Transient sources : synergies with XMM-Newton & ATHENA

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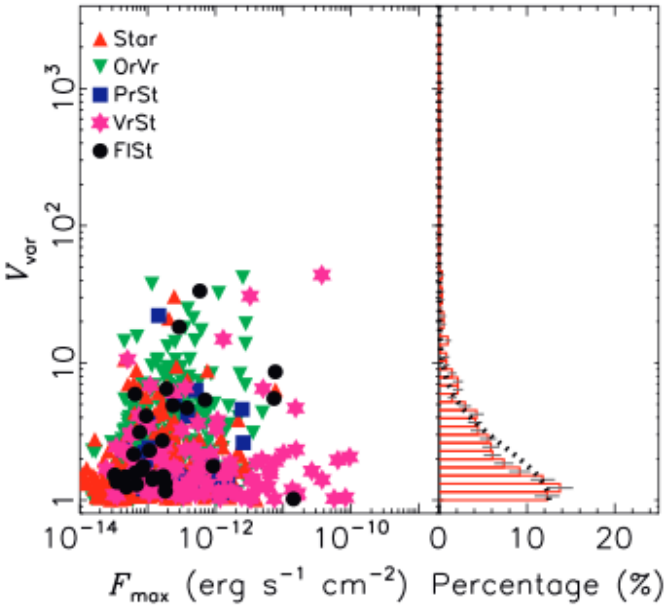
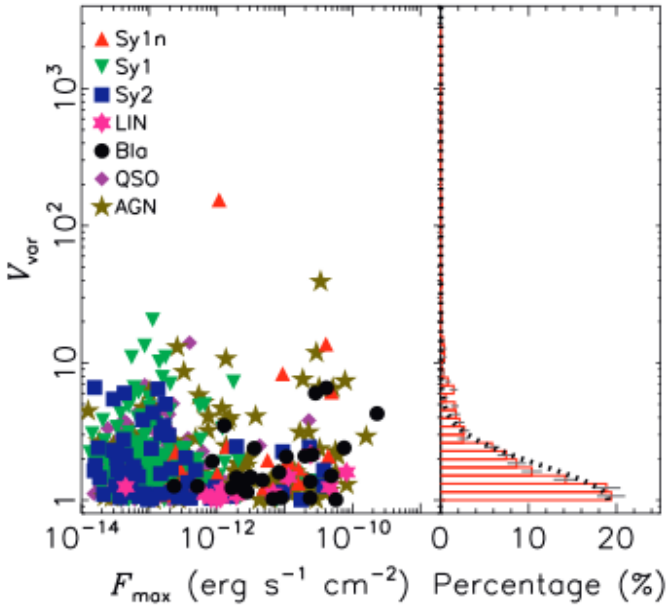
Variable sources

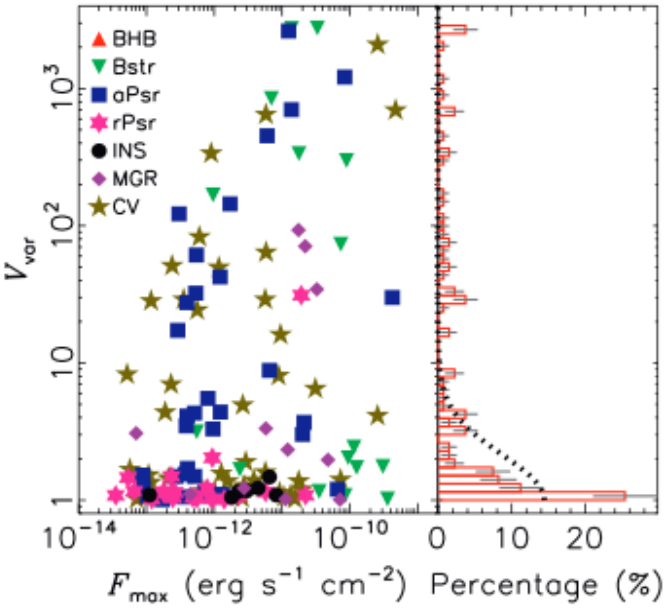
Investigation of 4330 point-like, good signal to noise sources with multiple pointings in 2XMM (Lin, Webb & Barret 2012)



(a) Stars



(b) AGN



(c) Compact objects

Variable sources are therefore a good way to identify compact objects

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Accreting compact objects

To date only small populations of accreting white dwarfs (CVs), neutron stars and black holes (X-ray binaries) known

Sub populations of CVs and X-ray binaries very diverse

Need to increase populations to understand nature and to use to :

- constrain initial mass functions
- understand the influence on the environment
- study accretion physics (disc structure, effects of B, viscosity)
- study particle acceleration
- constrain physics
  - neutron star equation of state
  - super-Eddington accretion
  - test relativity

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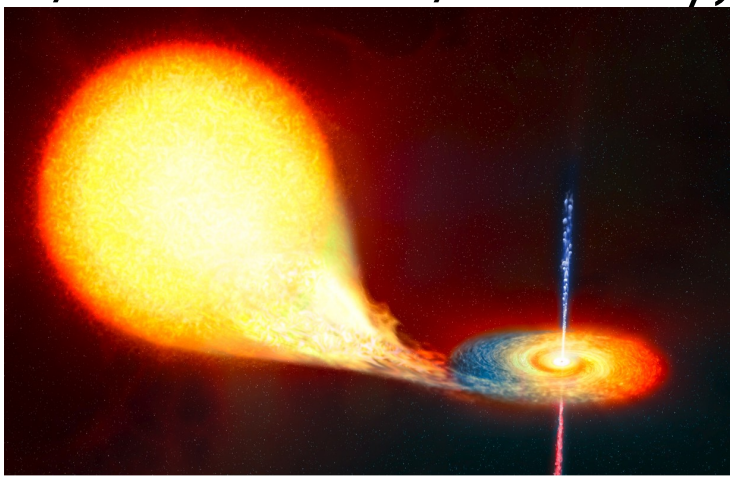
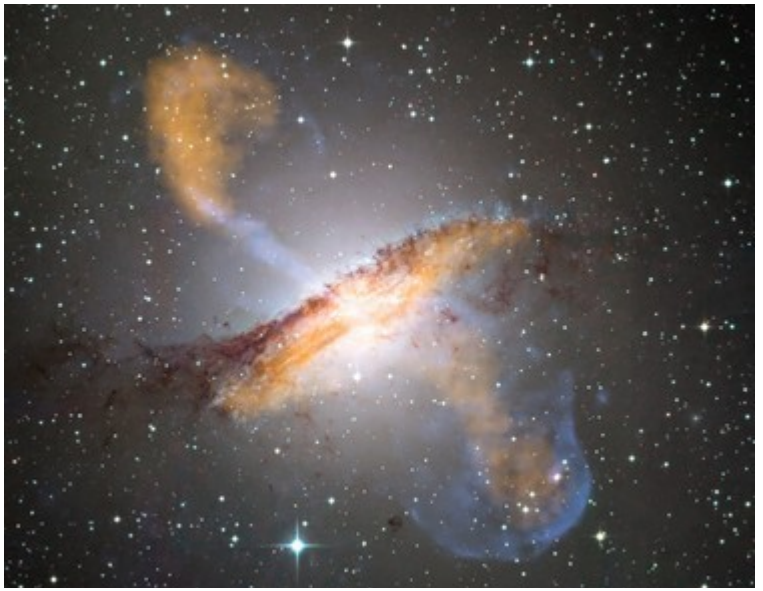
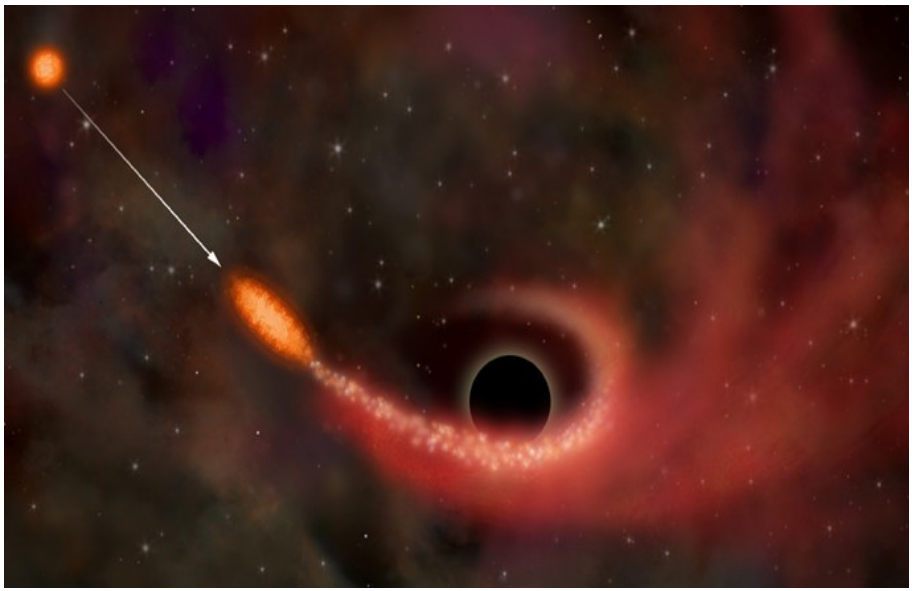


Accreting black holes

1) How do black holes grow and shape the Universe?

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





Tidal disruption events (TDEs, Rees '88)

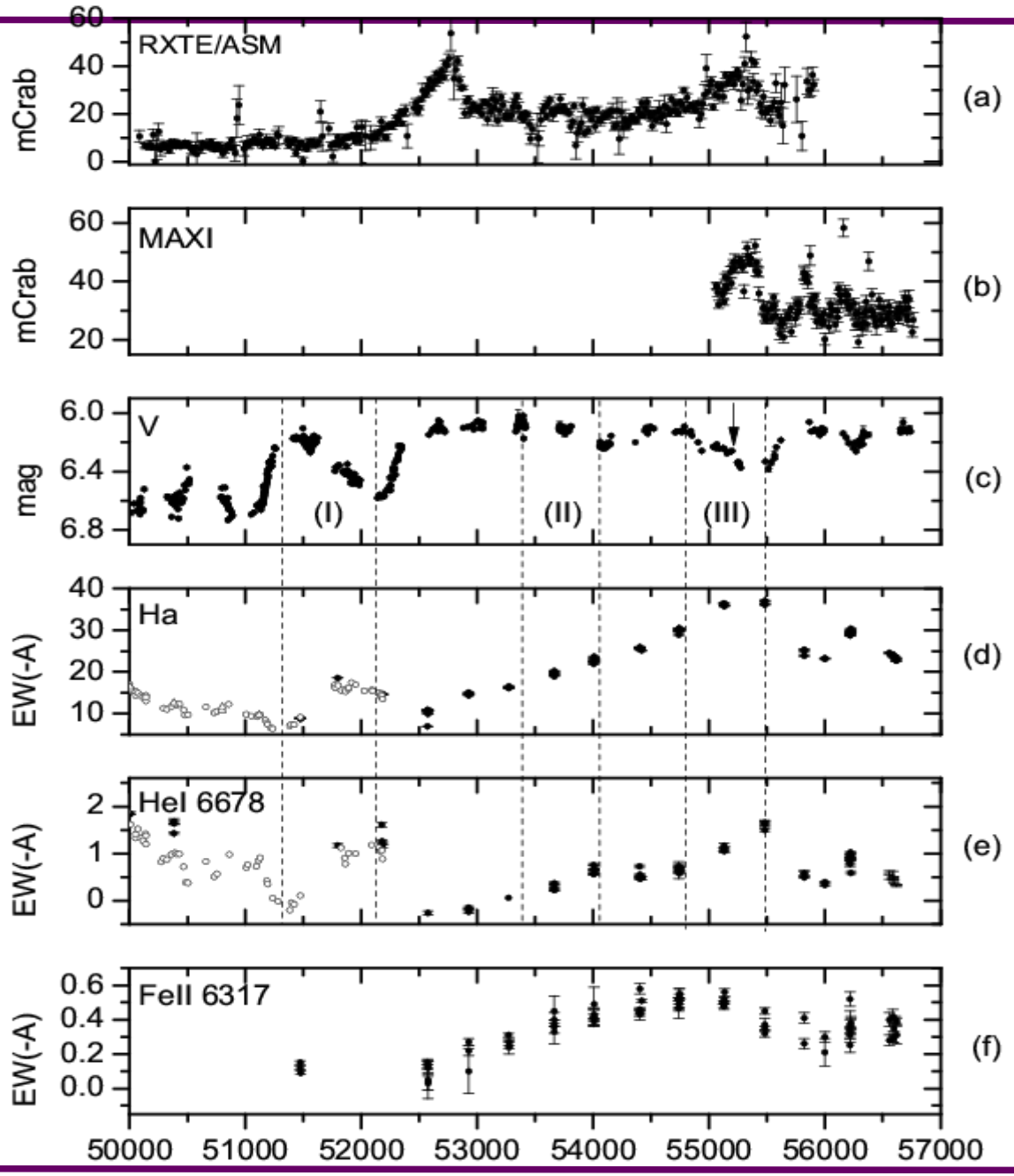
Tidal radius inside black hole event horizon for masses > 10^8 $M_\odot$

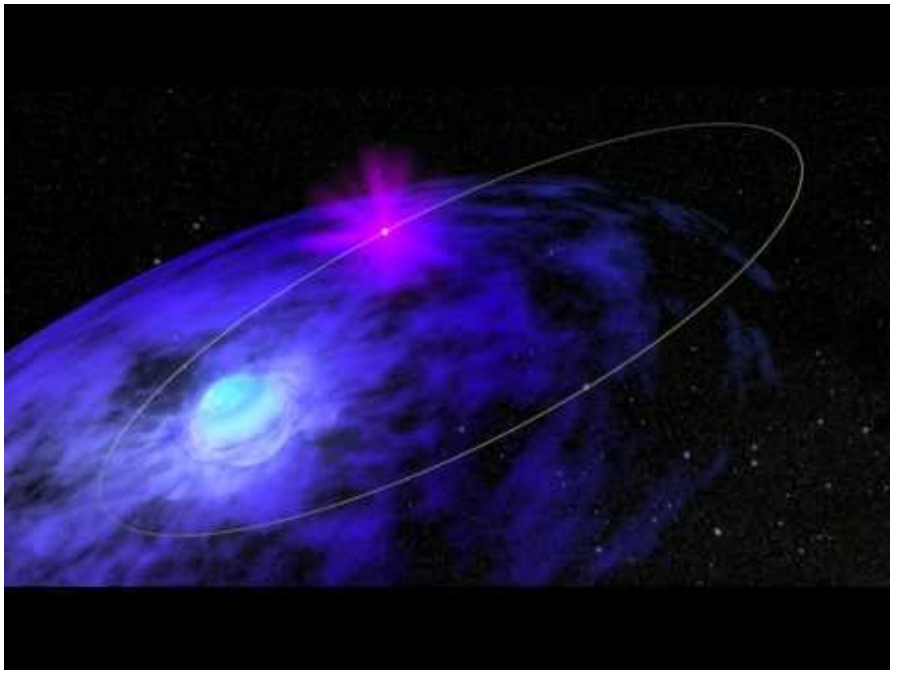
Observe TDE from lower mass BHs

~10^{-5} – 10^{-4} event/galaxy/year

~30 X-ray TDEs (Komossa 2015)

Accreting black holes





Li, Hui et al. (2013)
Variability of the Be X-ray binary, X Per

XMM-Newton

XMM-Newton Survey Science Centre (SSC)

The XMM-Newton Survey Science Centre was selected by ESA to ensure that the scientific community can exploit XMM-Newton data

Responsibilities :

Development of science analysis system (SAS)

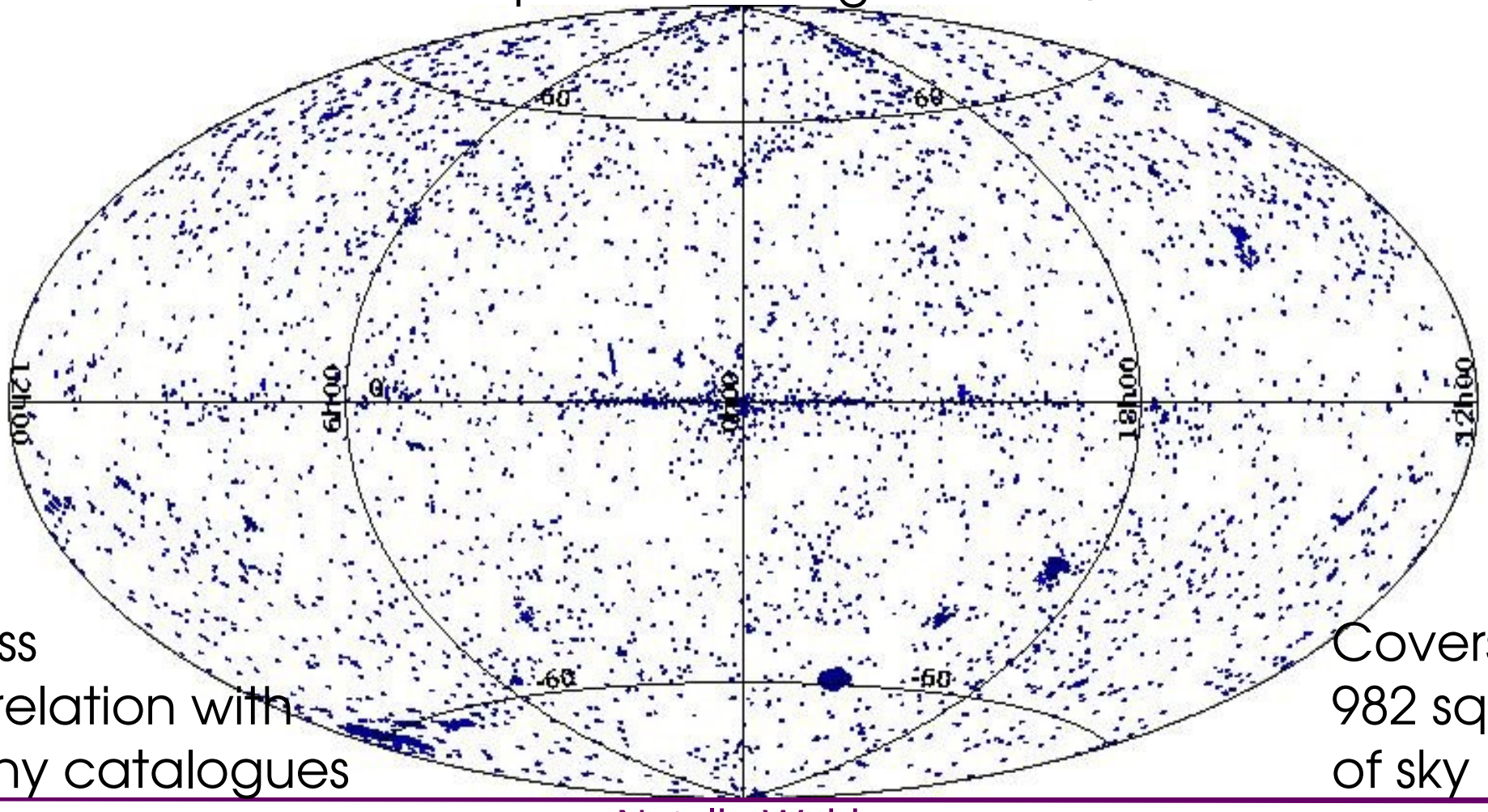
Pipeline processing of all XMM-Newton observations.

Follow-up/identification of the XMM-Newton serendipitous sky - the XID Programme

Compilation of the Serendipitous Source Catalogue.

3XMM-DR6

3 February 2000 – 4 June 2015
678680 detections, some sources up to 50 times
468440 unique sources
149968 detections with spectra and lightcurves, 5238 variable



Cross correlation with many catalogues

Covers 982 sq.deg of sky

The catalogue is excellent for :

- Quick access to data products (fluxes, spectra, images, etc)

- Finding new objects

- Population studies

- Cross correlation for multi-wavelength studies

Evolution of the XMM catalogue

3XMM-DR6

But : the lightcurves are heavily binned

Binning on the frametime (>73.4 ms) and searching frame by frame at different energies should reveal many variable sources

Also searching automatically as the data reaches the ground will allow us to better follow-up serendipitous supernovae, tidal disruption events, interacting binary outbursts etc

Such a quick turn around could also help in following up LSST alerts

Work has started to produce the software which can then be integrated into the pipeline

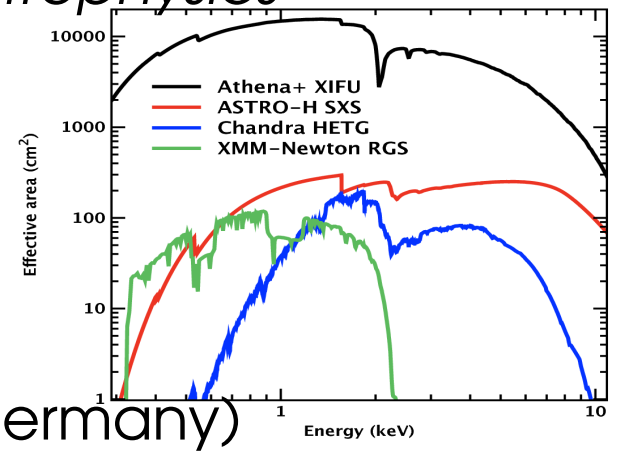
Combining optical and X-ray data will help us understand the nature and distance of the transient objects detected

ATHENA

ATHENA : *Advanced Telescope for High ENergy Astrophysics*

Launch 2028, lifetime 5+5 years

2m² of mirror



Two instruments:

1) Wide Field Imager (WFI) – PI : K. Nandra (MPE, Germany)

2) X-ray Integral Field Unit (X-IFU) – PI : D. Barret (IRAP, Toulouse, France)

ATHENA-LSST synergies

1) How do black holes grow and shape the Universe?

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

Athena will study the evolution of clusters and groups of galaxies from their formation epoch at z~2-3 to the present day.

Hot gas in clusters, groups and the IGM dominates the baryonic content of the local Universe, necessary to understand even if the framework for the growth of structure is set by the large scale dark matter distribution.

Hot baryon evolution is shaped by energy input – or *feedback* – from supermassive black holes. X-ray observations reveal mechanisms that launch winds close to black holes and help determine the coupling of the energy and matter. To do this Athena will study the first galaxies at z=6 -10.

Synergies with Athena

Cosmology
Galaxies and clusters
Stars
Planets
Transients (TDEs, orphan γ-ray bursts, supernovae, variable stars, merging compact objects, X-ray binaries, unknown unknowns!)
- a few dozen per year will be observed
- need to devise strategies/criteria to follow up most important

Discussions underway with SKA, CTA & ELT to study synergies

Multi-wavelength/multi-messenger astronomy is the future !

Summary

Wide range of rare objects already found in 3XMM catalogue

XMM-Newton may fly until 2028. With enhanced data analysis and complimentary multi-wavelength data, this provides the potential for many new discoveries

Access the catalogue at different sites from:
XMM-Newton SSC webpages :http://xmmssc.irap.omp.eu

Athena from 2028 will continue and extend the XMM-Newton work

Possibility to develop multi-wavelength strategies as of now !

http://www.the-athena-x-ray-observatory.eu/