AGN clustering in the XMM-ATLAS survey

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Overview

XMM-ATLAS

- Motivation-summary of XMM-ATLAS survey scientific goals
- XMM-ATLAS survey details

Angular **Clustering of XMM-ATLAS AGN**

- 2-8keV XMM-ATLAS AGN selection
- n(z) of the XMM-ATLAS AGN via x-correlations
- XMM-ATLAS AGN 2-D and 3-D information

- Summary – Future approach

ASTRO Park

Dude what's happening with AGN?

$%$£"!£
AGN
2312%£$%£$
BH
~~####%^&%
Host
£$%£$£$

XMM-ATLAS
Motivation

X-ray luminosity – SFR relation

If there is a relation between the growth of the black hole and the star-formation rate, as predicted in many evolutionary models, one would expect a correlation between the X-ray and infrared luminosities, as probes of the two processes.

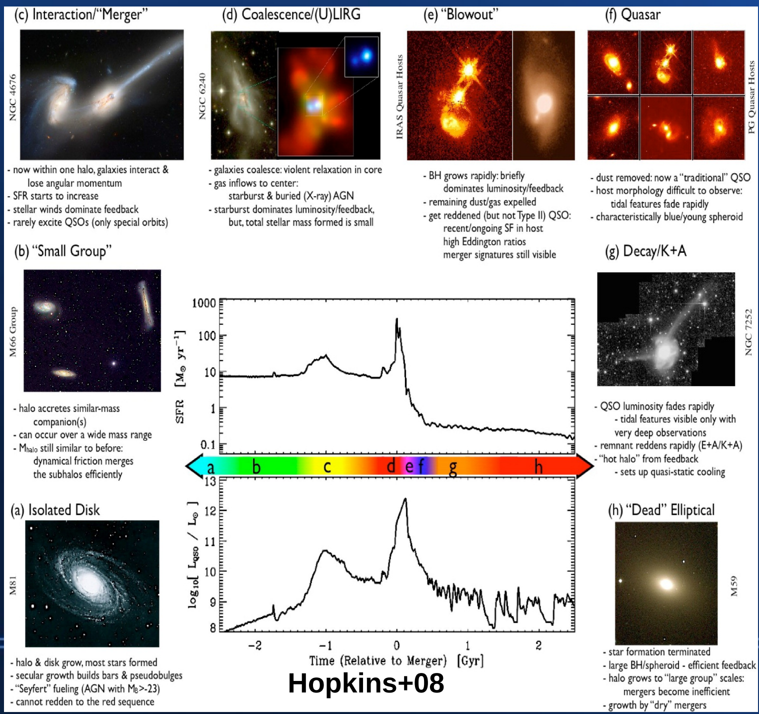
Shao+10, Mullaney+12 have no evidence for such relation.
Lutz+10 argue in favour of two paths of evolution, secular at low AGN luminosities and merger-driven for high L_X.
Rovilos+12 confirms the evolutionary connection between the host and the AGN in the z>1 Universe.

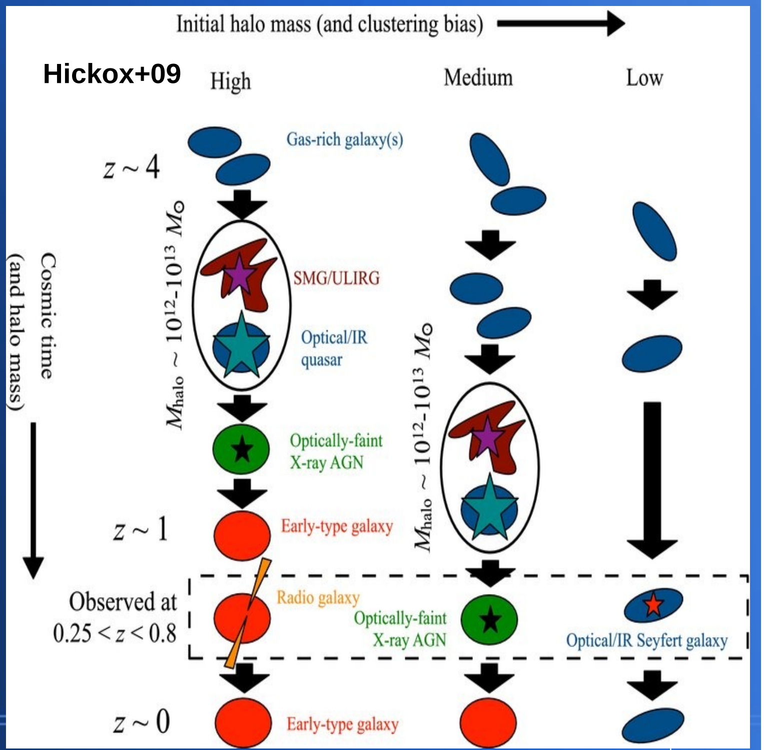
For lower-redshift cases the luminosity- redshift parameter space is scarcely populated, especially for z<0.5, owing to the narrow areas covered in pencil-beam surveys. Moreover, current wide-area studies of AGN hosts rely on optical identifications, tending to detect the most bolometrically luminous QSOs

Observations in XMM-ATLAS will increase the sample of intermediate-luminosity AGN observed both in X-rays and in the far-IR, allowing us to test popular models of AGN-host co-evolution.

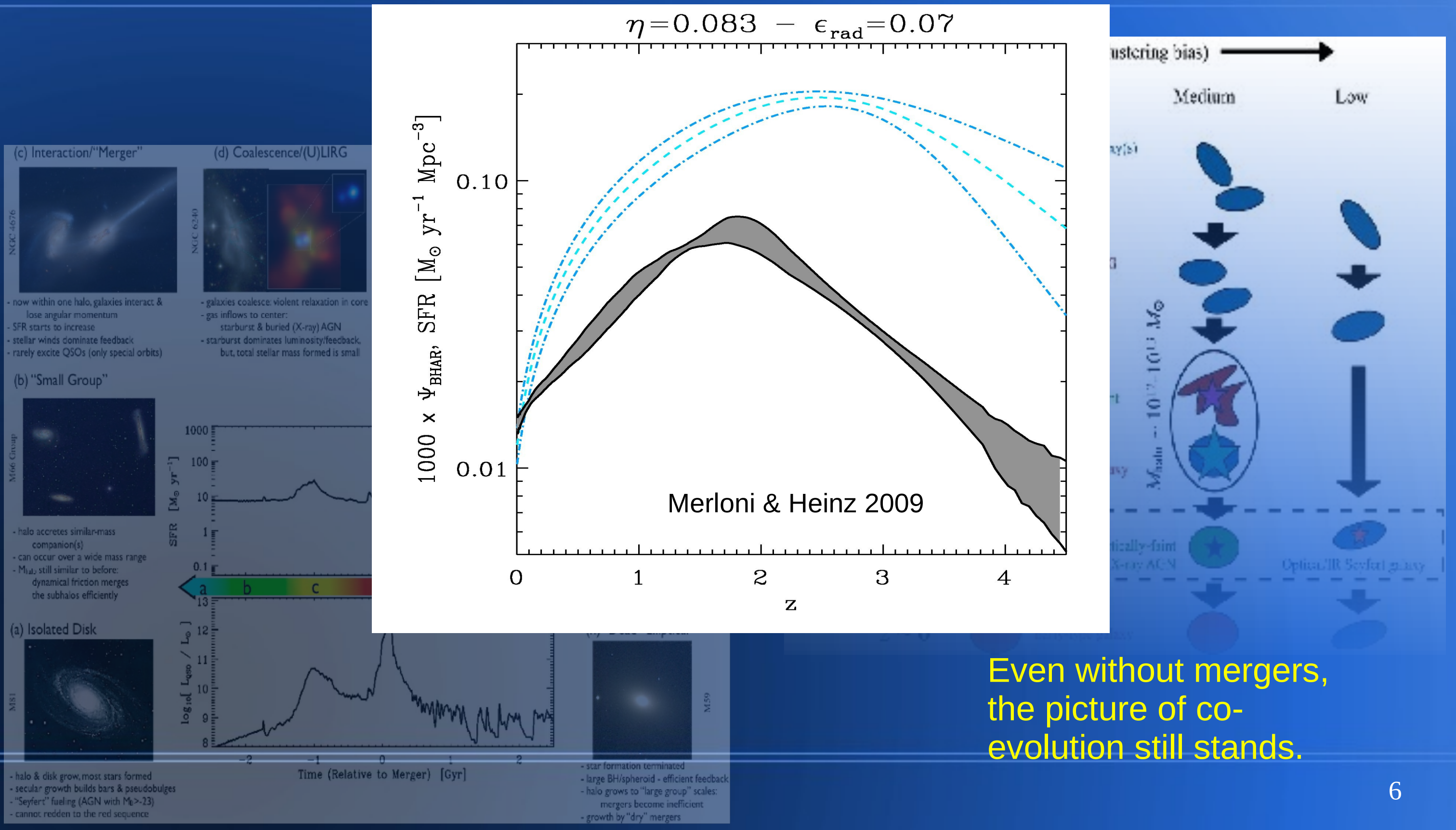
So far..

Co-evolution of AGN with hosts based on merger scenario is on the accepted move.





So far..



Even without mergers, the picture of co-evolution still stands.

XMM-ATLAS
Motivation

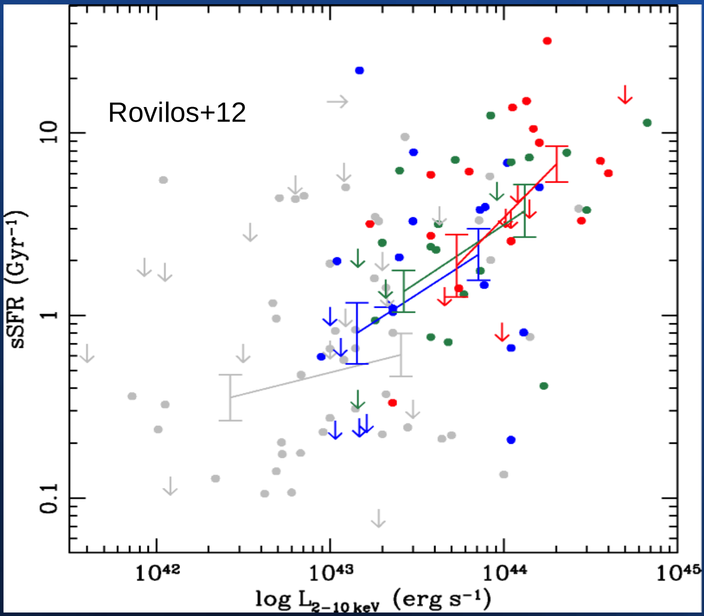
Investigation on the effect of very luminous AGN on their hosts.

According to recent observations of intermediate luminosity AGN at 1<z<3, they tend to reside in hosts with SFR rates similar to the non-active galaxies at their respective redshifts, indicating that there are no special host properties favouring the activation of the super-massive black hole.

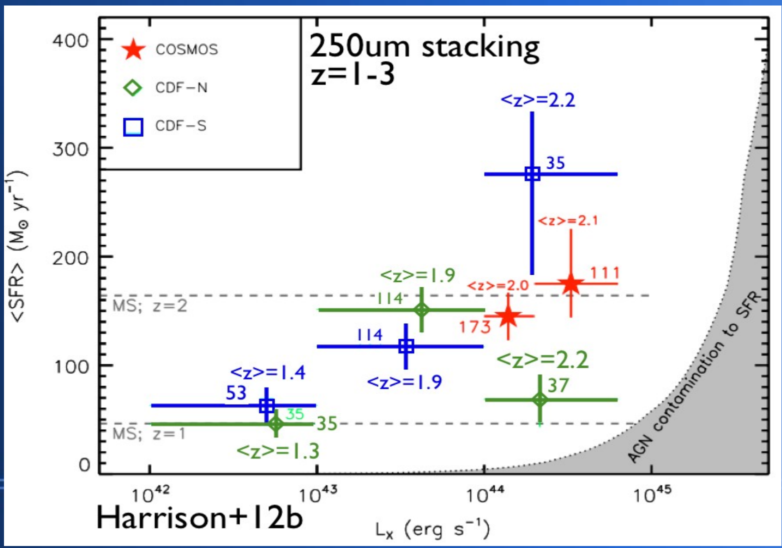
However, there is controversial evidence for the most active cases:

Rovilos+12
Page+12
Harrison+12

So far..



Puzzle is incomplete at low-z and high L_x



There is some evidence for dependence of the sSFR on L_x at high z, although there is no such evidence at low redshifts

XMM-ATLAS

Motivation

Investigation on the effect of very luminous AGN on their hosts.

According to recent observations of intermediate luminosity AGN at $z\approx1-3$, they tend to reside in hosts with SFR rates similar to the non-active galaxies at their respective redshifts, indicating that there are no special host properties favouring the activation of the super-massive black hole.

However, there is controversial evidence for the most active cases:

Rovilos+12
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A wide-area X-ray survey will provide a large number of $z=1-3$ luminous AGN, and in combination with excellent coverage in optical to far-infrared wavelengths will enable us to fit SEDs and derive their host properties.

XMM-ATLAS
Motivation

AGN environent at low-z

An important diagnostic of the evolution of AGN and their host galaxies comes from the large-scale environments in which AGN reside. A powerful way to constrain the environment is through the galaxy/AGN cross-correlation function
(e.g. Coil+2009).

Coil+09
Georgakakis+09
Hickox+09
} Find that AGN reside preferentially in group environments.

Of particular interest is the clustering dependence on X-ray luminosity as this can effectively differentiate between the main models for AGN fuelling: secular (i.e. Bower+08) vs. mergers (Hopkins+08)

Gal/AGN x-correlations to determine the AGN relative bias, then their absolute bias and consequently their dark matter halos.

So far...

There is no wide contiguous field with X-ray & far-IR in order to have an unbiased view of the AGN and host.

Fear of the Dark??

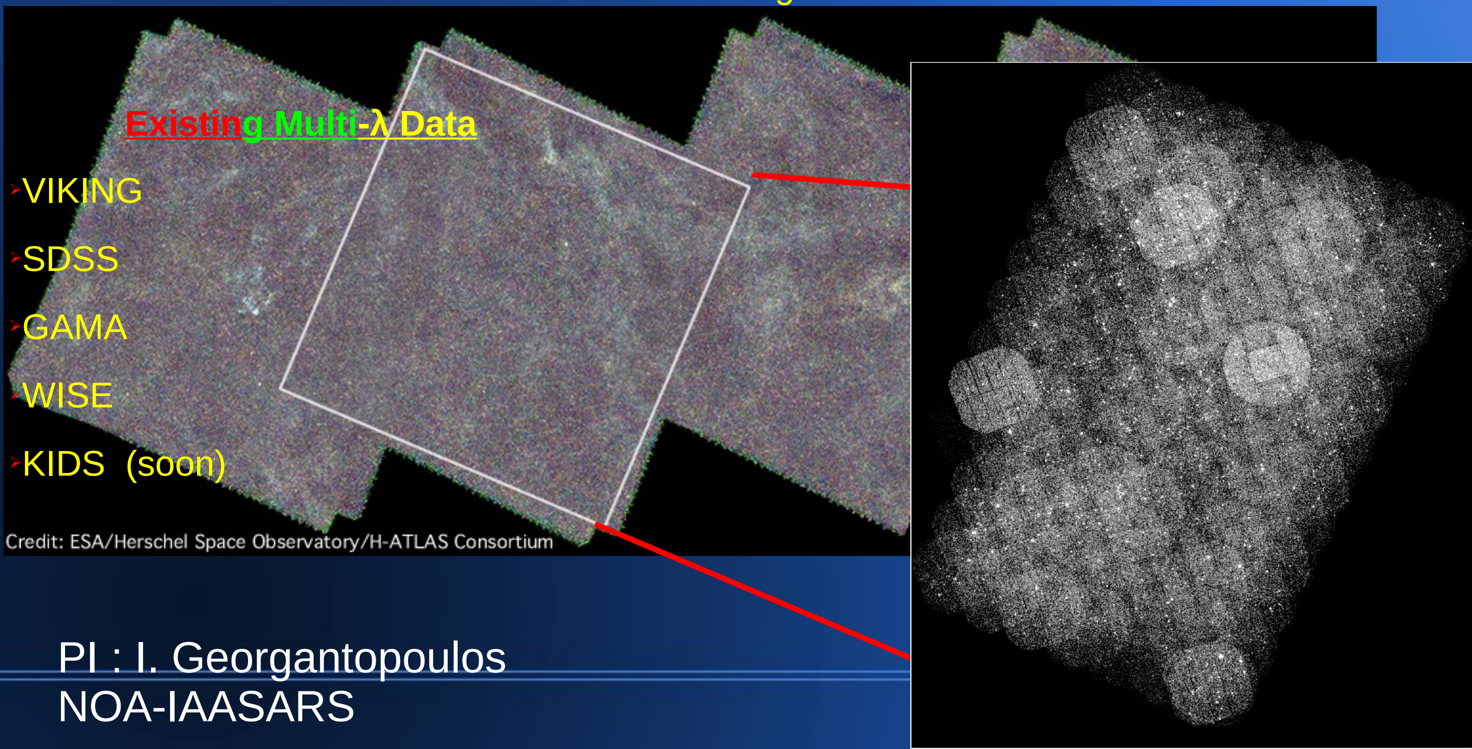
No fear ....

XMM-ATLAS Survey
Details

- 300Ks total exposure over 6 sq. degrees in Herschel Terahertz Large area survey
- XMM-Newton & Herschel SPIRE+PACS coverage

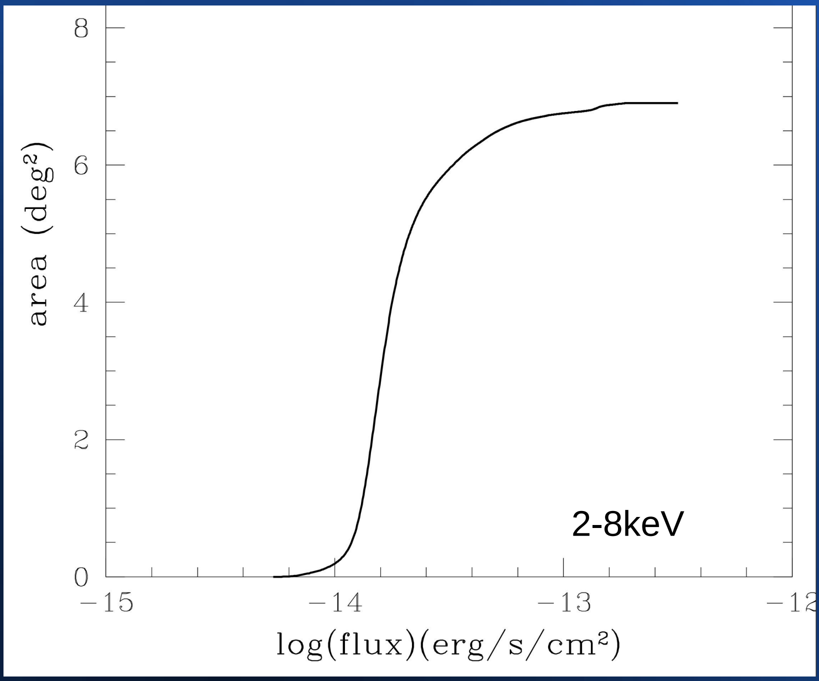
Existing Multi-λ Data

- VIKING
- SDSS
- GAMA
- WISE
- KIDS (soon)



PI : I. Georgantopoulos
NOA-IAASARS

XMM-ATLAS
2-8keV AGN selection



- 1831 AGN at 0.5-8 keV
- 1589 AGN at 0.5-2 keV
- 818 AGN at 2-8 kev

653 SDSS/VIKING counterparts for the 2-8 keV AGN

AGN Clustering

The X-ray selected AGN clustering and its dependence on luminosity can place strong constraints on the the AGN fueling modes, hence on the AGN-galaxy co-evolution models .

Numerous X-ray AGN angular studies in the past

Vikhlinin & Forman95; Akylas+00; Yang+03; Basilakos+04,05; Gandhi+06; Puccetti+06; Carrera+07; Miyaji+07; Plionis+08; Ebrero+09; Elyiv+12 etc

In all these studies the redshift distribution of the sources was an a priori demand, that could introduce further uncertainties in the results.

Clustering x-ray AGN studies adopting spectroscopic redshifts

Gilli+05; Yang+06; Gilli+09; Hickox+09; Coil+09; Krumpe+10; Cappelluti+10; Miyaji+11; Starikova+11; Allevato+11; Koutilidis+13 etc

Still there is no clear evidence towards the luminosity dependence of the clustering

Almost half of the studies are able to detect a strong correlation, while the rest do not present any strong/statistically accepted indication.

AGN Clustering

What is the key point between all clustering studies???

REDSHIFT

Free and cheap redshifts can be yours!!!

Recovering the n(z) of the XMM-ATLAS AGN

'Calibrating Redshfit Distributions Beyond Spectroscopic Limits With Cross-Correlations'
Newman 2008

$$\phi_p(z) = w(z)\frac{3-\gamma}{2\pi}\frac{d_A(z)^2 dl/dz}{H(\gamma) r_{0,sp}^{\gamma} r_{max}^{3-\gamma}}$$

Application on LSST, Euclid, eROSITA etc

$$w_{sp}(\theta, z) \sim \phi_p(z)\, r_{0,sp}^{\gamma_{sp}}$$

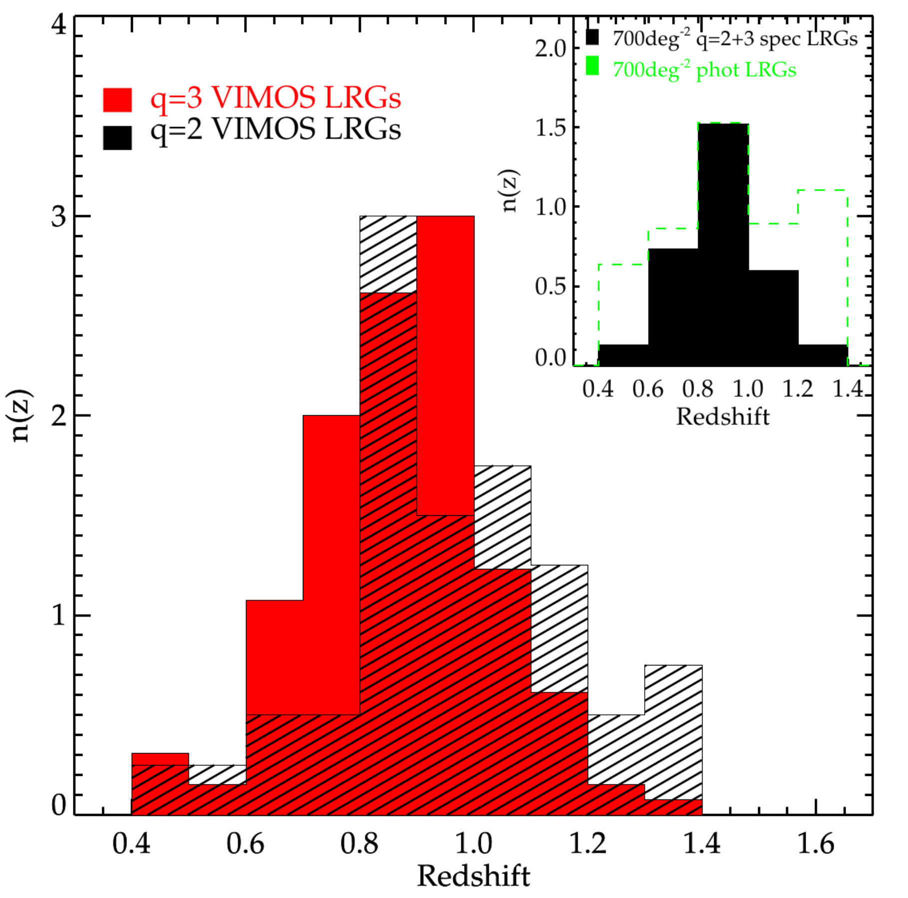
$$\xi_{sp} = (\xi_{ss}\xi_{pp})^{\frac{1}{2}}$$

Possibly systematics in Newman's method :

- Errors in assumed cosmology
- Bias evolution
- Errors from the spectroscopic auto-correlation
- Field-to-field zero points variations

Can affect more future photometric surveys that aim to constrain DE

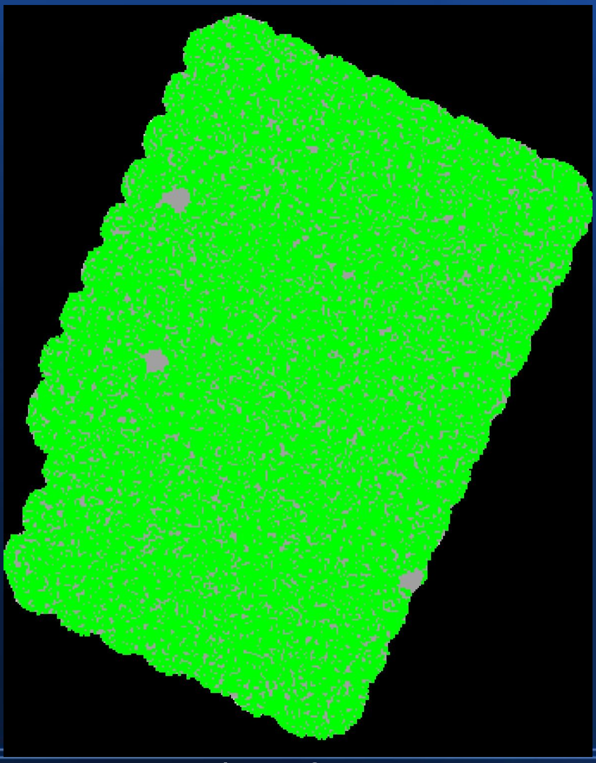
VLT/VIMOS P86 LRG spectra



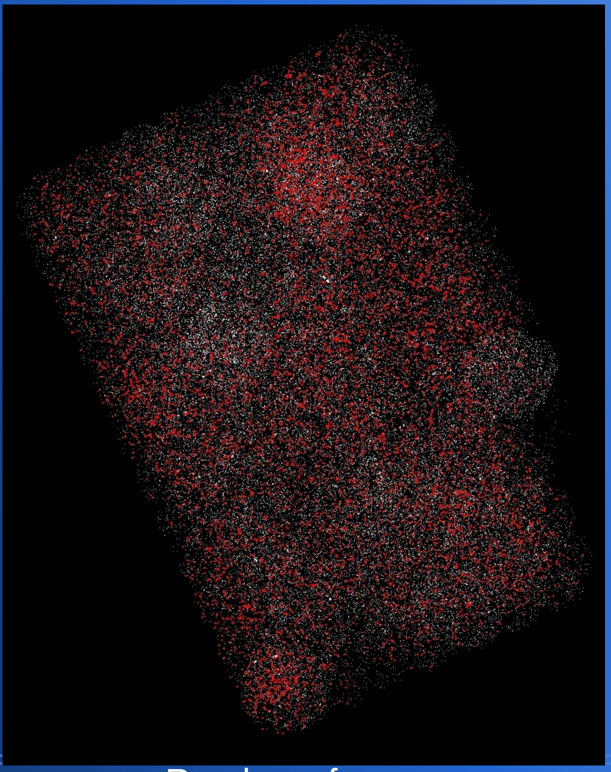
Nikoloudakis+13 was the first study ever that adopted Newman's method in real data, on Stripe 82 z~1 LRGs

Nikoloudakis & Shanks, in prep

Random catalogues
XMM-ATLAS

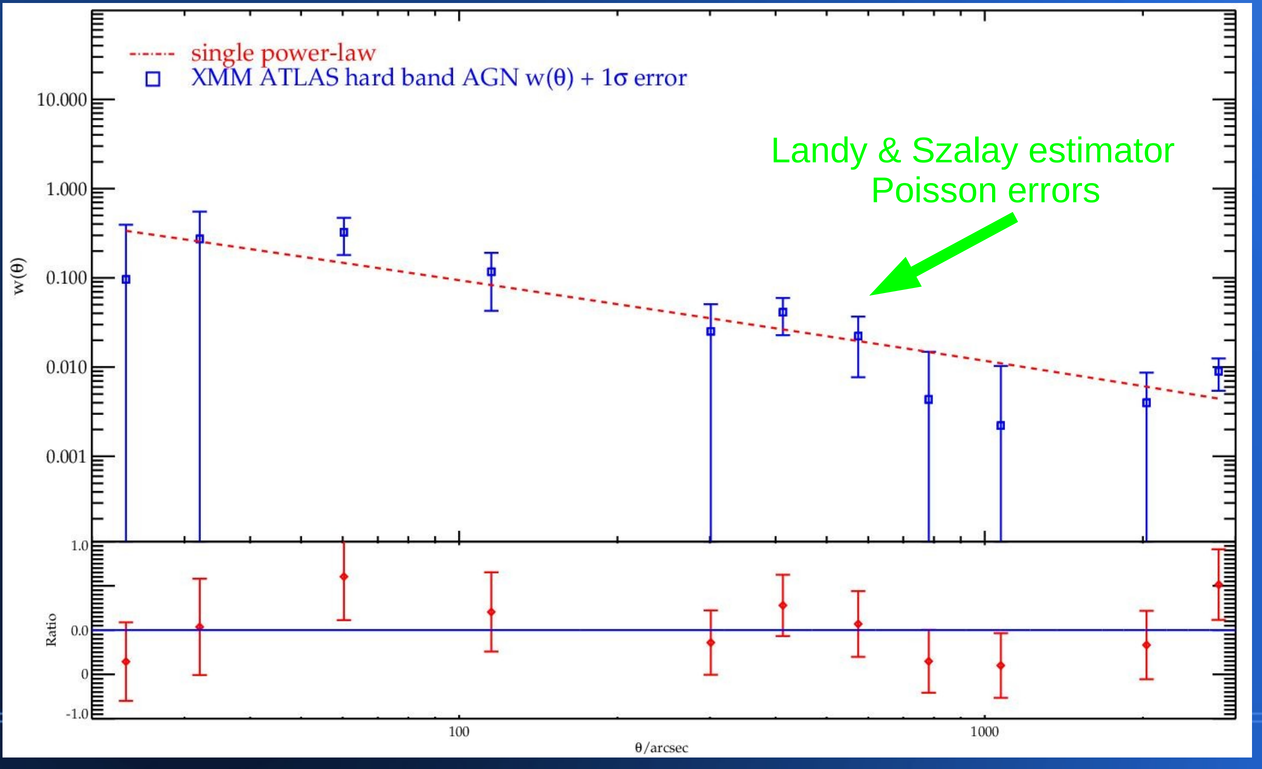


Randoms for
optical sources



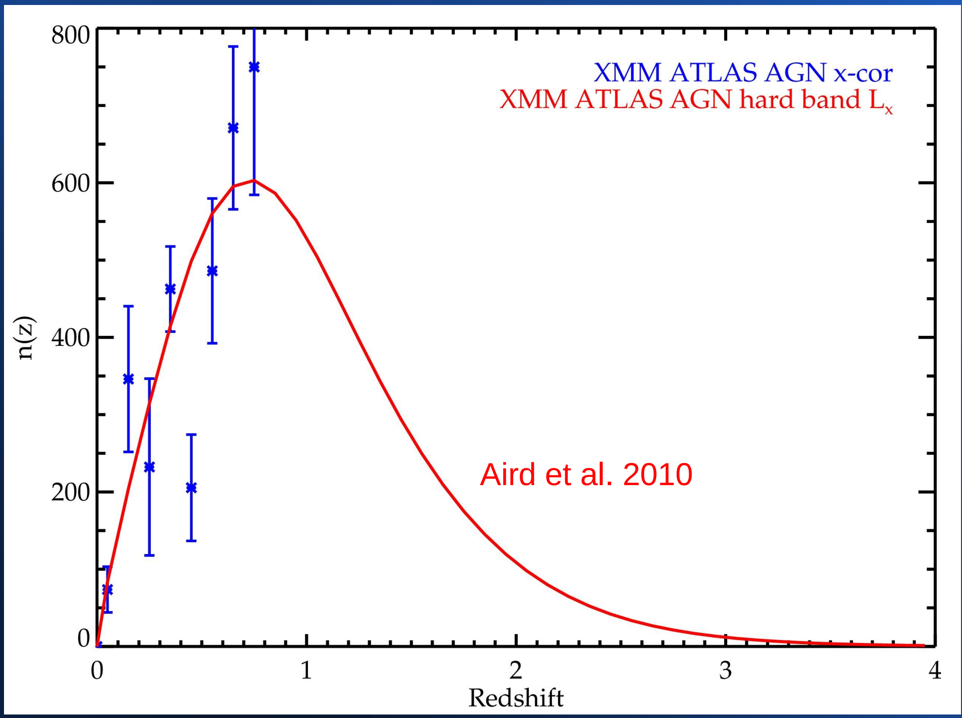
Randoms for
0.5-8keV AGN

w(θ) raw measurement

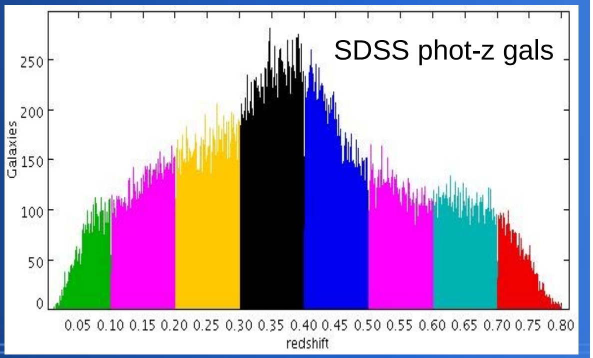


ATLAS AGN

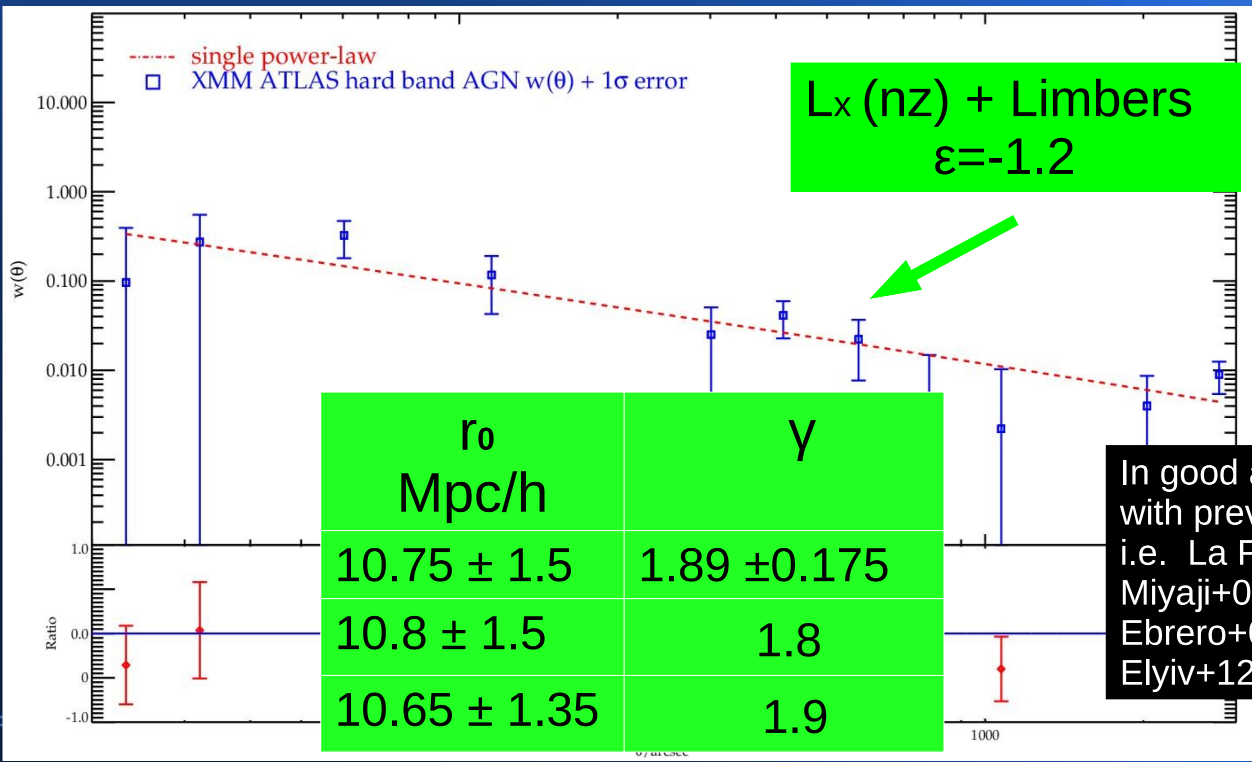
Newman + Hard band L_x n(z)



In the future, KIDS will provide sufficient deep coverage in XMM-ATLAS for accurate photometric redshifts that can used to better constrain the z>0.8 range.



w(θ) raw measurement & 3-D information



L_X (nz) + Limbers
ε=-1.2

r_0 Mpc/h	γ
10.75 ± 1.5	1.89 ±0.175
10.8 ± 1.5	1.8
10.65 ± 1.35	1.9

In good agreement with previous results : i.e. La Franca+05, Miyaji+07,Ueda+08, Ebrero+09,Gilli+09, Elyiv+12

Summary- Future approach

The XMM-ATLAS survey with its wide-contiguous area, with 300Ks XMM-Newton & Herschel SPIRE+PACS coverage, is a great opportunity to provide sufficient insights over:
i) the link between AGN and star-formation activity in the low-redshift Universe,
ii) the effect of very luminous AGN (with Lx>10^44 erg/s) on their hosts.

Clustering analysis for the hard band XMM-ATLAS AGN (818 sources/ 653 optical counterparts)

Newman's x-correlation technique for one more time is capable to reconstruct the observed n(z), establishing its efficiency for existing/upcoming surveys:
i.e. eROSITA + PanSTARRS/DES
The clustering strengths of the 0.5-8keV XMM-ATLAS AGN are in good agreement with previous findings.

see more about eROSITA's AGN clustering on Merloni & Kolodzig talks tomorrow

XMM-ATLAS AGN needed to be further studied, in order to derive the desirable quantities such as the clustering luminosity dependence, the large scale bias and its evolution, the dark matter of their host galaxies (i.e. via the HOD formalism, Miyaji+11)