The eROSITA/SRG All-Sky Survey

A new era of large-scale structure studies with AGN

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Abstract:

The 4 year X-ray all-sky survey (eRASS) of the eROSITA telescope aboard the Spektrum-Roentgen-Gamma (SRG) satellite will detect ~3 million active galactic nuclei (AGN) with a median redshift of z ~ 1 and typical luminosity of $L_{0.5\text{-}2.0keV} \sim 10^{44}$ erg s^{-1}. We show that this unprecedented AGN sample, complemented with redshift information, will supply us with outstanding opportunities for large-scale structure studies.

For the first time with a sample of X-ray selected AGN, it will become possible to perform detailed redshift- and luminosity-resolved studies of the clustering strength (alias linear bias factor), and to convincingly detected baryonic acoustic oscillations (BAOs). To exploit the full potential of the eRASS AGN sample, photometric and spectroscopic surveys of large areas and a sufficient depth will be needed.

State of the art & the potential of eRASS:

Large-scale structure (LSS) studies are an important tool in cosmology, and galaxy evolution research. The statistical significance of their results depend on the sky survey depth and sky coverage, which is used for such study. In X-rays, this significance has increased strongly in the last decade, due to the deep extragalactic sky surveys performed by XMM-Newton and Chandra (Brandt & Hasinger 2005; Cappelluti et al. 2012; Krumpe et al. 2013). The Table on the right shows main survey parameters for two representative LSS studies and expected survey parameters for the upcoming all-sky survey (eRASS) of the eROSITA telescope (see **Talk by P. Predehl on Th. 11:30,** and Predehl et al. 2010, Merloni et al. 2012, Kolodzig et al. 2013a). It demonstrates that LSS studies based on the eRASS AGN sample, complemented with redshift information, have the potential to outperform current LSS studies in X-rays by several orders of magnitude and shifting the analyzes from the statistically limited to the systemically limited regime. We show this potential in more detail with the following 2 quantities:

LSS study	# of AGN	Area [deg^2]	Depth
Krumpe et al. 2012	~3'500 ROSAT	~5'500	z < 0.5
Allevato et al. 2011	~600 COSMOS	~2	z ~ 1.0 (median)
eRASS sample	**~3·10^6 AGN**	**~34'000**	**z ~ 1.0 (median)** (40% of eRASS AGN: 1<z<2)

A) Clustering strength (linear bias factor)

This quantity is easy to measure and is an important parameter for understanding the AGN phase of the galaxy evolution.

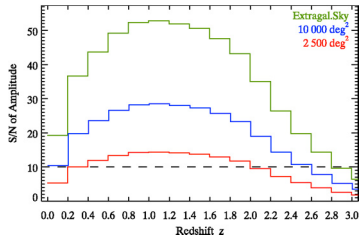

Fig. 1: *Expected signal-to-noise ratio (S/N) of the clustering strength (amplitude of the clustering power spectrum) of the eRASS AGN sample.*

Conclusions:

- high S/N (>10) for a wide redshift-range, even for *only* 2'500 deg^2
- possibility to split into luminosity groups → Fig. 2

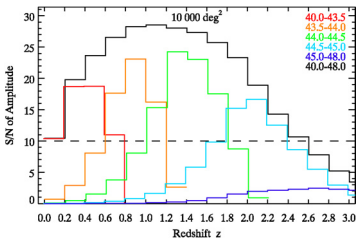

Fig. 2: *Same as Fig. 1, but for different luminosity groups.*

Conclusions:

- 1st time: accurate luminosity & redshift resolved studies of the clustering strength → study the mass of dark matter halos of AGN to unprecedented detail
- 1st time: statistical significant LSS studies for AGN with $L_X > 10^{44}$ erg/s → comparison with optical quasar-studies possible

Impact:

It will be a significant step forward in understanding major questions, such as:

- the nature of the AGN environment
- the main triggering mechanisms of AGN
- how supermassive black holes co-evolve with their dark matter halos over cosmic time

B) Baryonic acoustic oscillations (BAOs)

This quantity is difficult to measure but represents a powerful independent cosmological probe.

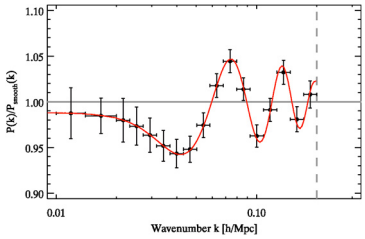

Fig. 3: *Expected BAO signal of the entire eRASS AGN sample in the clustering power spectrum*

Conclusions:

- 1st time: a convincing detection of BAOs with X-ray selected AGN
- ~11σ detection for the redshift region: 0.8 < z < 2.0, where BAOs have not been detected so far

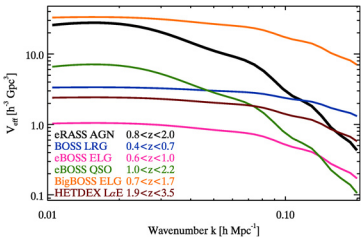

Fig. 4: *Effective volumes of dedicated optical BAO surveys and eRASS (The higher the value the better the statistical performance of the survey)*

Conclusion:

- the statistical performance of eRASS is comparable with dedicated optical BAO surveys (eRASS was never design for such a measurement)

Impact:

The detection of BAOs in the redshift region 0.8 < z < 2.0 with such high significance puts strong independent constrains on dark energy and will be a very significant milestone for the direct measurement of the kinematics of the Universe.

References:

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For further information, please see our paper **A&A, 558, 90 (ArXiv: 1305.0819)** *or contact me:* **alex@mpa-garching.mpg.de**