The Cosmological potential of distant clusters with Athena/WFI

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I. Detecting Clusters with Athena

Deep extragalactic surveys in X-rays are shown to be powerful tools to detect galaxy clusters and study their properties and evolution. We investigate the potential of the Athena/Wide Field Imager to deeply unveil the high-z universe (1<z<2), by inventoring the cluster population down to ~5x10^{13} h^{-1} M_{sol} . We consider 2 potential surveys sharing the same total Texp = 9Ms, and we aim at characterizing the detected cluster population and providing cosmological forecasts.

Survey A	Survey B
Depth 80ks Area 50 deg^2	Depth 20ks Area 200 deg^2

Work Hypothesis

- Sensitivity: WFI = 5 × XMM
- Background: 4.33e-6 cts/s/arcsec^2
- Fiducial Cosmology : Planck 2018
- Scaling relations:
  - M-T from Lieu et al, 2016
  - L-T from Adami et al, 2018
  - rc-R_{500} as in Pacaud et al, 2018
- Selection function: detection of clusters with a SNR>=5 inside a fixed-radius cell. The radius R_{opt} is optimised to maximize the number of cluster at high redshift. Fig 2 shows the corresponding selection function.

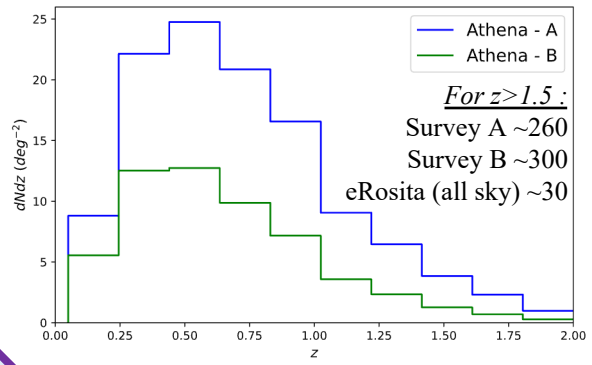

Figure 1: dndz for both surveys

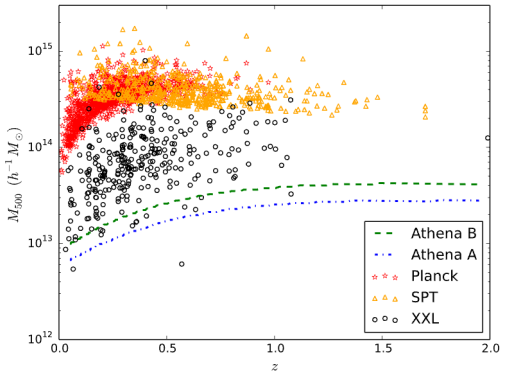

Figure 2: Mass limit of detection as a function of redshift

II. Cosmological Forecasts with Fisher Analysis

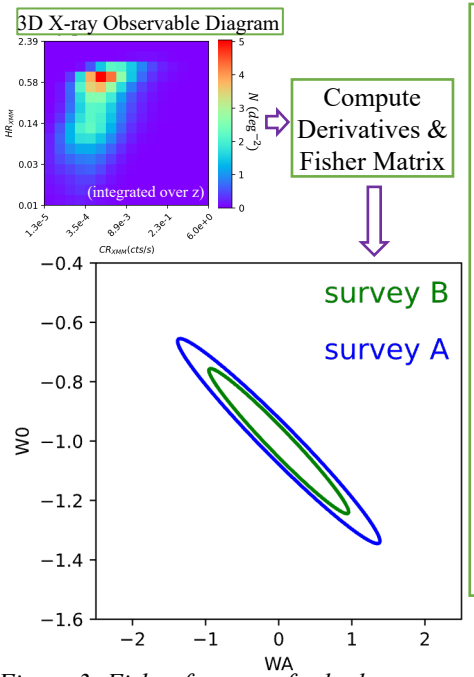

Figure 3: Fisher forecasts for both surveys

We use the ASPiX method (Clerc et al, 2012a) to represent the detected cluster population into 3D X-ray Observables Diagrams (z – CR – HR) and perform a Fisher analysis on this summary statistics. Driven by the numerous clusters detected in the regime z>1, we aim at providing forecasts on the DEoS parameters, w_0 and w_a.

- Free parameters: 7 cosmological + 6 physical
  $w_0, w_a, \Omega_m, \sigma_8, h, \Omega_b, n_s, L_0, \alpha_{LT}, \gamma_{LT}, M_0, \alpha_{MT}, \gamma_{MT}$
- Priors: Planck priors on h, Ω_b, n_s
  XXL priors: $L_0, \alpha_{LT} M_0, \alpha_{MT}$
- XODs resolution: 10x16x16, 0<z<2

Figure 3 compares the errors on w_0 and w_a, for the surveys A and B. The latter outperforms the former thanks to its larger sample size and Figure 5 shows the contribution of the z range [1 – 2] to the constraints. Lastly, we can compute eRosita forecasts, following the modelisation of Pillepich et al., 2018. Comparison with Athena is shown in Figure 4.

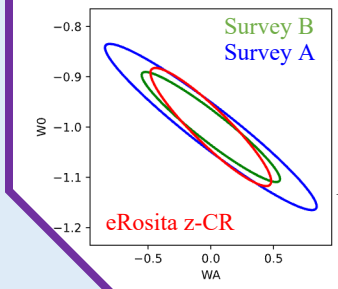

Figure 4: comparison between Athena and eRosita. The red ellipse reproduces the case of Pillepich et al.,2018. The ASPiX method with a similar modelisation (reduced priors on L-T, and M-T fixed) allows Survey B to yield comparable results.

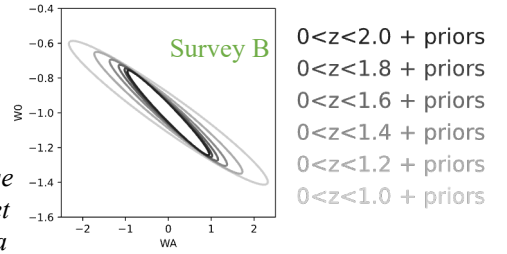

Figure 5: constraints on w0, wa for survey B as a function of z, marginalizing all other parameter. Discovering clusters at z>1 allows dividing by a factor >2 the error on wa.

References

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