Connecting Galaxy Evolution, Star Formation and the X-ray Background

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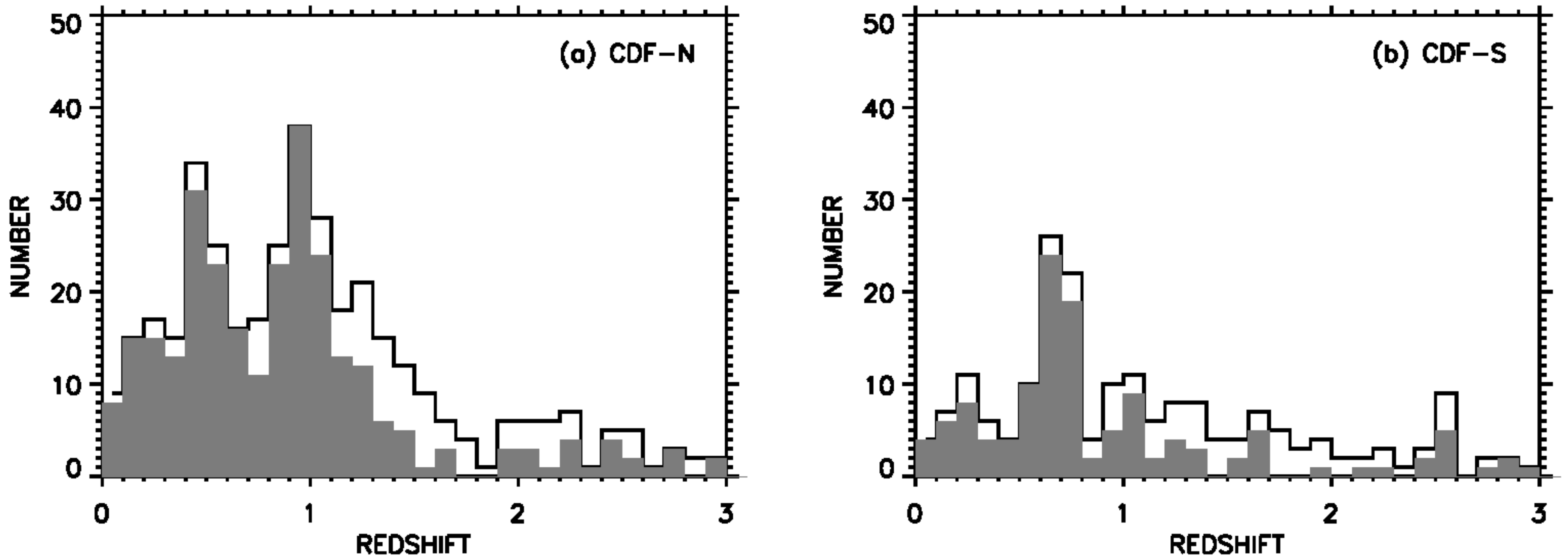
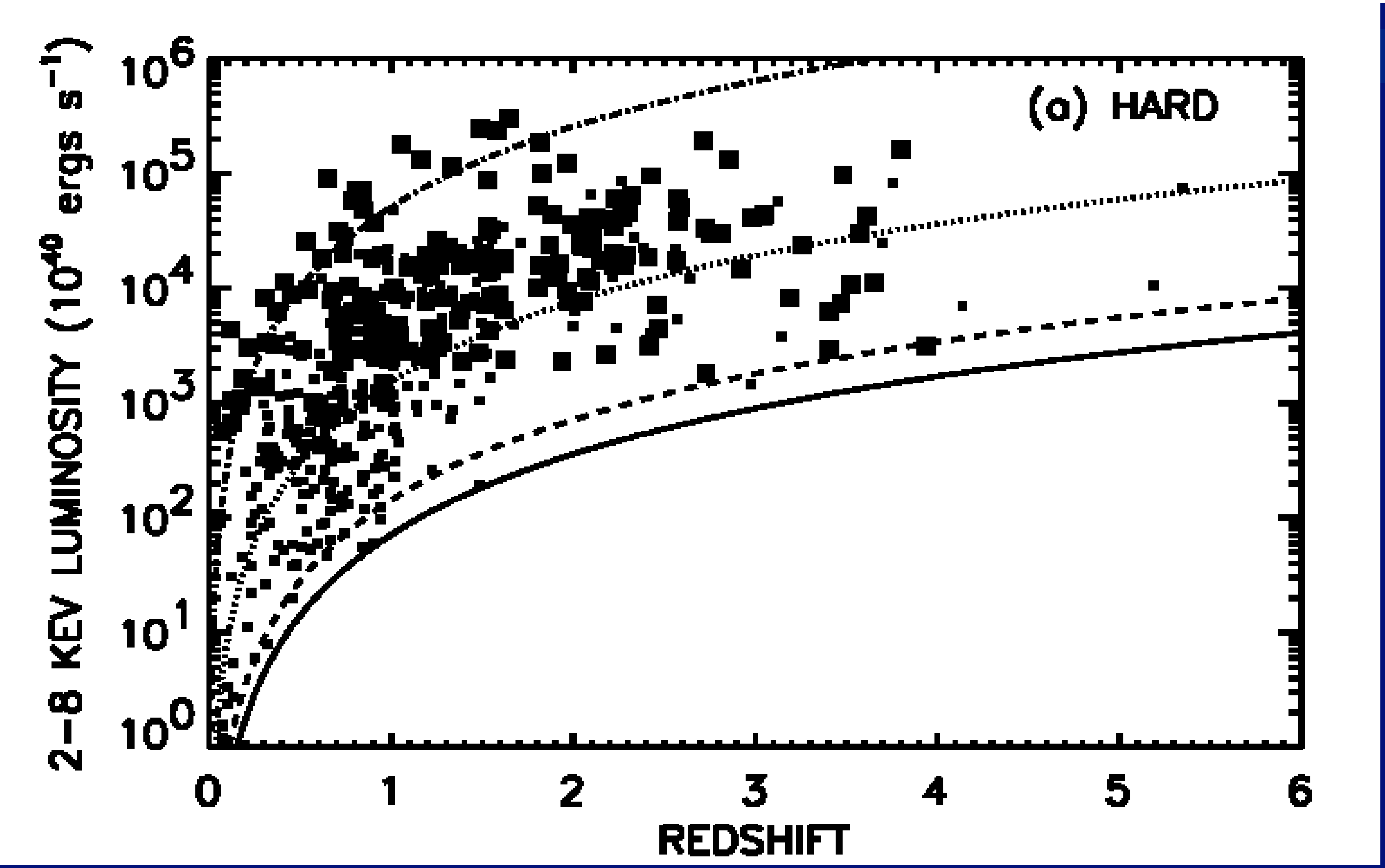
Along with: J. Everett & N. Murray (CITA)



Barger et al. (2005)

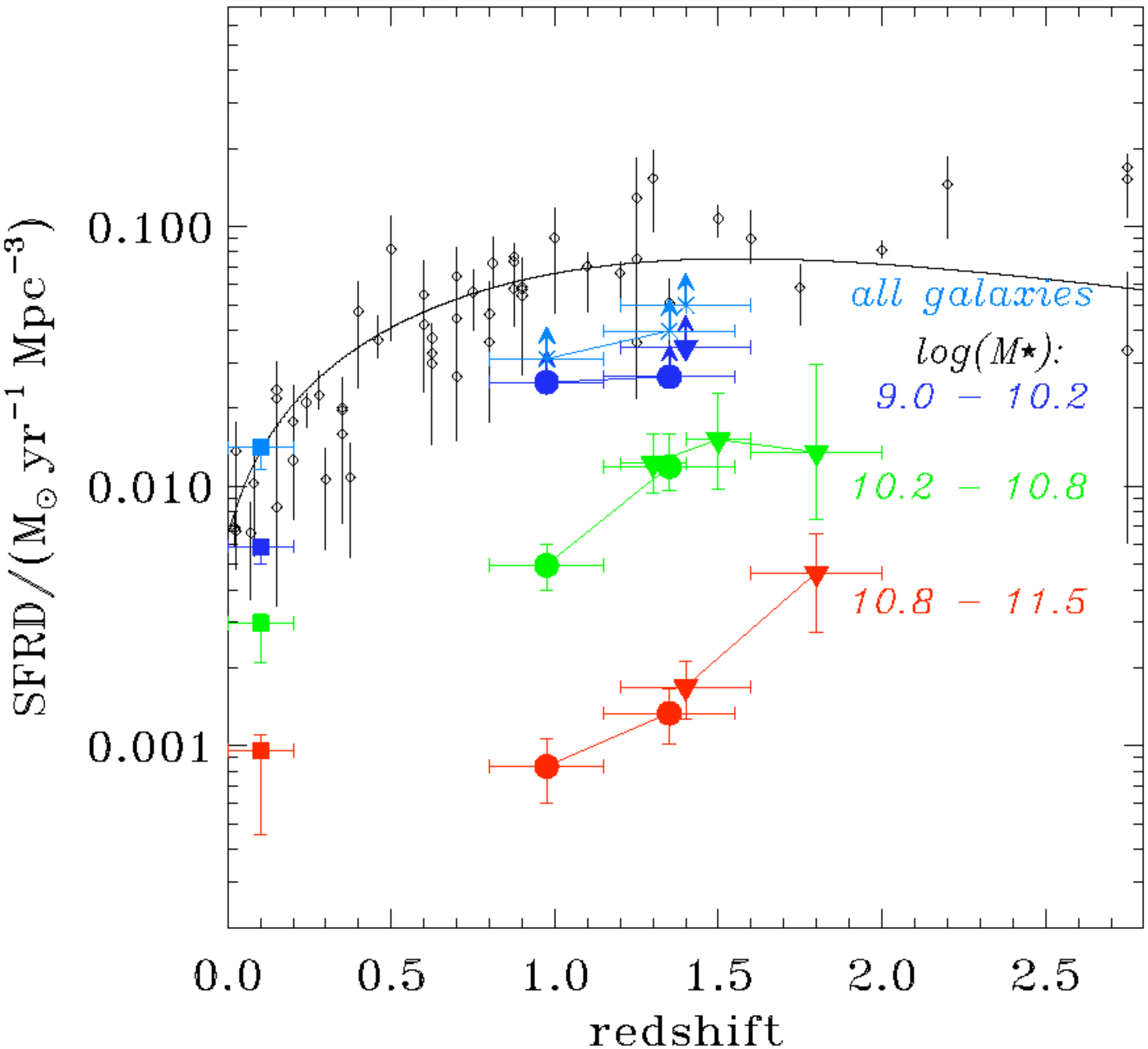
- The redshift distribution of the sources peak at z <~ 1
- Quasars, the most powerful AGN, are mostly found at z ~ 2-3



Barger et al. (2005)

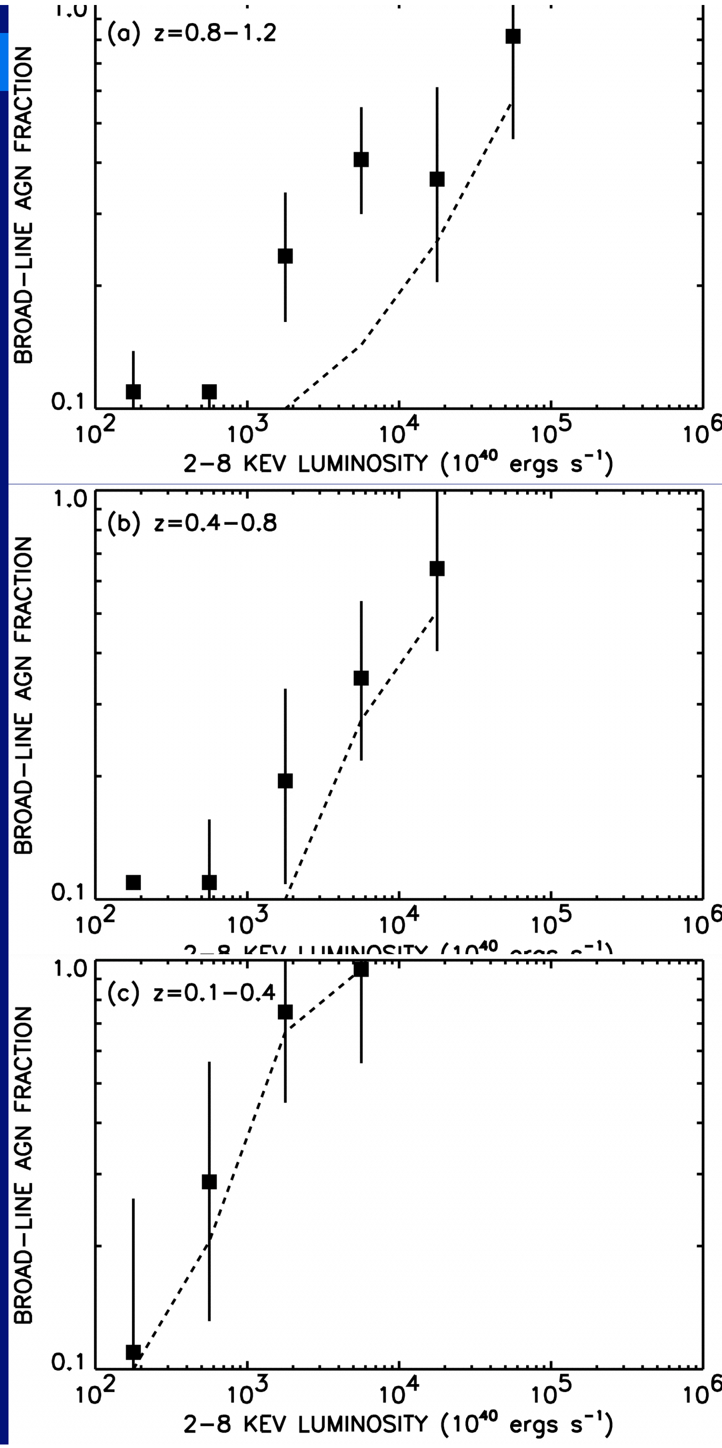
- The sources typically have X-ray luminosities < 10^{44} erg/s
- Again much less than quasars (> 10^{45} erg/s)

Connection to Star-Formation History?



Juneau et al. (2005

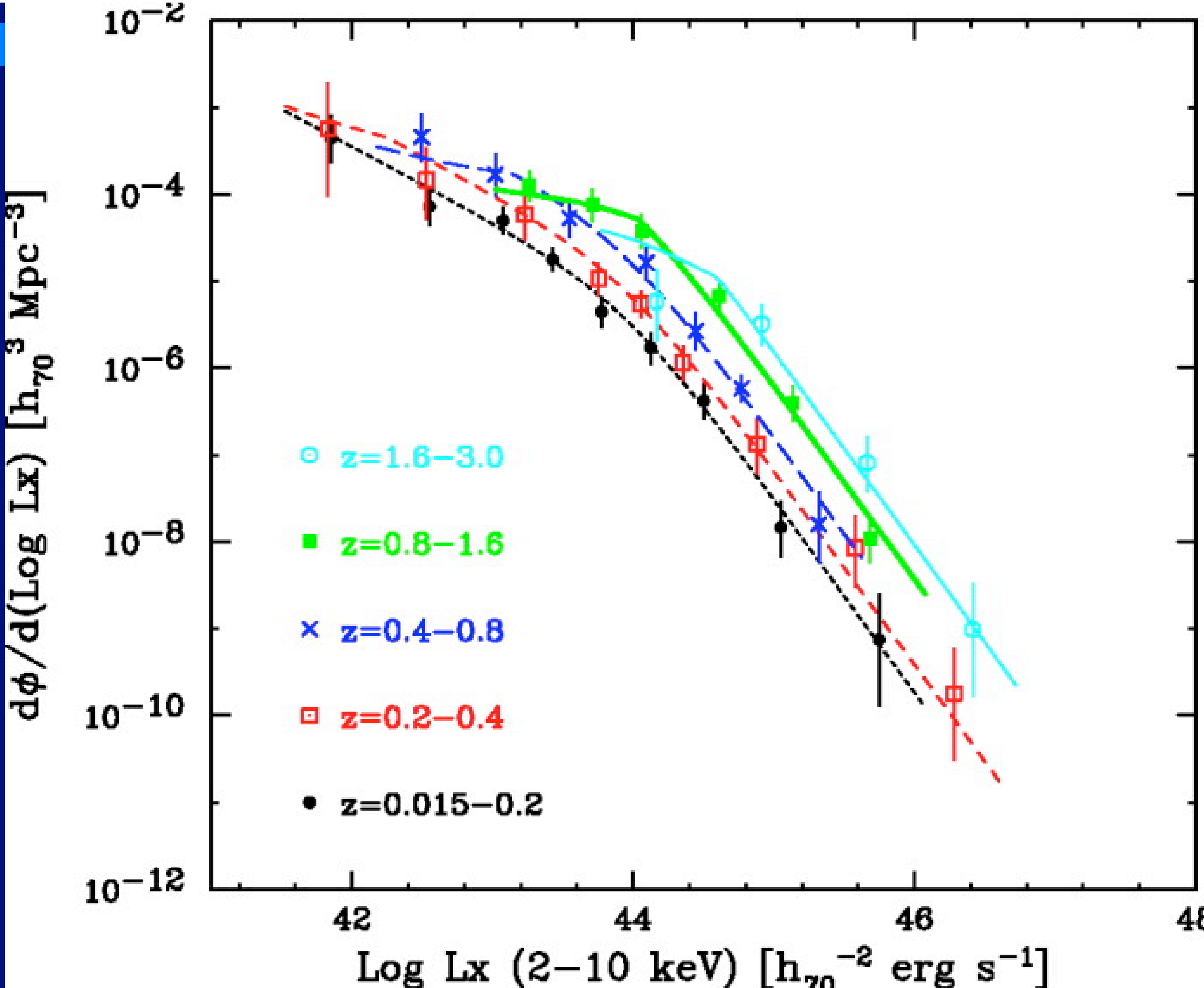
- The peak in the XRB z dist'n is close to where the cosmic SFR reaches its max
- The sources which produce the XRB are mostly obscured Seyfert-like AGN
- Hypothesis:
  - The increase in obscured AGN to z~1 is directly related to the increase in the cosmic SFR
  - i.e., the obscuration around the AGN is regulated by the host galaxy SFR -> it must evolve with z
- Prediction:
  - a Type 2/Type 1 ratio that evolves with z



Barger et al. (2005)

Testing the model

- Compute an XRB synthesis model and determine if there is a model that can simultaneously account for
  - the spectrum of the XRB
  - the number counts of X-ray sources in the 0.5-2 and 2-8 keV bands
  - the Broad-Line AGN fractions measured by Barger et al.



Ueda et al. (2003)

The N_H Distribution

- Need to specify what fraction of AGN are absorbed by a specific column
  - in general, will be a function of z and L
  - only observed constraints are local
- Define AGN absorbed by columns with $N_H < 10^{22}$ cm^{-2} as Type 1; otherwise, Type 2
- 10 N_H bins are defined: log N_H = 20, 20.5, …, 24, 24.5
- As a first try use a flat distribution
  - also used the Risaliti et al. (1999) dist'n where 50% of all Sy 2s are Compton thick

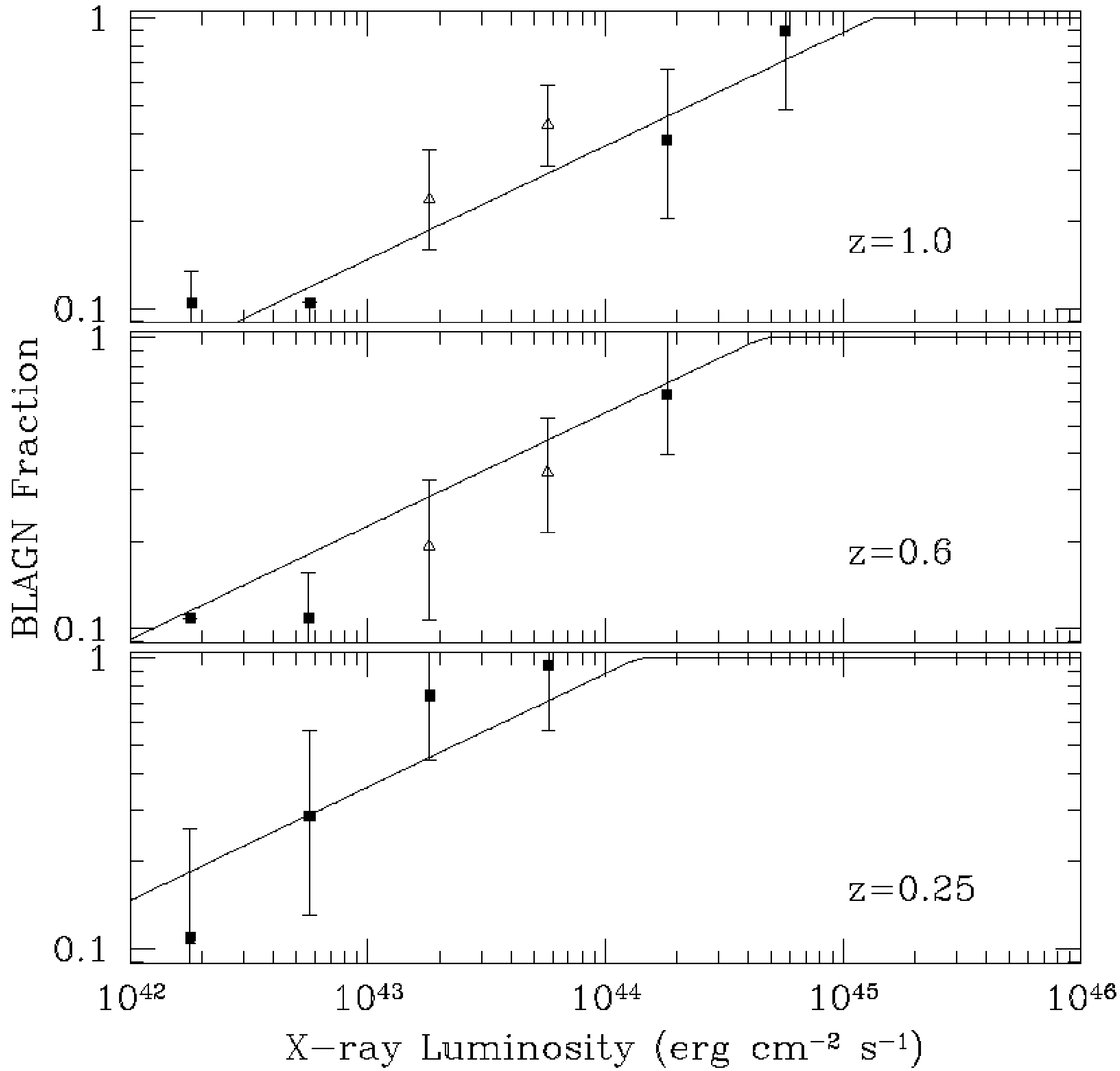
Methodology

- First search for an evolution in the AGN Type-2/Type-1 ratio, *R*, that best accounts for the Barger et al. data
  - four different (arbitrary) parameterizations are used
  - all have a (1+z)– term
  - z evolution is halted at z=1
- One other free parameter is the value of *R* at z_{min} and L_{min}, R_0
  - consider models with R_0 varying from 1,2,..,9,10

Results

R_0=6

Type 1 fract. ∝ $(1+z)^{-1.9}$



Ballantyne et al. (2005)

Results

R_0=6

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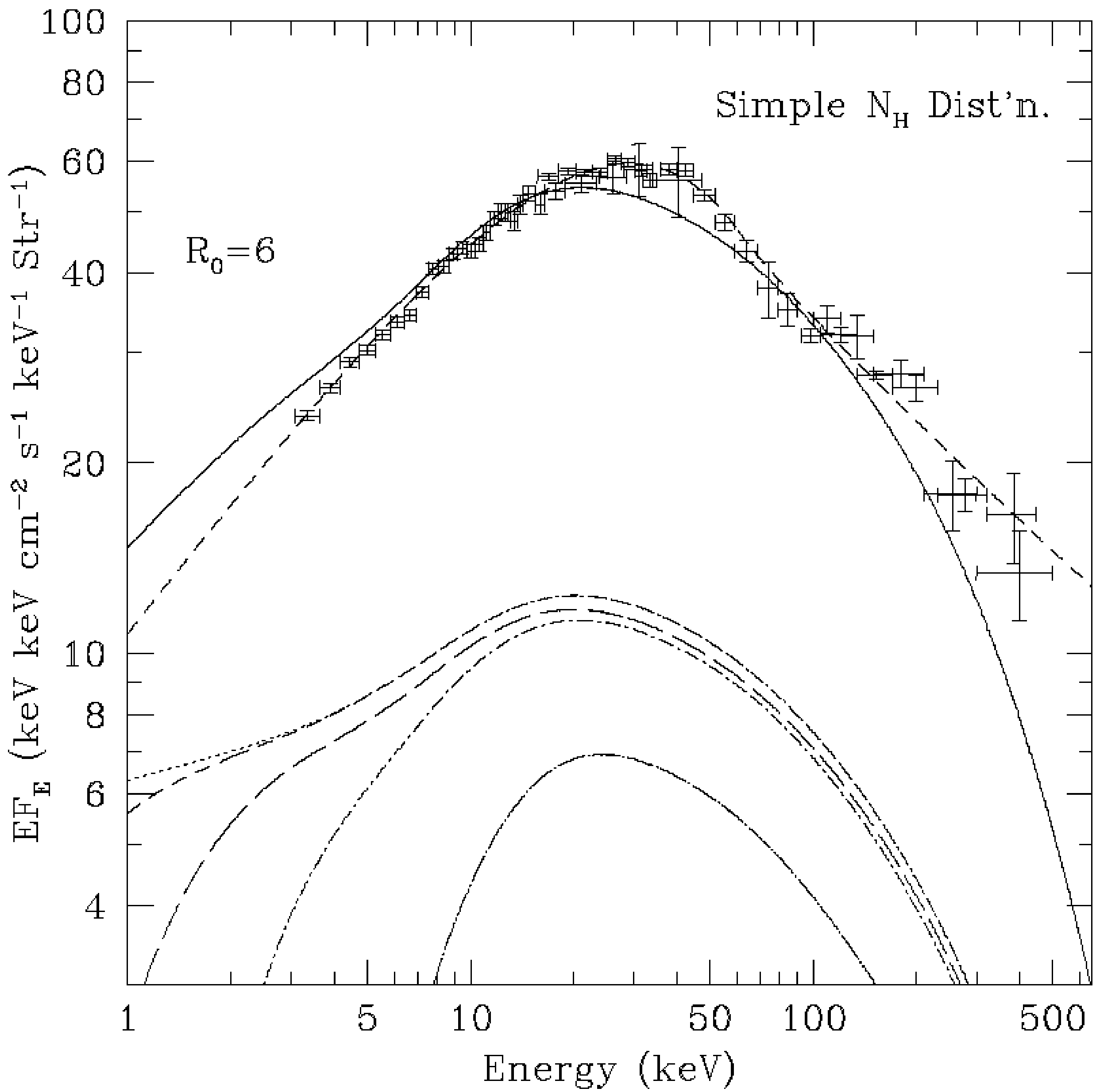
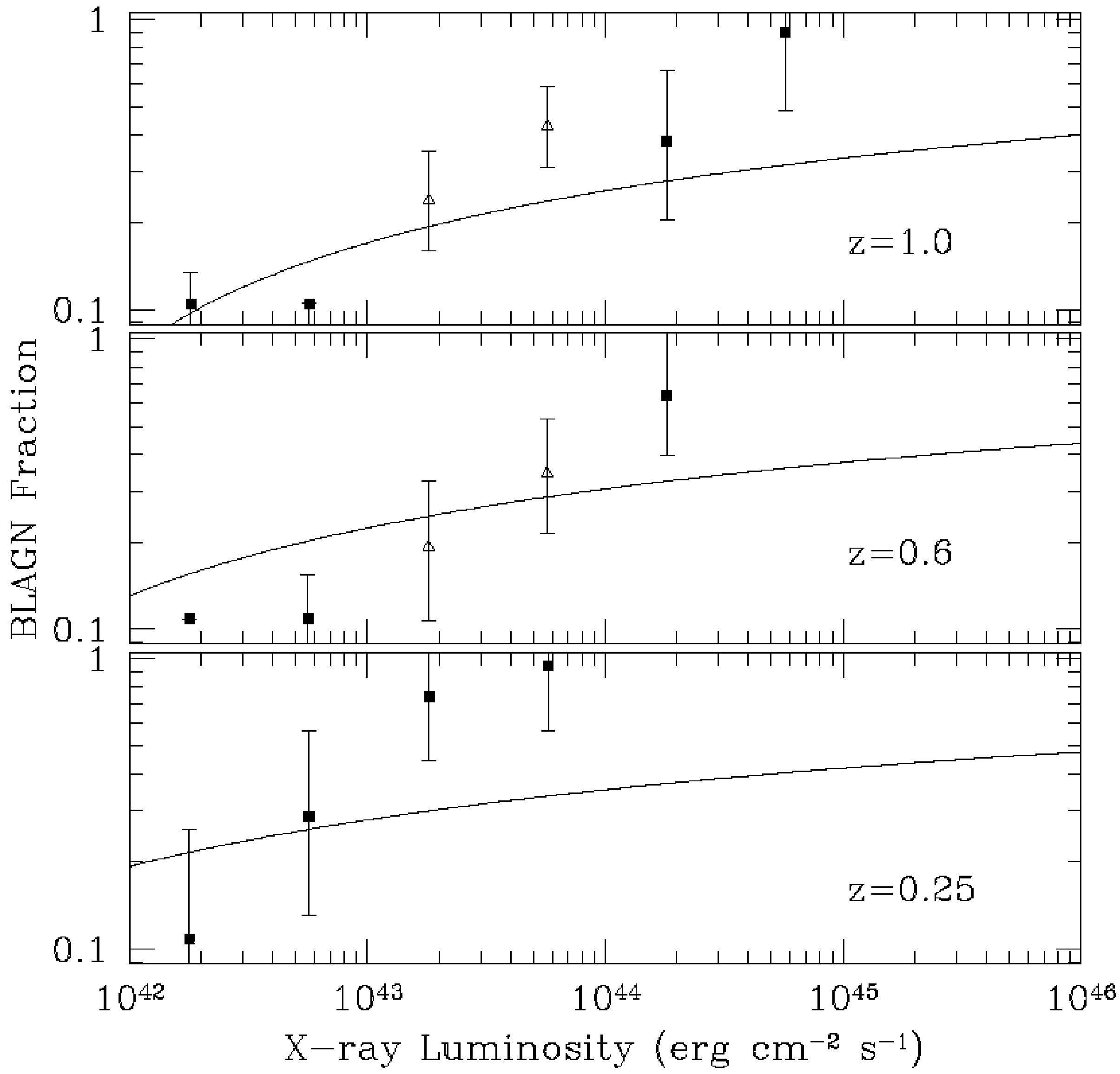


Ballantyne et al. (2005)

Results

R_0=4 (cf., Maiolino & Rieke 1995)

Type 2 fract. ∝ $(1+z)^{0.3}$



Ballantyne et al. (2005)

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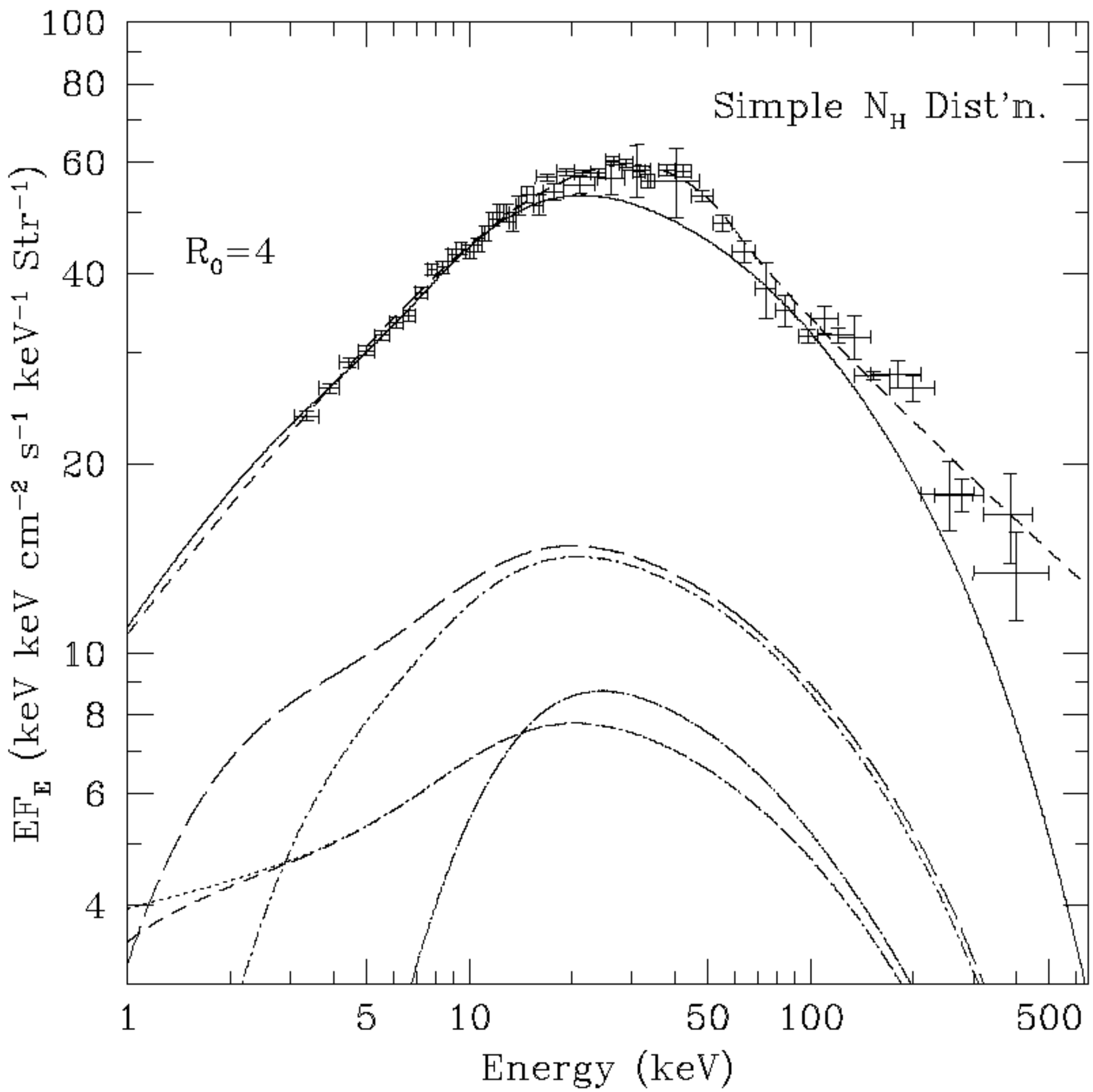
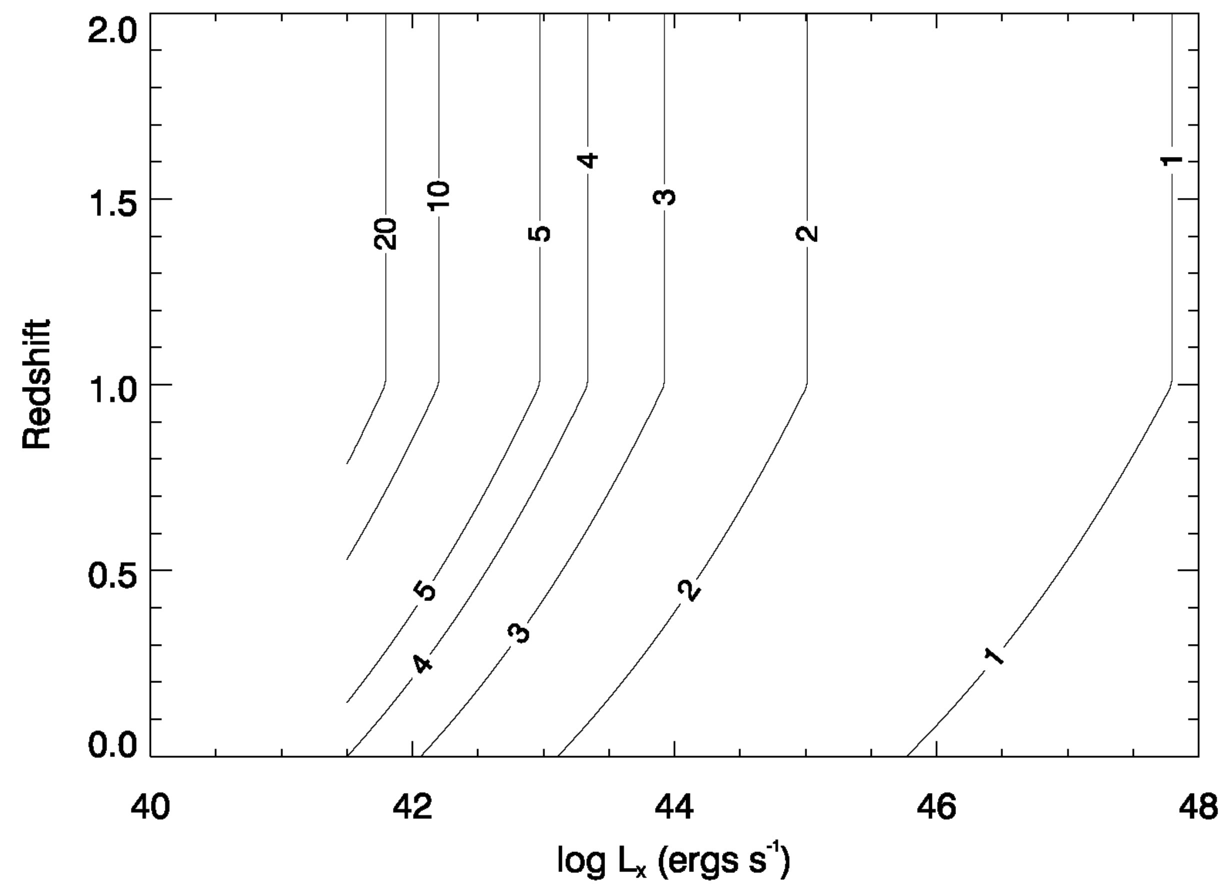


Ballantyne et al. (2005)

Results

R_0=4 (cf., Maiolino & Rieke 1995)

Type 2 fract. $\propto (1+z)^{0.3}$

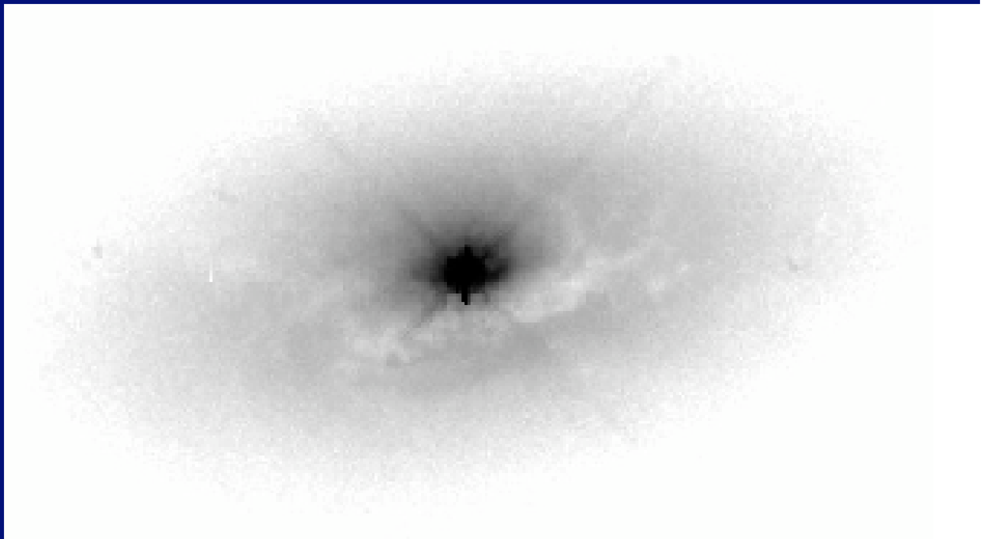


Contours of Type 2/Type 1 ratio

Ballantyne et al. (2005)

Implications

- The absorbing gas around an AGN is regulated by SF processes in the host galaxy
  - the obscuring medium could be spread over a range of radii



MCG-6-30-15; Malkan et al. (1998)

Implications

- The star formation and AGN in these galaxies are fueled by interactions and minor mergers
- Seyferts are distinct from quasars in more than their luminosity!

NGC 1531 & 1532

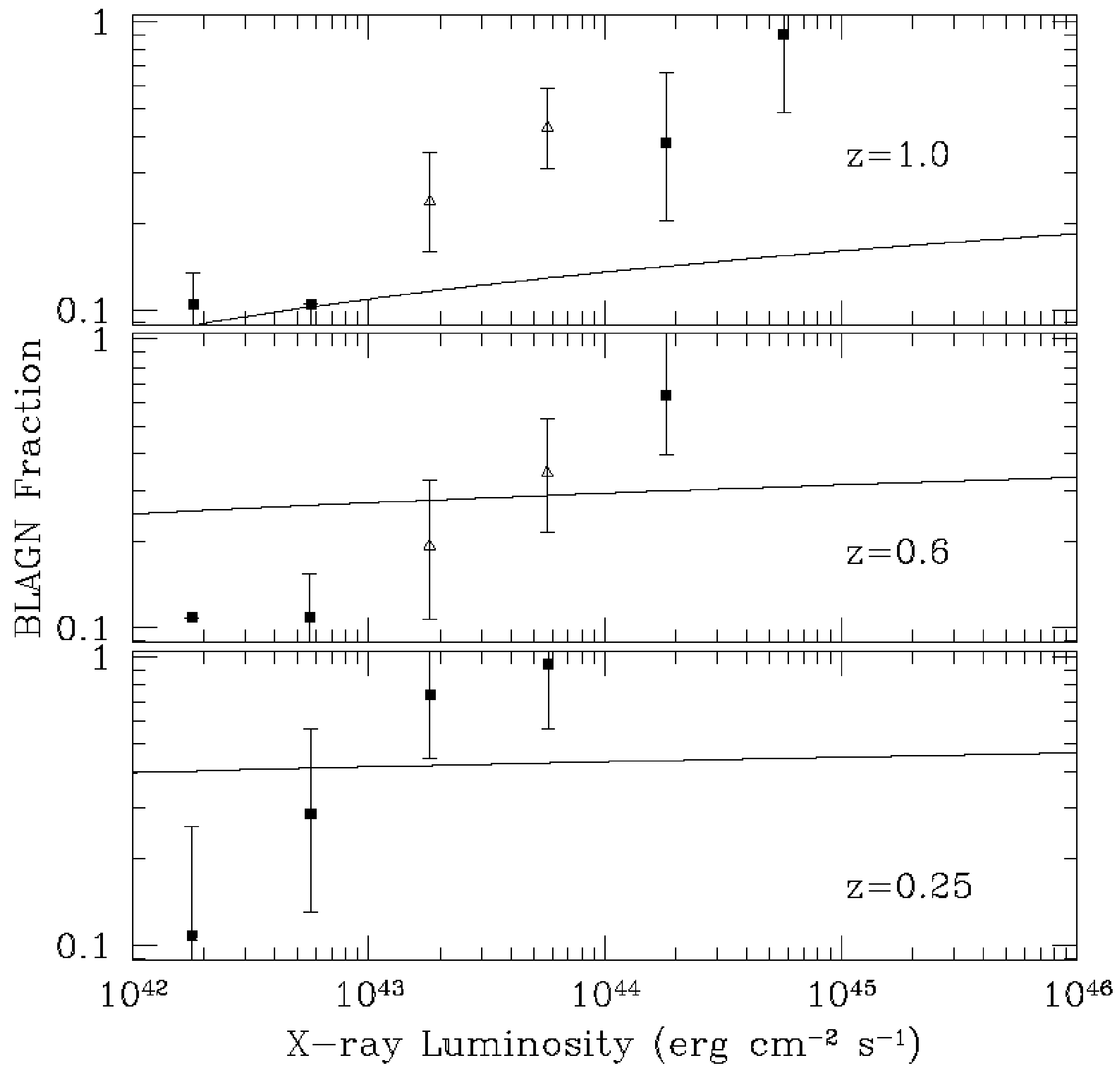
Conclusions

- The Barger et al. (2005) Type 1 fractions indicate that z evolution of *R* is required
- A model which can account for the Barger data, the CXRB spectrum and number counts has R_0=4
  - The Type 2 fraction in this model evolves as $(1+z)^{0.3}$
- A simple, non-evolving torus cannot alone provide the AGN obscuration over all cosmic time
  - the shape of the CXRB spectrum is due to obscuration correlated with the SFR in the host galaxy
- Seyfert galaxies, which mainly produce the CXRB, are likely fueled by minor mergers and interactions
  - there may be a sig. delay b/w the interaction and the subsequent ignition of the AGN

Results

R_0=1 (Hao et al. 2005)

Type 2 fract. ∝ $(1+z)^{0.9}$



Ballantyne et al. (2005)

Results

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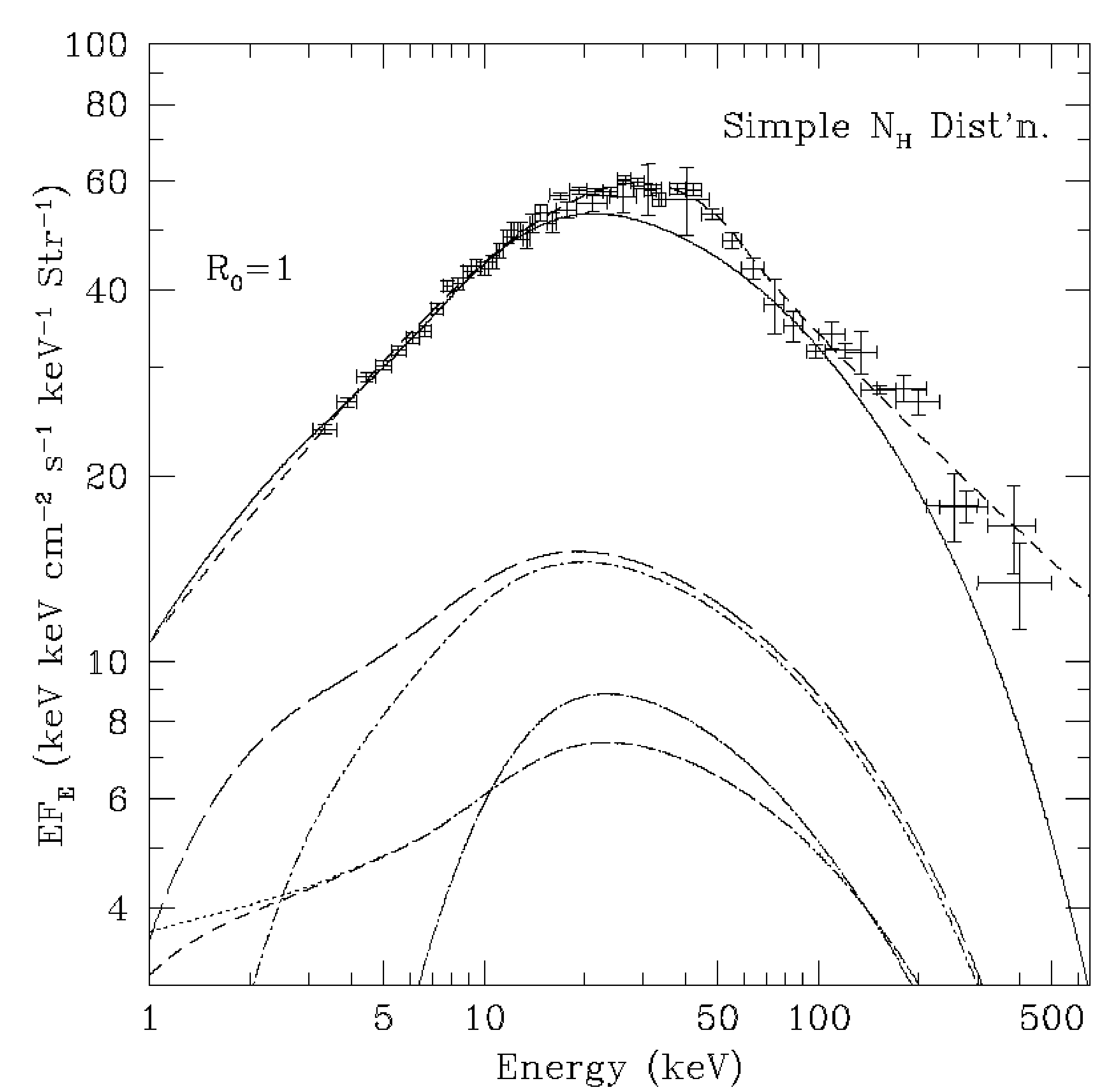

Ballantyne et al. (2005)