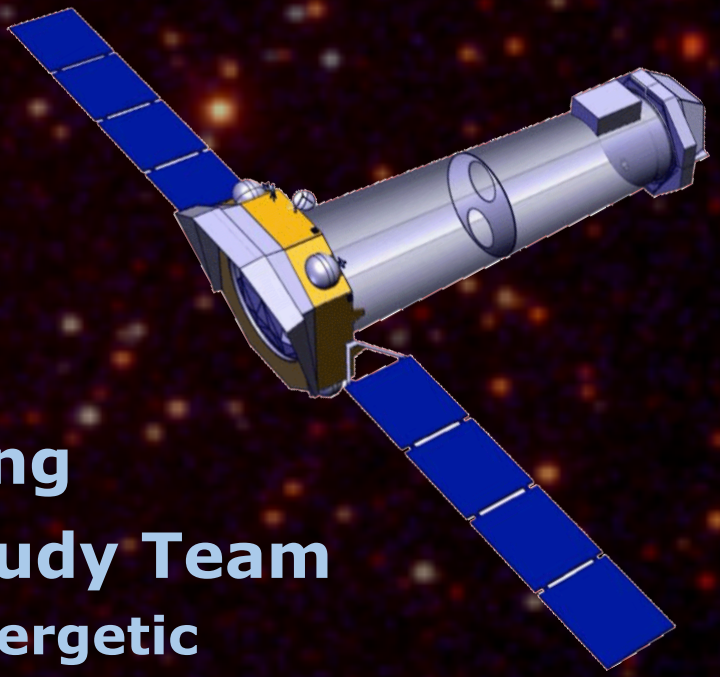
ATHENA: The Advanced Telescope for High Energy Astrophysics



Kirpal Nandra, MPE Garching

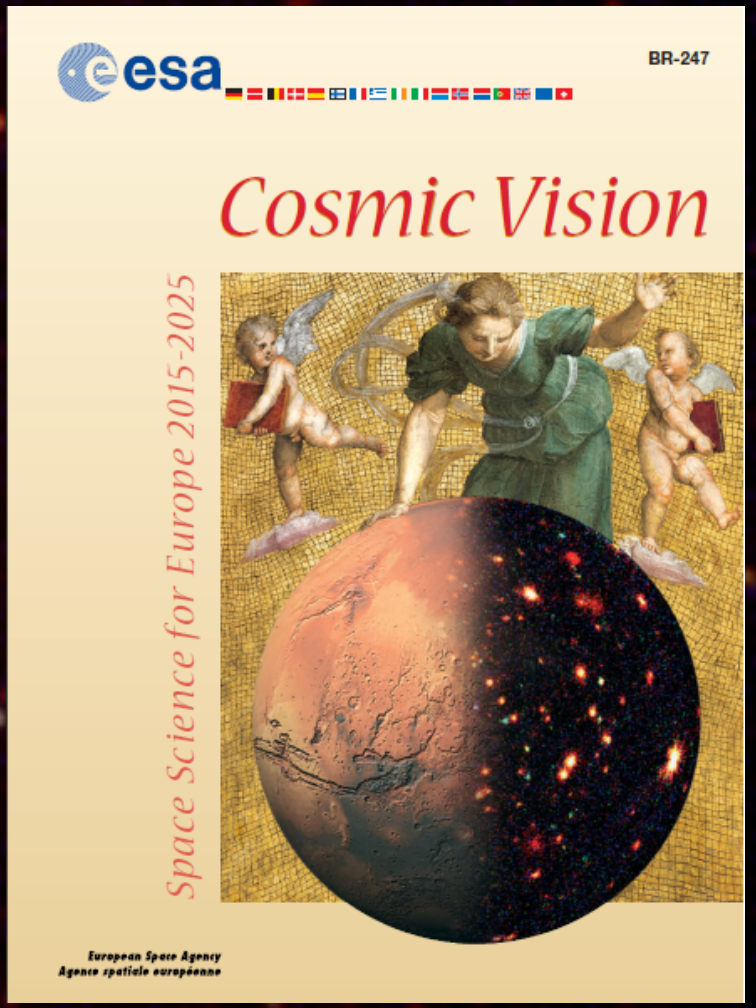
On behalf of the Athena Study Team

Mapping the Structure of the Energetic Universe, Garmisch-Partenkirchen, Oct 2011

ESA: Cosmic Vision

- What are the fundamental physical laws of the Universe
  - Matter under extreme conditions
- How did the Universe originate and what is it made of?
  - The Universe taking shape
  - The evolving violent Universe

➔ Large X-ray Observatory

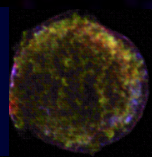


A Brief History of Athena

- Oct 2007 ESA selects XEUS as candidate L-mission
- June 2008 XEUS and Con-X merge ➔ IXO
- Feb 2011 presentation of ESA IXO assessment study
- Feb/Mar 2011 Decadal Surveys, new budget realities

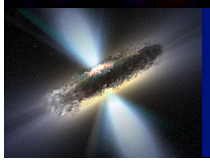
New Plan Required!

- **March 14th 2011:** ESA announces L-class reformulation.
- **Mar-Apr:** Baseline mission defined by study team
- **Jun-Aug:** parallel industrial studies
- **Sep-Nov:** Preparation of study report
- **Dec-Jan 2012:** ESA/Advisory structure assessment
- **Feb 2012:** SPC L-class down-selection

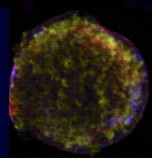


Athena Science

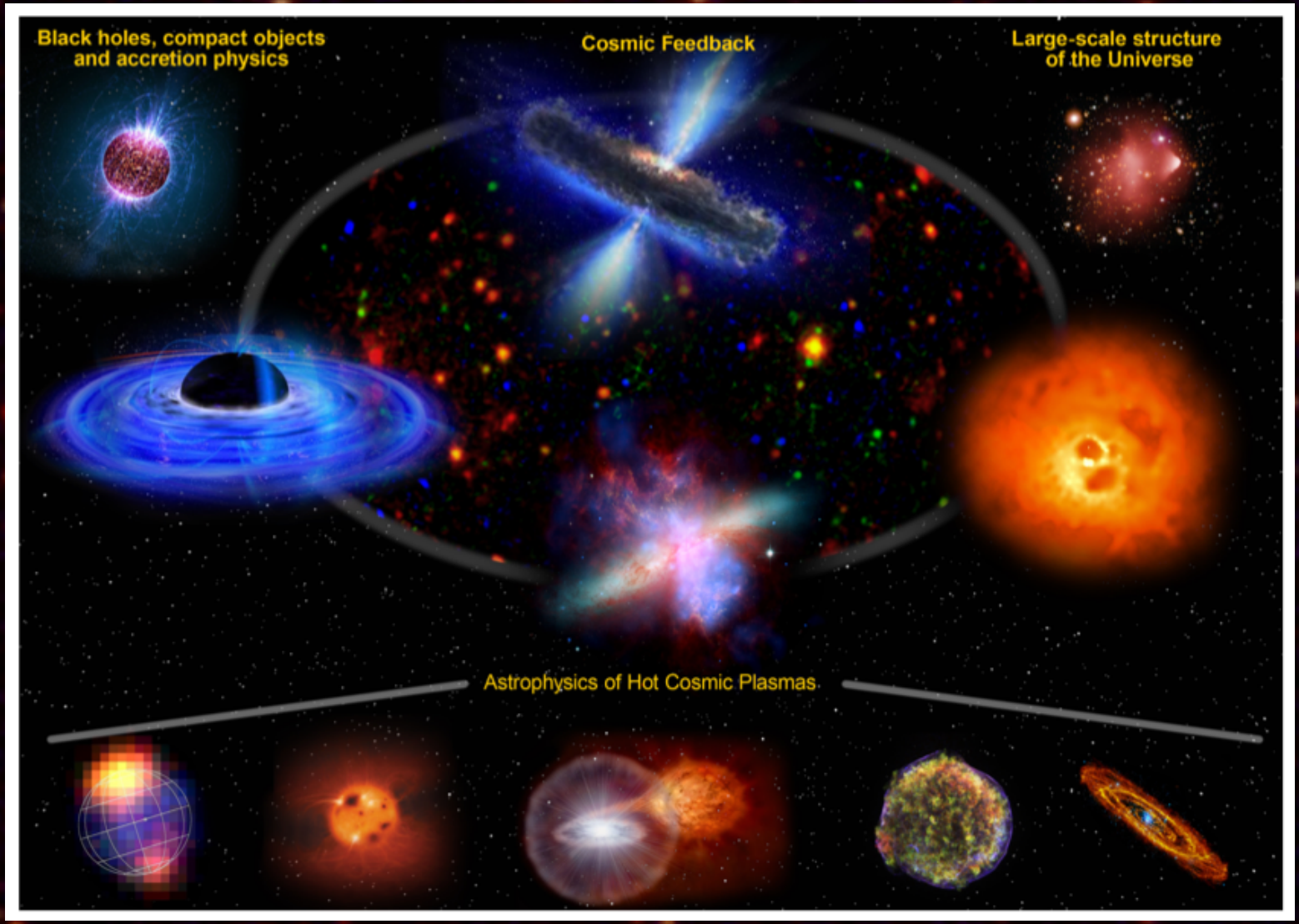
The Extremes of the Universe: from Black Holes to Large Scale Structure



Athena – Advanced Telescope for High Energy Astrophysics



Athena Science Objectives



Athena – Advanced Telescope for High Energy Astrophysics

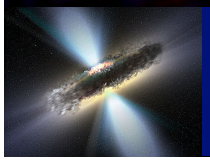
Athena Science Objectives

Black holes and accretion physics → **Cosmic feedback** → **Large-scale structure of the Universe**

- Probe accretion in the strong field limit around black holes, and determine their spins. Determine the physical conditions in the densest observable form of matter.
- Reveal the physics of cosmic feedback on all scales, and quantify its relationship with black hole growth and galaxy evolution.
- Trace the formation and evolution of large-scale structure via hot baryons in galaxy clusters, groups and the intergalactic medium comprising the cosmic web.

Astrophysics of hot cosmic plasmas

- Diagnose hot cosmic plasmas in all astrophysical environments via X-ray imaging and high resolution X-ray spectroscopy.



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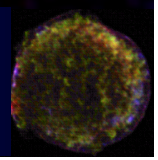
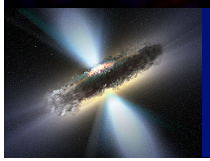
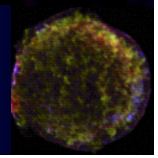


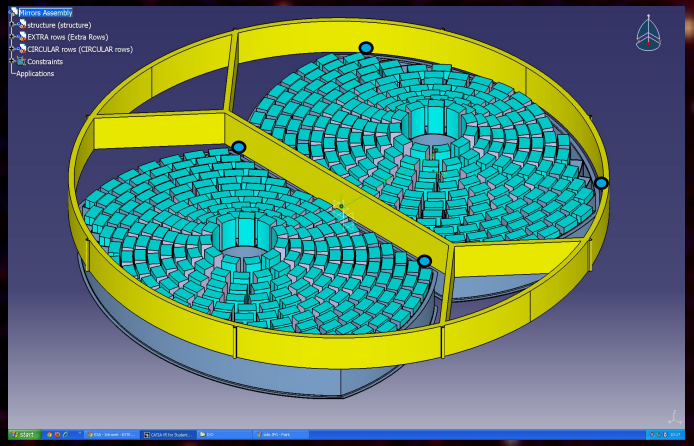
Athena Science Requirements

Effective Area	1 m² @1.25 keV (goal 1.2 m²) 0. 5 m² @ 6 keV (goal 0.7 m²)	Black hole evolution, large scale structure Strong gravity, cosmic feedback
Spectral Resolution (FWHM)	ΔE = 3 eV (@6keV) within 2 x 2 arc min (goal 2.5 eV and 4x3 arc min) ΔE =150 eV at 6 keV within 25 arc min diam (goal of 125 eV and >30 arc min)	Large scale structure, Cosmic Feedback Black Hole evolution, Large scale structure
Angular Resolution	10 arc sec HPD (0.1 – 7 keV) (goal of 5 arc sec)	Black hole evolution, Cosmic feedback, Large Scale Structure
Count Rate	1 Crab with >90% throughput. ΔE < 200 eV @ 6keV (0.3 – 15 keV)	Strong gravity
Astrometry	1.5 arcsec at 3σ confidence	Black hole evolution
Absolute Timing	100 μsec	Compact Objects



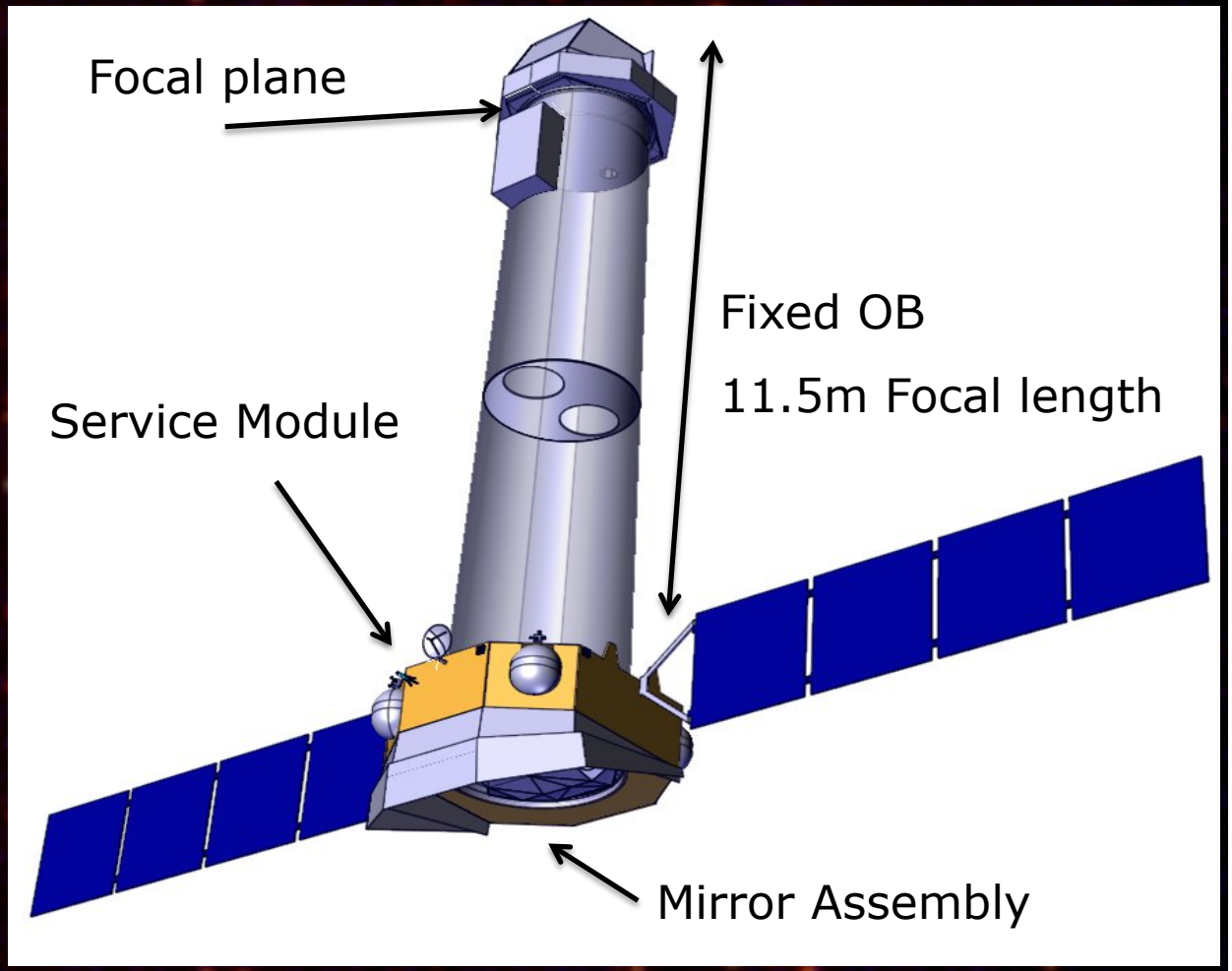


Athena Implementation

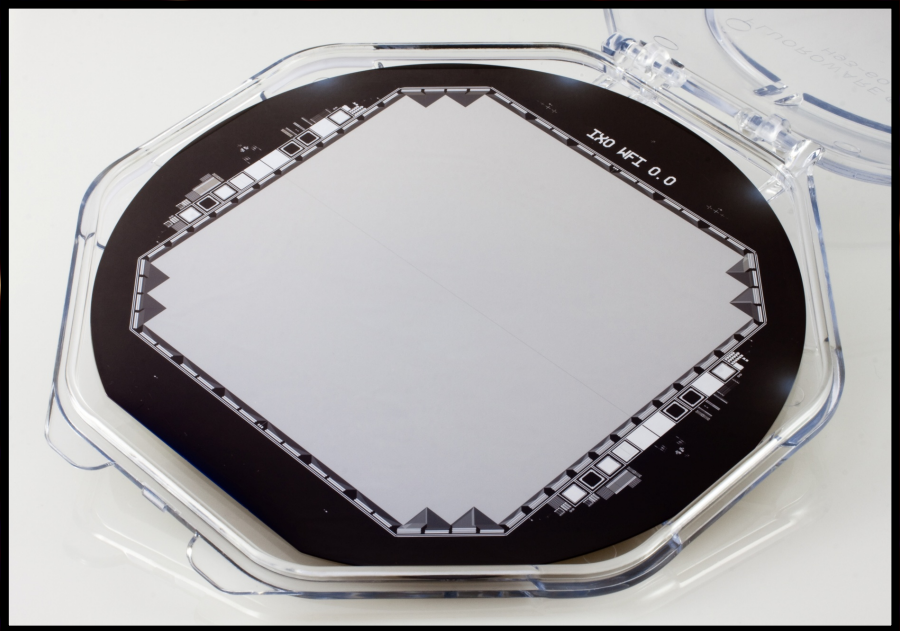


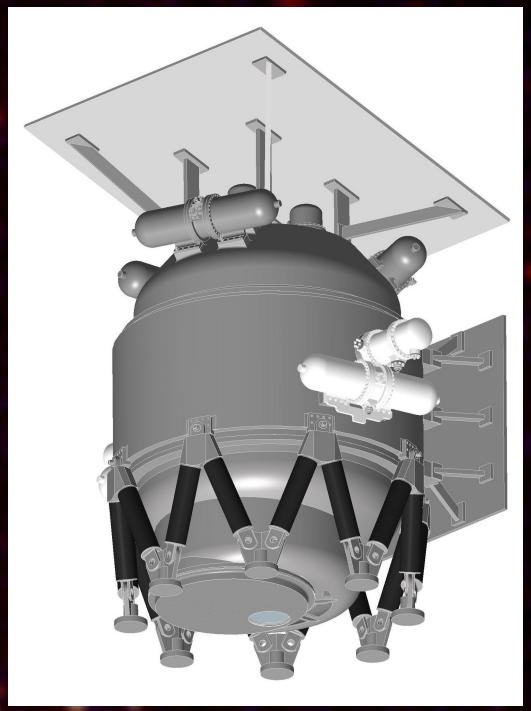
ESA Silicon Pore Optics
"OWL" design
5-10" resolution

Ariane V launch to L2
5yr nominal mission



Athena Instruments





Wide Field Imager (WFI)

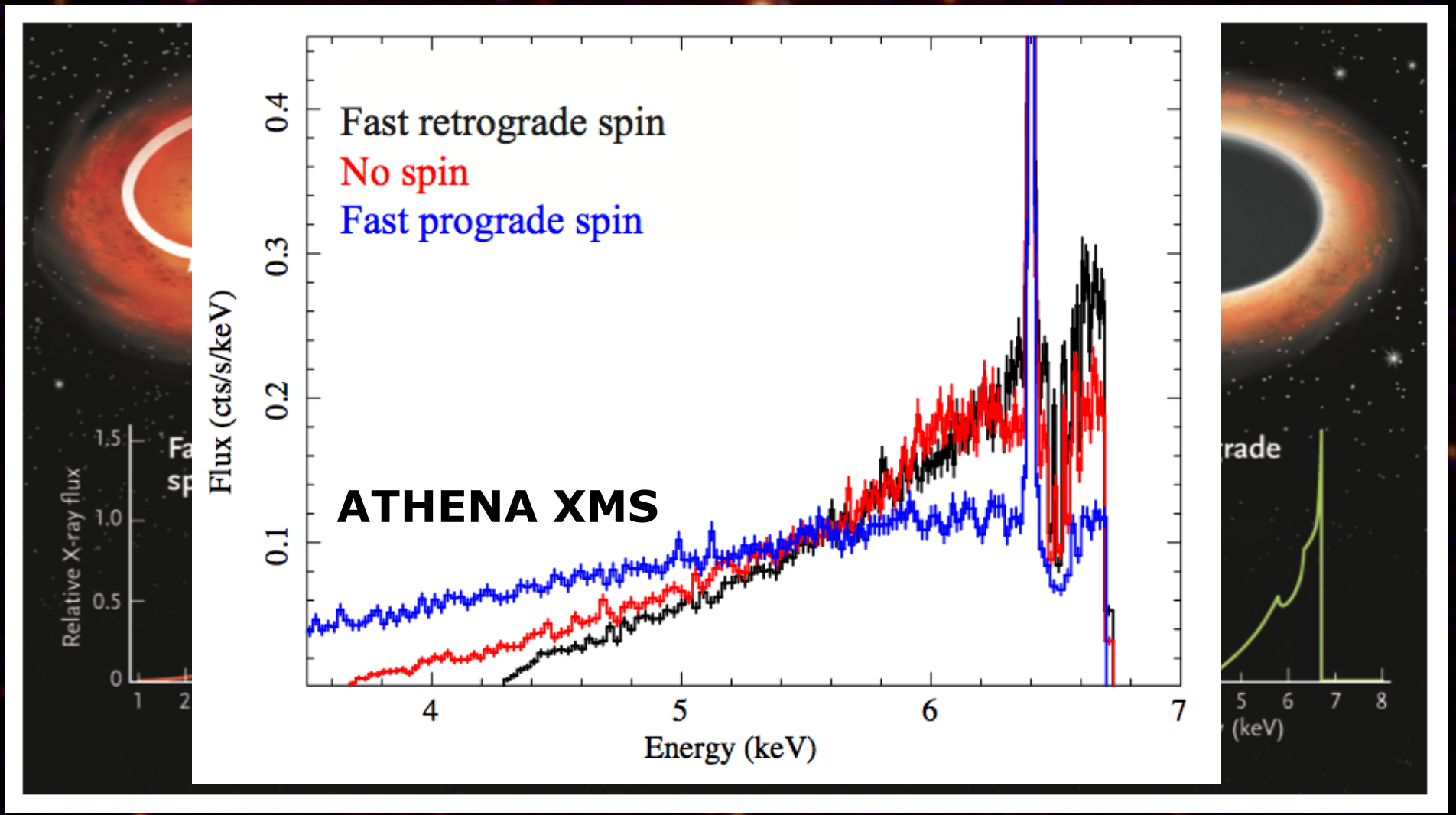
L. Strüder, MPE

Microcalorimeter (XMS)

J.-W. den Herder, SRON

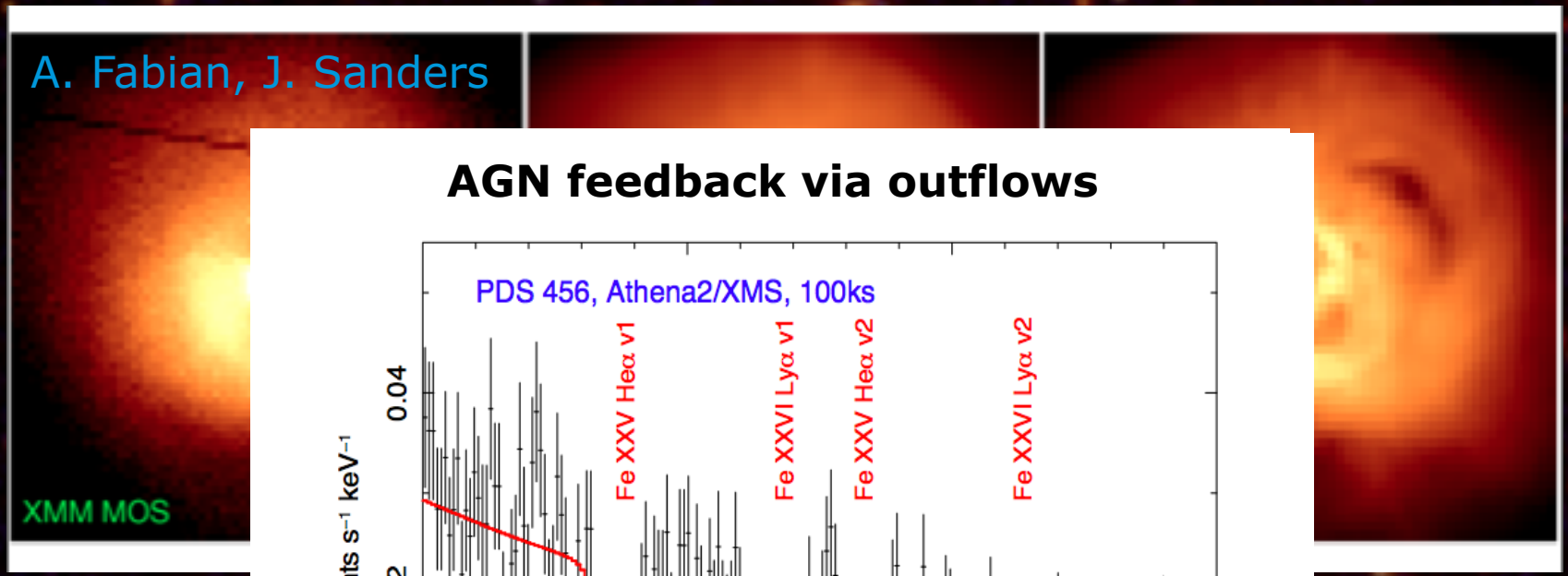
JAXA, NASA contributions

Black Holes and Accretion Physics

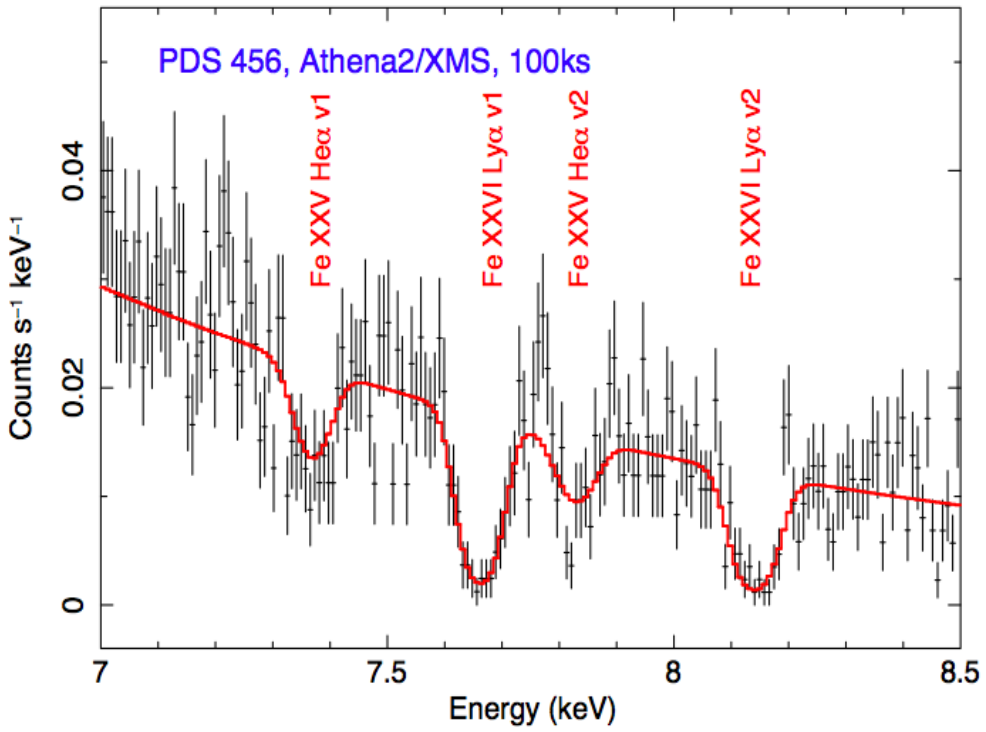


The Physics of Feedback

A. Fabian, J. Sanders

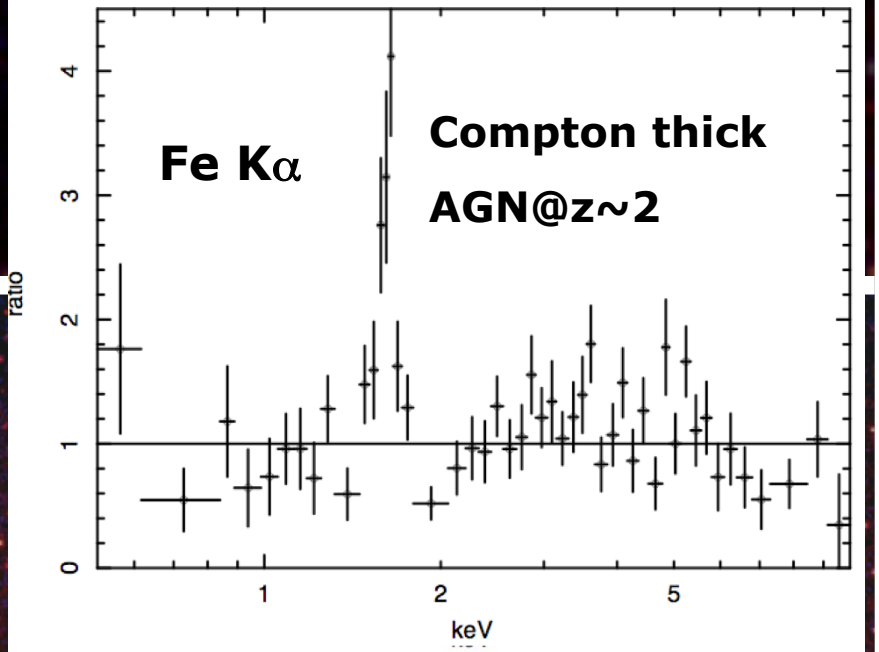


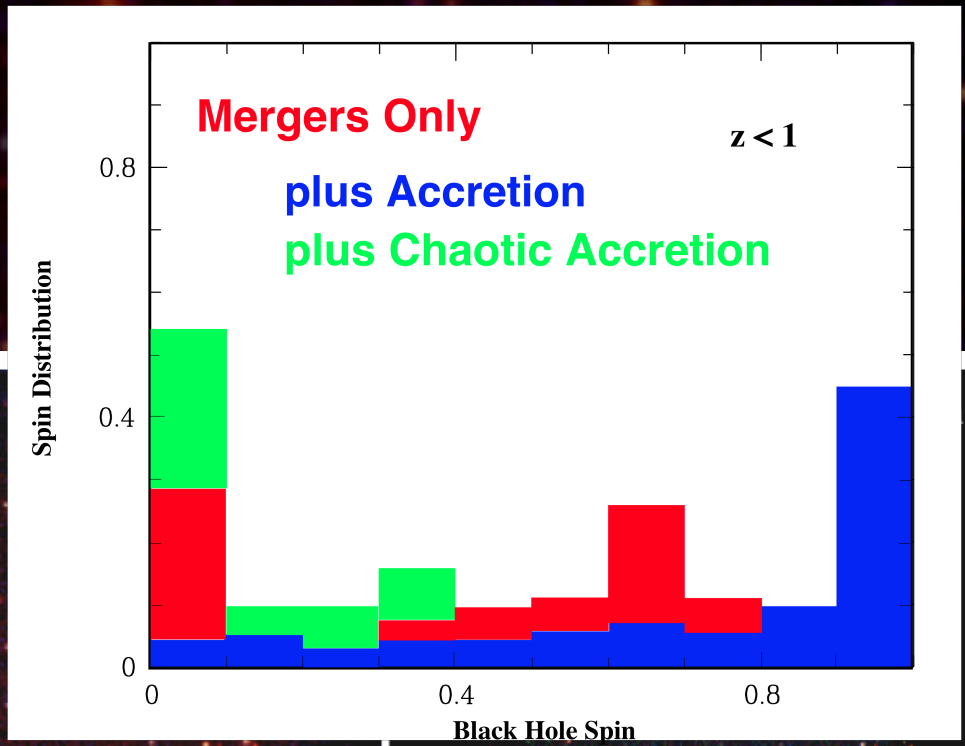
AGN feedback via outflows



Cosmic Evolution of SMBH

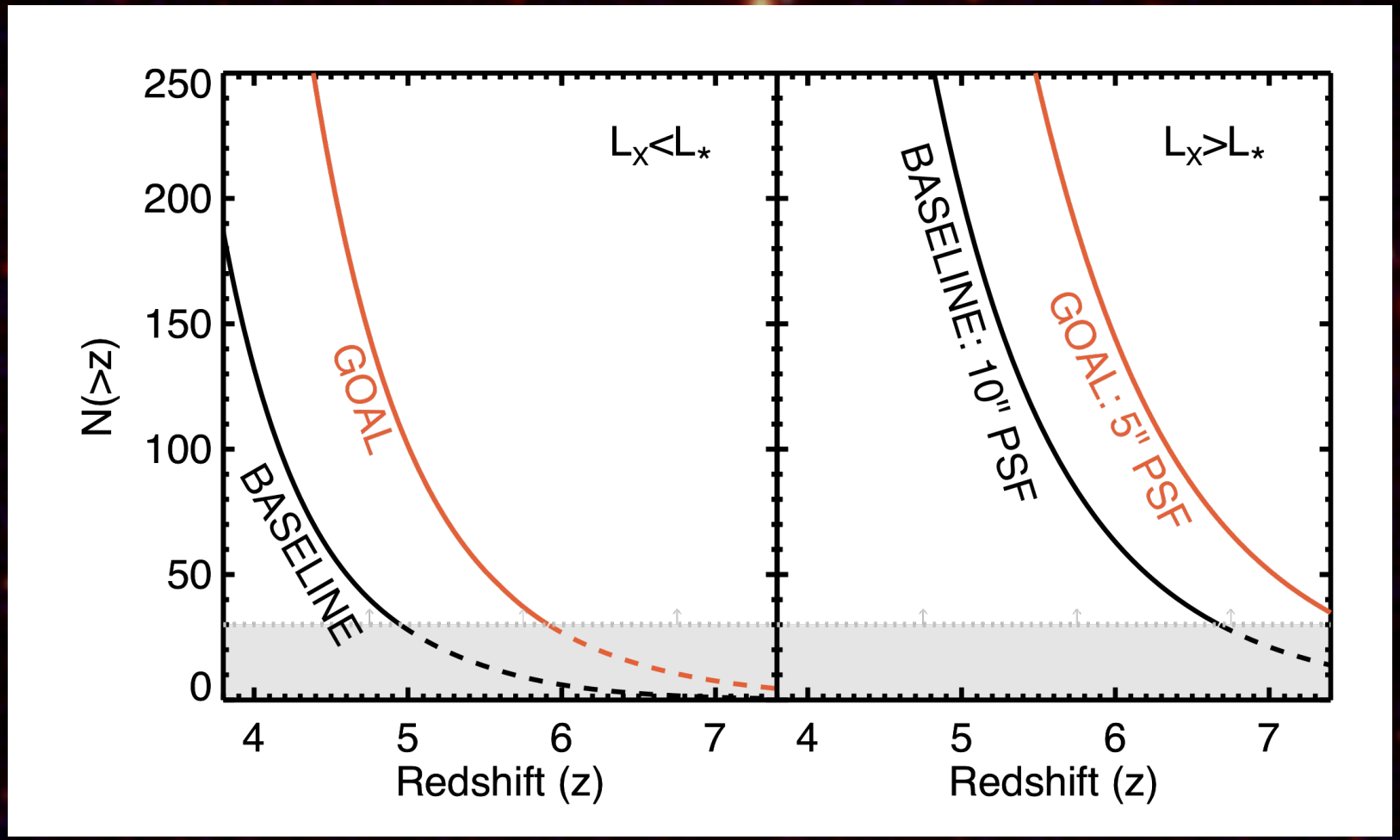
A. Comastri





AGN census at z>6? goal PSF (5") and max WFI FOV

Surveys: Athena and eROSITA



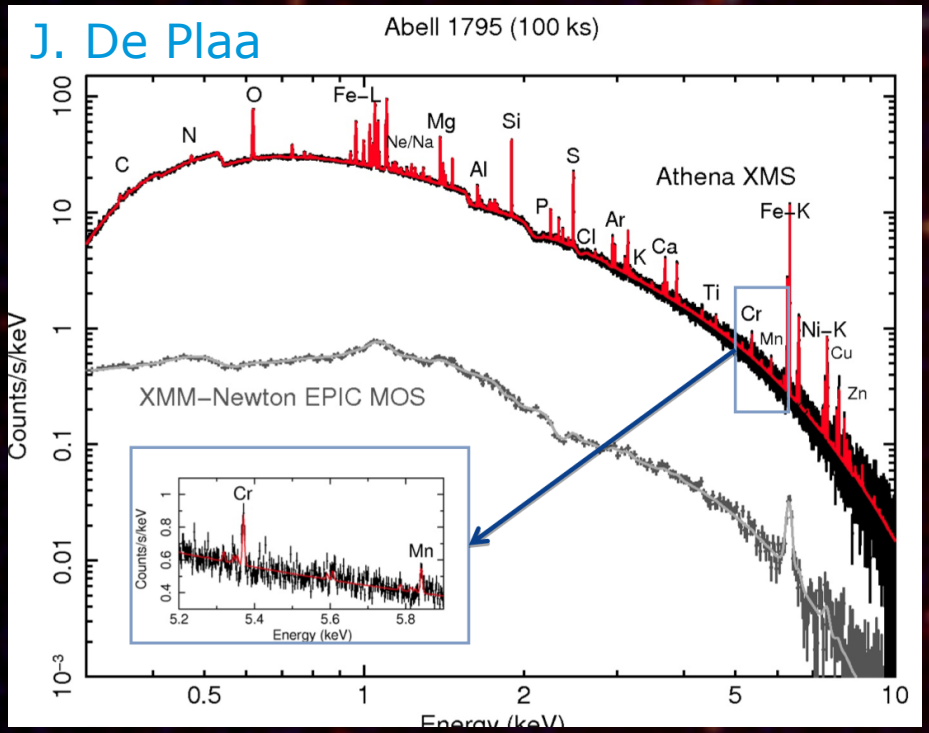
M. Brusa

J. Aird

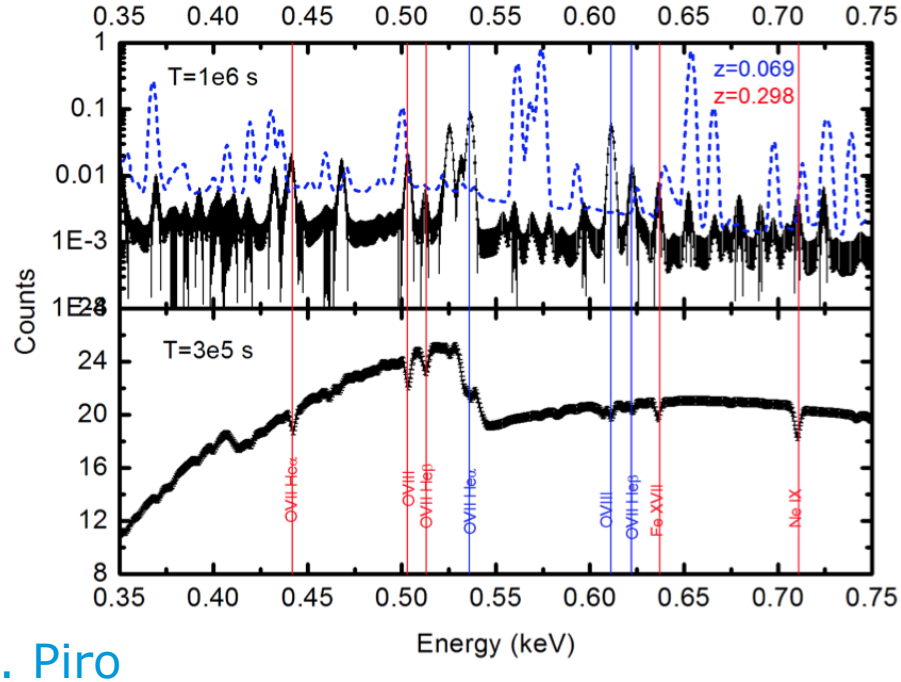
Large-Scale Structure

Clusters

J. De Plaa



Missing Baryons/WHIM



L. Piro

XMS: thermal, dynamical, chemical evolution of baryons, mass proxies
WFI: group, clusters census to $z>2$

➔ **COSMOLOGY**

Astrophysics of hot cosmic plasmas

Charge exchange in Solar System bodies:
planetary atmospheres, comets, etc.

Stellar evolution:

Young Stellar Objects

Cool stars

Massive stars, mass loss, magnetic fields, etc.

Supernovae and Supernova remnants

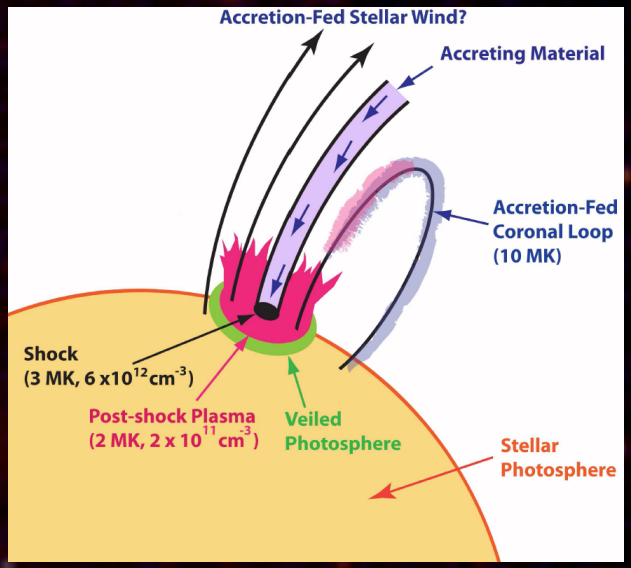
Winds and absorption studies in X-ray binaries

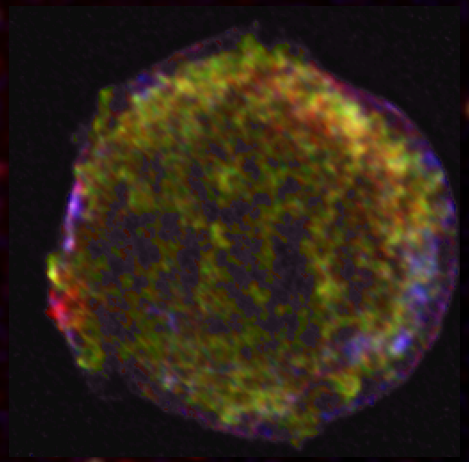
Cataclysmic variables

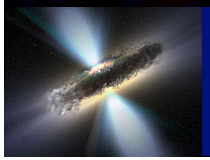
X-ray binary populations in external galaxies

The ISM of our galaxy

And many many more....







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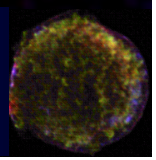
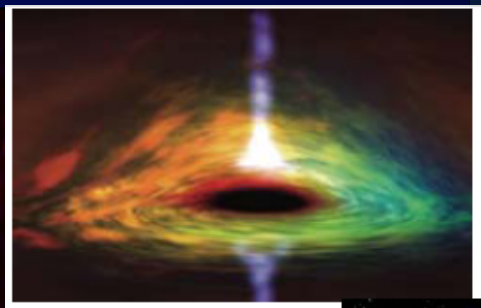
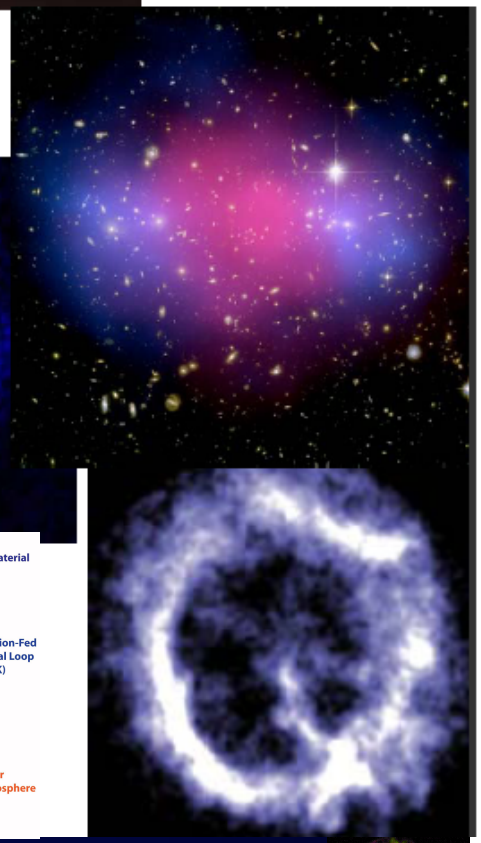
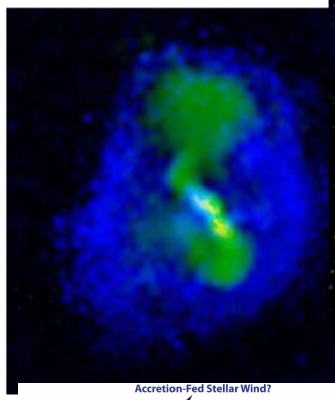


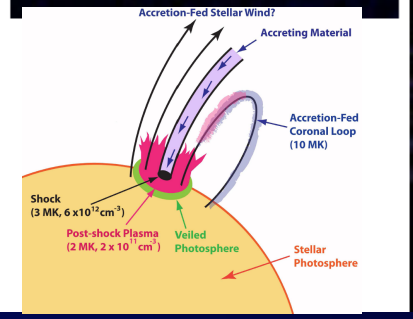
Athena: Summary

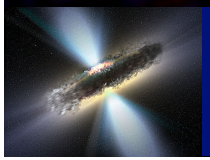
- Athena is ***the*** next generation facility-class X-ray observatory
- Will address key topics in astrophysics, but broad based
- Major opportunity for European leadership in X-ray astronomy
- Stiff Competition (LISA, Laplace)
- Community support essential
- February 2012: Decision time!











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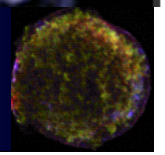
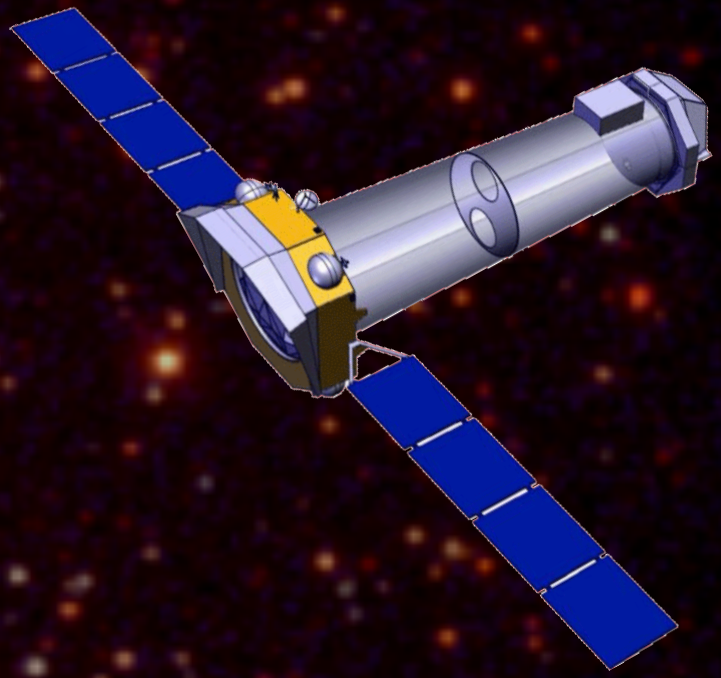


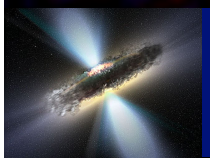
X-ray Astronomy Needs

YOU!



Sign up as an Athena supporter here:

https://lists.mpe.mpg.de/mailman/listinfo/athena-supporters



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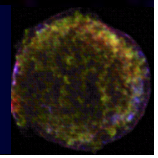

THE END

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