SED of Compton-thick AGN beyond the local Universe

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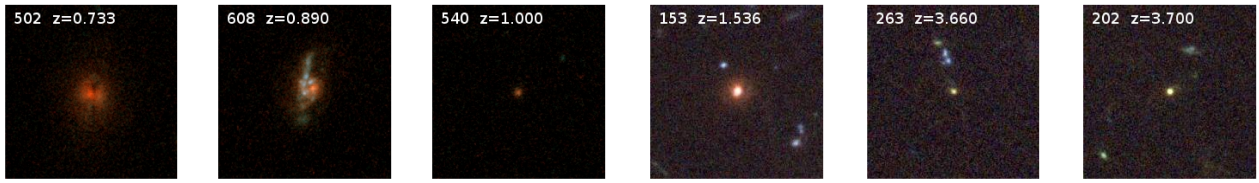
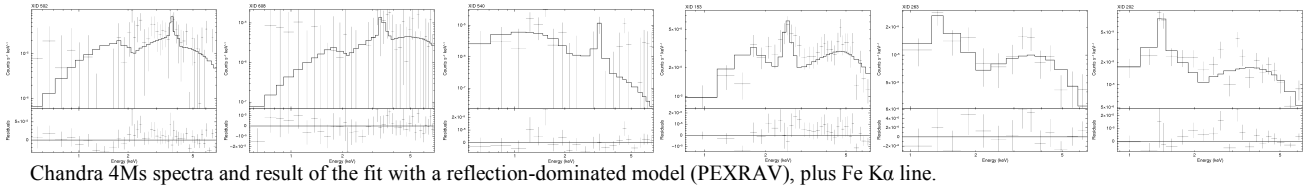
We present a multi-wavelength study of a sample of heavily-obscured AGN in the CDFS selected via X-ray spectral analysis. We aim at investigating the properties of the SED of heavily obscured AGN, in particular of Compton-thick (CT) AGN, and their evolution with redshift, as well as with properties of their host galaxies, such as stellar mass, star-formation rate, and morphology. We analyze the recent ultra-deep X-ray observations of the CDFS (i.e. 4Ms Chandra and 3Ms XMM) of a sample of 14 *candidate CT AGN*, selected by previous X-ray spectral analysis (Tozzi et al. 2006). With the exception of two objects, all the new, deep X-ray spectra of our sample are flat ($\Gamma<1$ for a simple power-law fit) and well-fit by either a transmission model with high absorbing-column densities ($N_H>10^{23}$ cm^{-2}) or by a reflection-dominated model, as expected for CT AGN. A relatively strong (EW~1 keV) Fe Kα emission line at 6.4 keV rest-frame is clearly detected (>3σ) in the spectra of 3 sources (plus 3 additional sources which show only a marginal detection), confirming that the primary X-ray radiation from their nuclei must be strongly obscured. Exploiting the new, publicly available photometric data and revised spectroscopic and photometric redshifts in the CDFS and Extended-CDFS, we investigate the properties of the SEDs of our sample by fitting them in the wave-bands between 0.1μm and 1mm with libraries of empirical and synthetical SED templates. We find that the SEDs of our sample are, generally, better fit by templates of strong star-forming galaxies. Also in the few cases, where the best-fit template is that of a passive galaxy, we detect some excess flux both in the mid-IR and UV, probably indicative of some residual star formation. A characterization of the SED of highly-obscured AGN at high redshift will help refining selection criteria for these objects, or will allow us to define new ones, with the aim to unveil obscured SMBH accretion in the distant Universe.

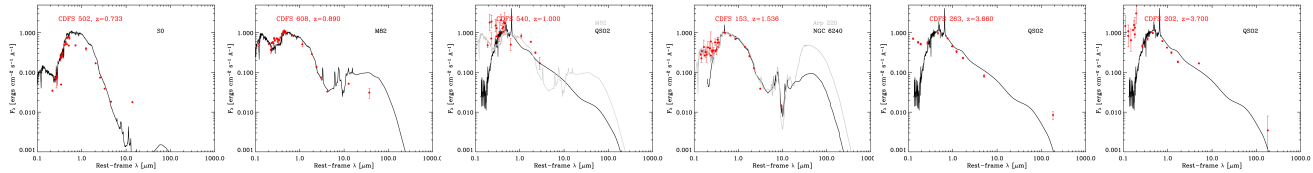
Six of the best candidate CT AGNs from our sample



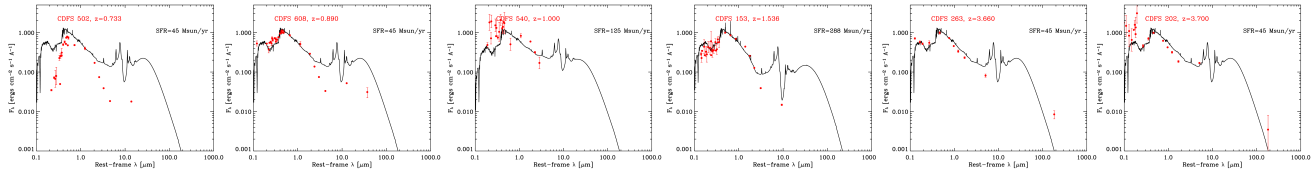
HST 6"×6" color cutouts. XID from Tozzi et al. (2006) and redshifts are indicated.



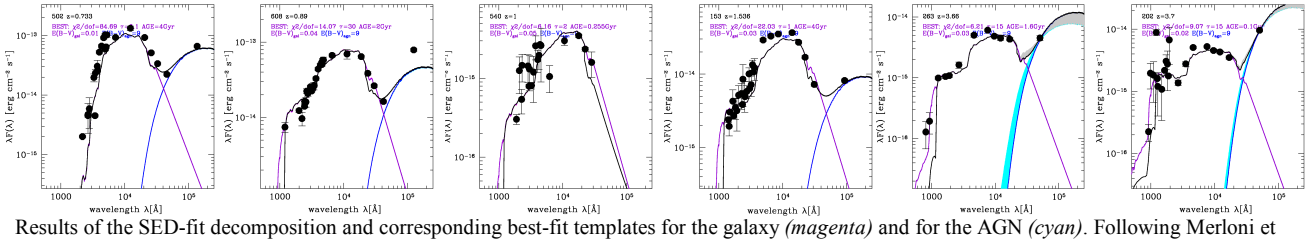
Chandra 4Ms spectra and result of the fit with a reflection-dominated model (PEXRAV), plus Fe Kα line.



SEDs and corresponding best-fit templates *(black)* from the library of empirical SED templates by Polletta et al. (2007).
If a second template gives comparable χ^2, a secondary solution is shown *(gray)*. All the SEDs are normalized at 5500Å.



SEDs and corresponding best-fit template (the *SFR* value is indicated) resulting from SED fitting with theoretical templates for dust-obscured galaxies (DOG) by Narayanan et al. (2010).



Results of the SED-fit decomposition and corresponding best-fit templates for the galaxy *(magenta)* and for the AGN *(cyan)*. Following Merloni et al. (2010), we use Bruzual & Charlot (2003) for the galaxy and the mean QSO SED from SDSS by Richards et al. (2006) for the AGN component.

XID	502	608	540	153	263	202
log(M_* [$M_\odot$])	10.04	10.31	10.35	11.13	10.42	9.25
log(*SFR* [$M_\odot$/yr])	2.42	1.20	2.06	0.66	1.39	1.35

References:
- Bruzual & Charlot (2003), MNRAS, 344, 1000
- Comastri et al. 2011, A&A, 526, L9+
- Merloni et al. 2010, ApJ, 708, 137
- Narayanan et al. 2010, MNRAS, 407, 1701
- Polletta et al. 2007, ApJ, 663, 81
- Richards et al. 2006, ApJS, 166, 470
- Tozzi et al. 2006, A&A, 451, 457

The SEDs of our 6 best candidates CT AGNs, out to *z~1.5*, are similar to those of local ULIRGs or strong, star-forming galaxies (e.g. NGC 6240, M82), while at higher redshifts *(z~3.5)* they closely resemble obscured QSOs, but with strong excess in the UV. In general, we always detect some excess in the mid-IR compared to "normal" galaxies, suggestive of enhanced star formation.
From our SED-fit decomposition we find that the stellar masses of the host galaxies range from ~10^9 $M_\odot$ to ~10^{11} $M_\odot$ and the *SFR* from a few $M_\odot$/yr to more than 100 $M_\odot$/yr.