New insights on the distant AGN population

Agnese Del Moro

In collaboration with:
Why looking for missing AGN?

BH-spheroid growth connection

Missing AGN population

Major-merger evolution scenarios

gas-rich galaxy(s) → SMG/ULIRG → obscured quasar → unobscured quasar → early-type galaxy

Alexander & Hickox (2012), review

X-ray background is not fully resolved at >6 keV

Worsley et al. (2005)
Deep X-ray surveys are great to detect distant AGN...
... but still not complete

Brandt & Hasinger (2005) for a review
Deep X-ray surveys are great to detect distant AGN... ... but still not complete

Brandt & Hasinger (2005) for a review

Go multiwavelengths!
**AGN-galaxy SED decomposition**

5 host galaxy templates (Mullaney+2011)

Extended to:
- 3 um using average SB SED (Dale+2001)
- radio band ($f_\nu = \nu^{0.7}$), FIR/radio ratio ~2.2 (Helou+1985)

Empirically defined AGN template (Mullaney+2011)
+ Extinction

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Milano – October 1-5, 2012
Identifying the AGN dominating the cosmic BH growth

- Large population of X-ray undetected AGN are identified in IR at z<2

- Stacking of X-ray undetected IR AGN at z<1 consistent with reflection dominated spectrum

Del Moro et al., in prep

Model tracks: 
- $\Gamma=1.8, N_H=2\times10^{21}$ cm$^{-2}$
- $\Gamma=1.8$, Pure reflection
- $\Gamma=1.8, N_H=10^{20}$ cm$^{-2}$

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Population of obscured quasars at $z \sim 2$

- MIR luminosity $\log L_{6\mu m} > 44.8 \rightarrow L_x > 10^{44} \text{ erg/s}, \ z=1-3$

- $\approx 25\%$ are BL AGN

- $\approx 25\%$ are X-ray undetected

2.5 times more obscured AGN than unobscured AGN

much higher than in previous studies (<1; e.g. Ueda+2003; La Franca+2005; Hasinger 2008; Assef+2012)
Population of obscured quasars at $z\sim2$

- Unobscured/moderately obscured high-$z$ AGN seem to follow the intrinsic $L_X$-$L_{6\mu m}$ relation.
- $\approx 25$-$50\%$ are likely to be heavily obscured Compton-thick AGN.

Alexander et al. (2012, in prep)
z~1 IR AGNs: the unresolved X-ray background?

Properties consistent with producing the unresolved X-ray background at 30 keV:

z~1, intrinsic $L_X \sim 10^{43}$ erg/s and heavily obscured

Stacked X-ray data of the X-ray undetected IR AGNs: consistent with reflection dominated: heavily obscured/Compton thick

NuSTAR may measure their >10 keV contribution
NuSTAR extragalactic survey: simulations

Deep survey simulation (E-CDF-S)
3-30 keV band image

NuSTAR exposure/pixel ranges from ~200-800 ks across the image

~50 of the ~760 Chandra sources are detected
Summary

- IR SED analysis very effective in identifying AGN out to $z \approx 2$
- Stacked X-ray data of X-ray undetected IR AGN at $z < 1$ consistent with reflection dominated spectrum $\rightarrow$ heavily obscured/CT AGN
- Population of IR bright quasars at $z \approx 2$ from IR SED analysis $\rightarrow$ 2.5 times more obscured AGN than unobscured AGN
- $\approx 25-50\%$ are likely to be Compton-thick AGN at $z \approx 2$
- NuSTAR will provide information at $E > 10$ keV for these heavily obscured AGN
- Directly resolve $\sim 25-50\%$ of the X-ray background at peak
- Indirectly resolve (via stacking analysis of Chandra/XMM sources) most of the remaining X-ray background