The High-Redshift AGNs in COSMOS

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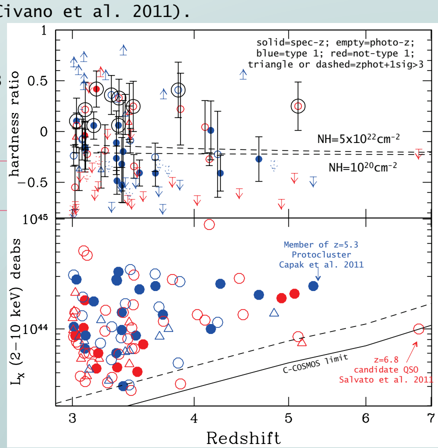
The z>3 Sample

The high-z AGN sample has been selected from the Chandra COSMOS X-ray catalog (Elvis et al. 2009), combining the spectroscopic and photometric information available from the identification catalog of the 1761 X-ray sources (Civano et al. 2011).

MAIN selection:
0.5-2 keV ➔ 2-10 keV at z>3
Obscured AGN selection:
2-10 keV band
0.5-10 keV band



X-ray Properties

To compare space density with model predictions, *obscuration*, which could diminish the observed X-ray luminosity, has to be taken into account.

To roughly estimate the obscuration affecting the sources and derive the *intrinsic luminosity*: hardness ratio (HR=(H-S)/(H+S), where H and S are the counts in the 2-7keV and 0.5-2keV bands, plus curves of constant NH (Γ=1.4) as function of z (top panel).

✓ 9 of the soft-band detected ➔ candidate to be obscured.
✓ 23 soft-band sources with no hard-band detection (upper limit) ➔ no obscuration but only faint below the hard-band flux limit.
✓ 9 hard-band only detected sources (lower limit) ➔ highly obscured $NH>5\times10^{23}$ cm^{-2} ➔ not visible at the soft band flux limit of C-COSMOS.

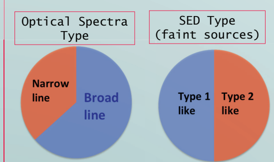
Number of Sources

z	Total			Spec-z			Phot-z			Phot-z*		
	S	H	F	S	H	F	S	H	F	S	H	F
>3	81	14	6	29	2	0	36	10	4	16	2	2
>4	14	1	1	6	0	0	7	1	0	1	0	1
>5	4	0	1	2	0	0	2	0	0	0	0	1

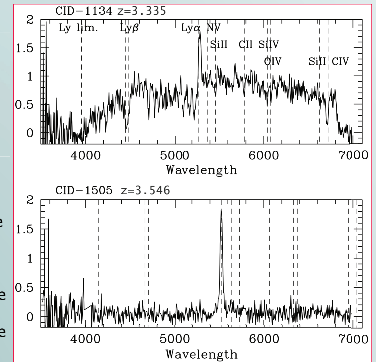
(S = 0.5-2 keV , H=2-10 keV, F=0.5 -10 keV)

The sample includes 101 sources with **spectroscopic** (31 sources; col.1) or **photometric** (50 sources; col.2) redshift >3 or $zphot+1\sigma_{zphot}>3$ (20 sources; col. 3).

Optical Properties



=>3 sources (as CID-1134) show spectra typical of normal star-forming galaxies with a narrow Lyα and all the stellar absorption lines (labeled in the Figure).
○No hint of CIV line in emission, a typical signature for nuclear activity.
○No spectra of this kind were found in the brighter z>3 XMM-COSMOS sample.

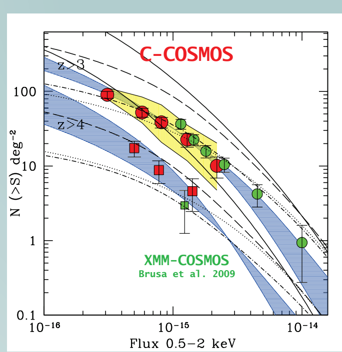


○The highest-z narrow line sources (z=4.909,5.07) in the sample show such a spectrum.
=> Three sources show strong narrow (FWHM~1000 km/s) emission lines (mostly Lyα) over a very faint almost zero continuum as in CID-1505.
○Their Lyα strength (EW~250 A) is comparable to the strongest lines found in Lyα emitter samples (Murayama et al. 2007).

Number Counts

We derived the 0.5-2keV number counts by folding the observed flux distribution of the z>3 sources through the sky coverage versus flux curve of C-COSMOS (Puccetti et al. 2009).

▪Blue dashed area represent the predictions from the Gilli et al. (2007)[1] and the Aird et al. (2010) models. Good agreement is found but the data cannot really choose between the models.
▪Extending this agreement to fainter fluxes, at both z>3 and z>4, where the C-COSMOS sample is 3 times larger than the XMM one (12 sources wrt 4).

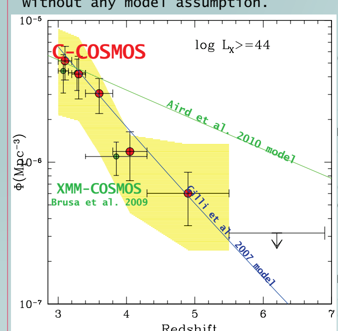


✓Comparison with the prediction of a basic model of quasar activation by major mergers of dark matter haloes (Black lines; Shankar 2009, 2010; Shankar et al. 2010)
✓A prolonged quasar light curve characterized by a long, post-peak activity phase, and a higher minimum halo mass (~3 10^{12} M_{sun}) hosting quasars (dot-dashed line) is preferred with respect to a model with smaller halo mass (dashed line, Shen 2009).

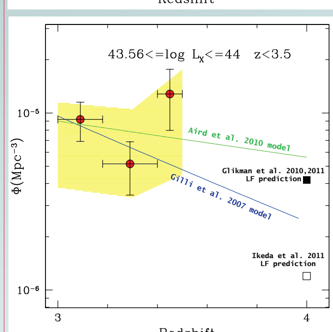
[1]Gilli et al. model: X-ray LF parameterized with a luminosity dependent density evolution (LDDE), and an high-z exponential decline with the same functional form adopted by Schmidt et al. (1995; $\psi(z) = \psi(z_0) \times 10^{-0.43(z-z_0)}$ and z_0=2.7) to fit the optical luminosity function between 2.5<z<6, corresponding to one e-folding per unit redshift.

Space Density

The combination of soft, hard and full band detected sources allows to account for the presence of highly obscured sources in the space density without any model assumption.



✓Space density of X-ray selected quasar up to z~5 at bright luminosity (top)
✓Agreement with the predictions from the LDDE Gilli et al. (2007) model at bright X-ray luminosity and at all redshift (top).
✓Confirming the declining space density as observed in the optical. Doubling the sample, at least, in the z>5 bin would strengthen this result.
✓The LADE Aird et al. (2010) model is over estimating the data at z>4 at 2σ, even when the errors are taken into account.



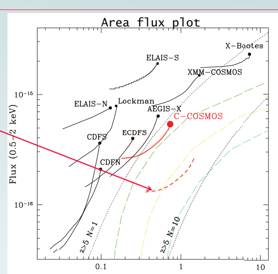
✓A space density at low luminosity and z>3 in the X-ray band has not been reported previously.
✓No strong constraints on the density evolution at the faint end (left) due to the flux limit of the survey, thus the lack of sources beyond z>3.5
✓Different results have been recently found in the optical band by Glikman et al. (2010, 2011) and Ikeda et al. (2011), with respect to previous studies (e.g., Fontanot et al. 2007).

Future surveys

Doubling the coverage of the COSMOS area and increasing the depth by a factor 2:

•Double the z>5 and high Lx sample
•Increase the z>3.5 low-luminosity AGNs sample, where the models diverge strongly.

Such a survey, performed with the same observational strategy of C-COSMOS (i.e. homogeneous exposure time and same tiling), would take approximately 6 Ms with Chandra, the scale of the X-ray Visionary Projects.



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