The AGN Butcher-Oemler Effect

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Collaborators

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Motivations

AGN feedback on galaxy clusters and cluster galaxies

Do AGN preheat the intracluster medium?

What are the triggers of AGN?

Allen et al.

The Butcher-Oemler Effect

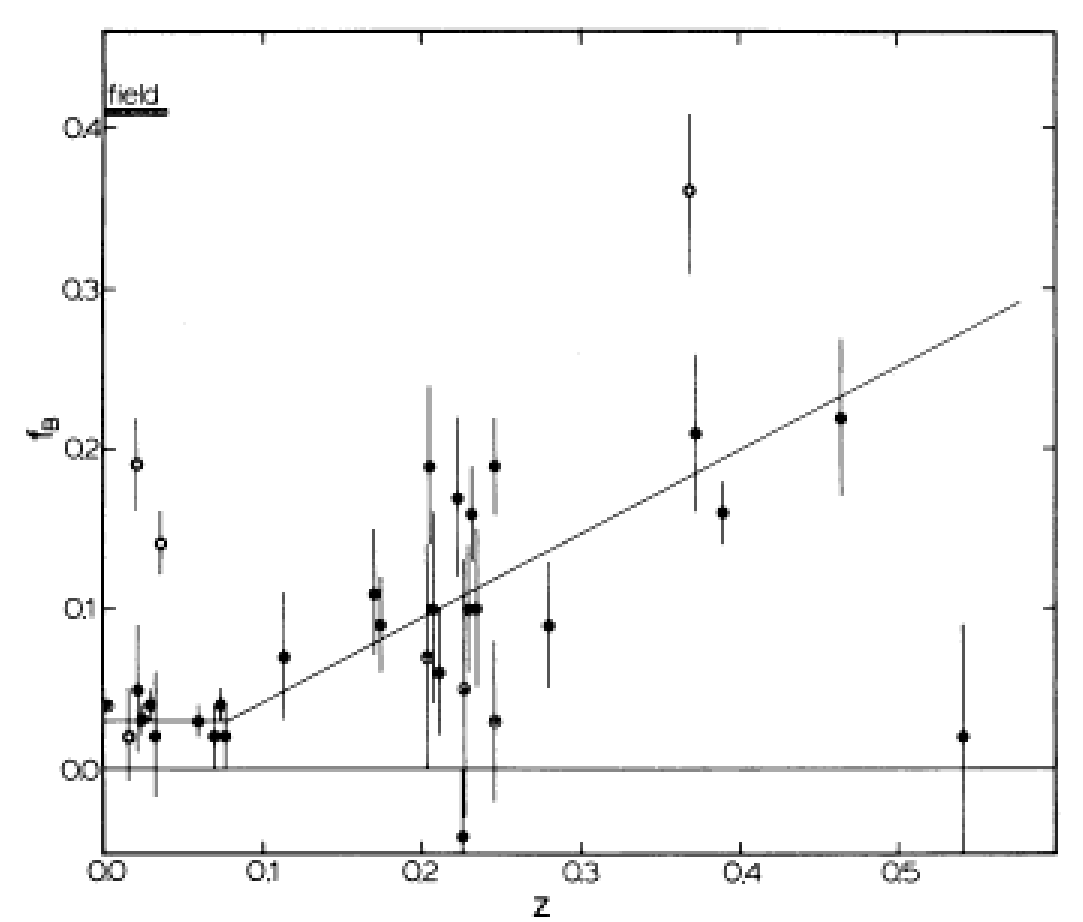


FIG. 3.—Blue galaxy fraction versus redshift. *Filled circles*, compact clusters ($C \geq 0.40$); *open circles*, irregular clusters ($C < 0.35$); *dotted circles*, intermediate clusters ($0.35 \leq C < 0.40$).

Butcher & Oemler (1984)

The Butcher-Oemler Effect

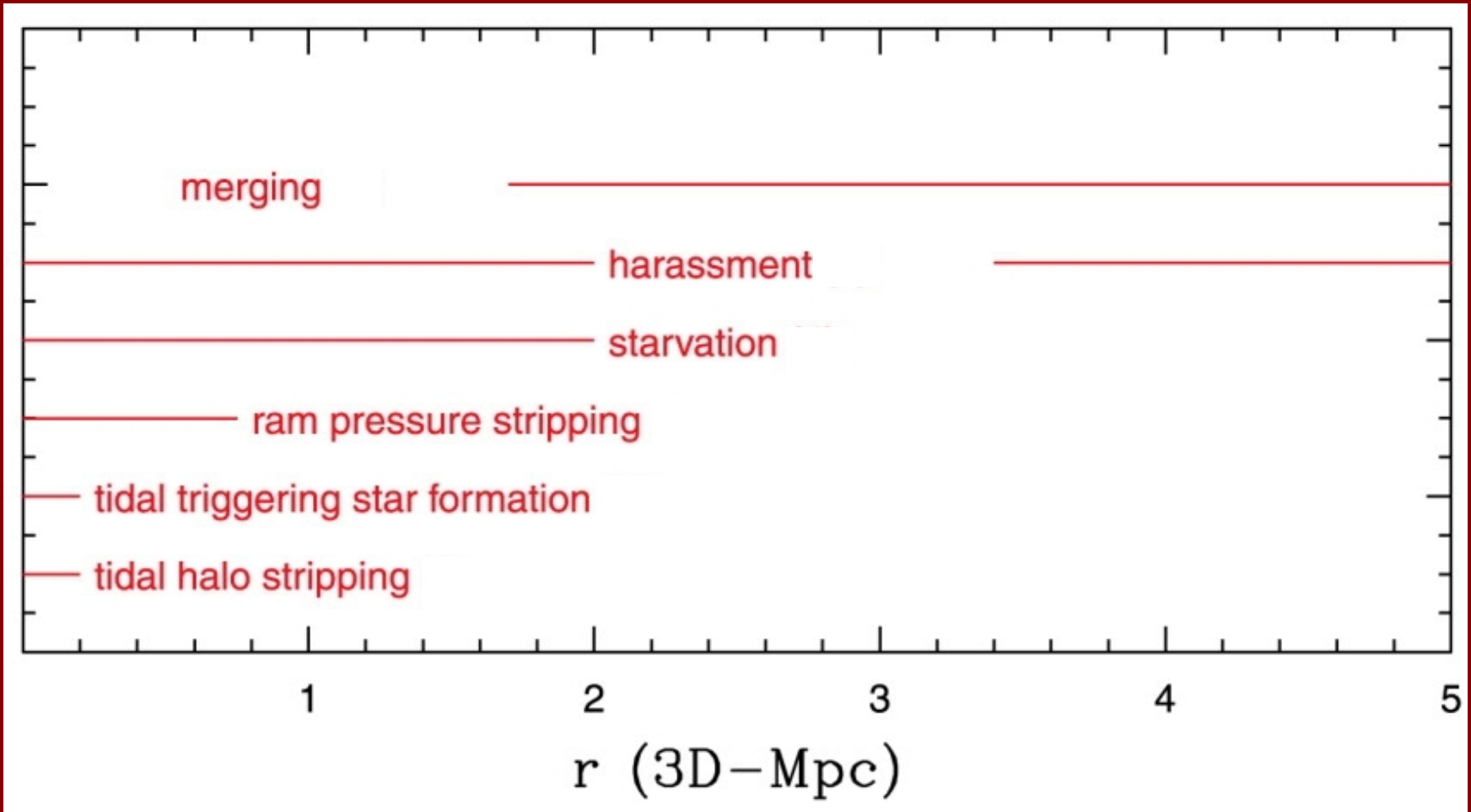
0.04 < z < 0.08

0.4 < z < 0.8

Galaxy Fraction with [OII]

Poggianti et al. (2006)

Galaxy Evolution in Clusters

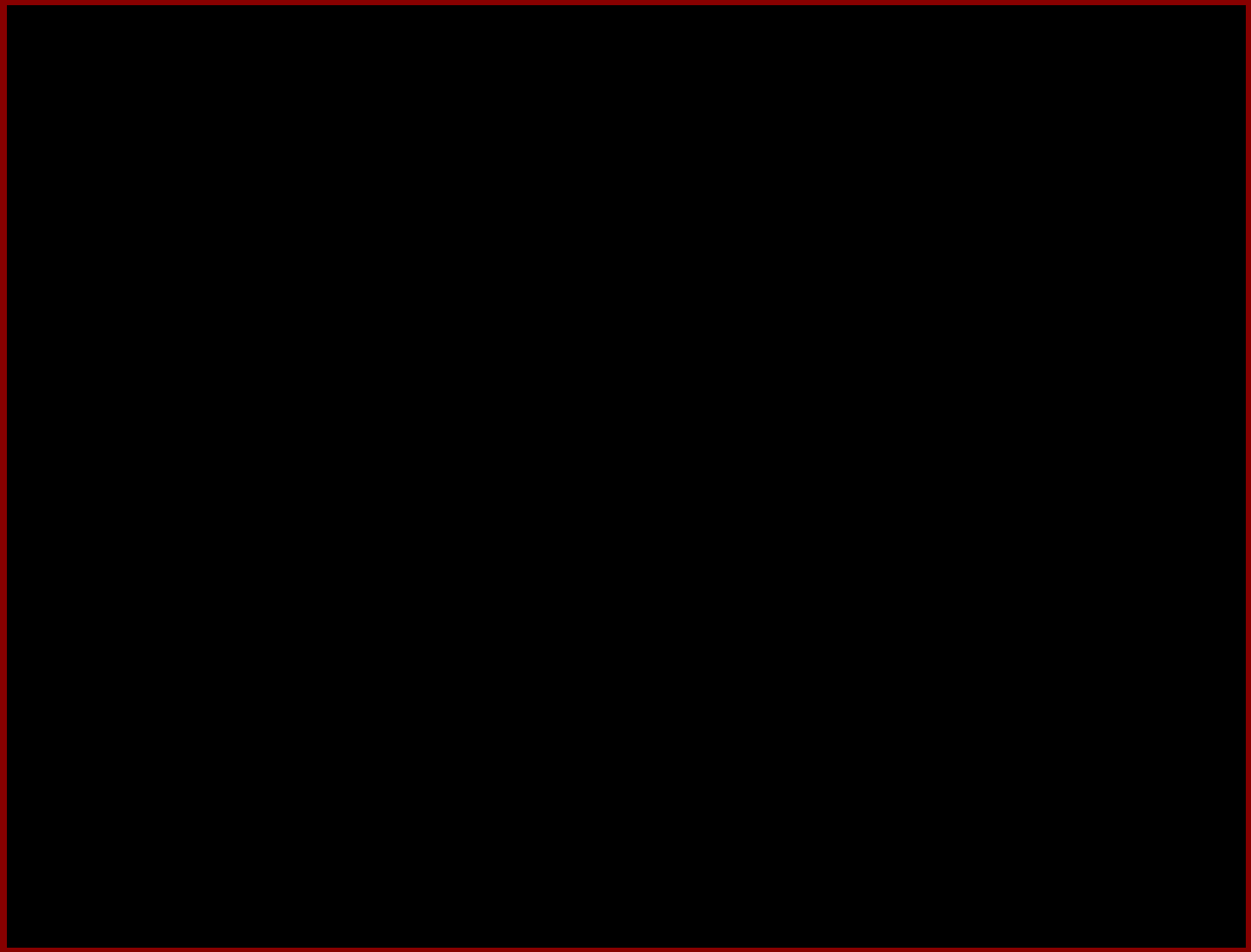


From Treu et al. (2003)

AGN Identification

Eastman et al. (2007)

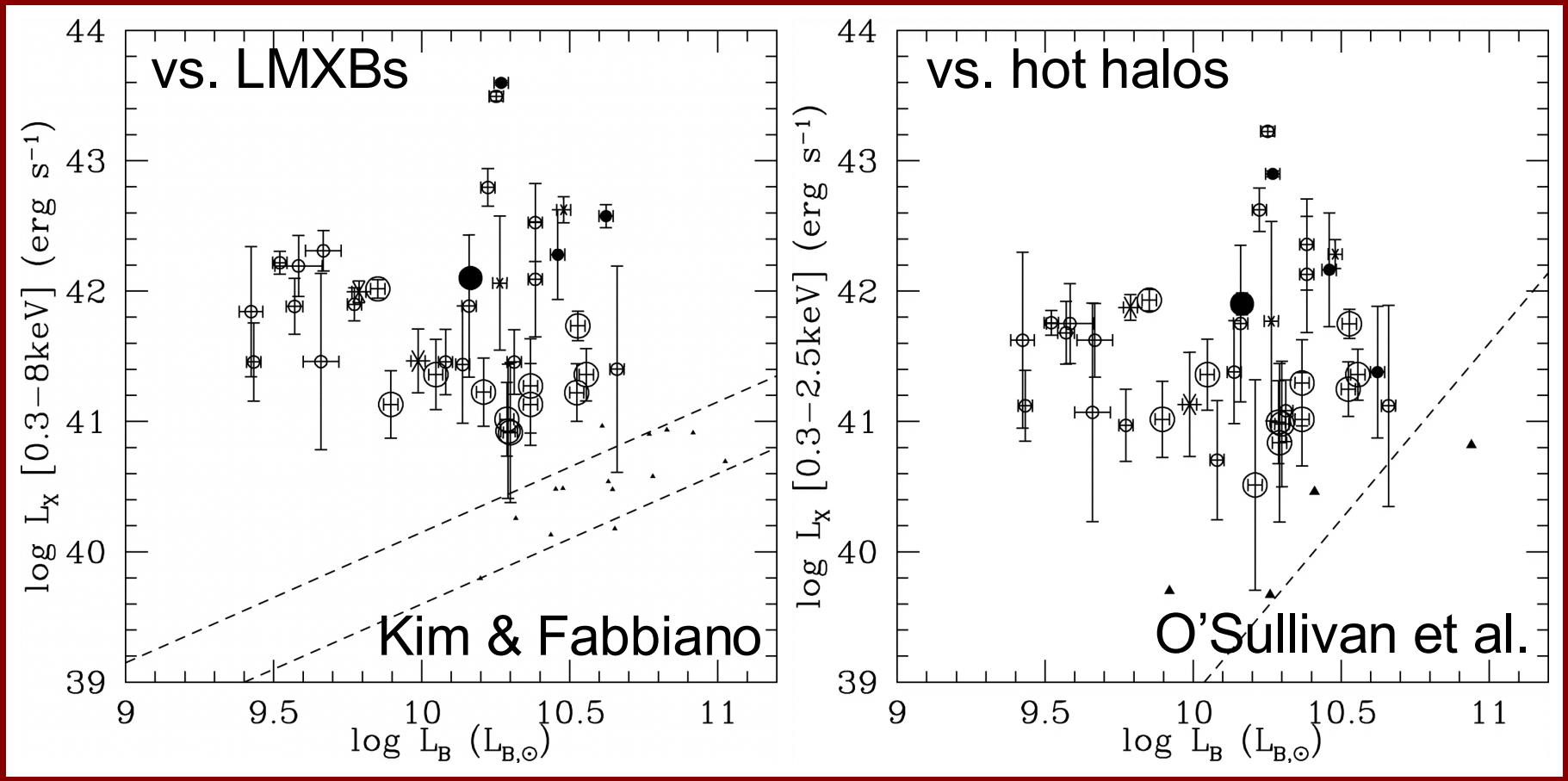
Determine Cluster Membership



Eastman et al. (2007)

AGN Classification

40 X-ray sources in 8 clusters with 0.06 < z < 0.3



35 are classified as AGN

Only 4 show AGN spectral signatures

Martini et al. (2006)

Evolution of the AGN Fraction

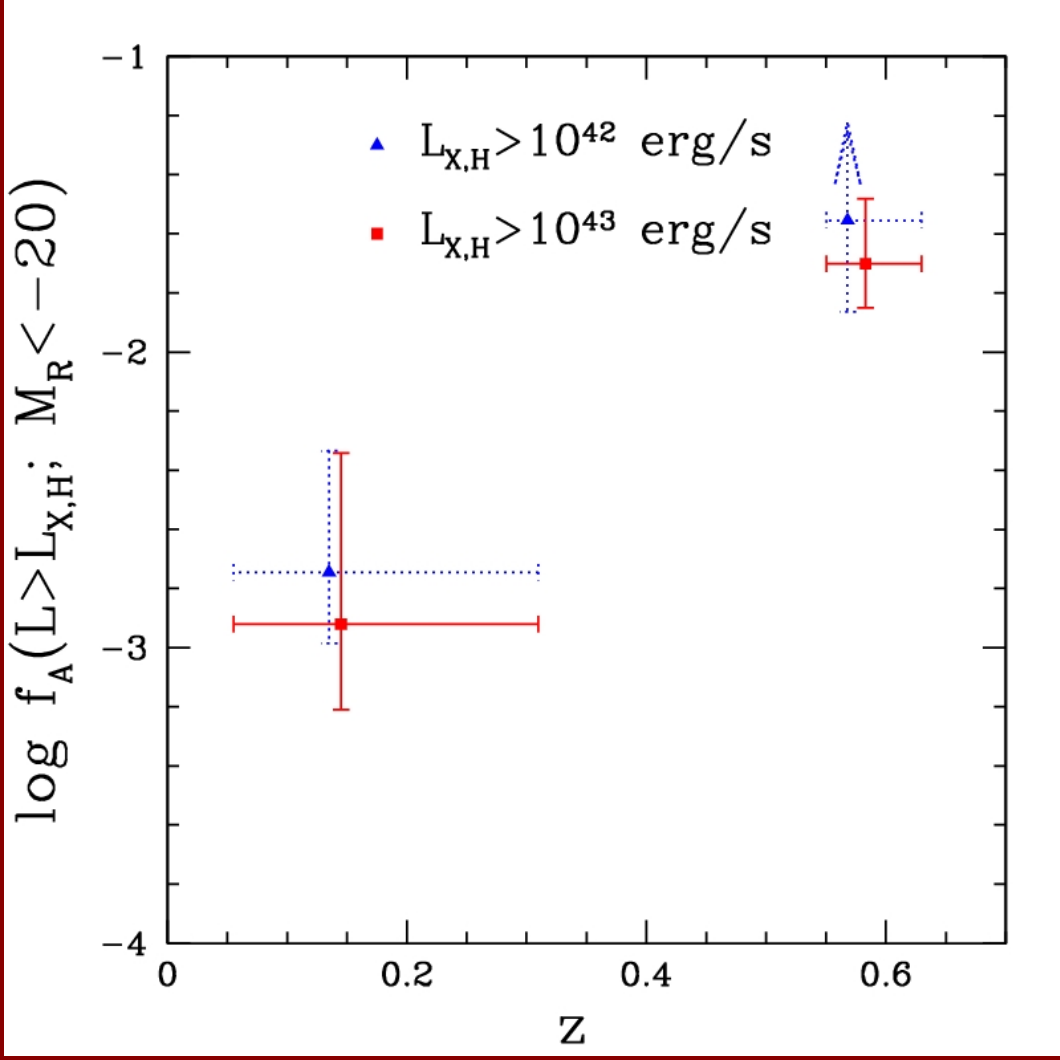
$$f_A = \frac{N_X\ (L>L_X;\ M_R<-20)}{N_{gal}\ (M_R<-20)}$$

Comparison of AGN in the low and high-redshift clusters shows:

- 11 low-z clusters have 2 AGN with $L_{X,H}$ $>10^{43}$ erg/s in over 1600 member galaxies
- 4 high-z clusters have 8 AGN with $L_{X,H}$ > 10^{43} in over 400 member galaxies

An AGN Butcher-Oemler Effect

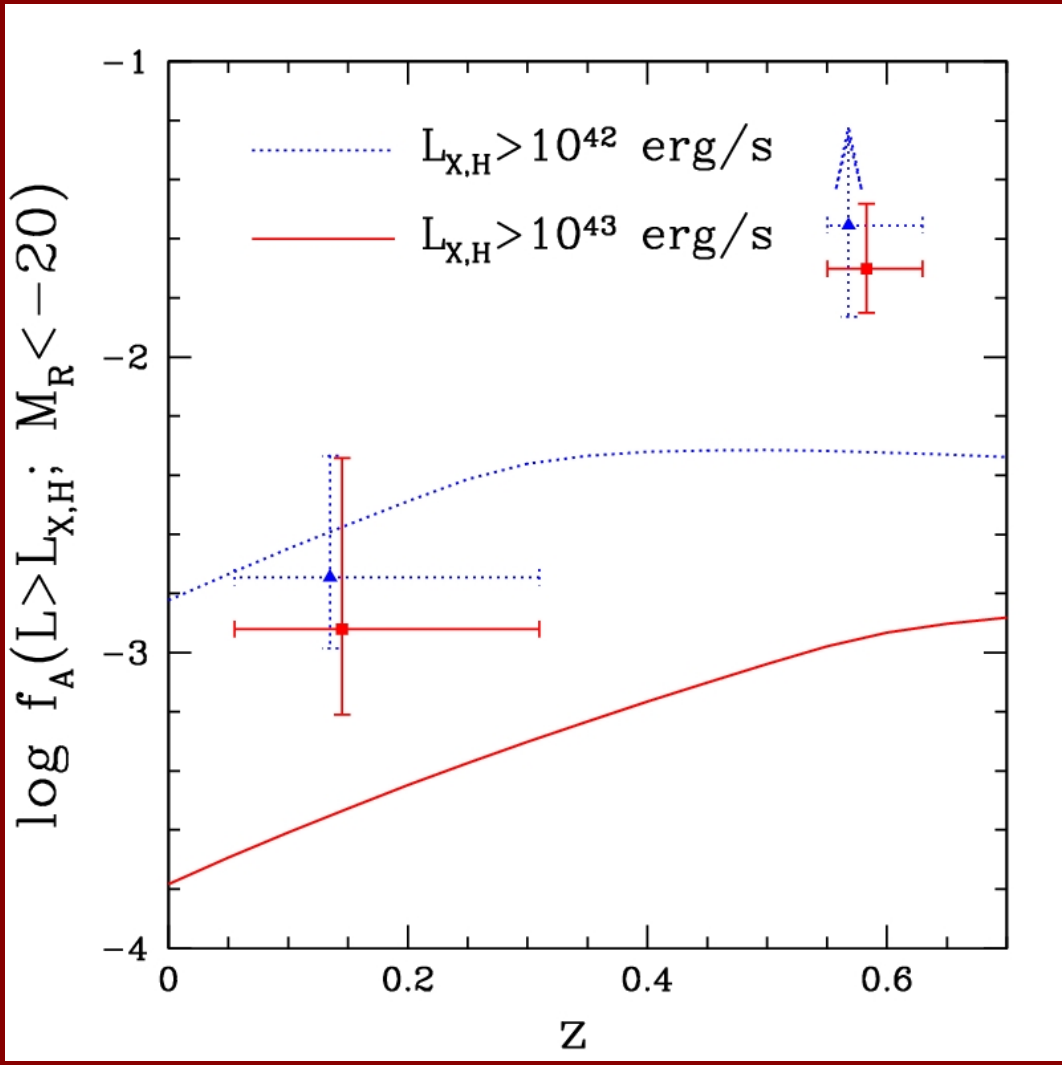
- Factor of >10 increase in the cluster AGN fraction
- Due to systematics, this is likely an underestimate



Eastman, Martini, et al. (2007), Sivakoff et al. (2007)

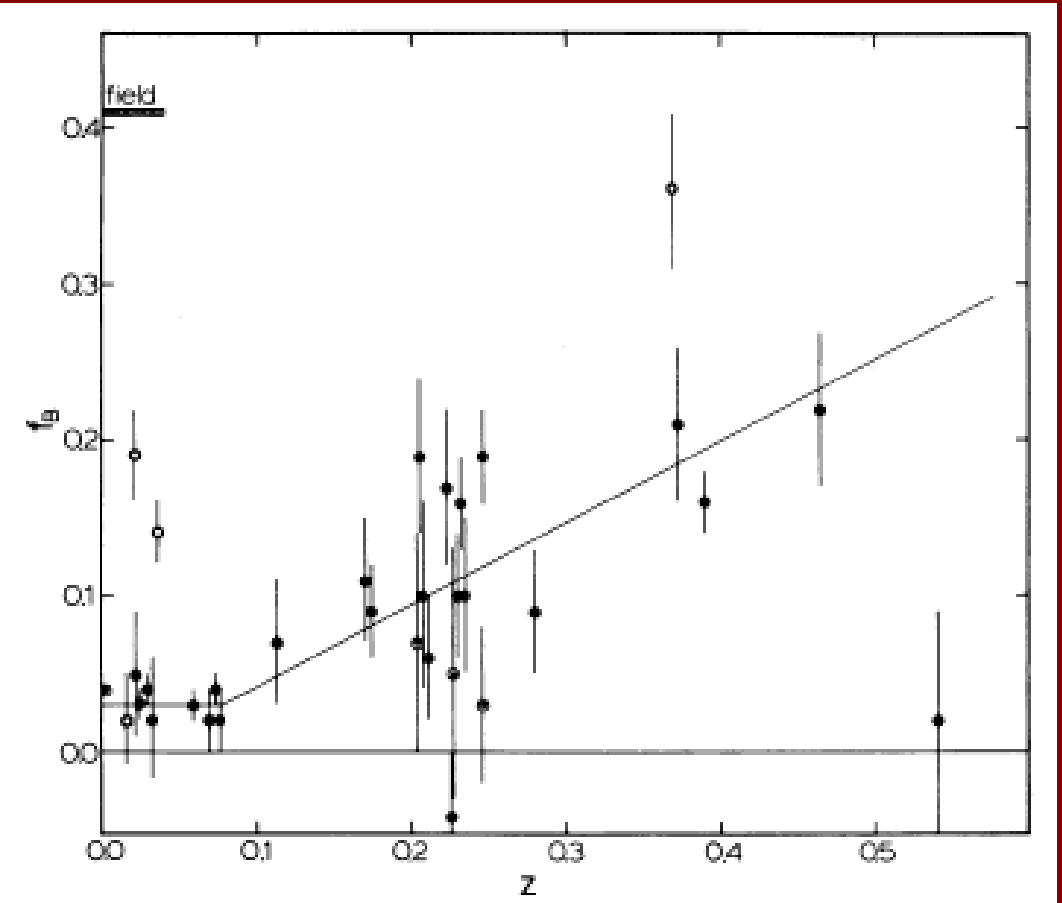
An AGN Butcher-Oemler Effect

- More pronounced than the field evolution (Ueda et al. 2003)
- Evidence for environment-dependent downsizing



Eastman, Martini, et al. (2007), Sivakoff et al. (2007)

The Butcher-Oemler Effect



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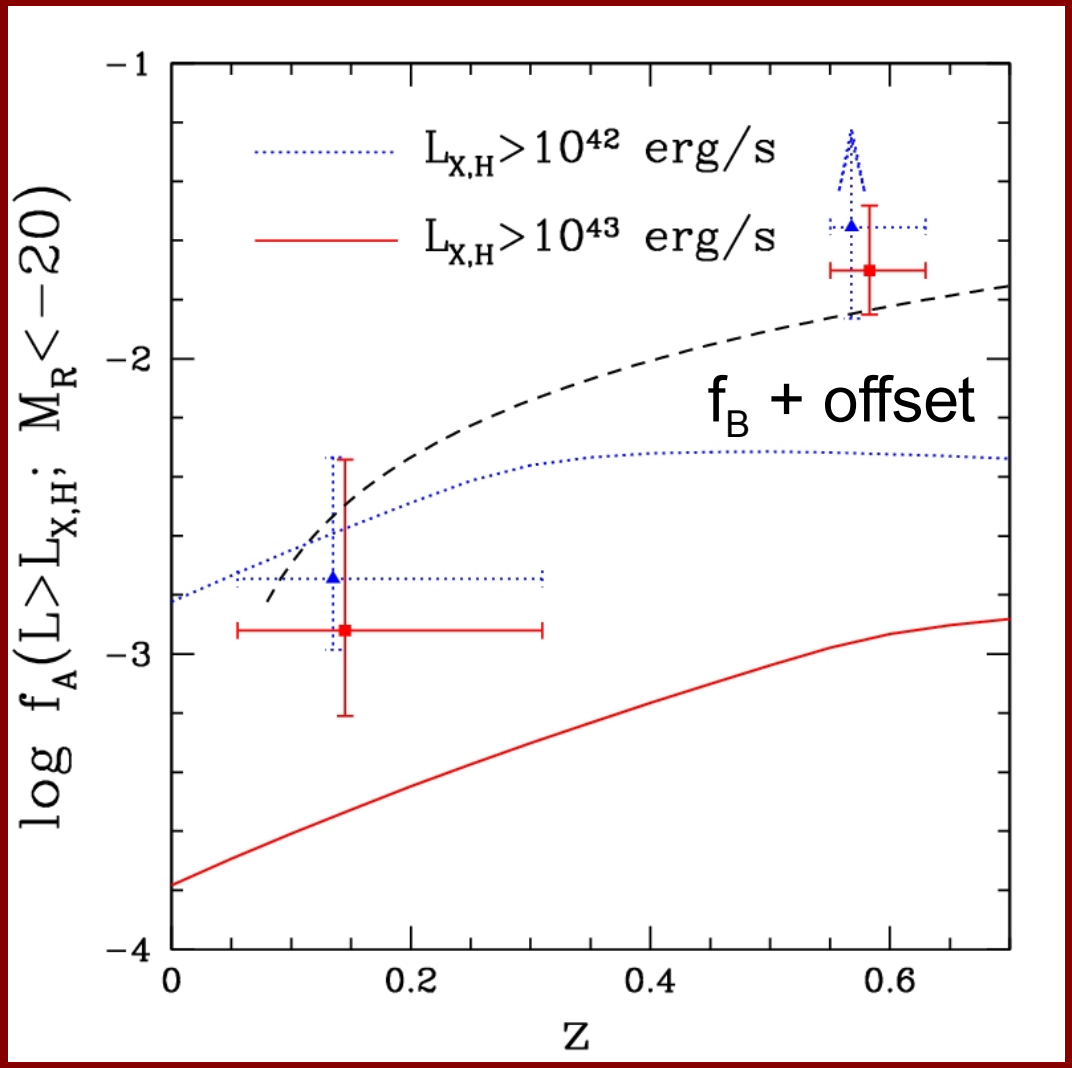
AGN Butcher-Oemler Effect



Rate of evolution is consistent with blue galaxy fraction

Cosmology Implications?

Evolution:

- Cluster environment provides a unique set of conditions to explore triggering, AGN feedback
- May have implications for clustering properties of high-redshift X-ray sources

X-ray:

- AGN can be a significant fraction (>10%) of the cluster L_X, which impacts selection

SZ:

- A comparable evolution in radio sources could bias SZ selection vs. redshift