Luminous obscured quasars in the HELLAS2XMM survey: the Spitzer perspective

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on behalf of **F. Pozzi**

In collaboration with A. Comastri,

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morphological information

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multi-band photometry (X, opt, NIR, MIR-Spitzer)

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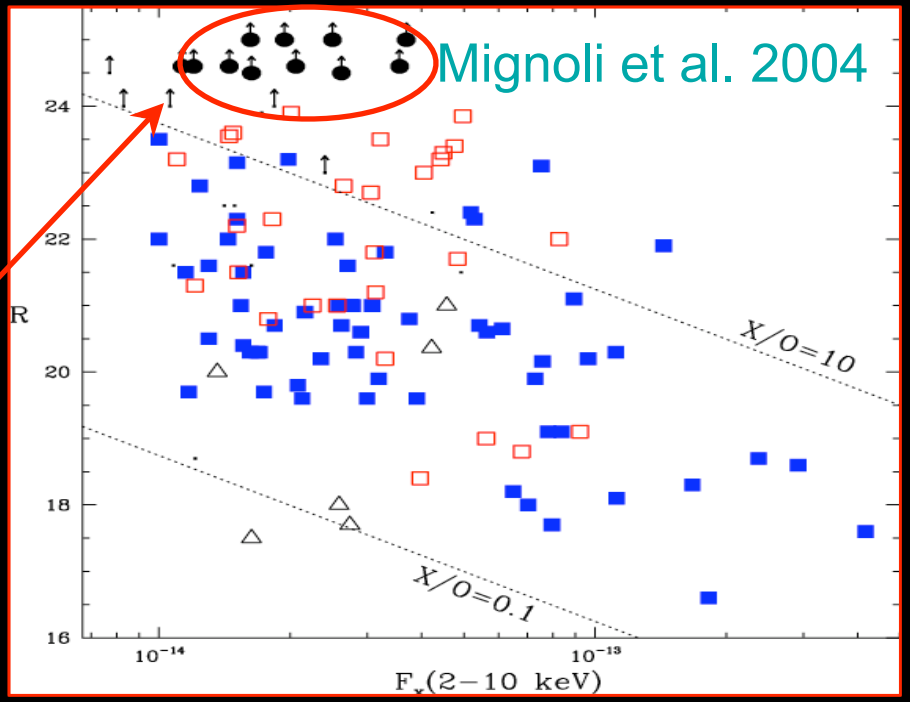
2) To compare the results with other samples of AGN (mainly Type 1, i.e., broad-line), like the SDSS QSOs

Sample selection: Extreme sources

- SAMPLE: **HELLAS2XMM**
  $F_{2\text{-}10\ keV} > 10^{-14}$ erg cm^{-2} s^{-1} over 1.4 deg^2
- Optically faint (**R>24**) sources with no optical identification

➔ high X-ray-to-optical flux ratio (X/O>10) sources with indications of X-ray obscuration



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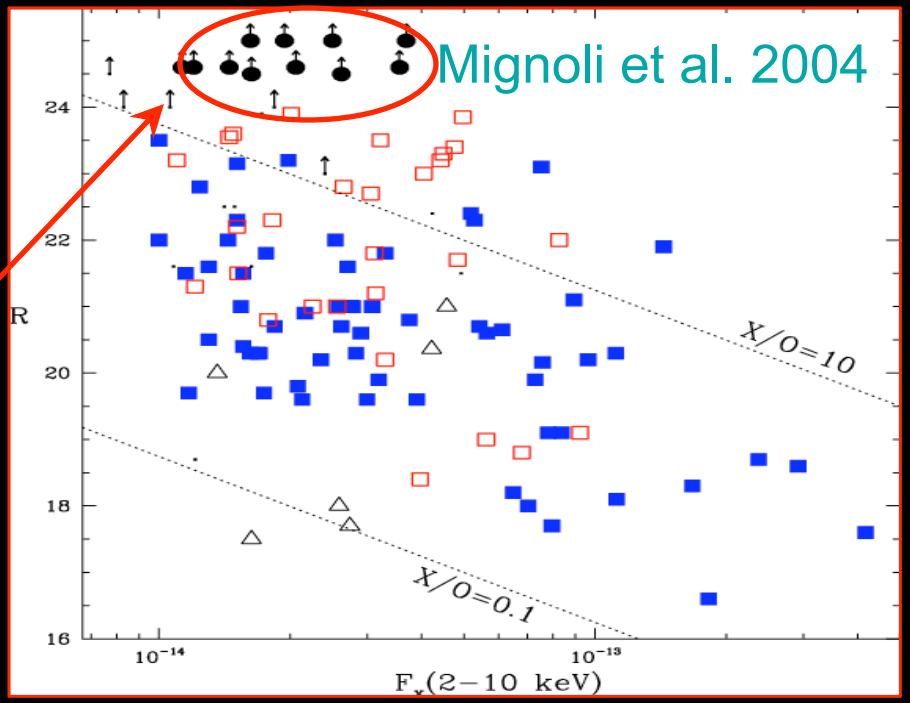

ISAAC K_S-band follow-up

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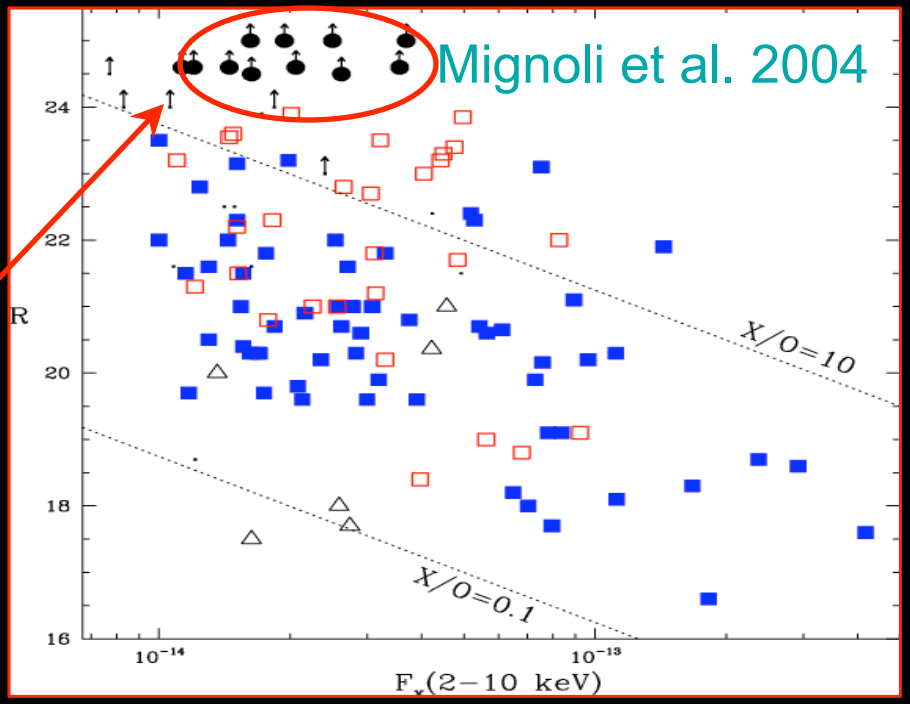

ISAAC K_S-band follow-up

- **ALL bright in the K_S band**
- All have **R-K_S>5** ➔ Extremely Red Objects (**EROs**), some are extreme
- Most have **elliptical** profiles, two are point-like (Mignoli et al. 2004)

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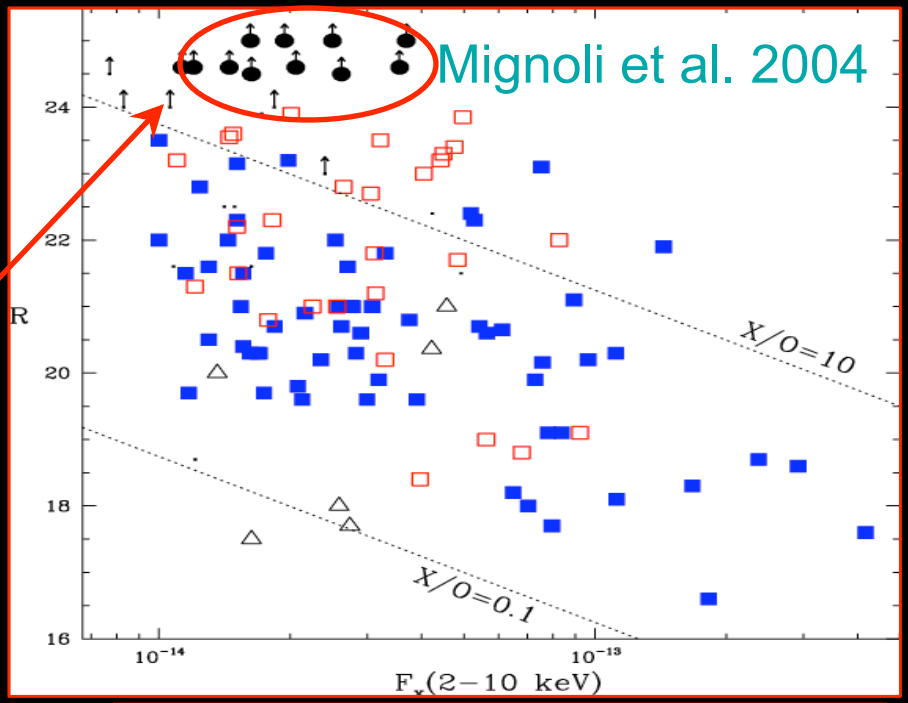

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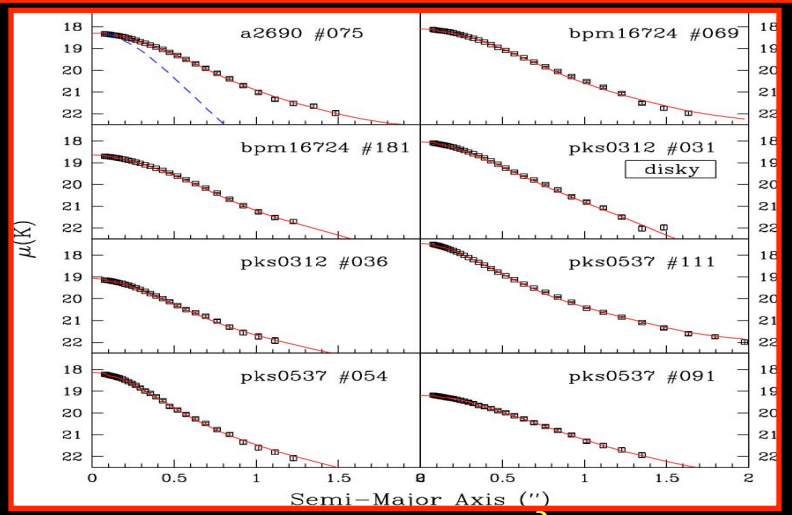
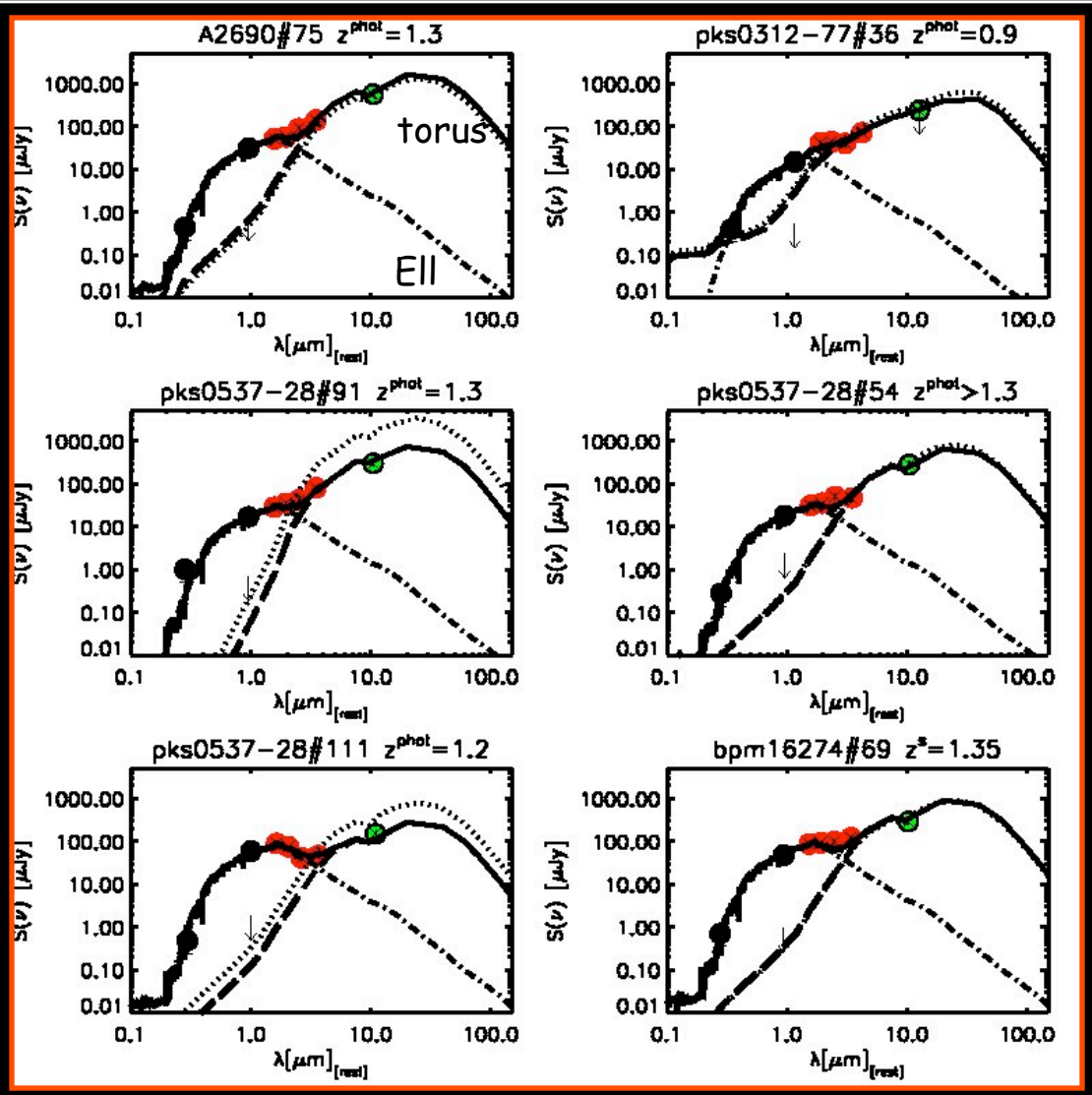


SED analysis I: Bulge-dominated sources (K_s band)

nuclear emission + host-galaxy emission

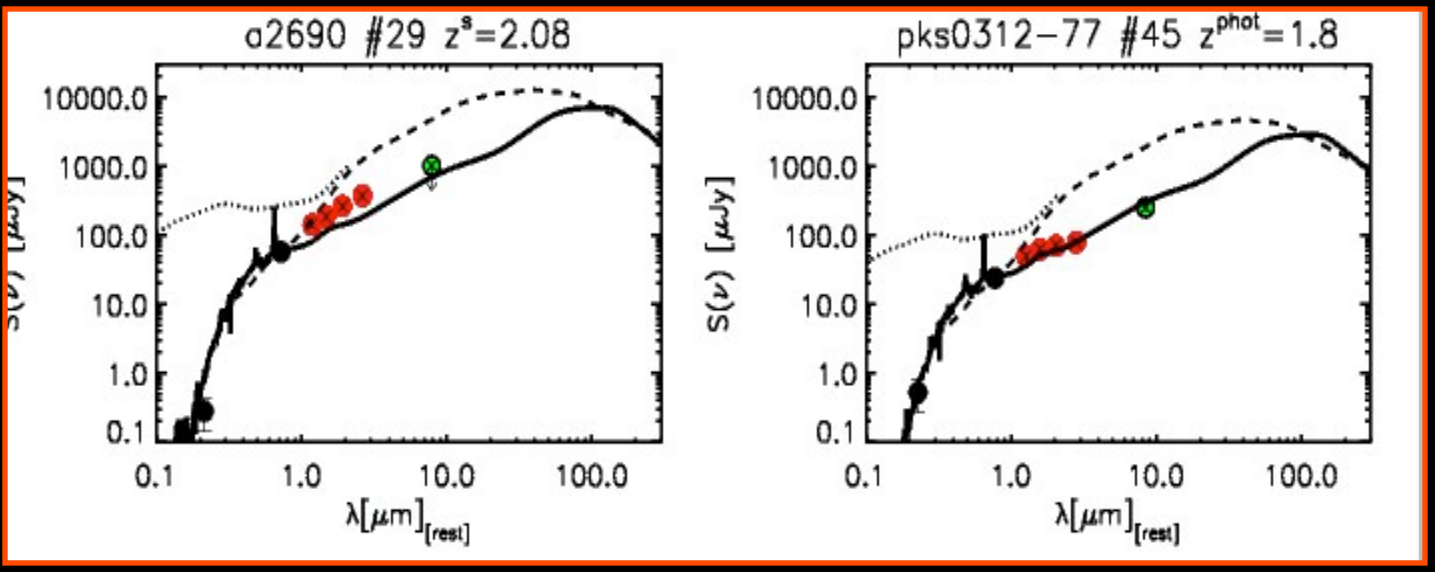


- ✓ Nuclear comp. consistent with K_S upper limits
- ✓ Nucleus starts dominating at ≈6 μm
- ✓ Torus consistent with Silva et al. (2004) predictions -normalized to the X-rays- within factor of 2-3
- ✓ z-phot consistent with the spectroscopic ones (when available)

from Pozzi et al. (astro-ph/0704.0735)

SED analysis II: Point -like sources (K_s band)

Extincted Type 1 quasar or red quasar template (from Polletta et al. 2006)



✓ Extincted Type1 quasar NOT able to reproduce the data ➜sharp decrease in the optical

✓ Good match using a **red QSO template**

Bolometric correction and luminosity

Bolometric luminosity = $L_{BOL} = K_{bol,x} \times L_{2\text{-}10\ keV}$

bolometric correction (≈35 in Type 1 QSOs from Elvis+ 94)
BUT large dispersion in the broad-line QSO SEDs

L_{BOL}

1. Sum the radiation directly linked to the accretion

→ $L_{BOL} = L_{X,INT} + L_{OPT,UV}$

REQUIRED: ►to remove IR bump (re-processed radiation)
►to correct for gas/dust absorption in X & optical/UV

2. Sum of the X-ray intrinsic radiation + IR radiation

→ $L_{BOL} = L_{X,INT} + corr^{*} L_{IR,OBS}$

our approach

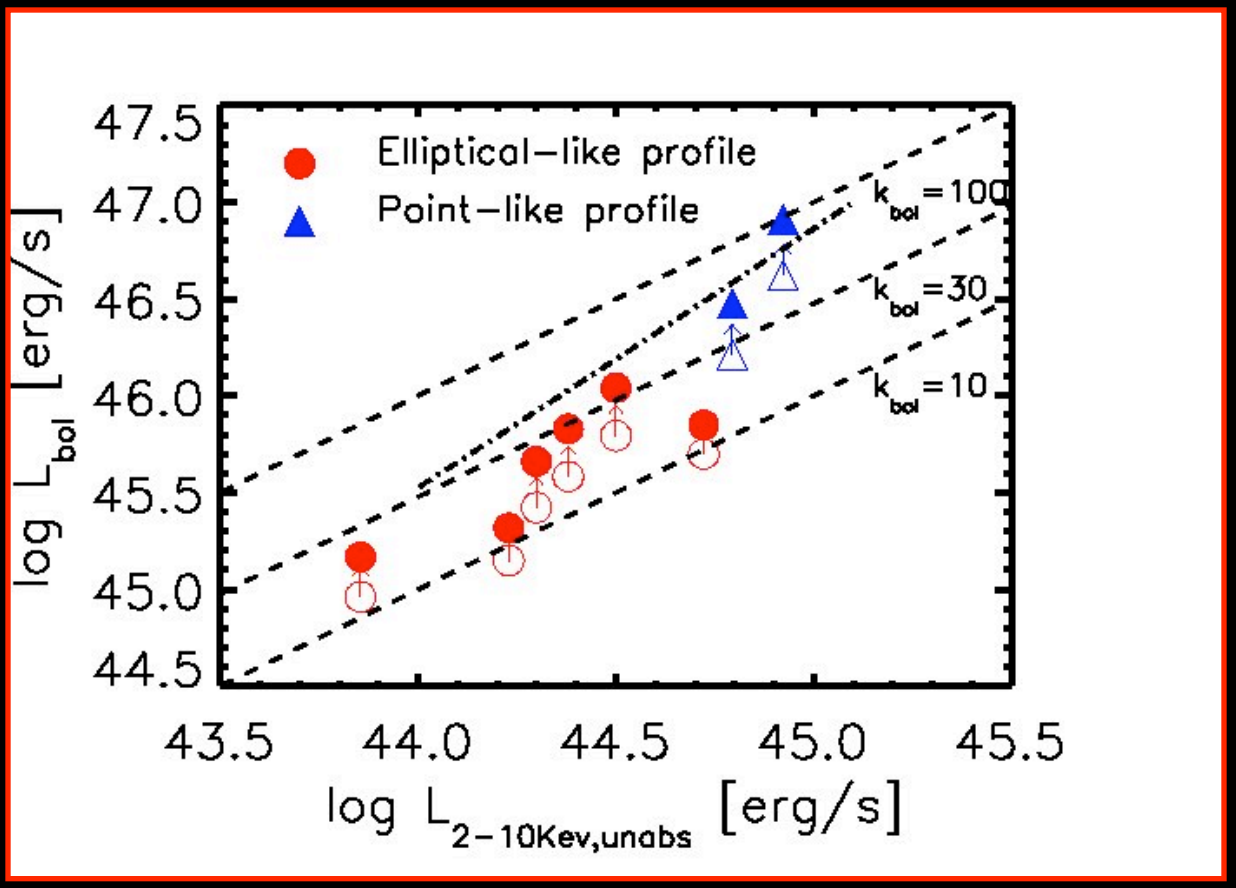
REQUIRED: ► to correct for gas absorption in X-ray
► to correct IR emission for geometry & orientation

Results (I) : Bolometric correction

$L_{BOL} \approx 10^{45}$- 10^{47} erg s^{-1}

$k_{X,bol} = L_{BOL}/L_{2\text{-}10\ keV} \approx 25$ (median)

$= 35 \pm 9$ (average)



$k_{X,bol}$

- large spread ⇒ important to correct each source for its value
- mean value consistent with Elvis et al.1994

Results (II): Bulge and black hole masses

Bulge-dominated sources

Bulge masses: Ks -band flux density mostly from the host galaxy.

$M_{bulge}/L_k \approx 0.3$-1 (for old population - Bruzual & Charlot '03)

$M_{bulge} \approx 3 \cdot 10^{10}$-$8 \cdot 10^{11}\ M_\odot$

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BH masses: using the Marconi & Hunt (2003) local relation + assuming $(M_{BH}/M_*)_{z=1} = 2 \times (M_{BH}/M_*)_{z=0}$ (Peng et al. 06)

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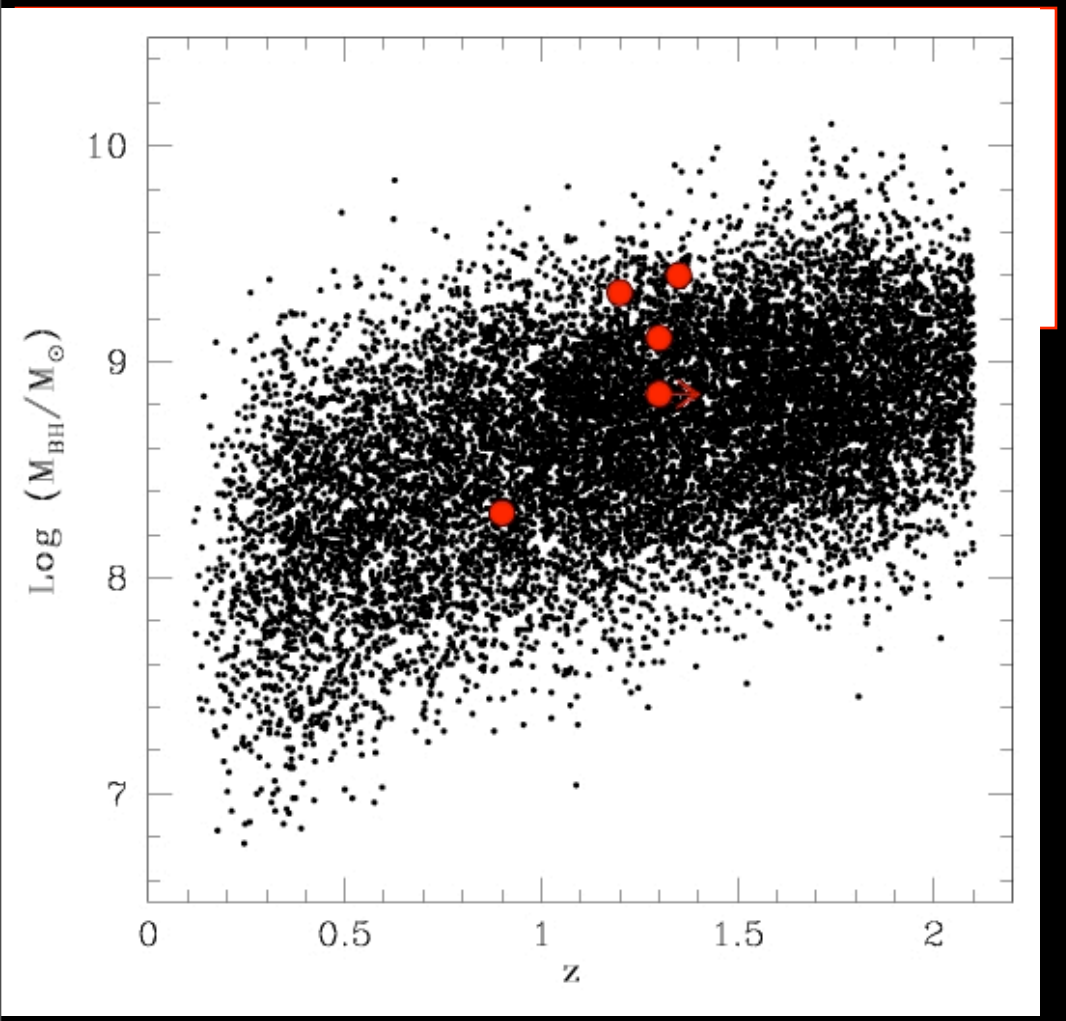


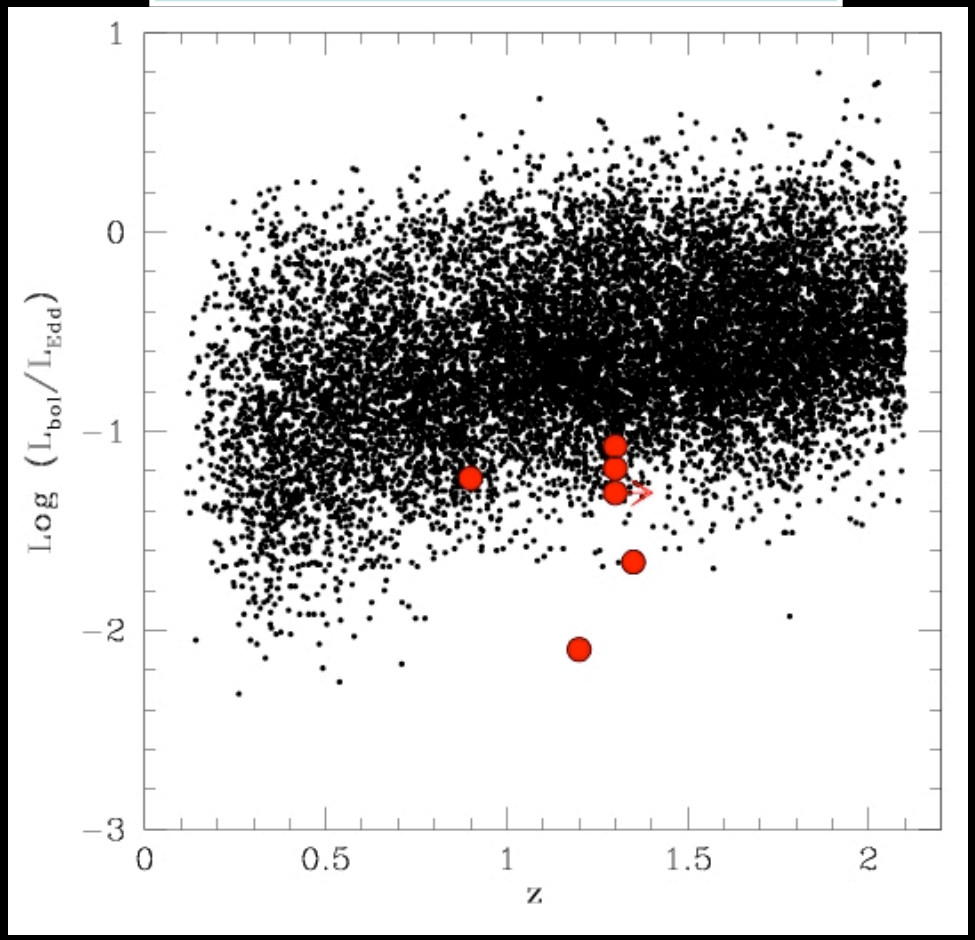
$M_{bulge} \approx 3 \cdot 10^{10} - 8 \cdot 10^{11}\ M_\odot$

$M_{BH} \approx 2 \cdot 10^{8} - 2.5 \cdot 10^{9}\ M_\odot$

Massive black holes consistent with SDSS quasars (see work by McLure & Dunlop 2004)

Results (III): Eddington ratios.

$\lambda = L_{BOL} / L_{EDD} \approx 0.06$



Indications that:

- these very massive, X-ray luminous black holes at $z \approx 1\text{-}2$ have already passed their rapidly accreting phase
- they have reached their final masses with low accretion rates

SDSS data from McLure & Dunlop '04