Galaxies et grandes structures avec XEUS

M.Arnaud (CEA-Sap Saclay)

XEUS: next generation X-ray observatory

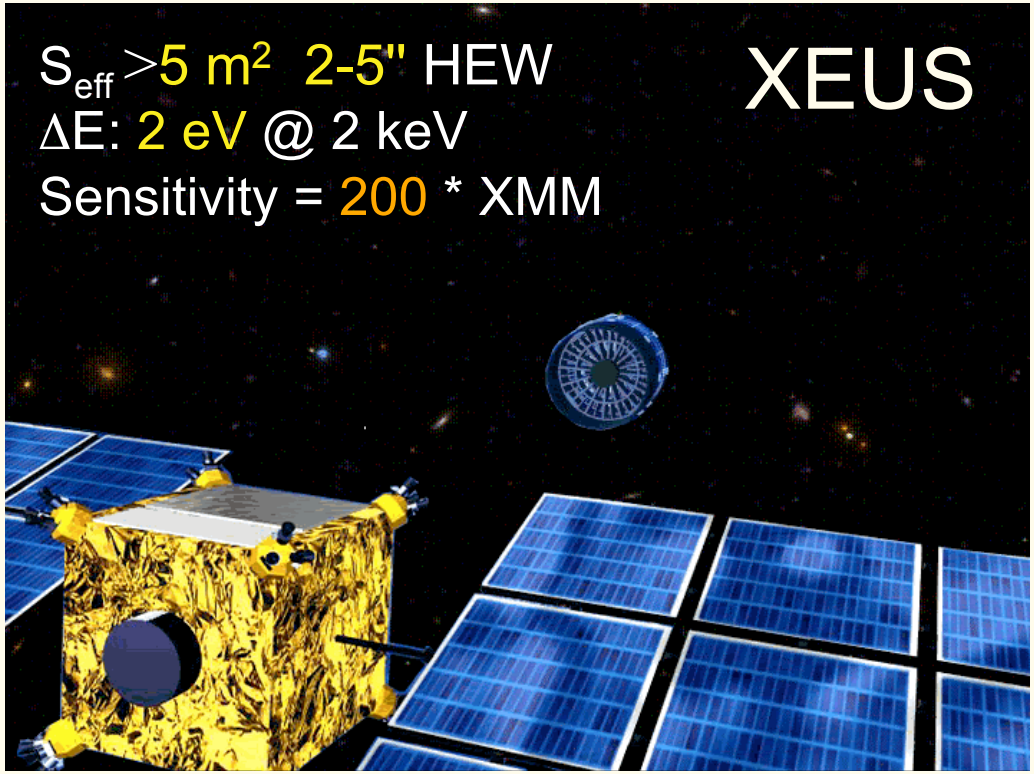
XMM-Newton

0.4 m^2 15" HEW
ΔE: 100 eV

Potential successor of XMM

First concept 1996

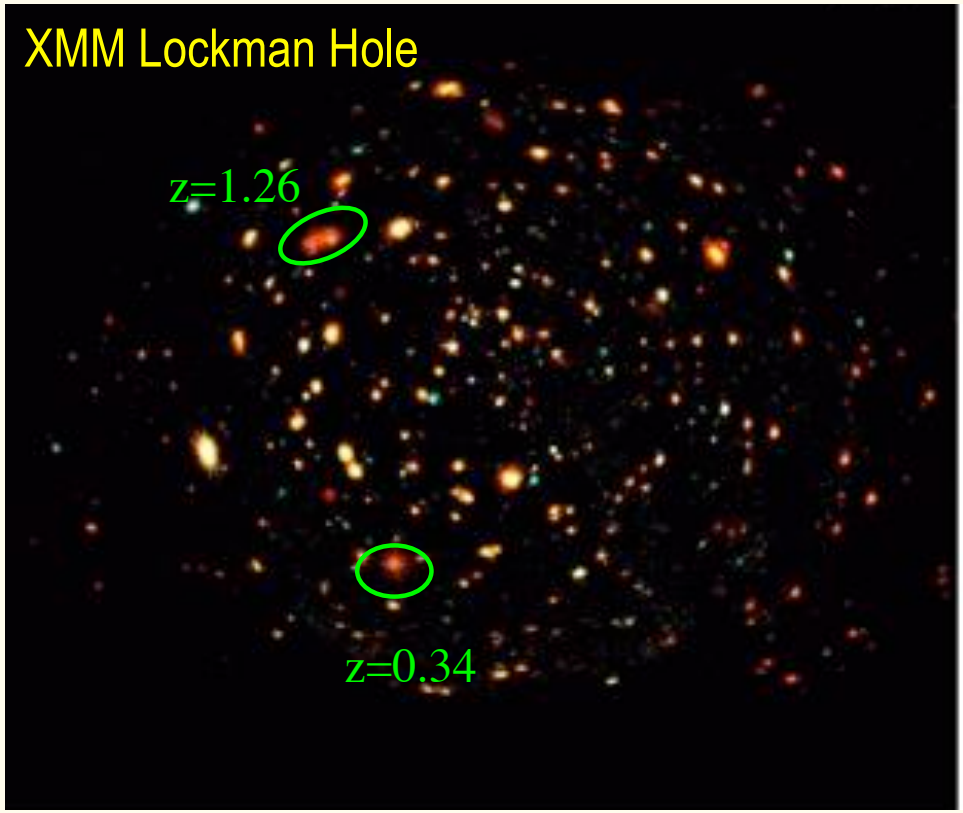
Selected as Cosmic-Vision
L mission candidate



XEUS: X-ray Evolving Universe Spectroscopy

The cool Universe:
Stars

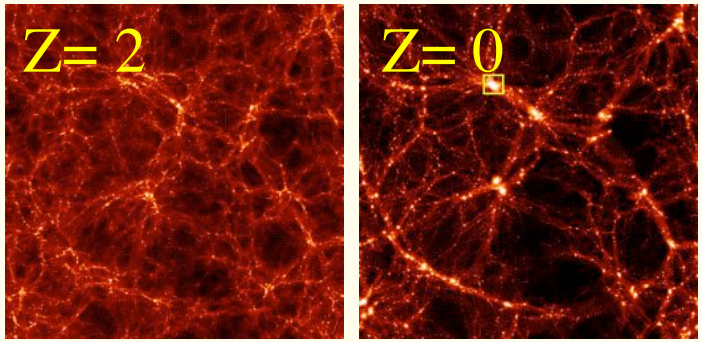
The hot/warm Universe:
Black Holes + Hot Gas

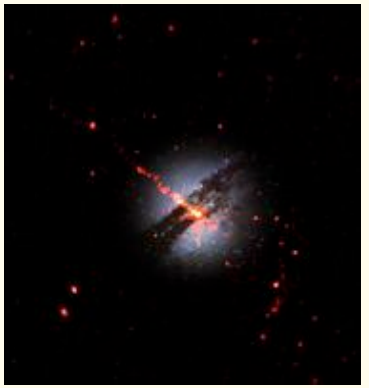


JWST, ELT, SKA , ALMA

XEUS

Key scientific objectives

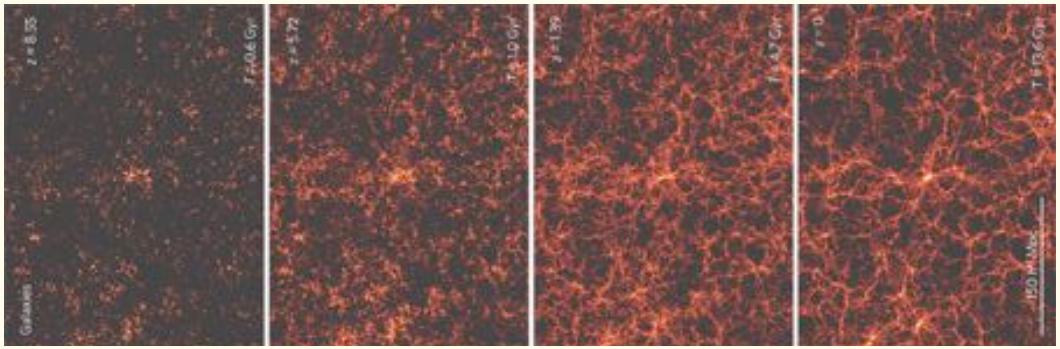




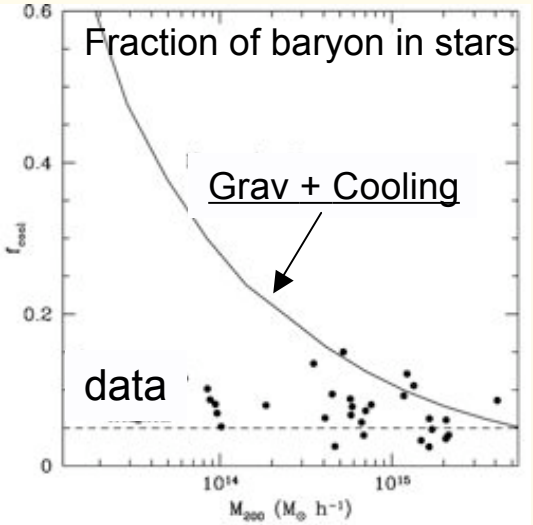
- Evolution of Large Scale Structure and Nucleosynthesis
- Coeval Growth of Galaxies and Supermassive Black Holes
- Matter under Extreme Conditions

and an observatory with a vast array of science topics..

Do we understand structure formation ?



Springel, Frenk & White, 06

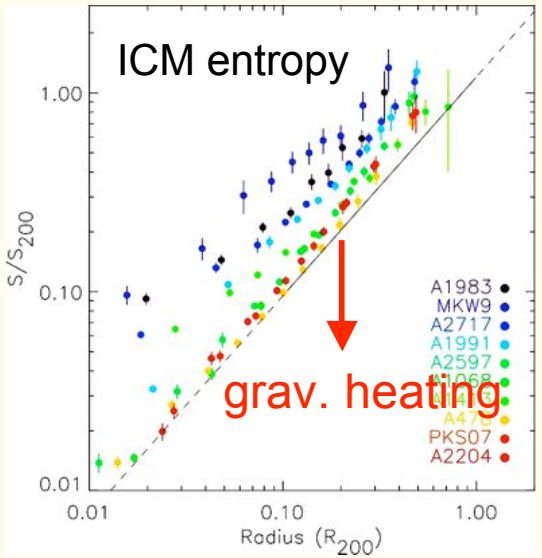


Oh & Benson , 04

- Dark Matter clustering: ~ understood
- Baryons history: complex physics *not* understood
  - Gravity
  - Star/galaxy formation
    ⇒ Cooling but over-cooling; wrong LF, SFR(z)
  - Intra Cluster Medium properties (e.g. entropy)

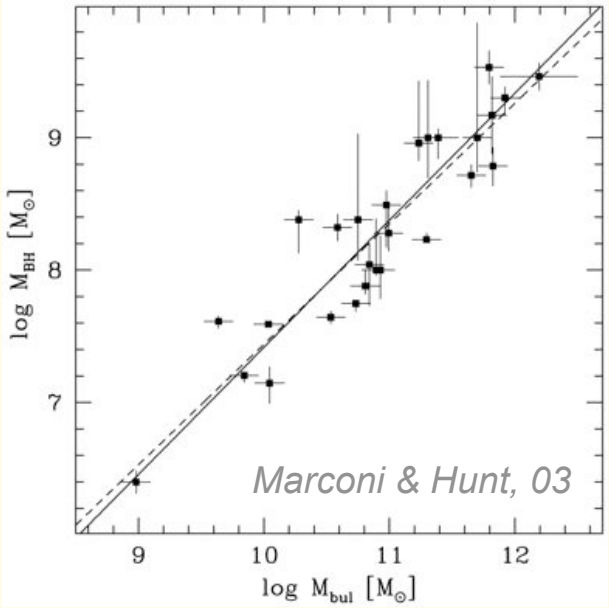
⇒ SN+AGN+? extra-heating
feedbak & regulation mechanism

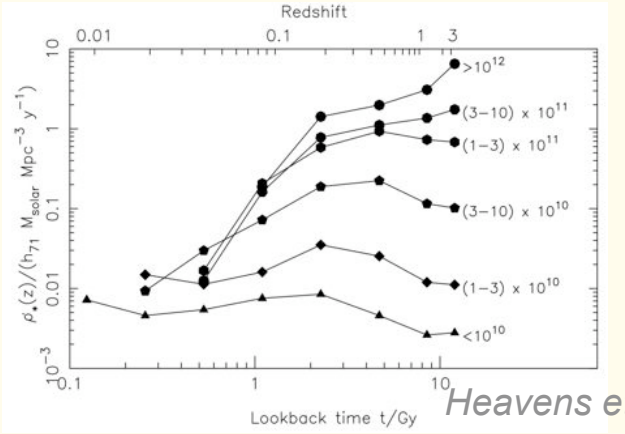
⇒ *Observe formation and evolution*



Pratt,Arnaud&Pointecouteau , 06

Coeval Growth of Galaxies and Supermassive Black Holes



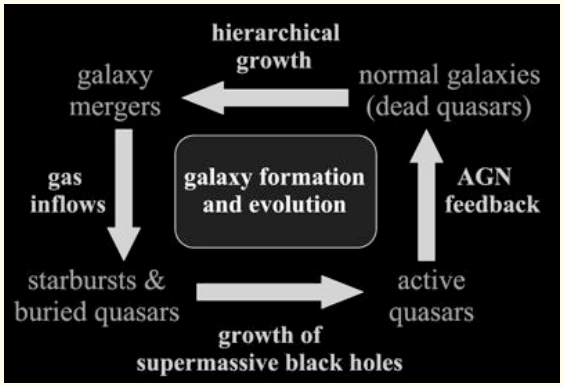


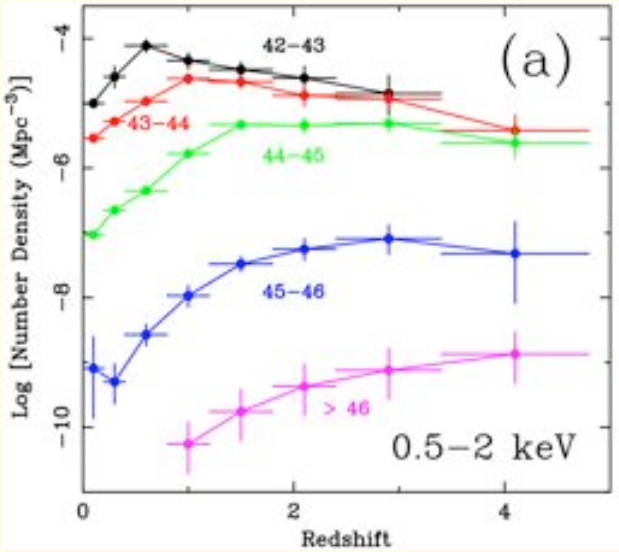
Heavens et al, 04

« downsizing »

Co-evolution of stars and SMBH

AGN regulated SF/SMBH growth conjecture

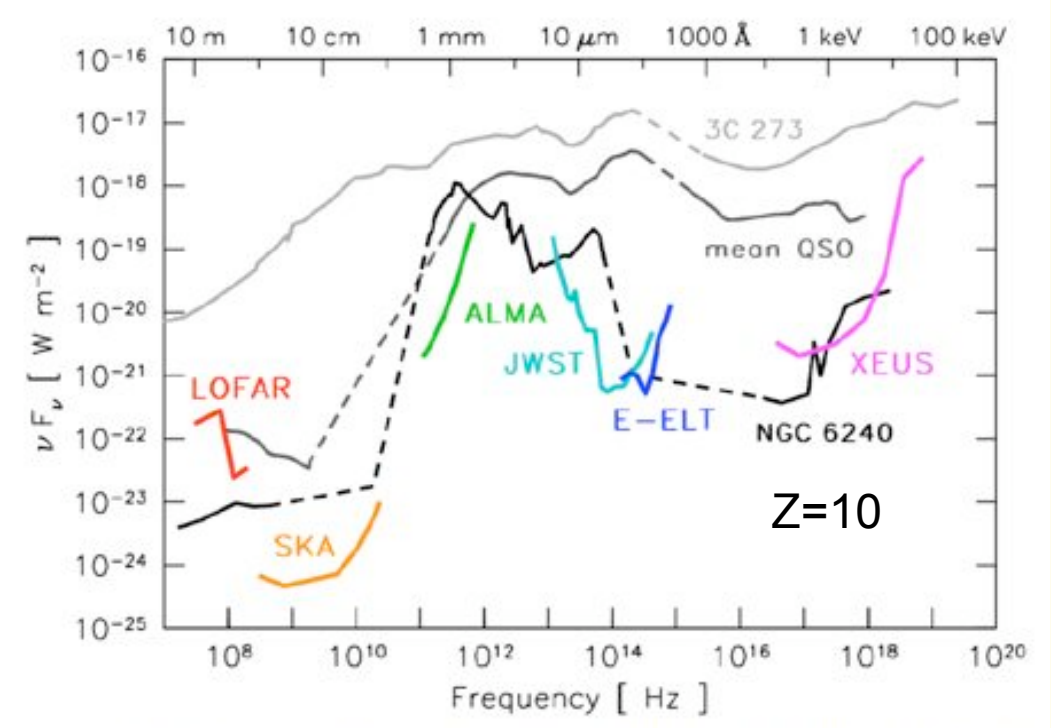




From Hasinger fig Hopkins et al, 05

Hasinger, Miyaji & Schmidt 05

Coeval Growth of Galaxies and Supermassive Black Holes

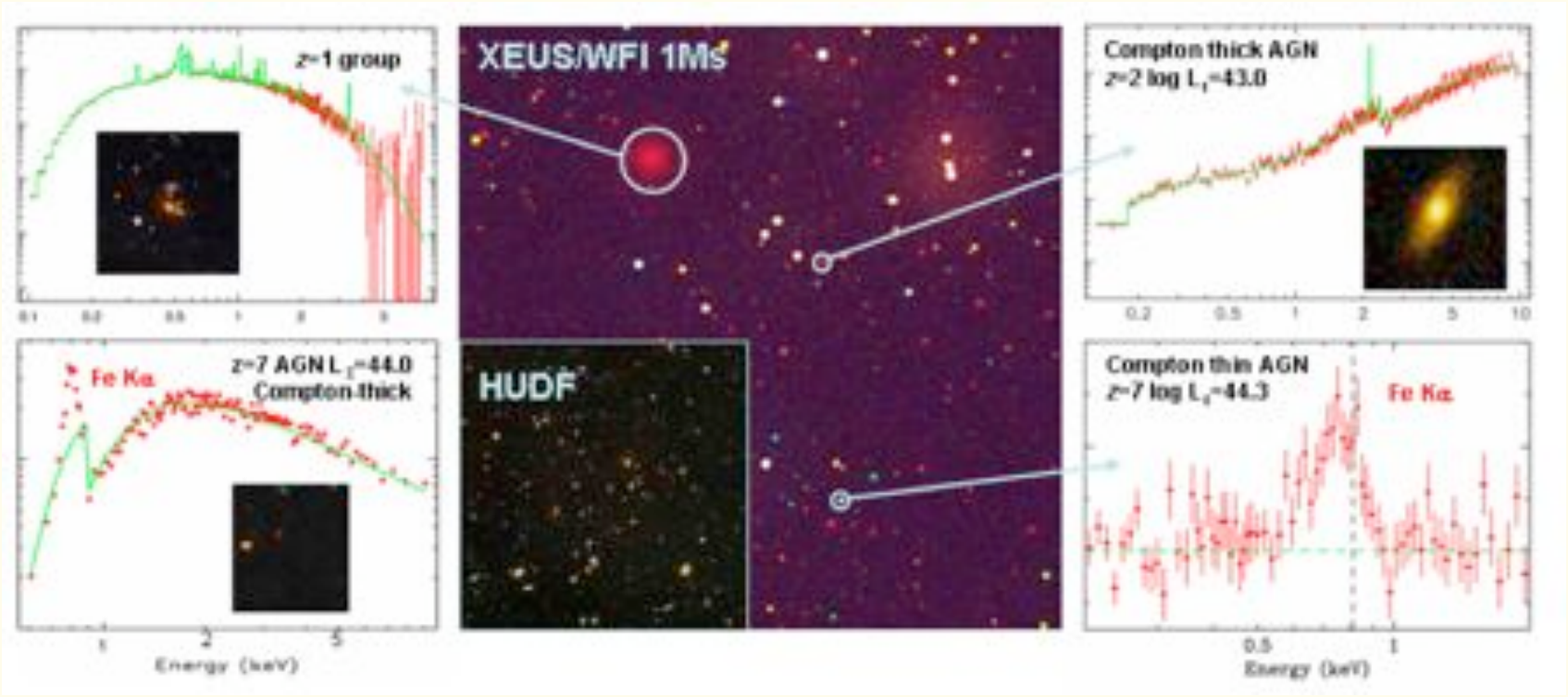


The first massive black holes

Detect first massive BH at z~10 with M~$10^{6\text{-}7}$ M_o, $10^{43\text{-}44}$ erg s^{-1}

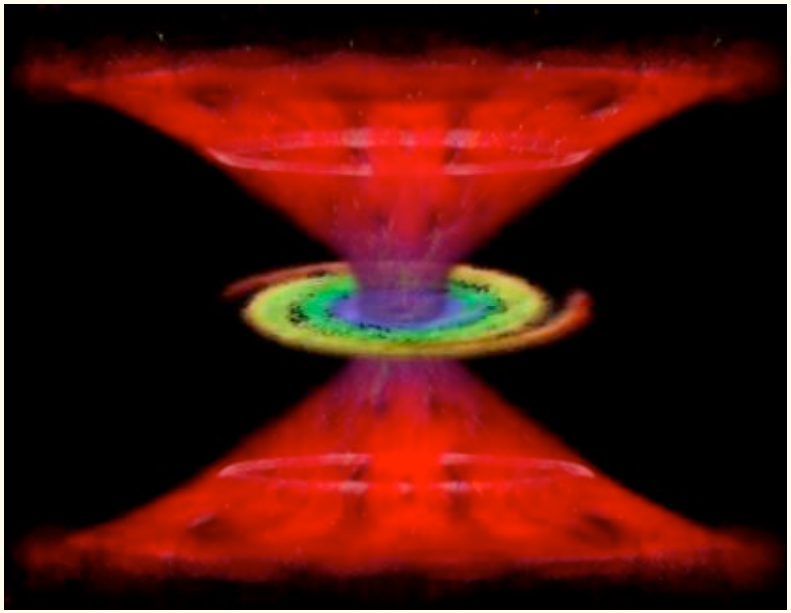
Sensitivity well matched to future IR/radio/opt observatory; *separate starburst/AGN*

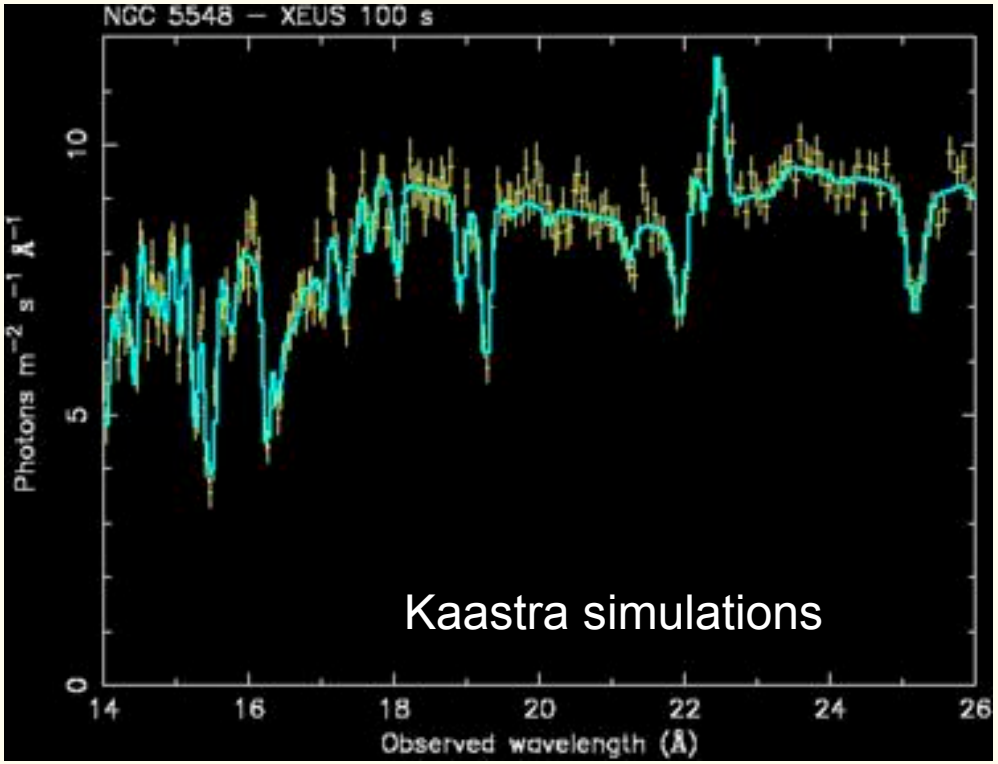
Coeval Growth of Galaxies and Supermassive Black Holes (II)



Obscured black hole growth N(Lx,z)

Coeval Growth of Galaxies and Supermassive Black Holes (III)



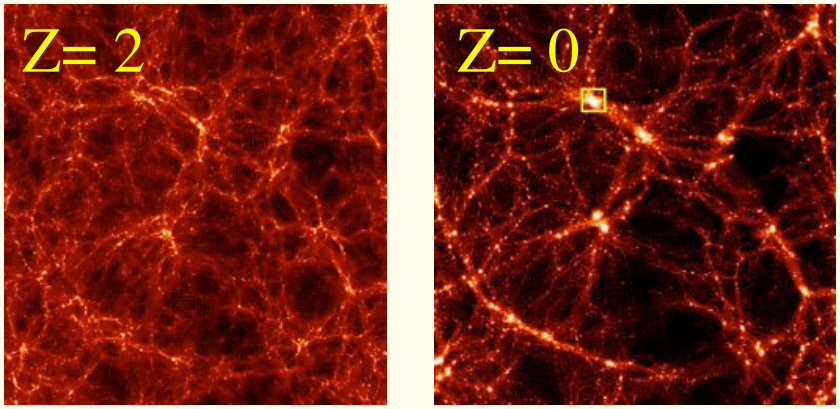


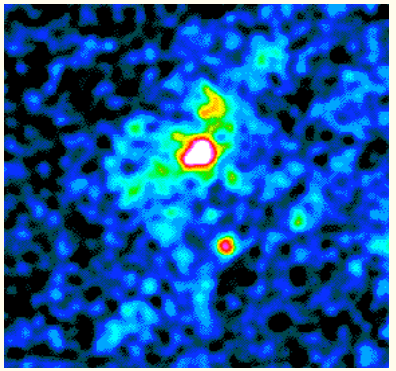
AGN outflows physics

Location and velocity (thus energy) from high resolution time variable spectra

In typical QSO at z=1-3

Evolution of Large Scale Structure and Nucleosynthesis (I)

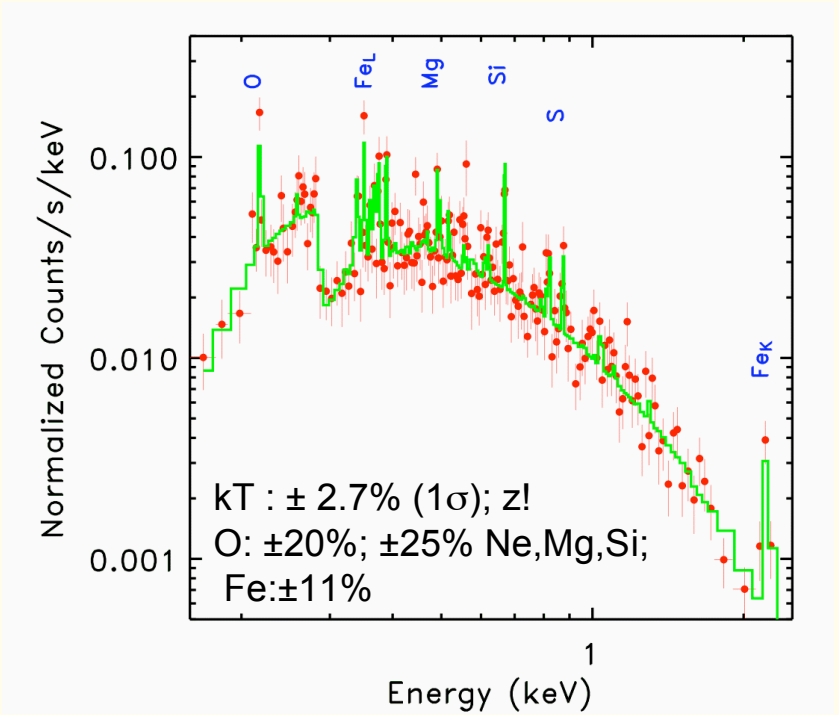




Credit: H. Bohringer + MA

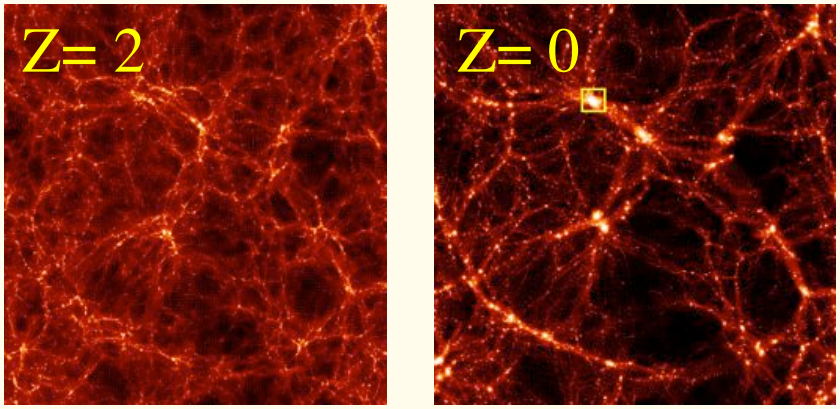
- Formation of the first galaxy groups
- Trace their evolution to today's massive clusters

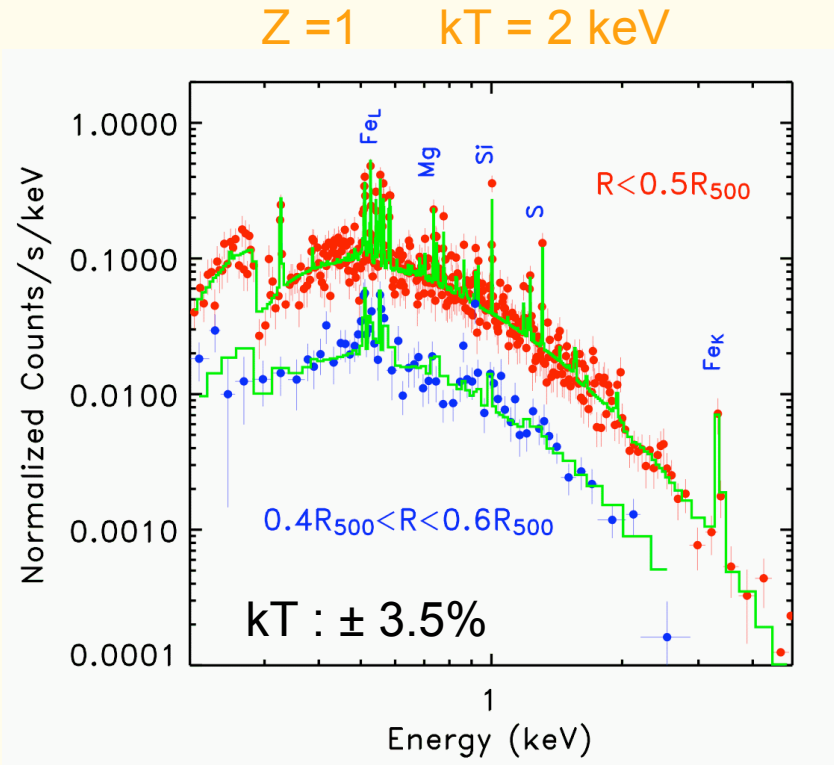
  incl thermo-dynamical history
- Evolution of metal synthesis



Global properties up to z=2, kT> 2keV

Evolution of Large Scale Structure and Nucleosynthesis (II)





- Formation of the first galaxy groups
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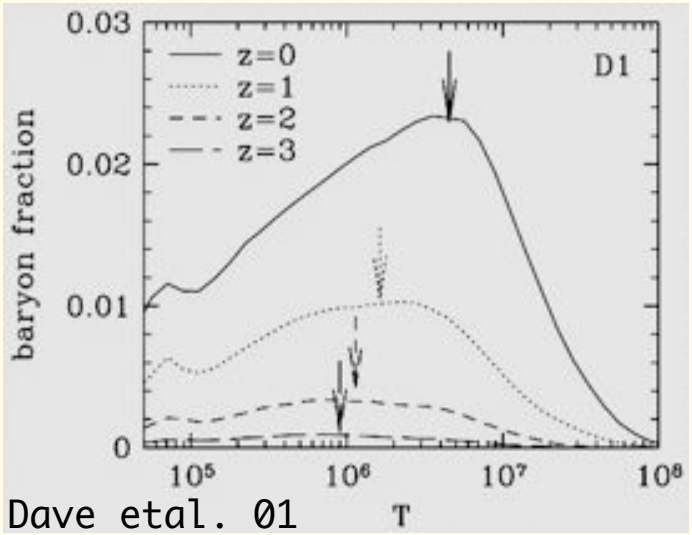
kT profiles ⇒ S (r) and M(r)
As in local Universe with XMM/Chandra

Credit: H. Bohringer + MA

Evolution of Large Scale Structure and Nucleosynthesis (III)



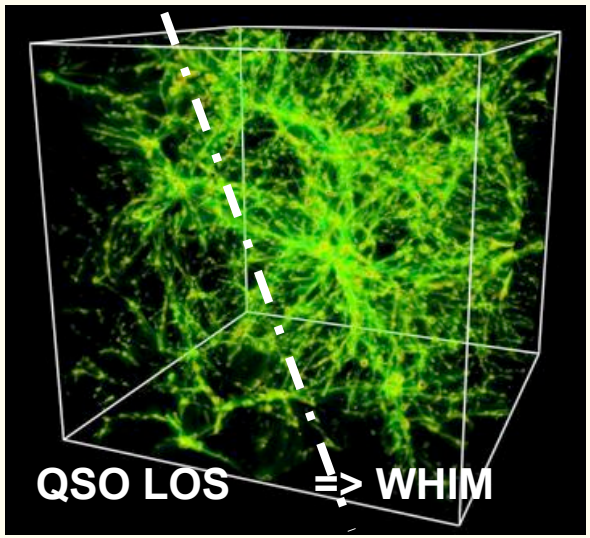
The Missing baryons

~ 50% at z <2

in WHIM (filaments)?

IGM hotter at low z:

shock heating + SF & AGNs heating?



10 AGN/deg^2 @ S_x[0.5-4.5] > 10^{-13} cgs; <z> =0.7

=> detect N_{OVIII} > 3 10^{15} cm^{-2}

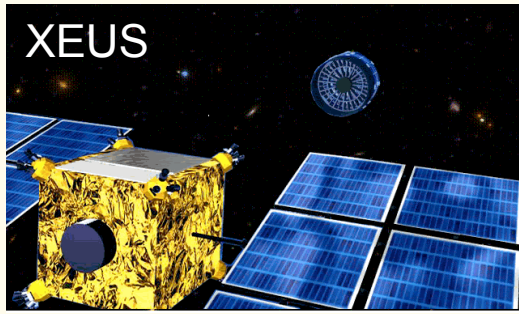
XEUS: absorption lines in X-ray

- Detect and study properties vs z: ($d\mathcal{N}$/dzdN, kT, metallicity)
- Probe LSS/galaxy formation

XEUS: mission requirements

0.4 m^2 15" HEW
ΔE: 100 eV

Sensitivity: 5 x 10^{-18} erg cm^{-2} s^{-1}
$\Delta\theta$: 2-5"
ΔE: 2 eV @ 2 keV; 6 eV @ 6 keV
Bandpass: 0.1 - 40 (80) keV
FOV: 7' $\varnothing$
Time resolution: 10μ sec



- Mirrors: high resolution, high effective area (> 5 m^2 @ 1 keV, 1 m^2 @ 6 keV) with F=35-50 m
- Focal Plane Instruments: Wide Field Imager (semi-conductor spectro-imager), Narrow Field Imager (cryogenic high resolution spectrometer), Hard X-ray Imager (CdTe camera) , High Time Resolution Spectrometer and X Polarimeter

Key new technology developments

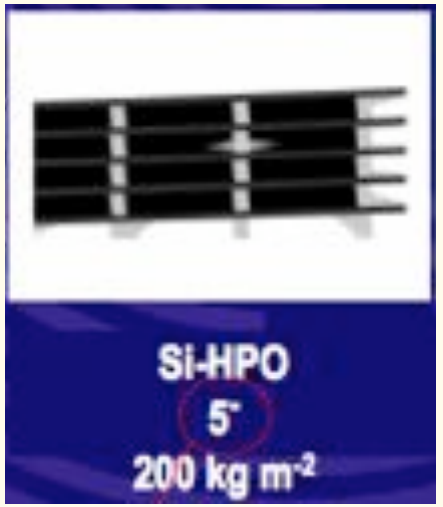
Formation Flying

Mirrors:

New ESA light-weight Si HPO mirror technology

Detectors:

- WFI: Silicon active pixel sensor G-MPE
- NFI: TES baseline (EURECA consortium)
  MIS R &D bolo X (F CEA/CNES et al) FOV!
  cryo cooler (incl CEA grenoble)
- HXI: CdTe Japan (Suzaku,NeXT)
  collaboration with F (Simbol-X) starting
- HTRS: SDD F-CESR / G-MPE
  add CdTe (Sap) to cover high energy
- XPOL: Italy



- Passive/active shielding (spec NFI, HXI): J on going (HXI), F-APC/Sap (from SX)

Past, present and future

- Long history (since 1996..)
- June 2007: Proposed as L mission for ESA Cosmic Vision 2015-2025

  PI: M. *Turner* G. Hasinger; Co-I EU/J/*Russie/Chine/US;* F: M. Arnaud/D. Barret
- Autum 2007: Selected for assessment study

  ESA + national studies; ESA-XSST (MA/DB); Working groups: TWG,IWG,AWG (open)
- End 2009:
  - XEUS,LISA,Tandem/Laplace ⇒ down selection to 2 L mission candidates

  criteria: science & feasability; TRL; consolidated intern collaboration; ESA cost (<650 M€)
  - AO for instrument consortia

    Potential important F contribution :
    - leadership: HTRS (CESR)
    - collaboration to HXI and NFI
- End 2011: selection of L1 mission for a launch in 2018 ……

Mission Summary

http://sci.esa.int/xeus

XEUS X-ray Evolving Universe Spectroscopy	
Themes	• What are the fundamental physical laws of the Universe? • How did the Universe originate and what is it made of?
Primary Goals	• How did supermassive black holes form and grow & influence galaxy growth? • How did large scale structure evolve? • How did the baryonic component of this structure become chemically enriched? • How does gravity behave in the strong field limit?
Targets	• High redshift AGN • Clusters of galaxies • Neutron stars & black holes
Wavelength	X-ray (0.5-40 keV)
Telescope	4.2m diameter mirror
Orbit	Halo orbit at L2
Lifetime	5 years
Partners	ESA-JAXA
Type	L-class Mission

http://www.xray.mpe.mpg.de/~xeus

http://sci.esa.int/science-e/www/object/index.cfm?fobjectid=42392

http://astro.ic.ac.uk/Research/Xray/xeus_meeting/