

Obscured QSOs in the COSMOS survey

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Outline

- Introduction
- COSMOS X-EROs: the largest sample of X-ray selected EROs with multiwavelength coverage
- Spectral Energy Distributions
- Color-color diagram: an example the BzK plane
- BH-Mass and Eddington ratio estimates

EROs in X-ray survey

- A sizable fraction (15% at $F_x \geq 10^{-15}$) of the hard X-ray selected sources are associated with EROs $R-K > 5$
- The population is dominated by obscured AGN:

hard X-ray colors \longrightarrow gas absorption
optical red colors \longrightarrow dust extinction

X-EROs and QSO2

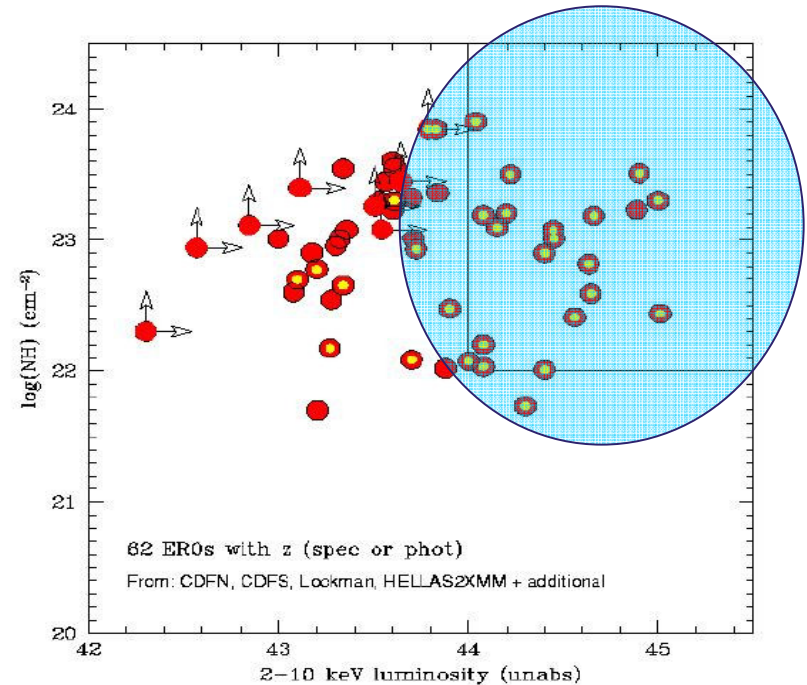
High X/O and red colors
selection

pick up

High NH and high redshift
sources

--> QSO2

(Brusa et al. 2005, Severgnini et al. 2005)



EROs in X-ray survey

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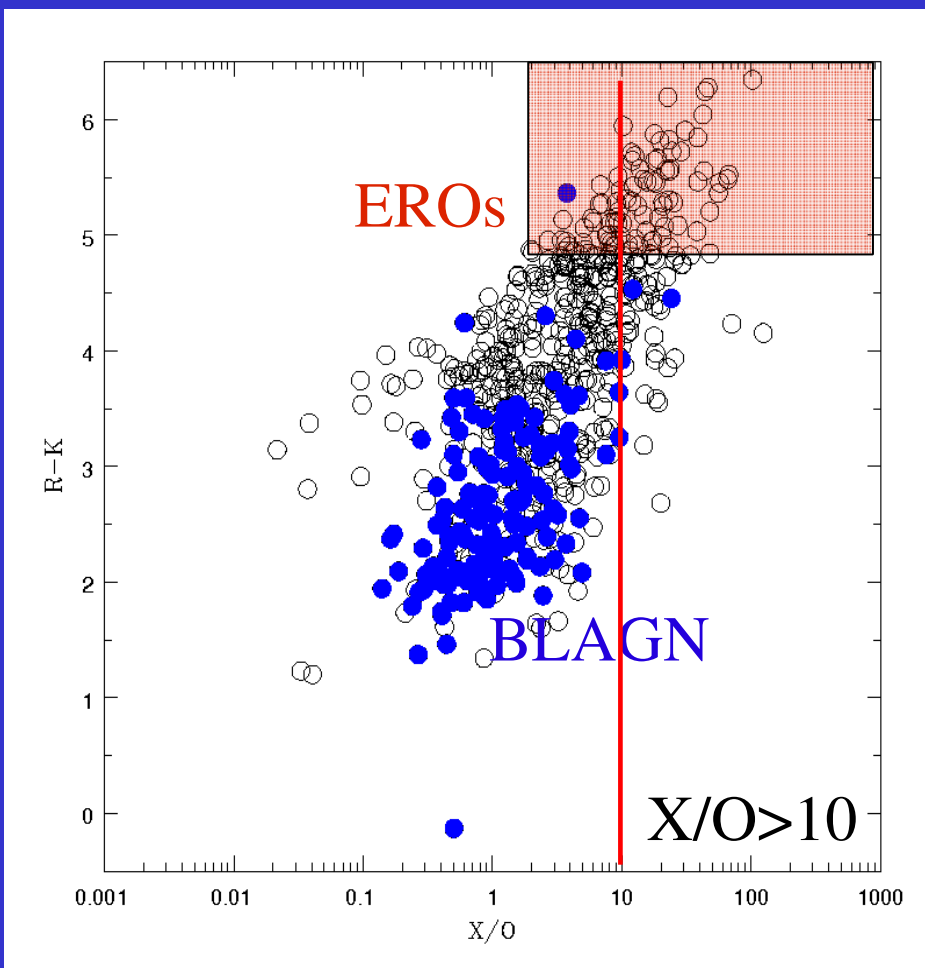
- Red SED: reddened AGN contribution or old stellar

Need a better multiwavelength dataset to distinguish between the two possibilities--->COSMOS

X-EROs in COSMOS

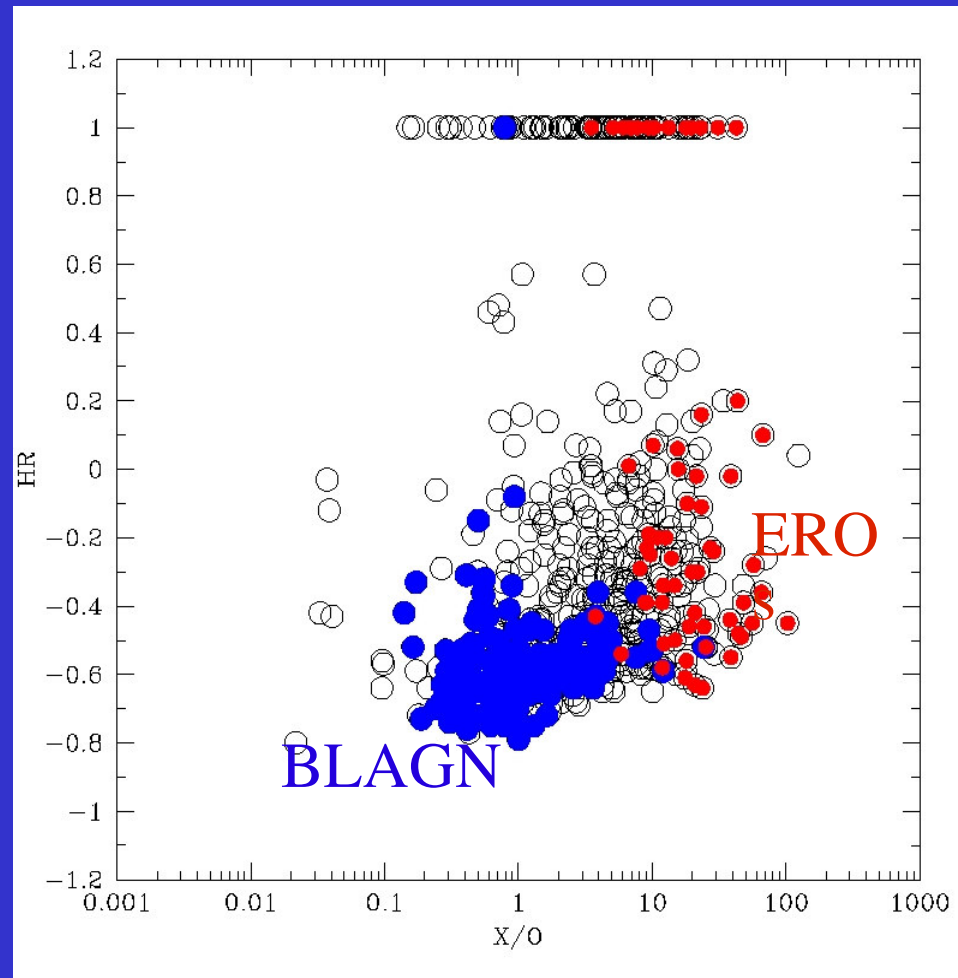
- 83 hard X-ray selected EROs with $R-K > 5$:
the largest X-EROs homogeneous sample!!
- ~12% of the hard sample
- ~80% have $X/O > 10$
- Photometric redshift available $\langle z \rangle \sim 1.2$
- 11 spectroscopic redshift available
($0.8 < z < 1.8$)

RK vs lg(X/O)



EROs have higher X-ray to optical ratio than BLAGNs

HR vs lg(X/O)



$\langle HR(EROs) \rangle \sim -0.1$ $lgNH \sim 22.5$ @ $z=1$
 $\langle HR(BLAGN) \rangle \sim -0.6$

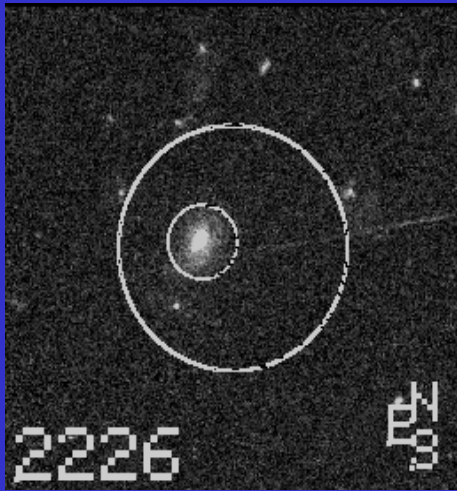
SEDs & Morphology

- Spectral Energy Distribution analysis to separate the contribution of the AGN and of the host galaxy

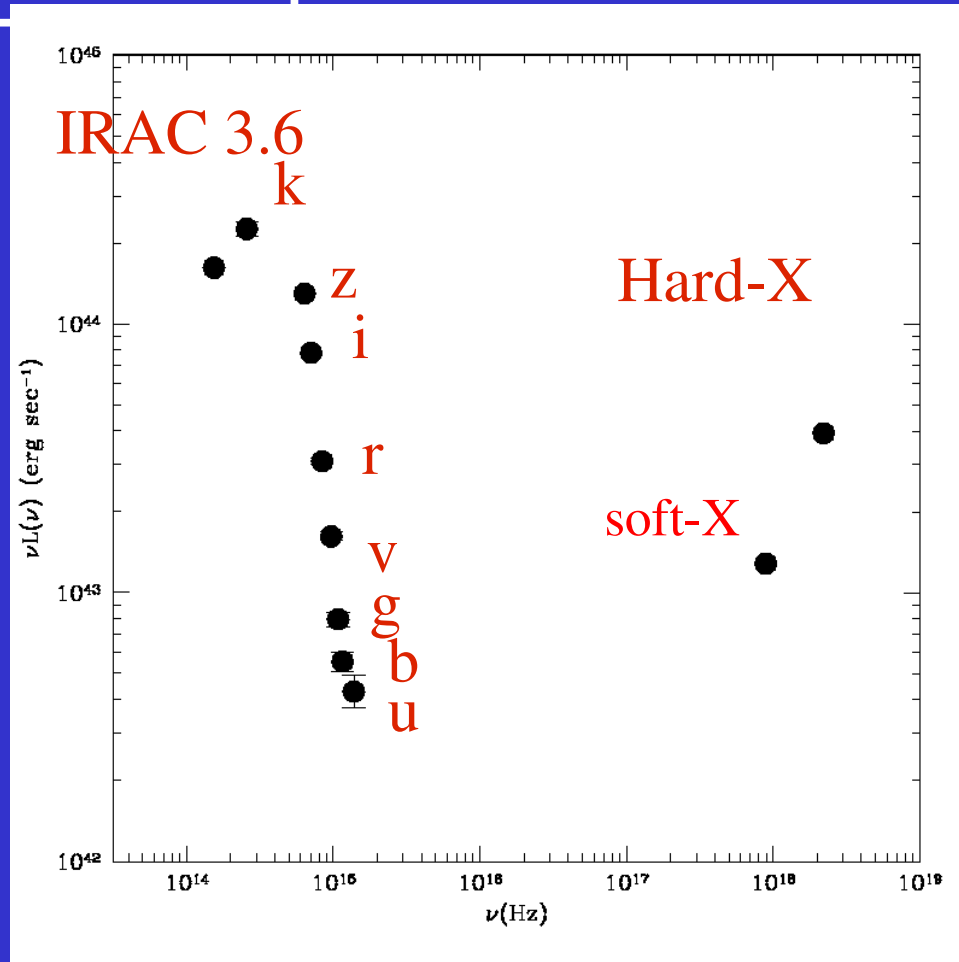
Data Available:

Radio, MIPS (approved this month), IRAC (preliminary), k, z, i, r, v, g, b, u, ACS, X-ray

An example:



ACS image



XID 2226

$z=0.844$

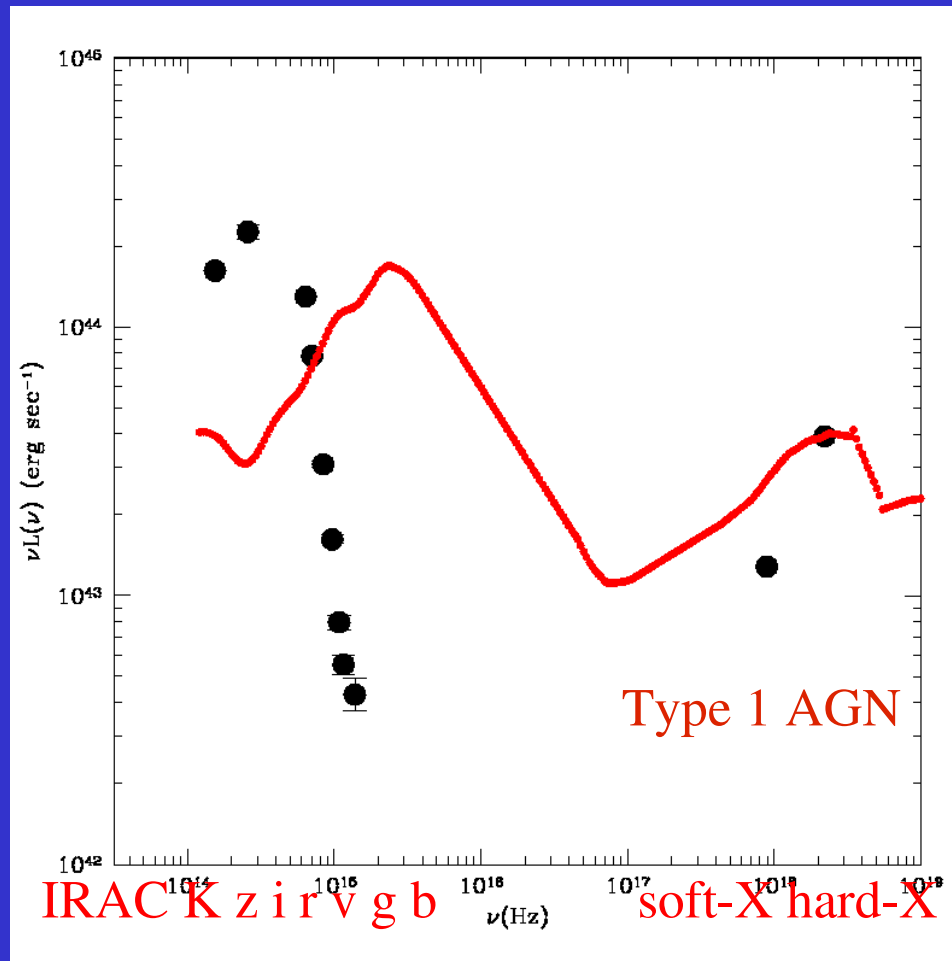
$R-K=5.1$

$F_x=1.66 \cdot 10^{-14}$

STEP 1:

X-ray emission comes from the AGN

Type 1 Elvis
template
normalized to
the hard X-ray
band



XID 2226

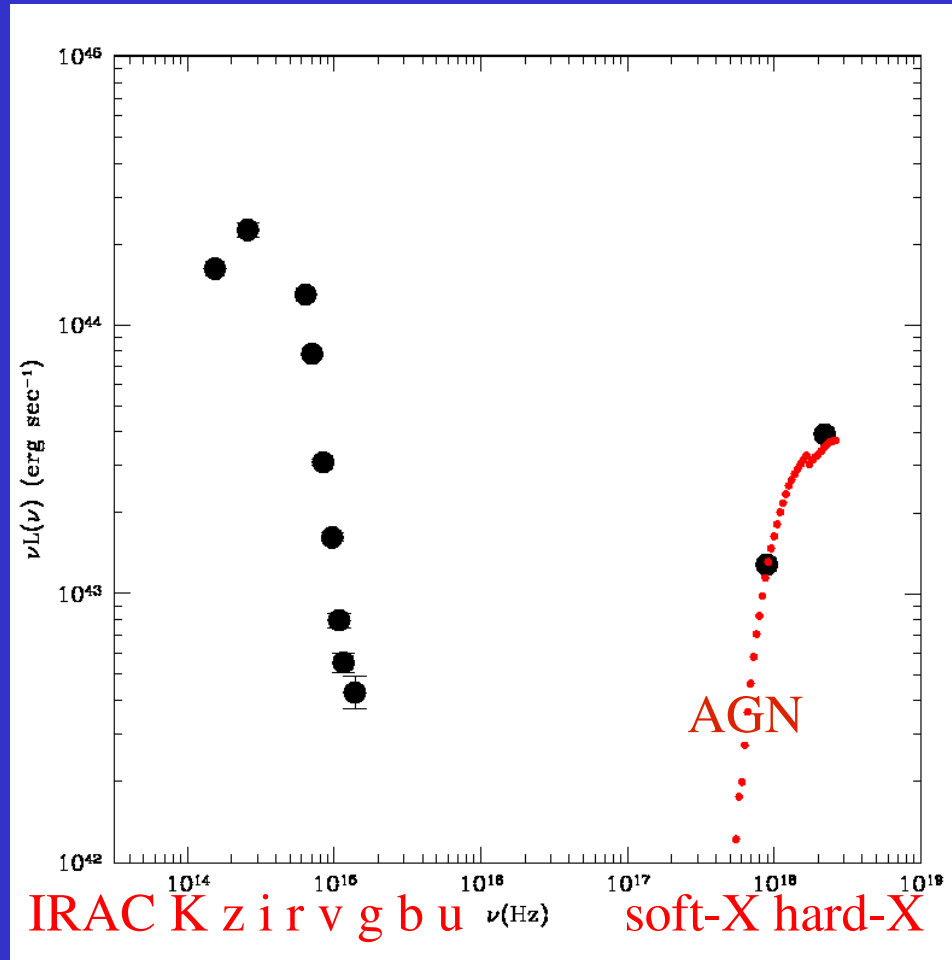
$z=0.844$

$R-K=5.1$

$F_x=1.66 \cdot 10^{-14}$

Need absorption
in the X-ray!

STEP 2: X-ray Absorption

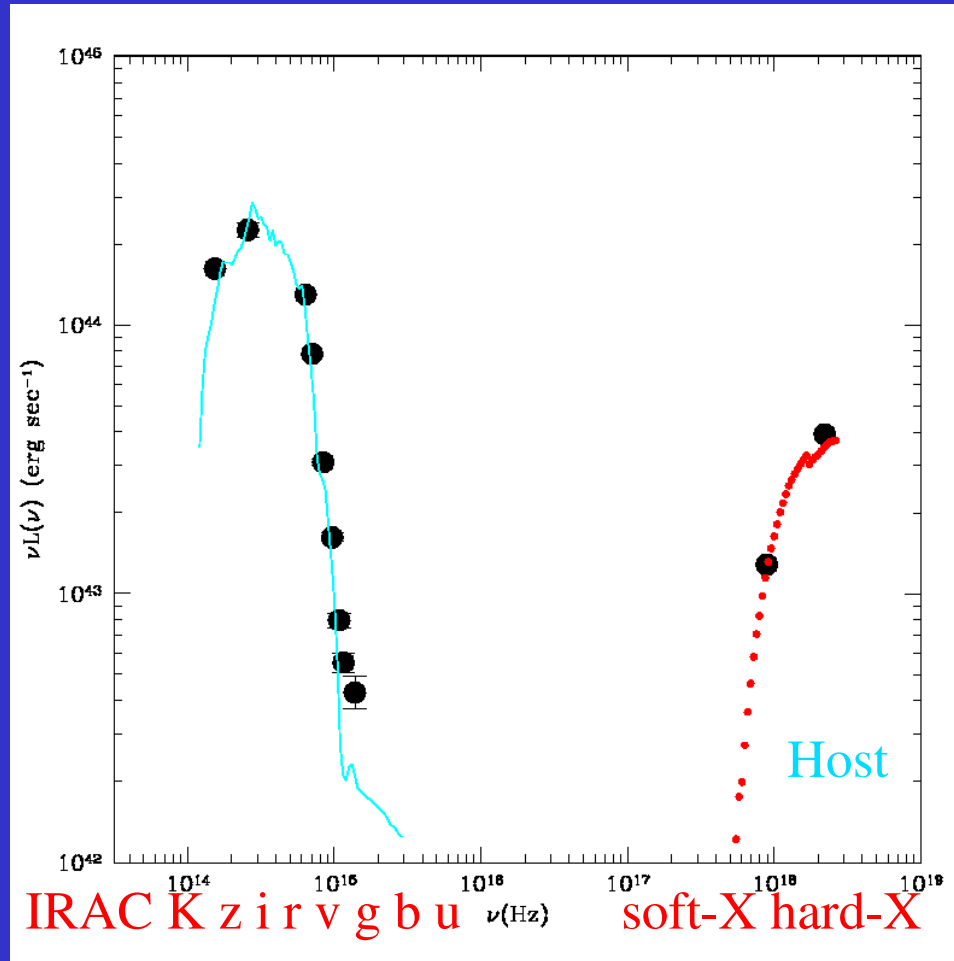


XID 2226
 $z=0.844$
 $R-K=5.1$

X-ray absorption
 $NH \sim 10^{23}$

STEP 3: K band emission comes from the host

Elliptical galaxy
normalized to
the K band flux

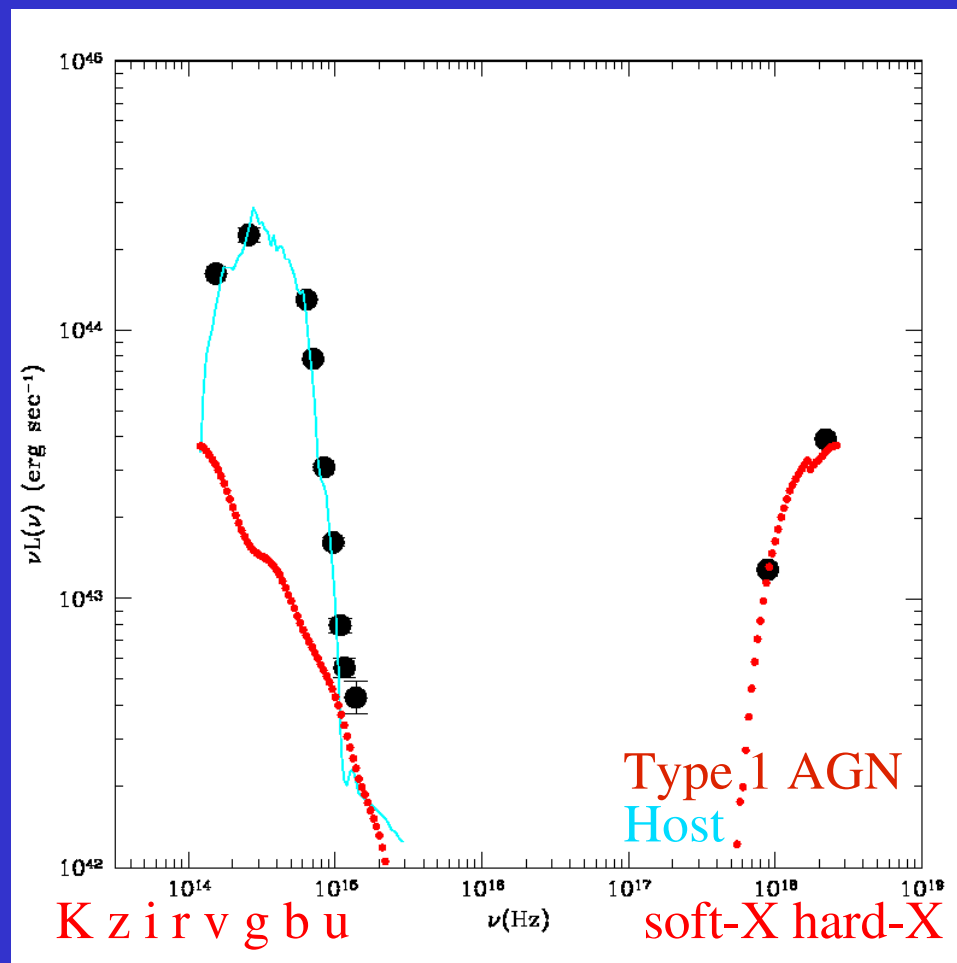


XID 2226
 $z=0.844$
 $R-K=5.1$

The host
reproduces
almost all of the
optical emission!

STEP 4: optical extinction of the AGN template

Calzetti
Extinction Law

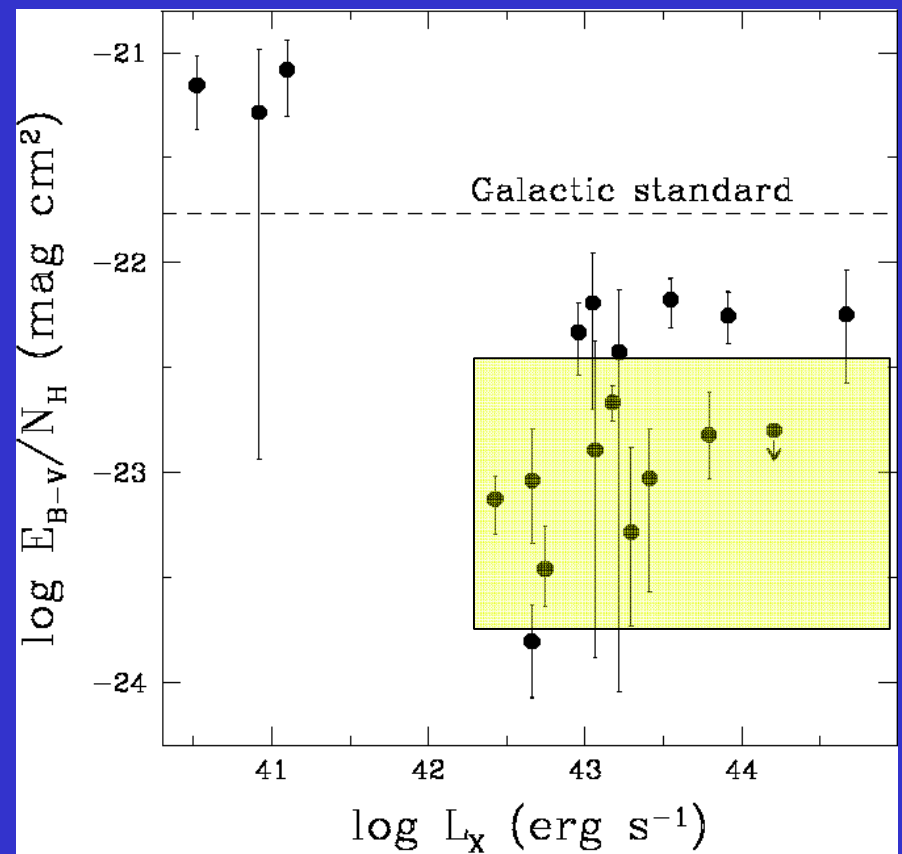


XID 2226
z=0.844
R-K=5.1

If we use a Galactic standard dust to gas ratio to convert the N_{H} from X-ray to optical, the extinction is too high !!

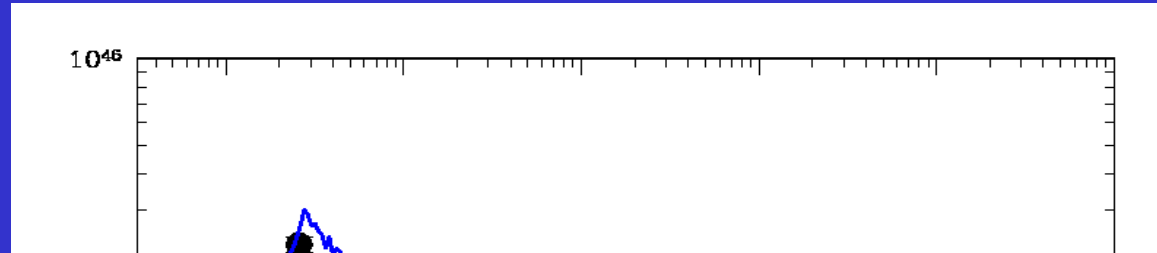
X-ray vs optical extinction

The optical and X-ray extinction
don't follow a Galactic
standard relation



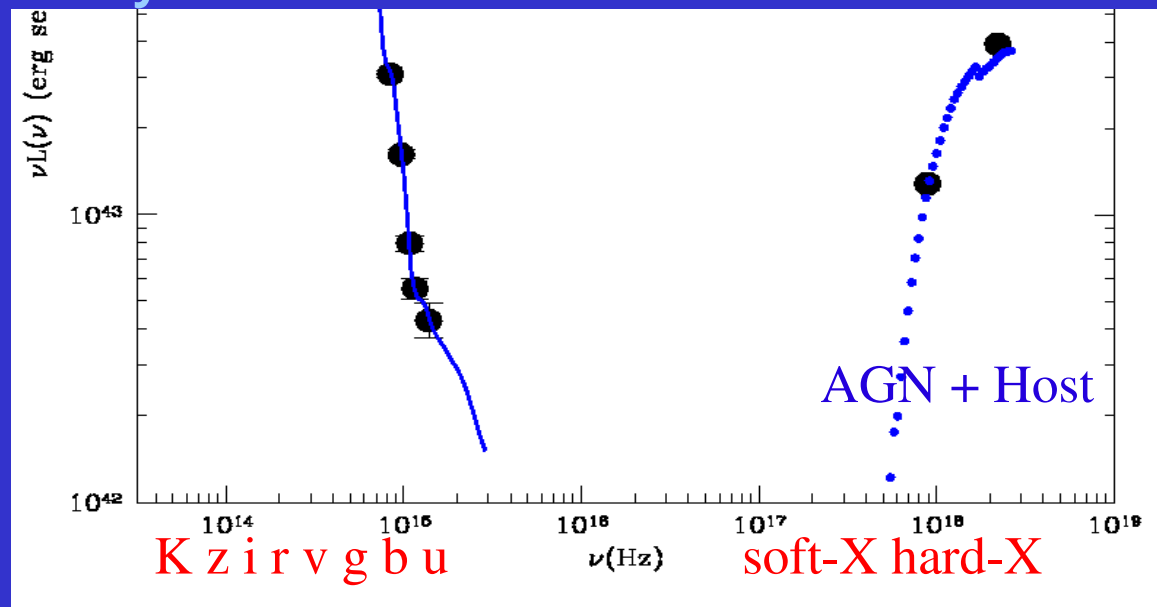
(Maiolino et al. 2001)

STEP 5: AGN+ HOST



XID 2226
 $z=0.844$
 $R-K=5.1$

80% of the EROs show optical SED dominated by an old host galaxy

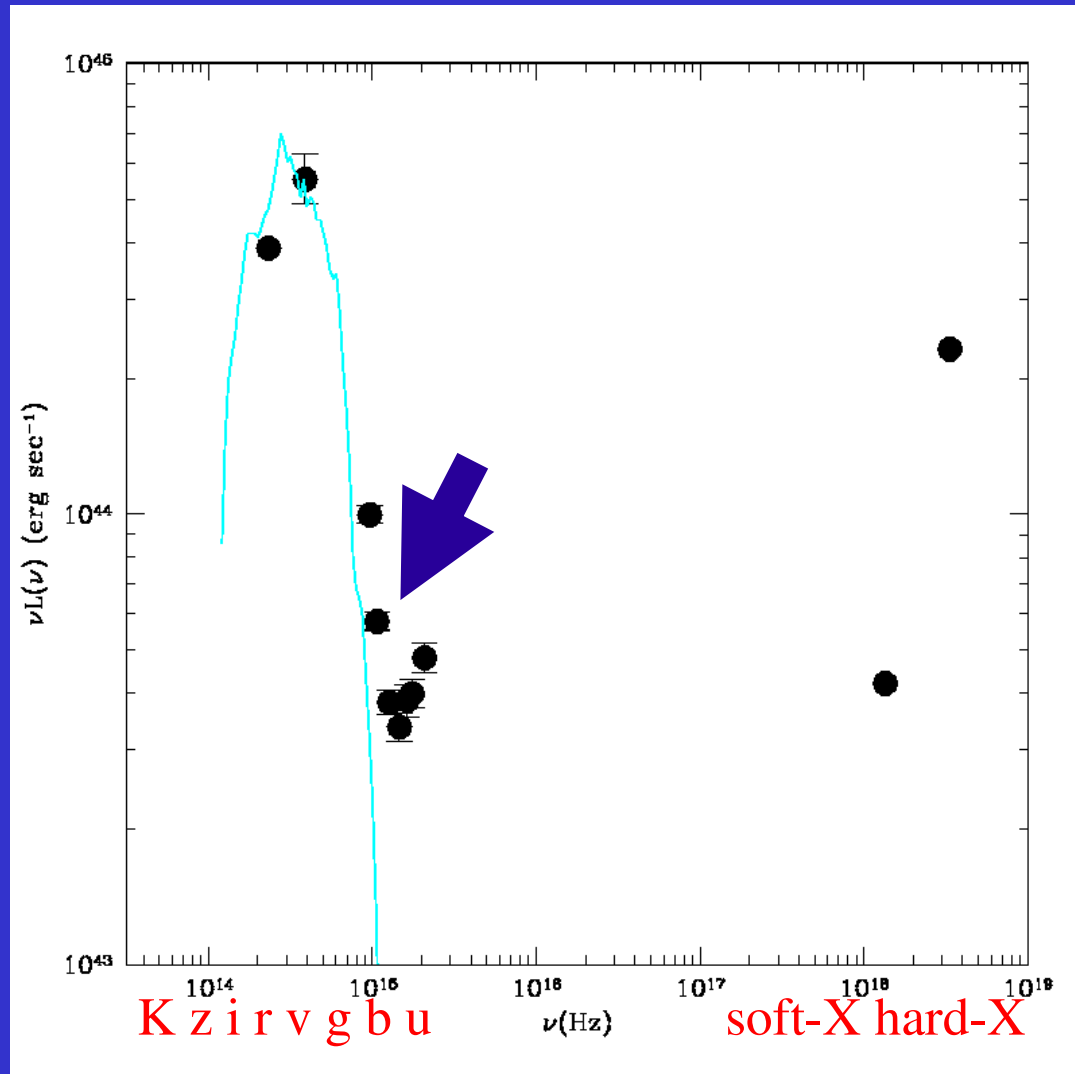
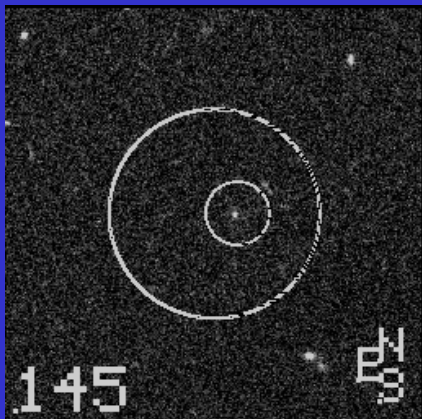


X-ray absorption
 $N_H \sim 10^{23}$

$A_V \geq 1$

Blue EXCESS

20% of the EROs show a Blue EXCESS with respect to an elliptical host



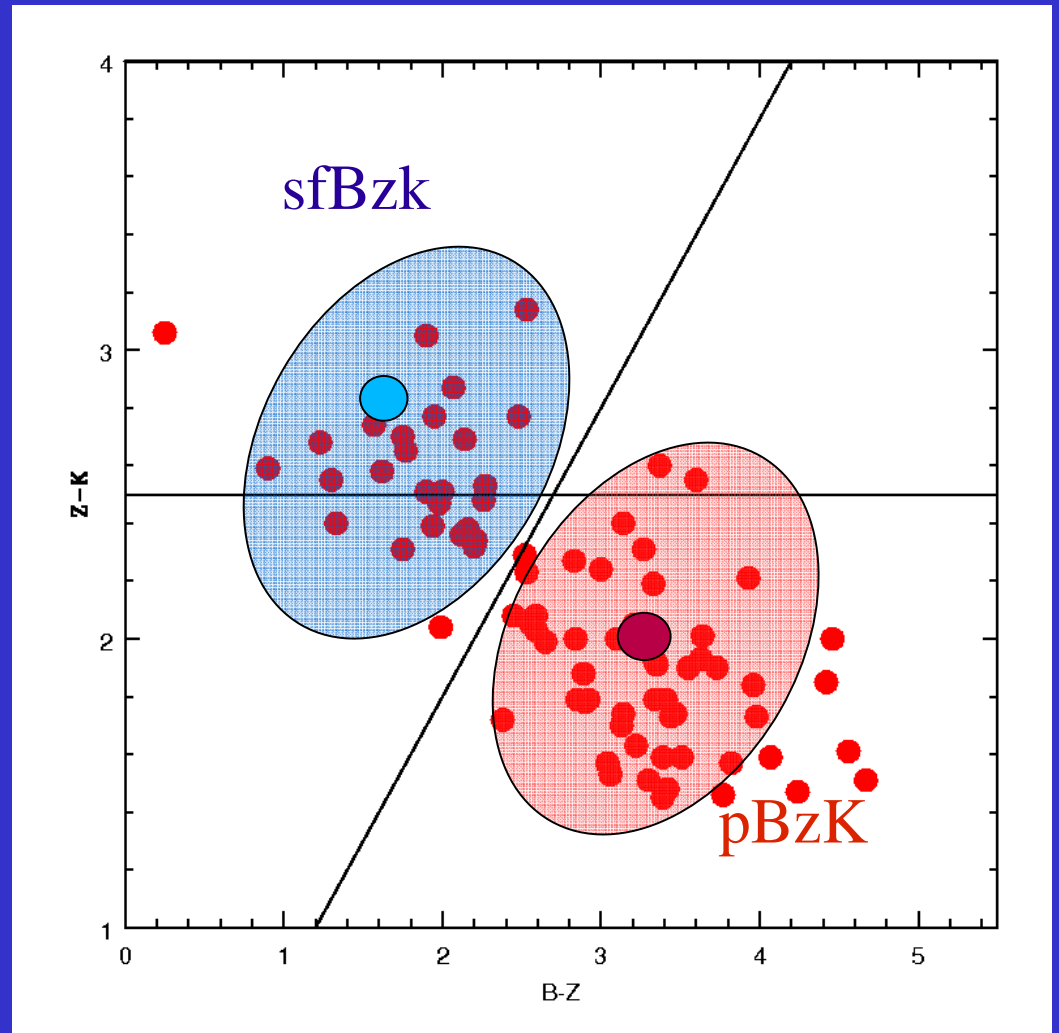
XID 145
z=1.8
R-K=5.9

- AGN with different X/UV-bump ratio
- Star formation activity

Color-color diagram: BzK plane

The BzK plane is a tool to select high redshift ($z \sim 1.4$) starforming and passive galaxies (Daddi et al. 2004)

- Same distribution of the not X-ray emitting EROs
- Separation between star forming and passive BzK
- Sources with UV excess in the SED occupy the star forming region



BH mass vs L_x

Evidences:

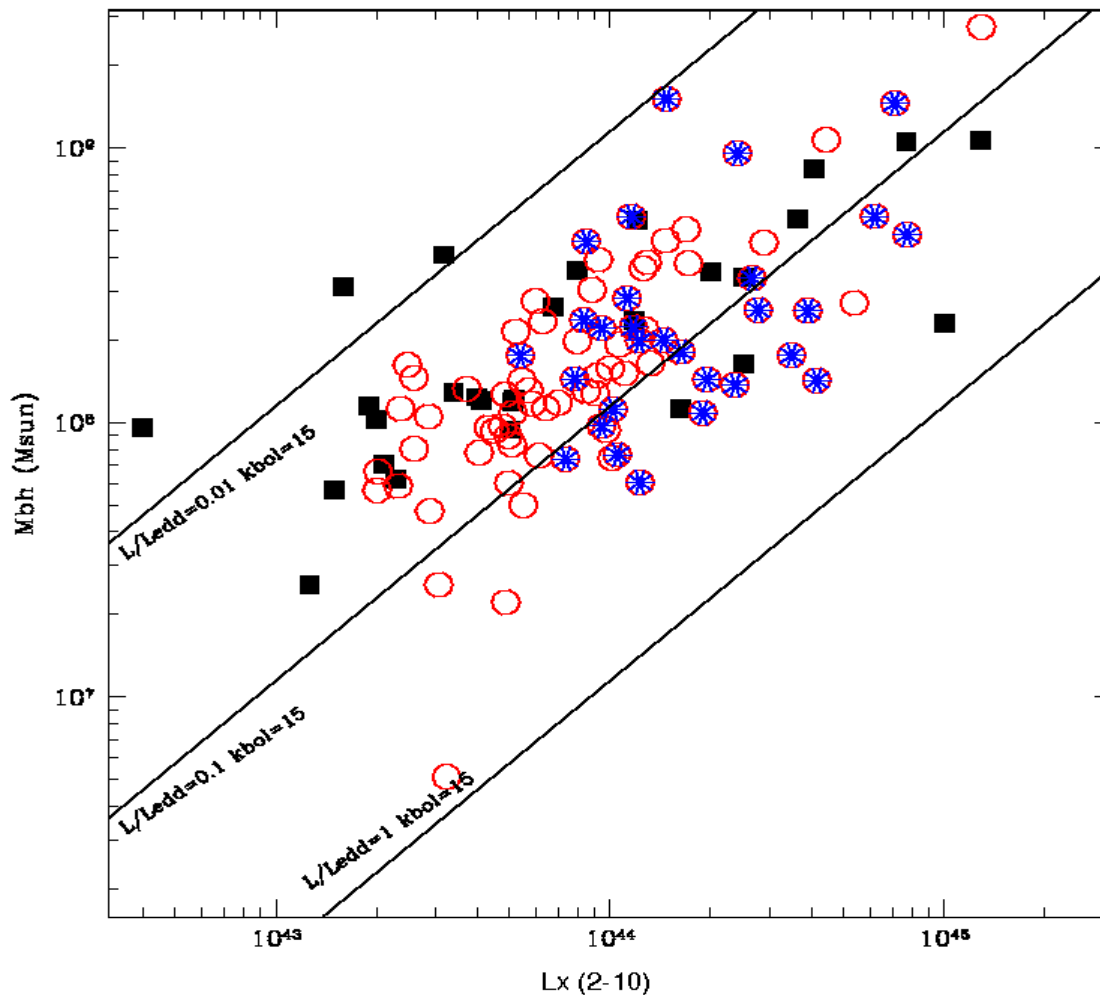
- K emission comes from the host galaxy
- X-ray emission comes from the AGN

Assumptions:

- Marconi & Hunt 2003 relation is true also at high redshift
- $K_{bol}=15$ appropriate for the luminosity range of the sample (from Marconi et al. 2004)

It is possible to estimate the BH masses

BH mass vs Lx plane



Brusa et al. 2005

+
83 X-EROs COSMOS

$L_{bol}/L_{edd} \sim 0.03-0.2$
 $MBH > 10^7 M_{sun}$

Star forming BzK have
on average higher L_x
than passive BzK

Summary

- 12% of the hard COSMOS sample are EROs
- EROs are on average more obscured than BLAGN
- 80% of the EROs have red colors completely due to the host galaxy contribution
- Hard colors are due to large amount of gas
- The dust to gas ratio is lower than the Galactic standard
- 20% of the EROs have an UV excess: weak UV bump or star forming phase ?
- AGN powered EROs have BH masses larger than $10^7 M_{\text{sun}}$ and are accreting with a $L_{\text{bol}}/L_{\text{edd}} \sim 0.03-0.2$