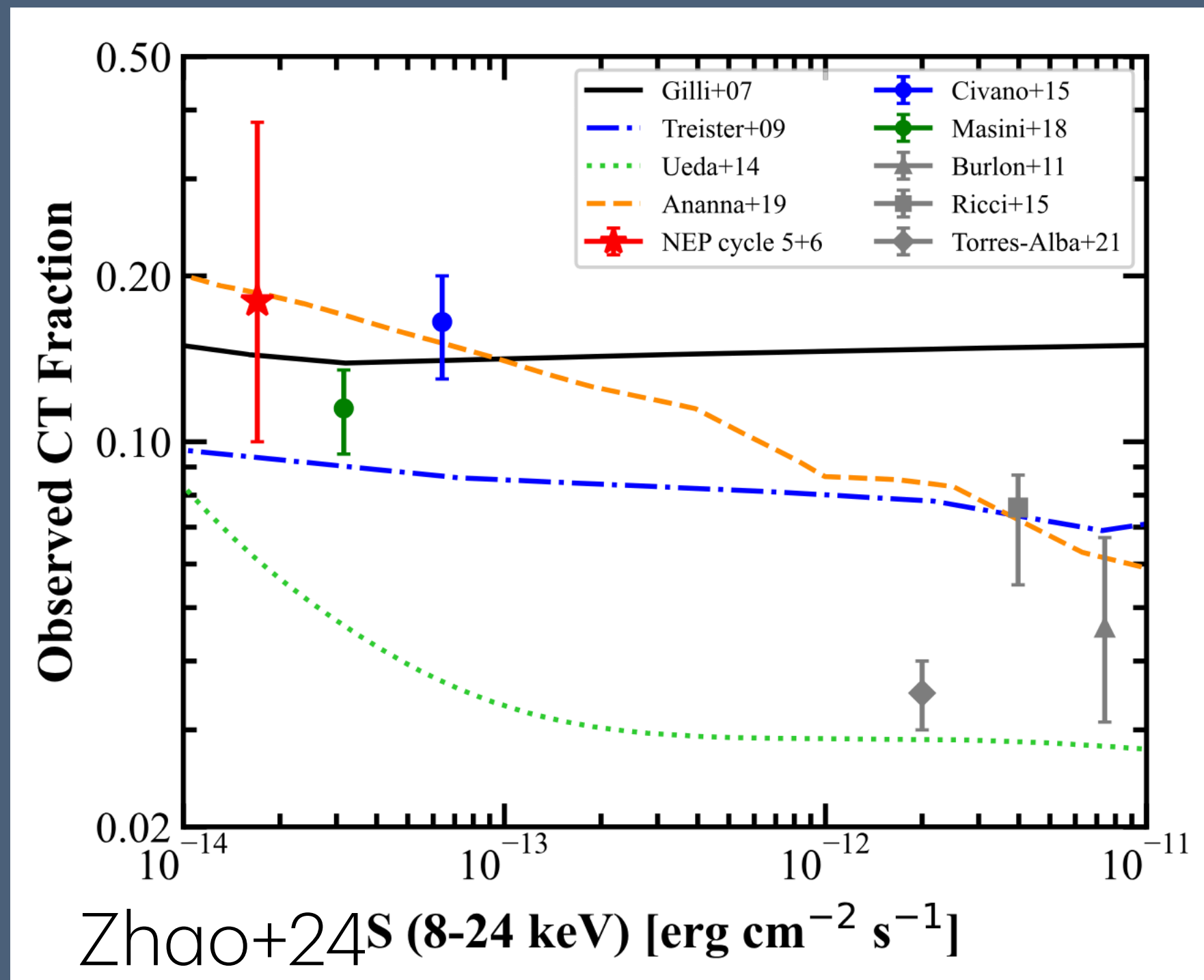
- The sum of unobscured/moderately obscured AGN population fits the <10 keV CXB almost perfectly — but it takes a significant fraction of Compton-thick AGN to account for the CXB peak — establishing the fact that most of the accretion happens in the dust-obscured phase
- But we don't know very well what the CT fractions are — just that the CXB needs it
- However, only $\sim 1/3$ of the CXB has been resolved at its peak

Resolving CXB at > 10 keV



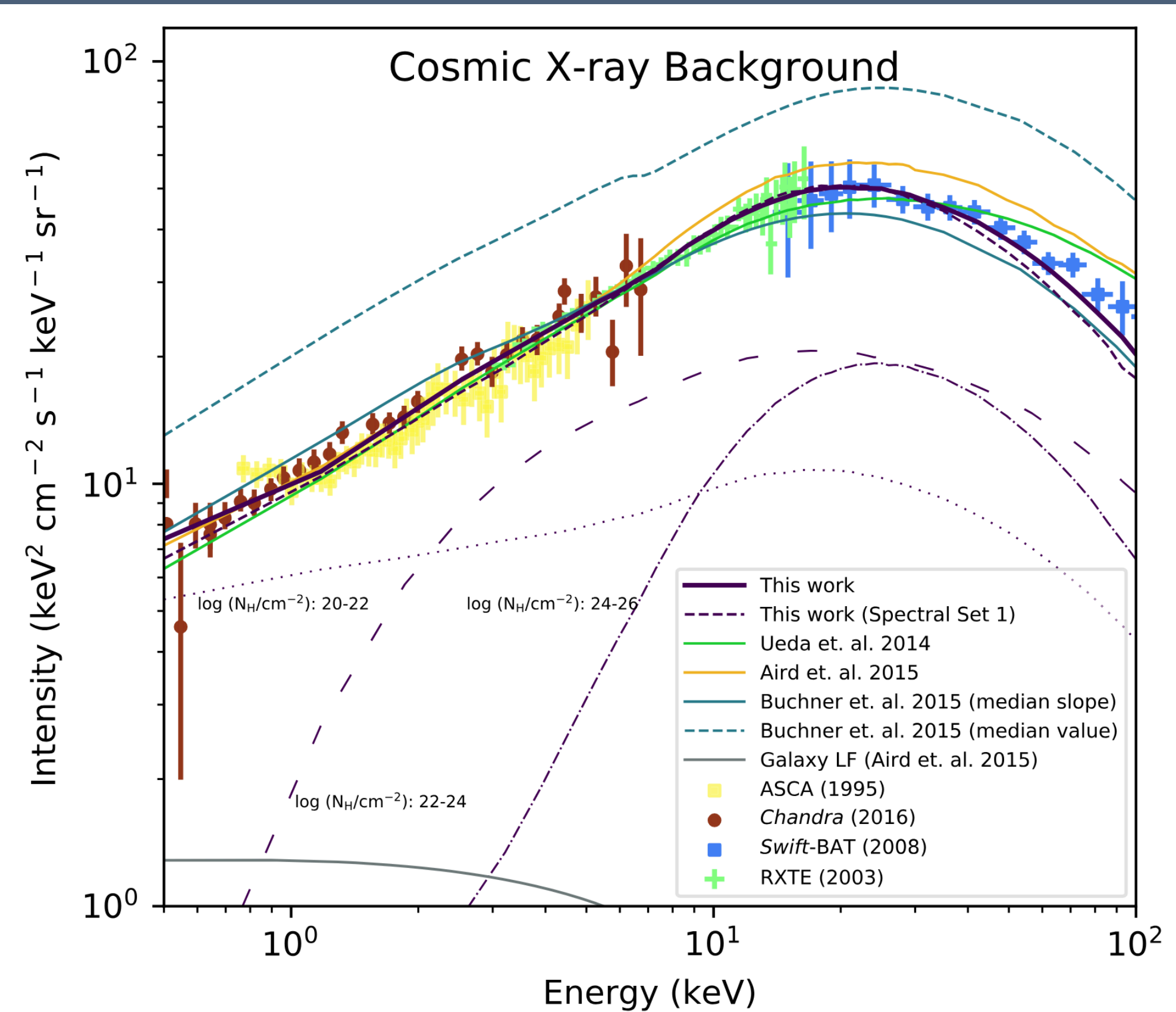
Harrison+13

Broad-band, high angular resolution observatory the key to understand the accretion history of the Universe



- Obscured SMBH growth carries most of the AGN feedback energy budget: we need to get this right to understand the *Drivers of Galaxy Evolution*
- Directly measuring CT AGN fractions beyond the local Universe
- Find missing populations not seen in soft X-rays (for instance, Little Red Dots or their local analogs)
- CXB can distinguish different Compton-thick fraction models, but they can be also model dependent (torus geometry, photoelectric absorption, AGN corona physics) — all of which require broad-band capabilities

CXB is the key boundary condition for AGN population synthesis models — but degeneracies exist in almost everywhere that we haven't resolved



Ananna+2019, 2020a, 2020b
(and references therein)

Peak CXB energy:
AGN population power-law
index and Cutoff Energy

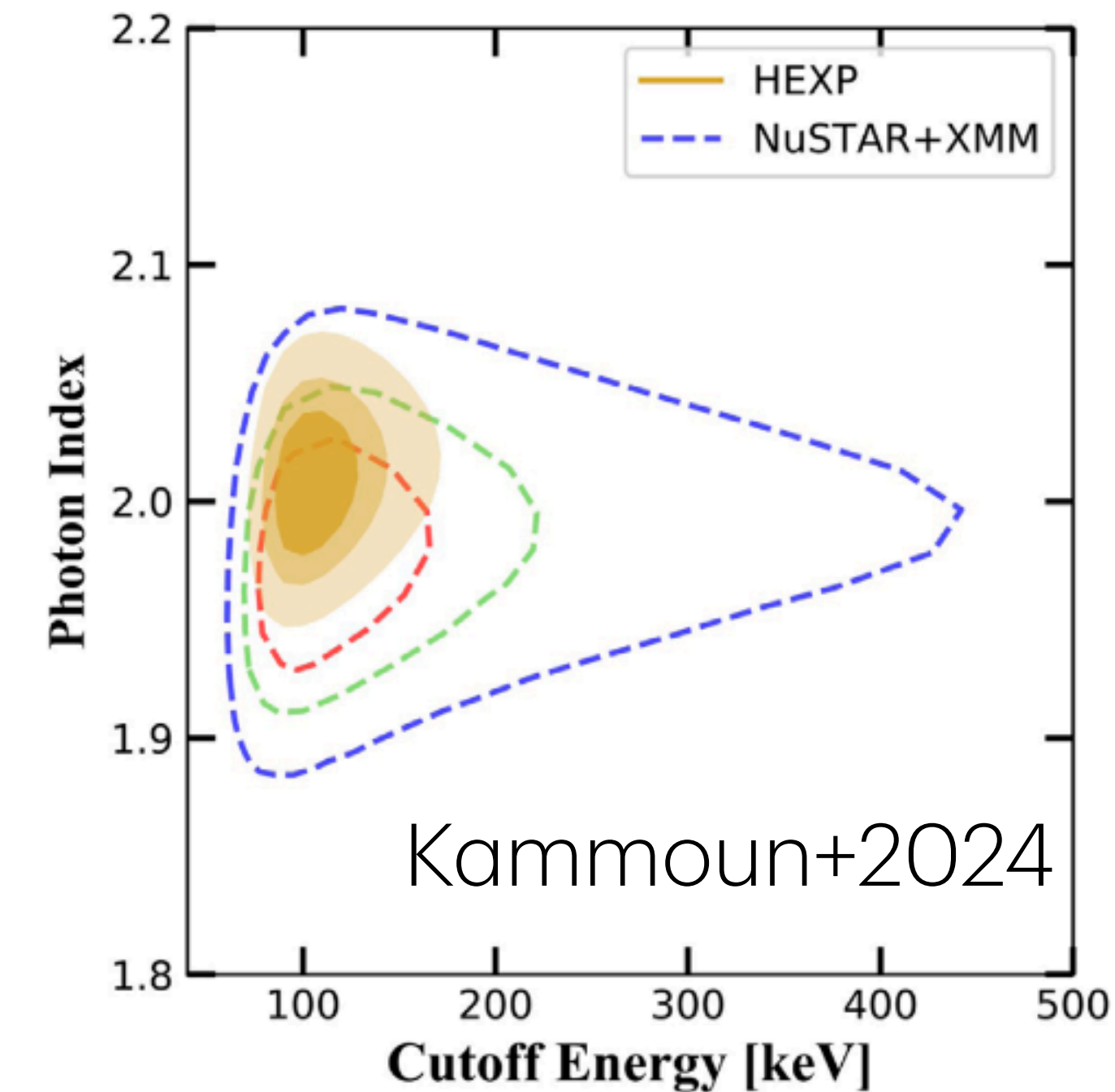
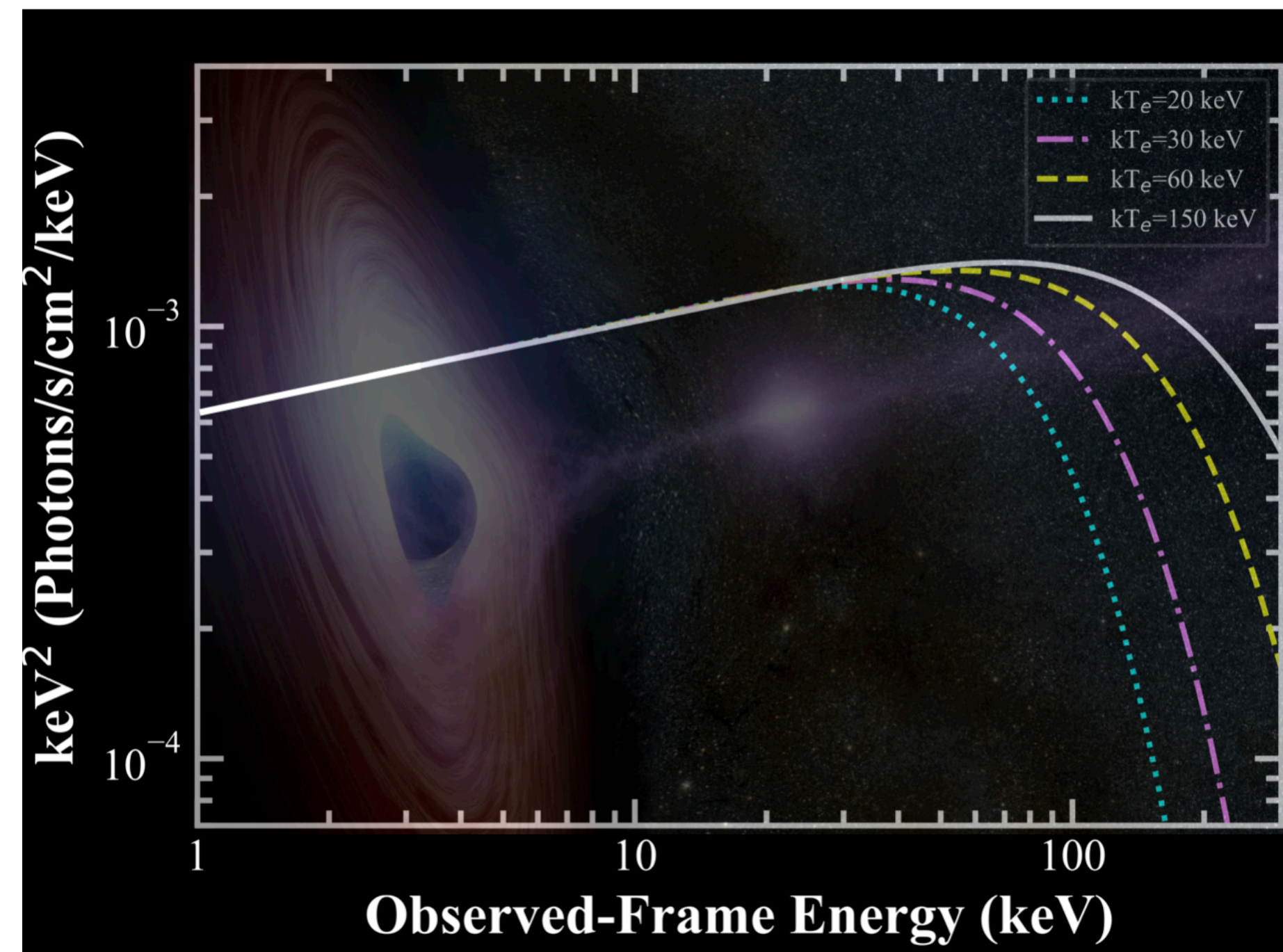
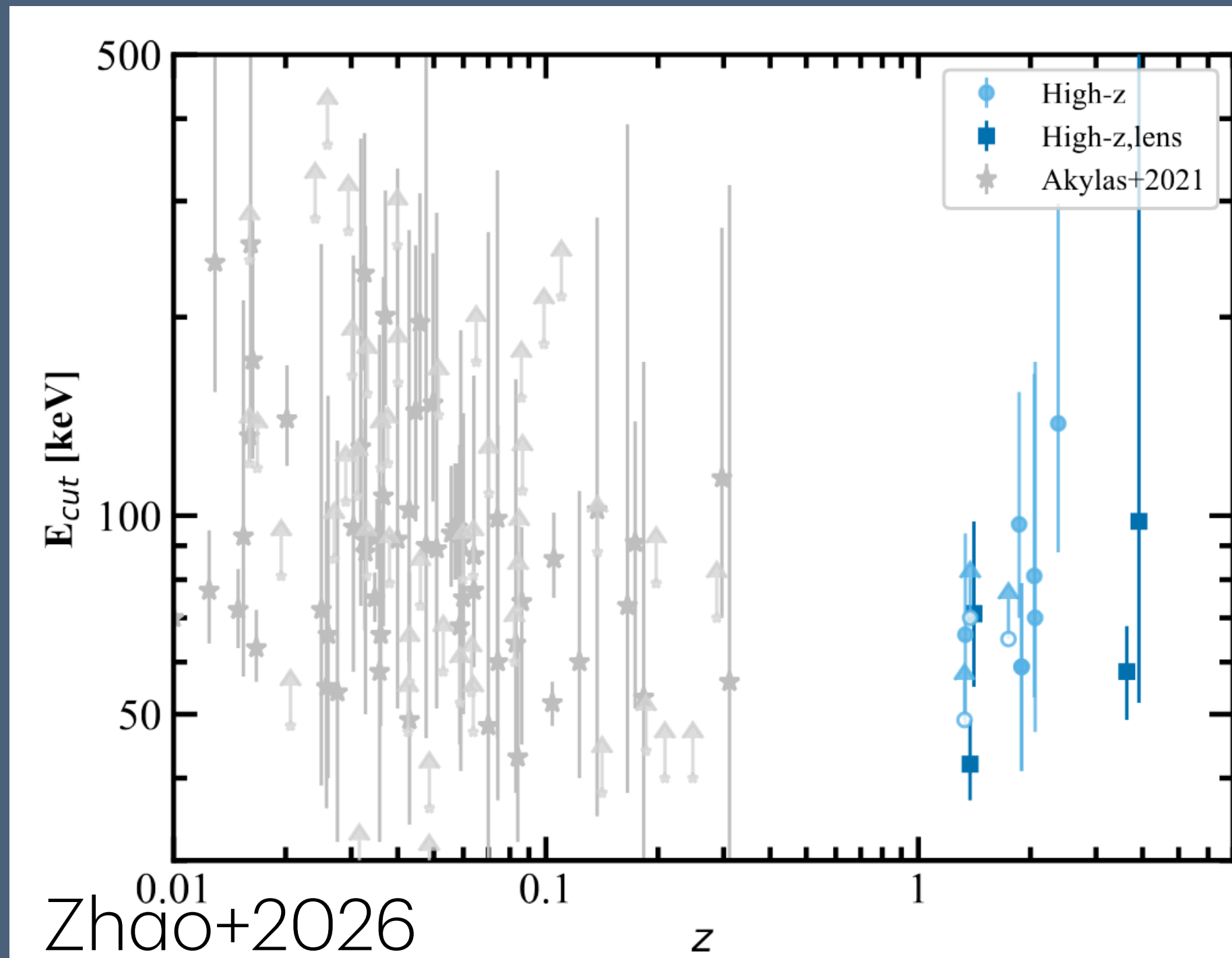
CXB peak amplitude:
Reflection strength and
Compton Thick Fraction

High Energy Tail:
Distribution of the AGN
coronal properties

Overall normalization:
X-ray Luminosity Functions
(the space density of AGN
in different redshift bins,
as well as contribution
from galaxies)

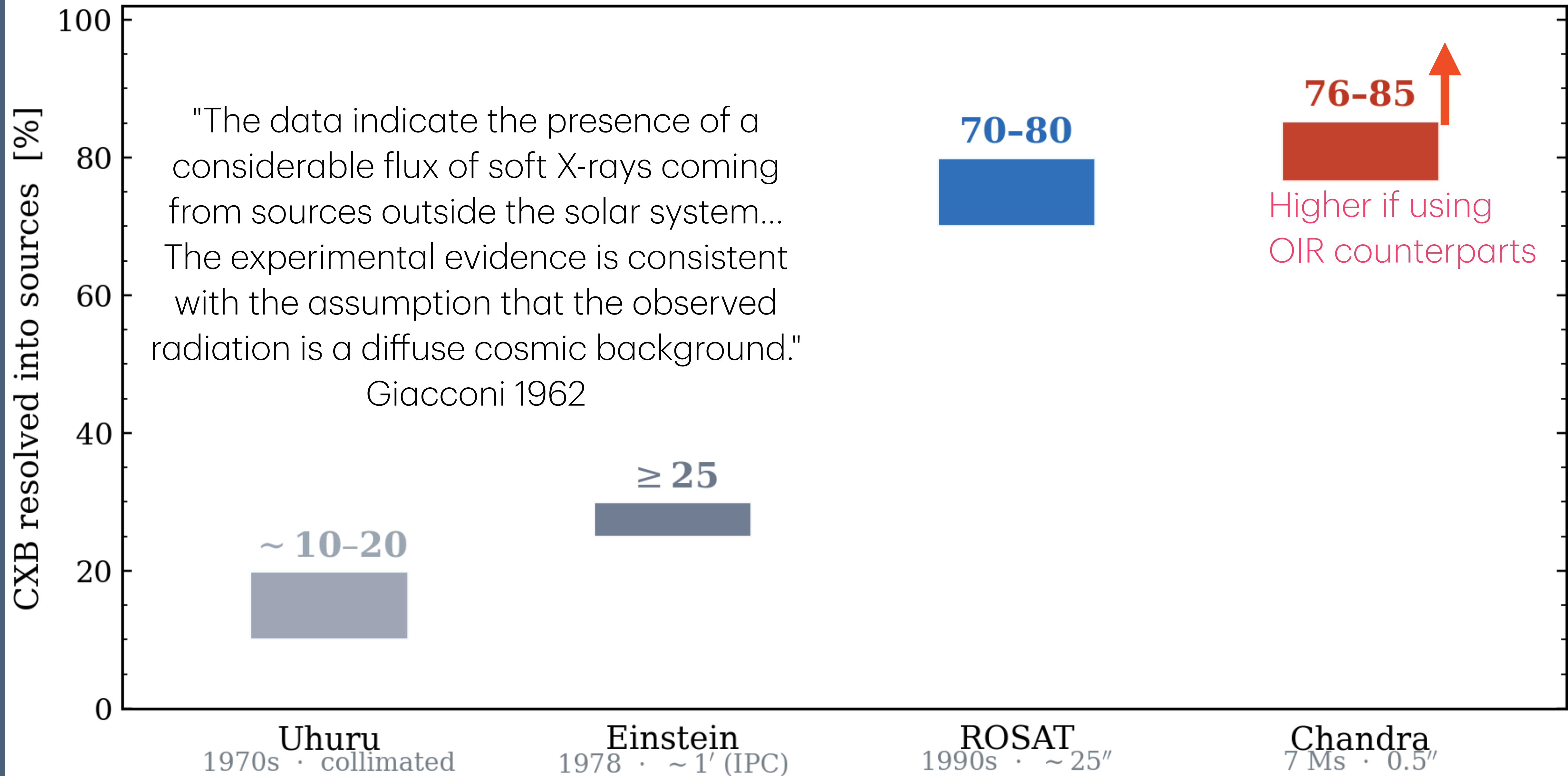
How well do we know the AGN cutoff energy?

Only a handful beyond $z > 0.1$ —
missing the population that contributes the most to CXB



Broad-band observatory will enable:
larger sample size, better constrained parameters
to inform the CXB population synthesis model

CXB in the soft X-ray since 1970s



A BBXO to make as much of a leap at the peak of CXB

