Highly obscured AGN: do they preferentially harbor small, fast accreting SMBH?

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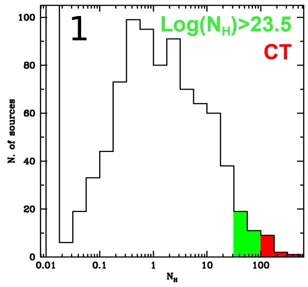
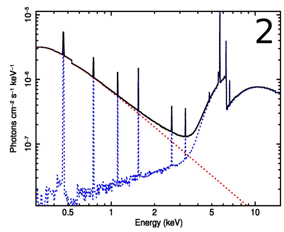
Compton Thick (CT) AGN are thought to represent an important, early evolutionary phase in the AGN/Galaxy co-evolution. However, clearly identify CT beyond the local Universe is a challenging task, even for the deepest X-ray surveys, while given their low number density, large areas are needed to collect sizable samples. We performed an *X-ray based* blind search for CT sources in the COSMOS field, which represent the state-of-the-art of *deep but wide* multi-wavelength surveys. Through direct X-ray spectral analysis, we selected a sample of 40 (12 of them CT candidates) heavily obscured AGN at bright fluxes ($F_{2\text{-}10}$ >1x10^{-14} erg s^{-1} cm^{-2}) in the *XMM*-COSMOS catalog. **Thanks to deeper X-ray data and multi-wavelengths information available in the field, we can unambiguously define 10 of them as *bona fide* CT**, spanning a large range of z (0.1-3) and L_X (10^{43}-10^{45}), with an estimated identification success rate of 80%. The distribution of SMBH properties (M_{BH}, Accretion rate) show that these sources tend to have **smaller SMBH, accreting at higher Eddington ratios** with respect to type-1. The HST-ACS images show that **~40% of them are in merging/interacting systems**.



Selection and Modeling

The *XMM*-COSMOS catalog[1,2] comprises ~1800 sources. We pushed the X-ray spectral analysis of the *XMM* pn data to the very low counts regime[3] (>30 net counts) using an unbinned statistic[4], background modeling and a simple 2 power-law model: *po+zwabs*po*. We measured N_H values for ~1300 sources with redshift[5] (fig. 1). The sample of highly obscured sources (30 with log(N_H)>23.5 and 12 log(N_H)>24) was then reanalyzed with a model that better reproduce the complex geometry and spectral features of highly obscured sources: The *[torus]* model[6] (fig. 2), which **self-consistently reproduce photoelectric absorption, Compton scattering and fluorescence.**

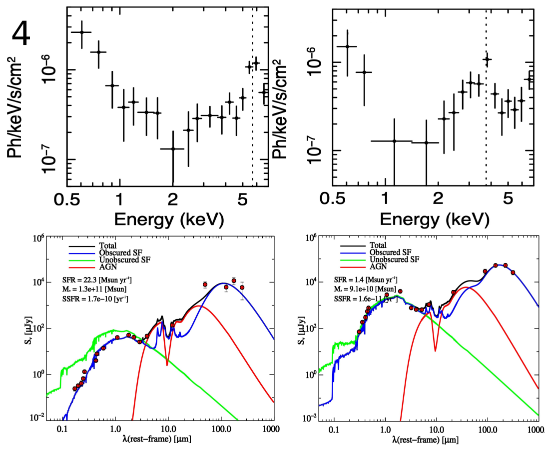


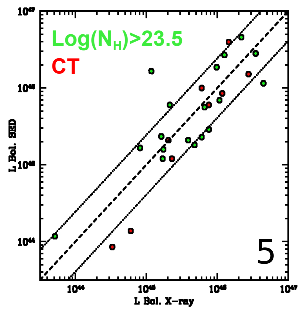
Are they *bona fide* CT?

- Deeper *Chandra* observations available in the same field[7,8] allow us to evaluate *a posteriori* the reliability of our selection: together, *XMM* pn, MOS and *Chandra* data increase the available number of photons by a factor 2.5-3. **80% are confirmed to be CT.**

Two *fluxed* spectra are shown in fig. 4 top: they show a primary power-law, obscured up 7-8 keV, a strong Fe Kα line plus reflection, plus a scattered component emerging in the soft band.

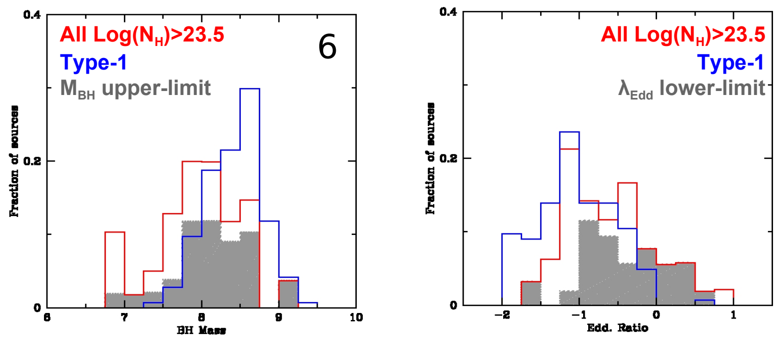
- A significant **highly obscured torus component** (in red in fig. 4 bottom) is needed in order to reproduce the optical to Mid-IR SED[9] of the CT sources.
- The L(Bol) derived from X-ray (through absorption and bolometric corrections) is in **very good agreement** (± 0.3 dex) with the L(Bol) obtained from SED fitting[9,10] (fig. 5).





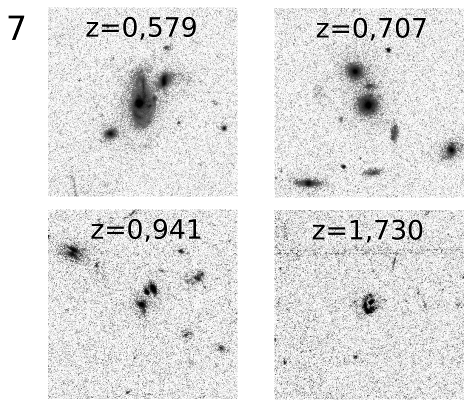
SMBH properties

BH masses and accretion rates are available for most of the sources in the XMM-COSMOS catalog[10,11,12]. Altogether, **highly obscured sources tend to have smaller M_{BH}** with respect to a matched sample of type-1 AGN (fig. 6 left). The evolution in M_{BH} translates into an evolution of the **Eddington ratios** (fig. 6 right). The difference is statistically significant (>5σ). However, large systematic uncertainties are involved in the derivation of M_{BH}, L(Bol) and λ_{Edd} (~0.3-0.5 dex).



Morphology

40% of the obscured sources are hosted in systems with merging/disturbed morphologies (four examples are shown in fig. 7) while the merger fraction for X-ray selected AGN is typically ~15%[13].



Conclusions:

Direct discovery of CT sources in the shallow *XMM*-COSMOS catalog is **challenging but possible**, through careful modeling of the X-ray spectra. The deeper *Chandra* data and rich multi-λ dataset available in COSMOS allow us to securely identify 10 CT (80% success rate). Their SMBH properties seem to be different with respect to unobscured sources, **with obscured AGN having smaller M_{BH} and higher accretion rates.** However, even in COSMOS, the quality of the data does not allow yet for a proper quantification of the significance of these differences. Finally, HST imaging reveal that 30-50% of the highly obscured AGN are hosted in merging/interacting systems, a significantly higher rate with respect to normal AGN.

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