ATHENA and GRBs

Luigi Piro
IAPS/INAF, Rome

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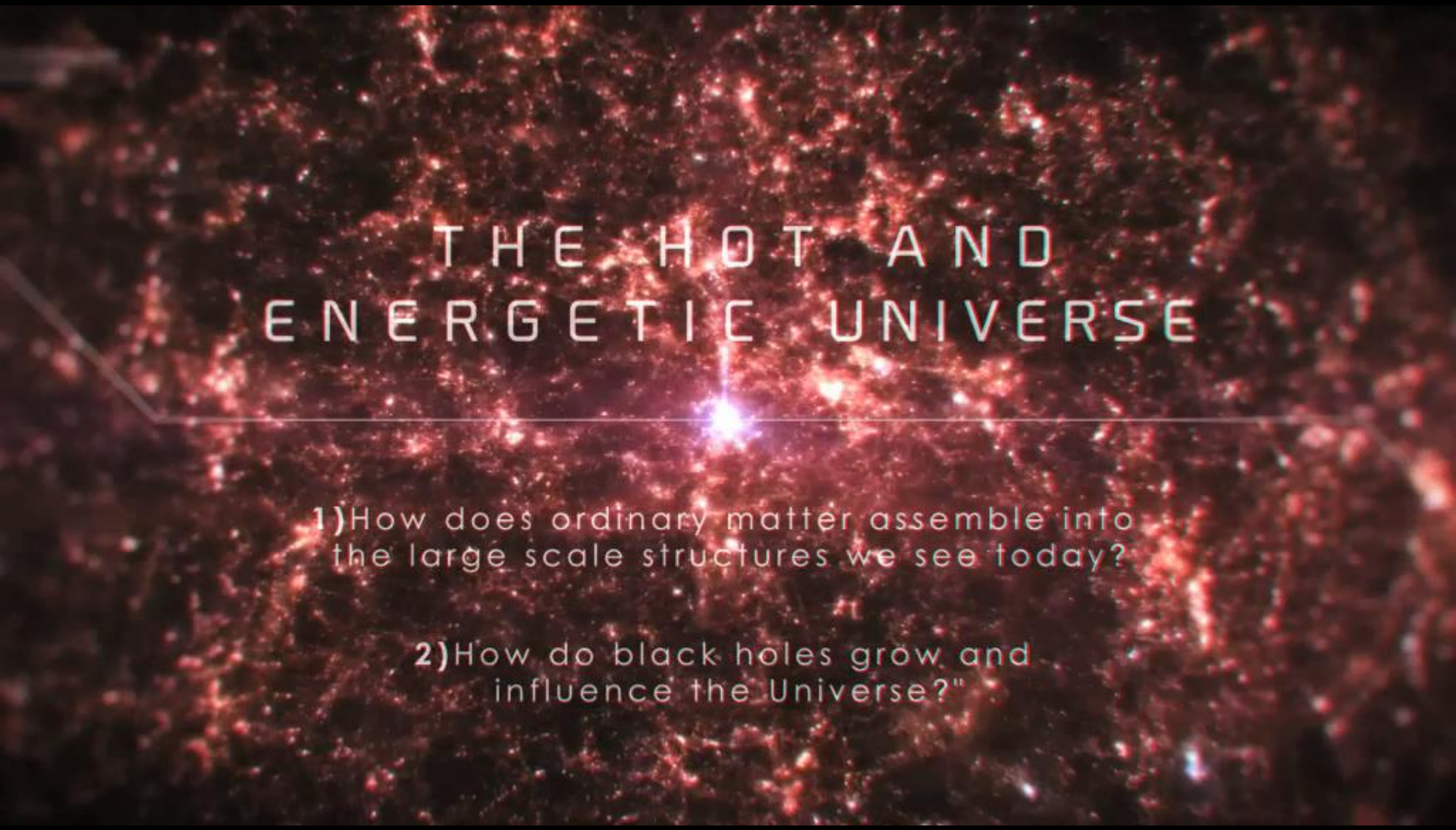
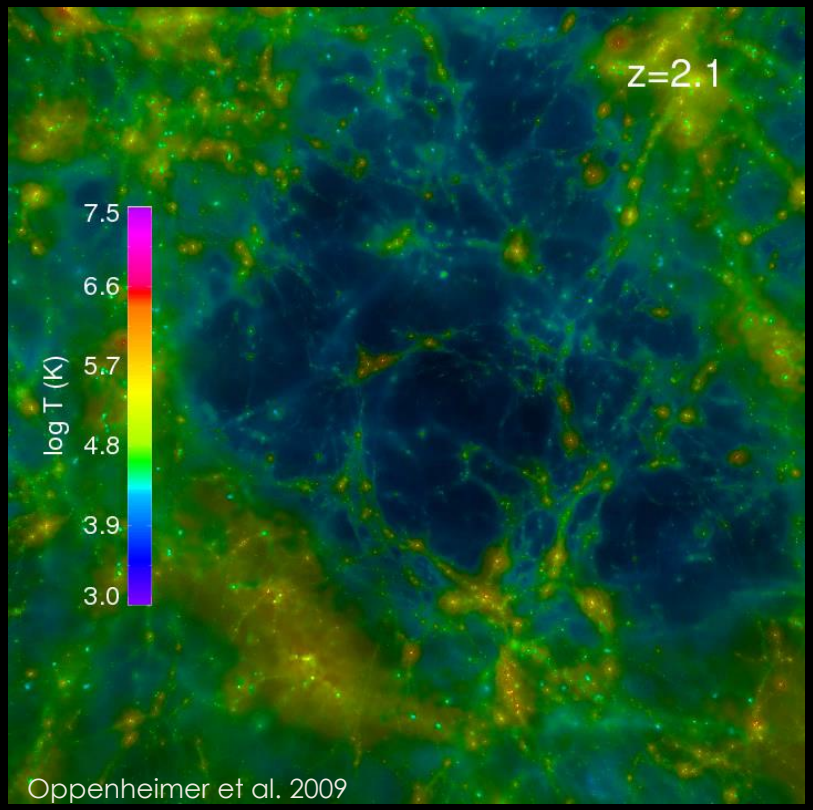
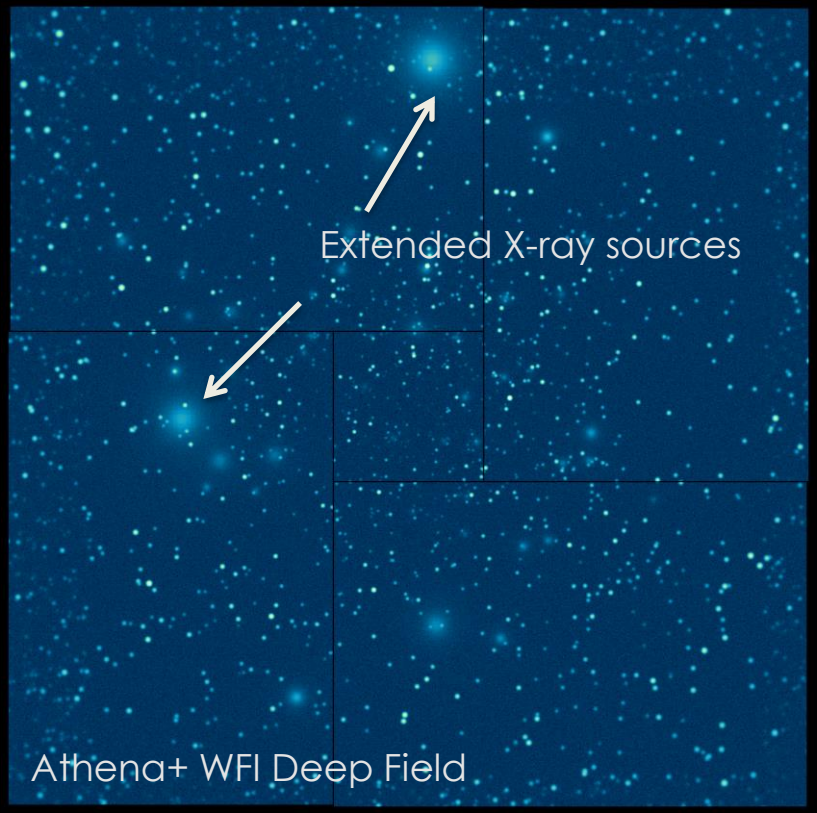


The Science Theme motivating the Athena+ mission

Key questions for observational astrophysics in 2028

1. How does ordinary matter assemble into the large scale structures we see today?

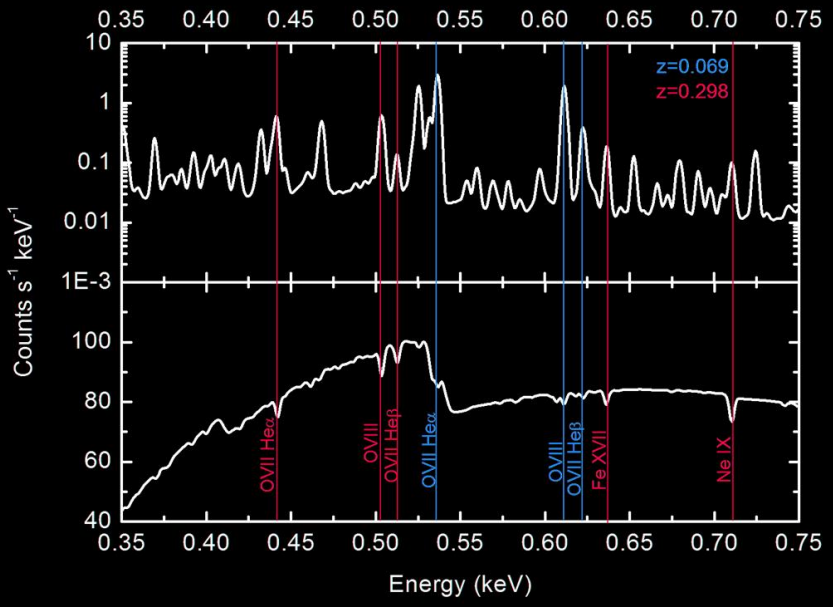




Pointecouteau, Reiprich et al., 2013 arXiv1306.2319

The Warm-Hot intergalactic medium (WHIM)

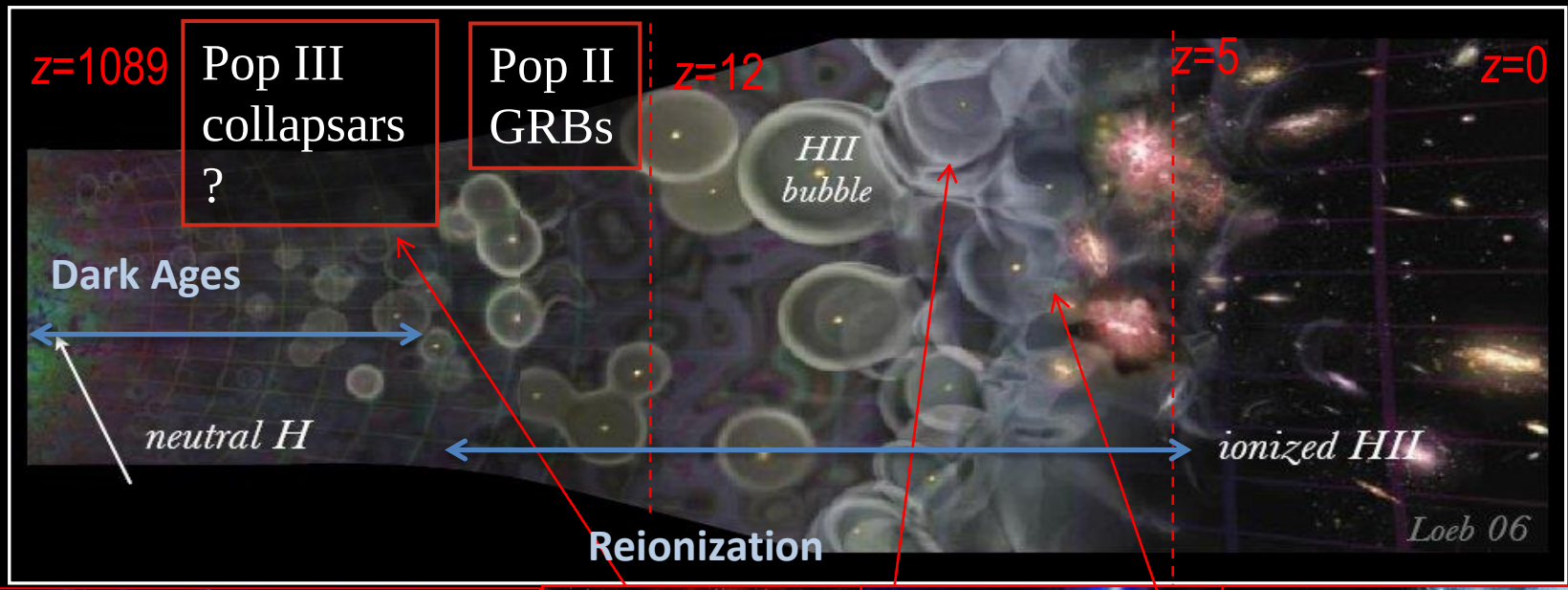
Where are the missing baryons in the local Universe? What is the underlying mechanism determining the distribution of the hot phase of the cosmic web?

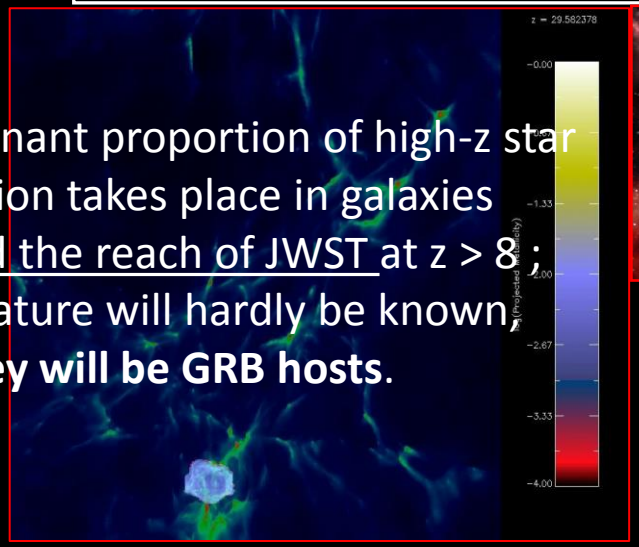


Kaastra, Finoguenov et al., 2013 arXiv1306.2324

How does ordinary matter assemble into the large-scale structures that we see today?

The first stars, the first BH, the first metals





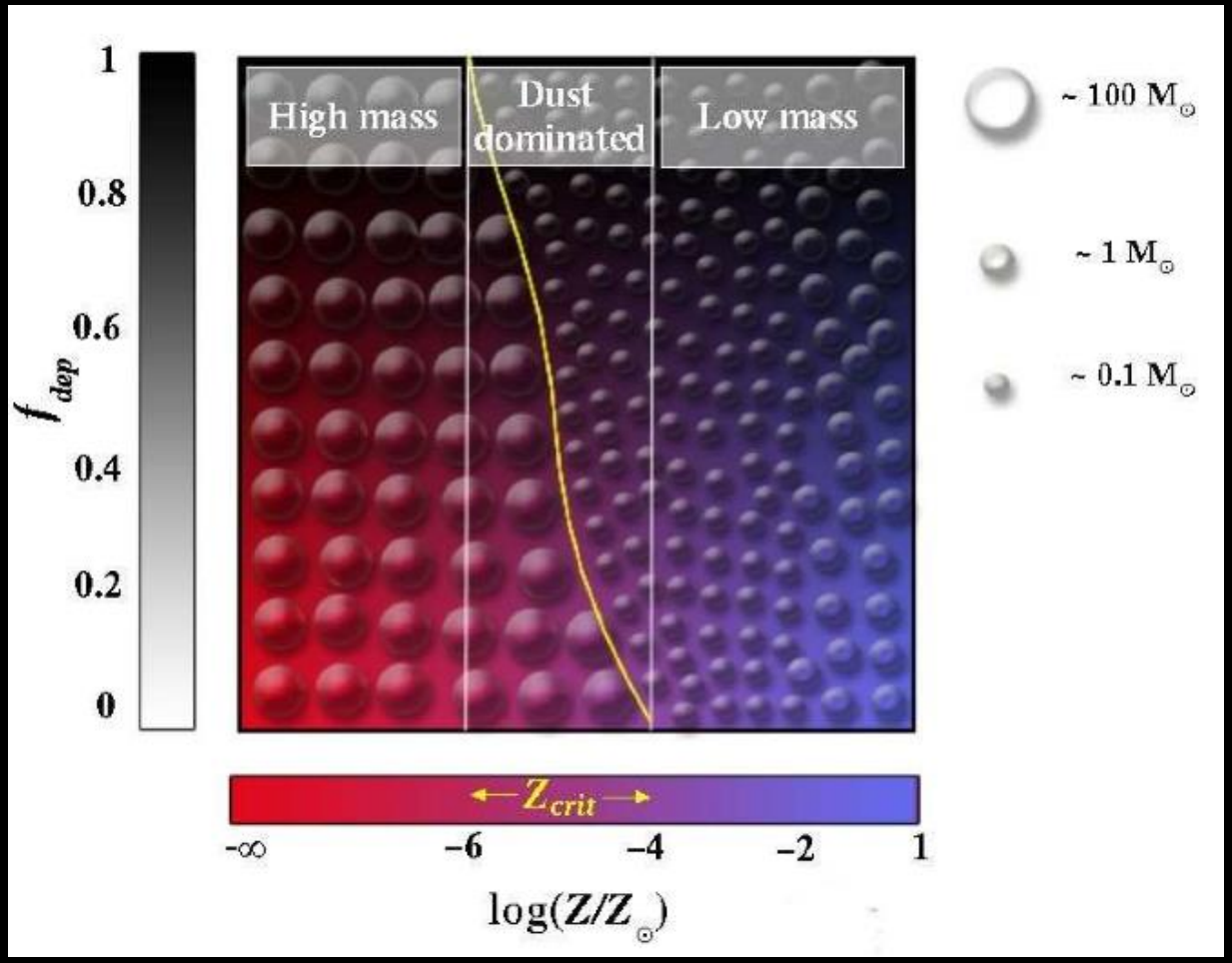
- A dominant proportion of high-z star formation takes place in galaxies <u>beyond the reach of JWST</u> at z > 8 ; their nature will hardly be known, but **they will be GRB hosts**.

- There will likely be no direct detections of population III sources; **pop III collapsars predicted to produce GRB-like events**.

Population III

Z<Zcr ≈ 10^{-4}
formation of clouds
M>100 Msun

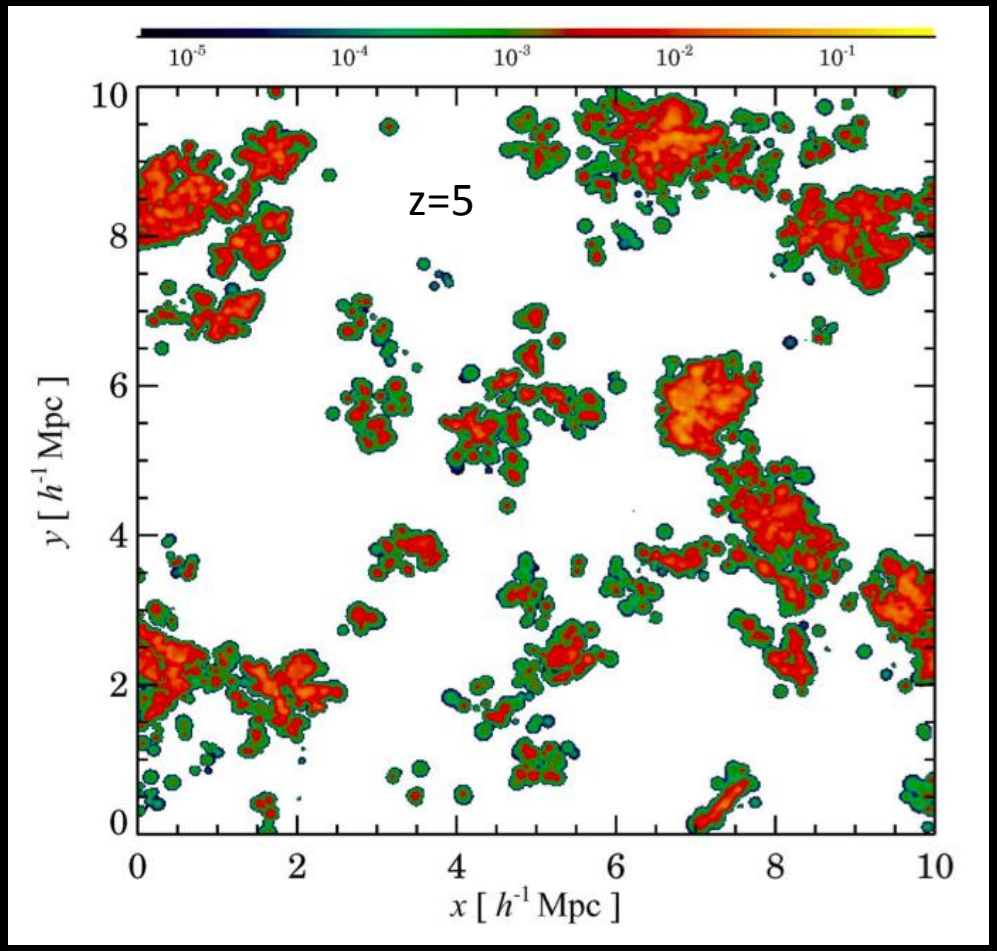
the final mass popIII:
gas accretion vs
radiation feedback,
typical ~40-50 Msun
but [10-1000 Msun]
possible



Schneider 2005

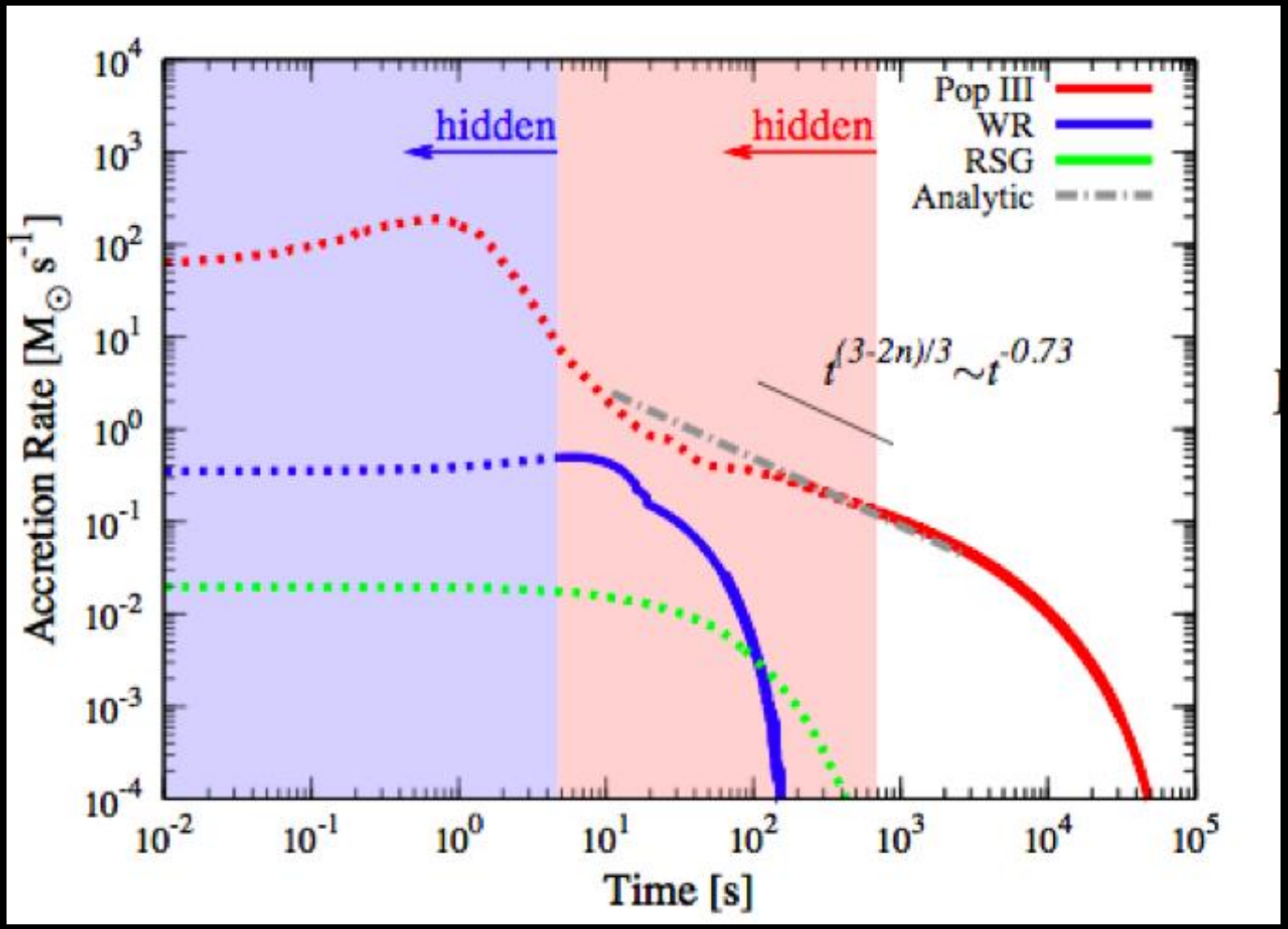
popIII-popII transition

Chemical enrichment is highly inhomengenous: popIII and popII coexhists for a long period



Tornatore et al 2007

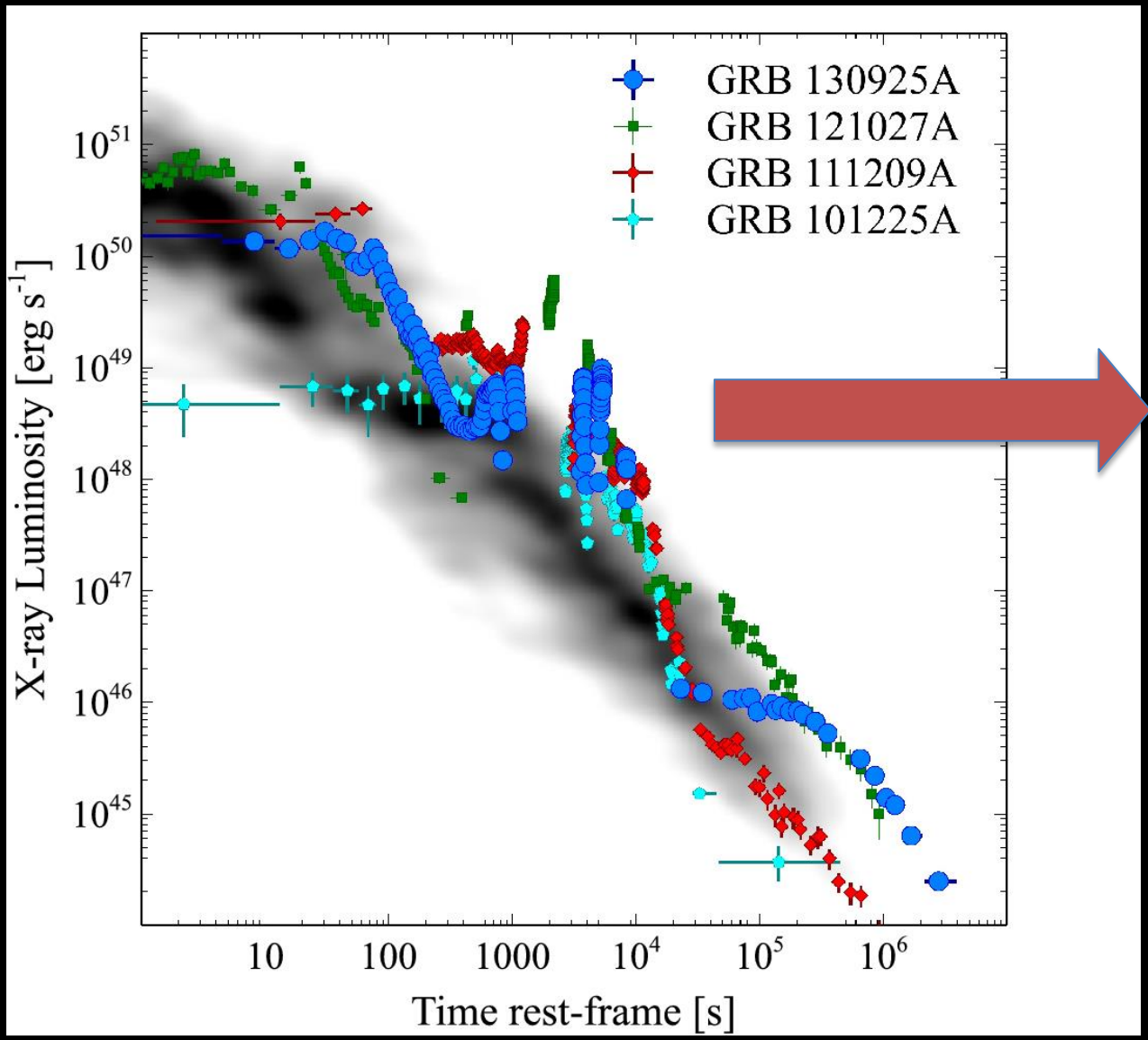
popIII GRBs



$T_{90}=10^4$ s
$Eiso=10^{55}$ erg
$L=10^{52}$ erg/s

Suwa&Ioka 2011

Ultralong GRB: a popIII analogue?



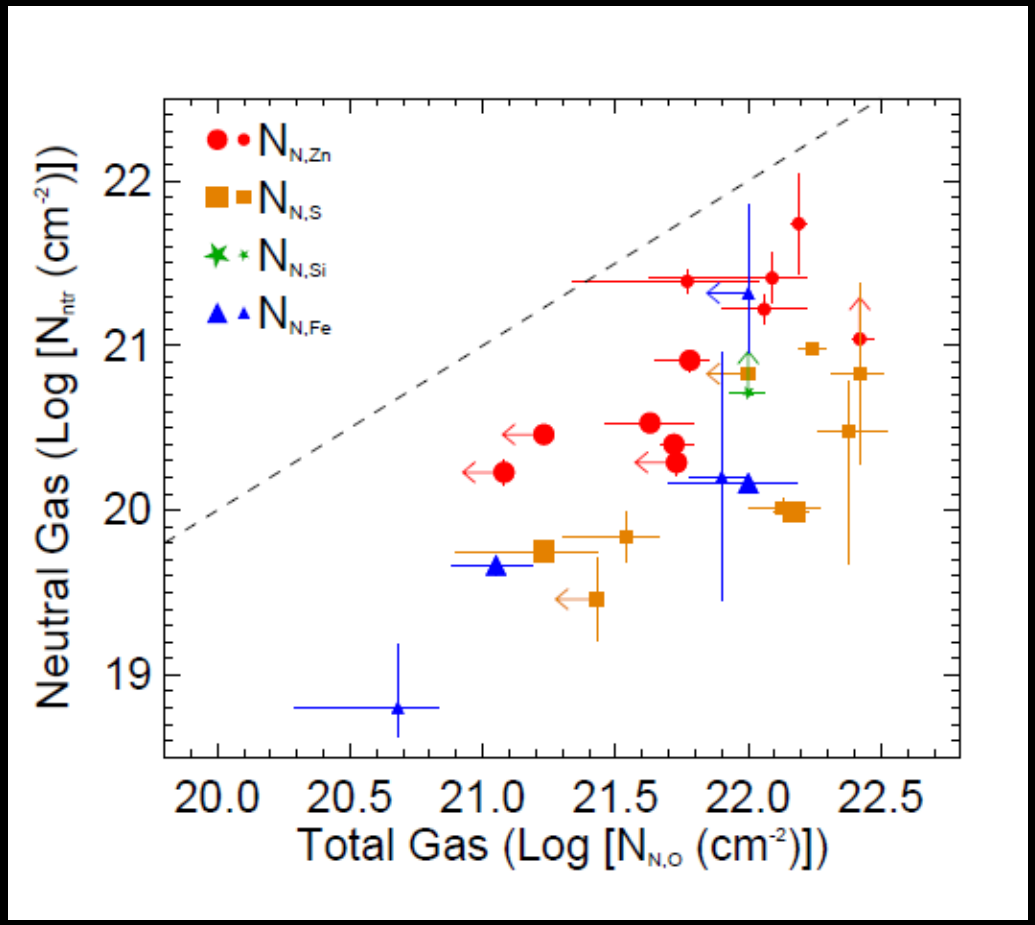
Flux@z=10

10^{-12-11} erg/cm^2/s

Piro+ 2014

X-rays probe the close ionized environment

Opt-IR



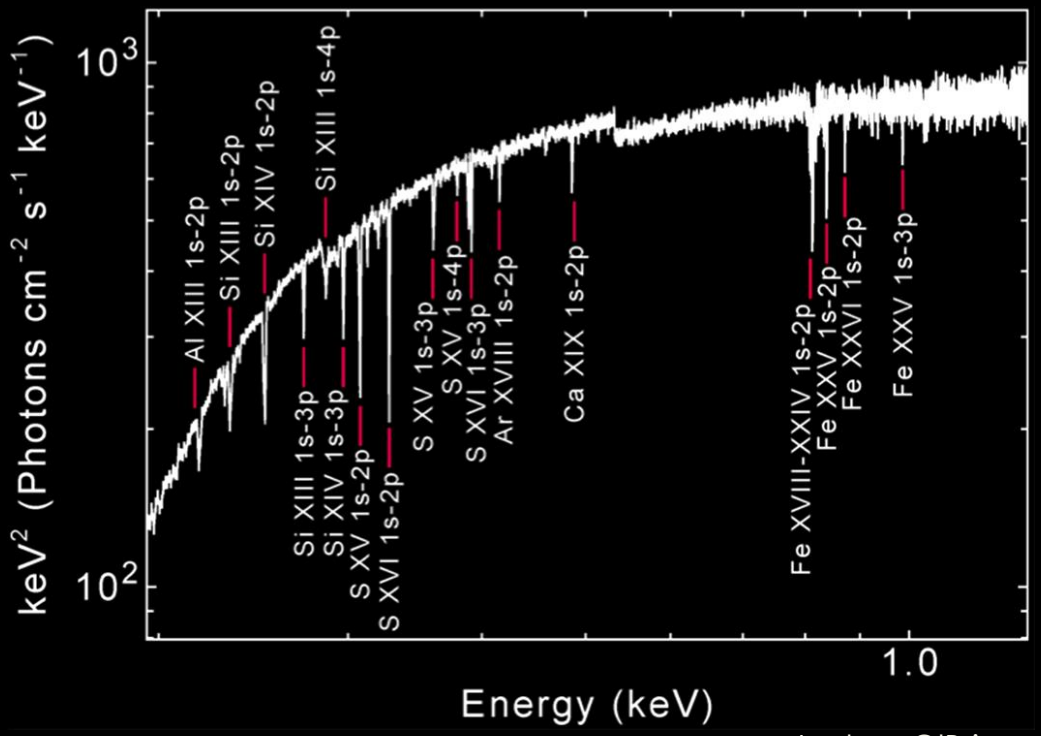
X-Ray

Schady et al 2010

The first stars and black holes

When did the first generation of stars explode to form the first seed black holes and disseminate the first metals in the Universe?

Gamma Ray Burst at z=7 by ATHENA-XIFU



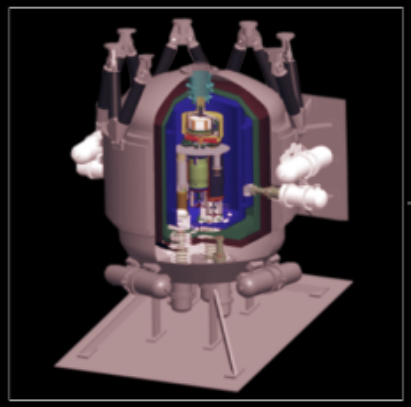
Jonker, O'Brien et al., 2013 arXiv1306.2336

How do black holes grow and shape the Universe?

The Athena Observatory

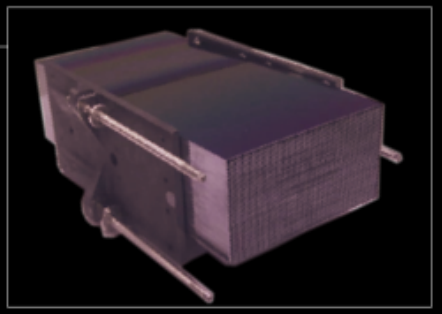
Willingale et al, 2013
arXiv1308.6785

L2 orbit Ariane V
<5100 kg
power 2500 w
5 year mission

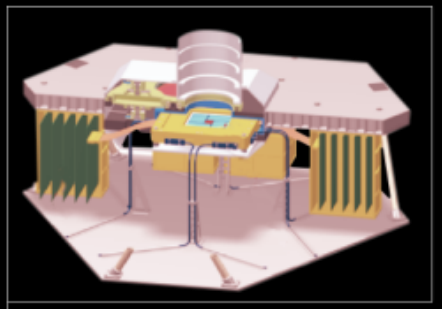


X-ray Integral Field Unit:
ΔE: 2.5 eV
Field of View: 5 arcmin
Operating temp: 50 mk

Barret et al., 2013 arXiv:1308.6784



Silicon Pore Optics:
2 m^2 at 1 keV
5 arcsec HEW
Focal length: 12m
Sensitivity: 3 10^{-17} erg cm^{-2} s^{-1}

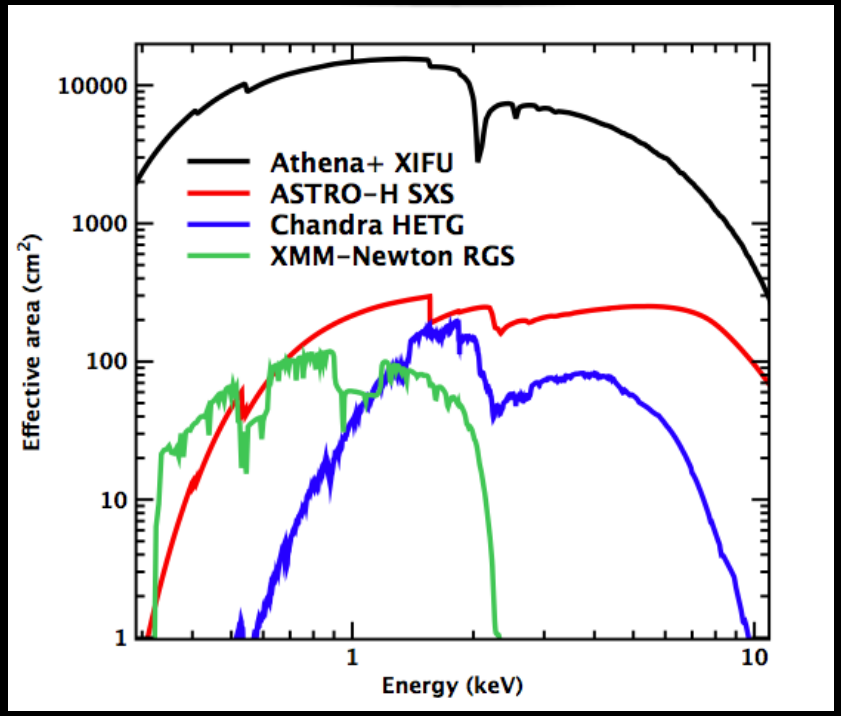


Wide Field Imager:
ΔE: 125 eV
Field of View: 40 arcmin
High countrate capability

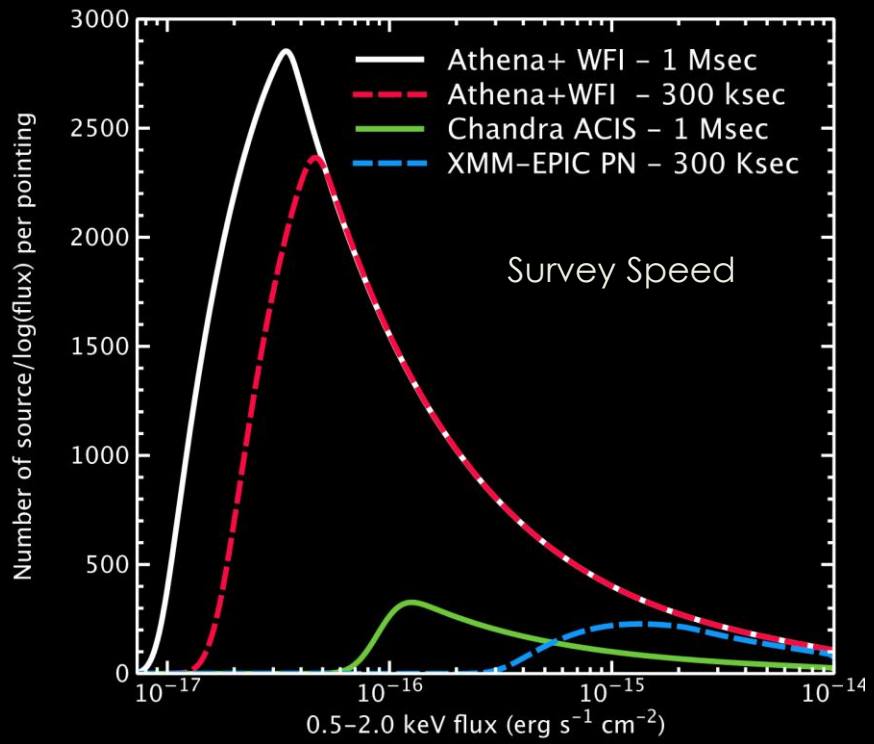
Rau et al. 2013 arXiv1307.1709

The first Deep Universe X-ray Observatory

Athena+ has vastly improved capabilities compared to current or planned facilities, and will impact on virtually all areas of astrophysics

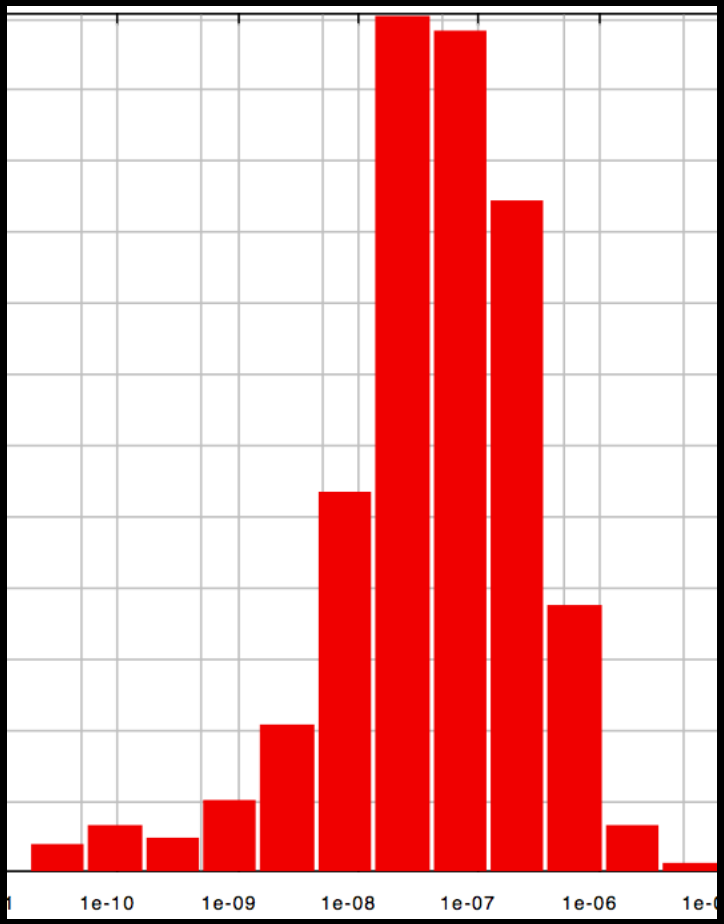


X-ray spectroscopy at the peak of the activity of the Universe



Deep survey capability into the dark ages and epoch of reionization

GRB fluence distribution and counts in Athena



10^4 10^5 10^6 10^7

counts in XIFU
(at 2hrs for 100 ksec)

P.Evans

GRB requirements for trigger

- ✓ XIFU FOV is 5'=> localization at ~ arcmin level
- ✓ For the WHIM only the brightest:
- ✓ GRB monitor: FOV main driver, area can be relatively small, use prompt as pre-selection
- ✓ For high z GRB: about 30-50 (depending on models) GRB at z>7 per year in the Universe.
- ✓ GRB monitor: Need to secure most of GRB (at least 500 GRB per year) => FOV (at least 3 p AND sensitivity)
- ✓ If popIII as GRB possibly ultra long and dim and soft (Lobster)
- ✓ Need photo-z to pre-select in IR

GRB with Athena

- ✓ GRB are in the core science of Athena as beacons to
- ✓ Find the missing baryons in the WHIM:
- ✓ About 10 GRB afterglows per year selected for brightness (prompt emission as proxy)
- ✓ Find primordial stars sites in the High-z Universe:
- ✓ About 5 GRB afterglows pre year selected for redshift (photo-z with IR telescopes, other indicators…)
- ✓ Physics of GRB in Observatory science (late time follow up)

- ✓ Mission requirement: TOO in 4hrs (2 hrs goal) for 50% of sky

Athena science in context

Athena is a crucial part of the suite of large observatories needed to reach the science objectives of astronomy in the coming decades