The prevalence of X-ray AGNs in quiescent galaxies at z~2

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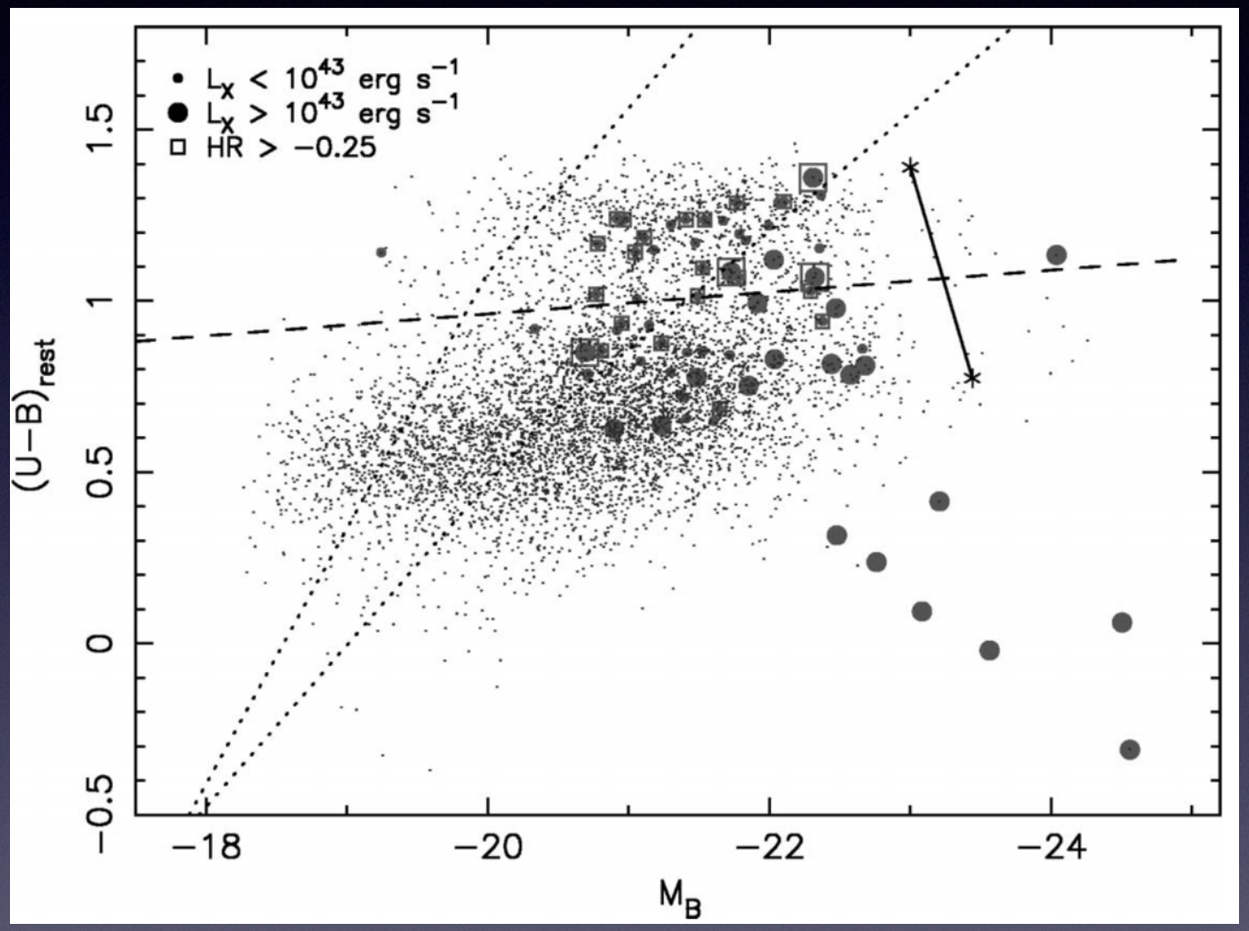
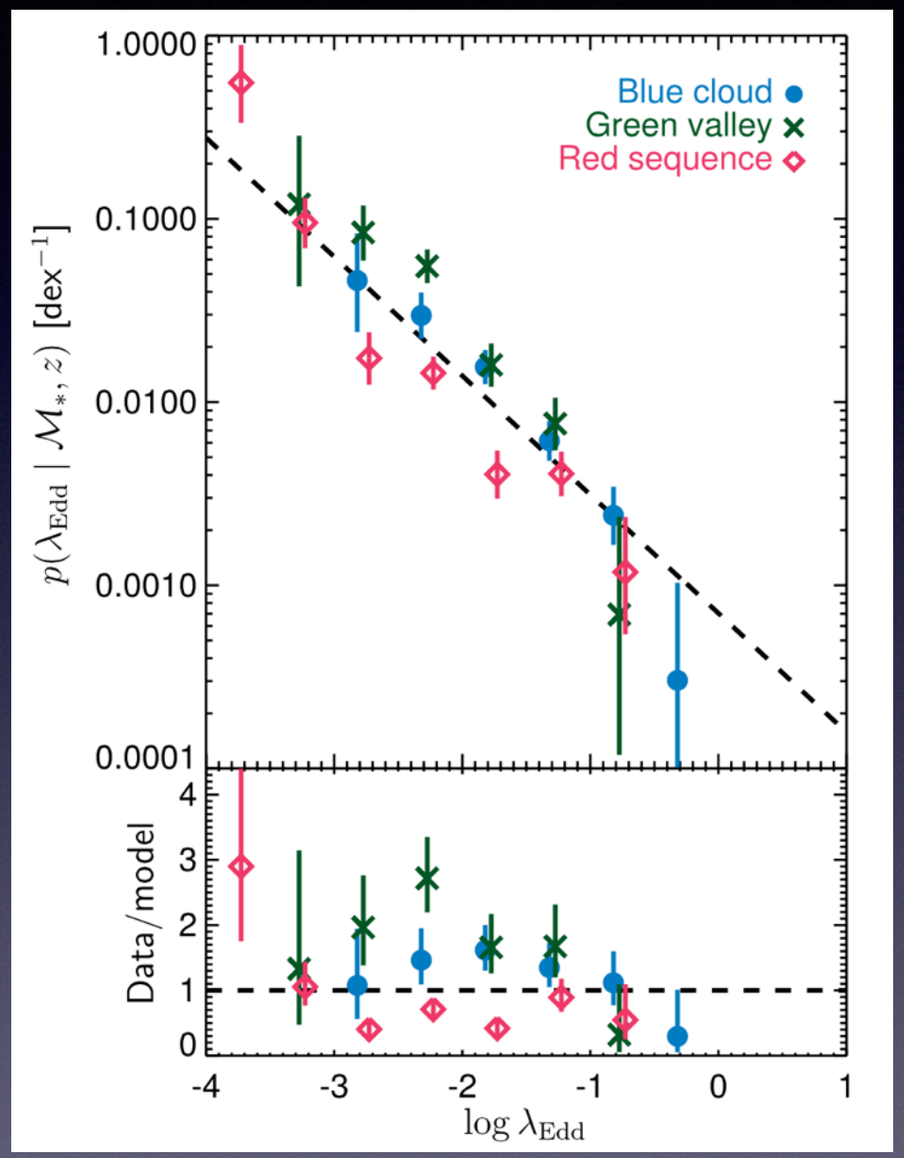
Outline

- The dependence of X-ray AGN activities on host galaxy colors at $0.5 < z < 2.5$
- A new, value-added Herschel catalog in CANDELS fields

Motivation: What are the roles of AGNs in galaxy (trans)formation?

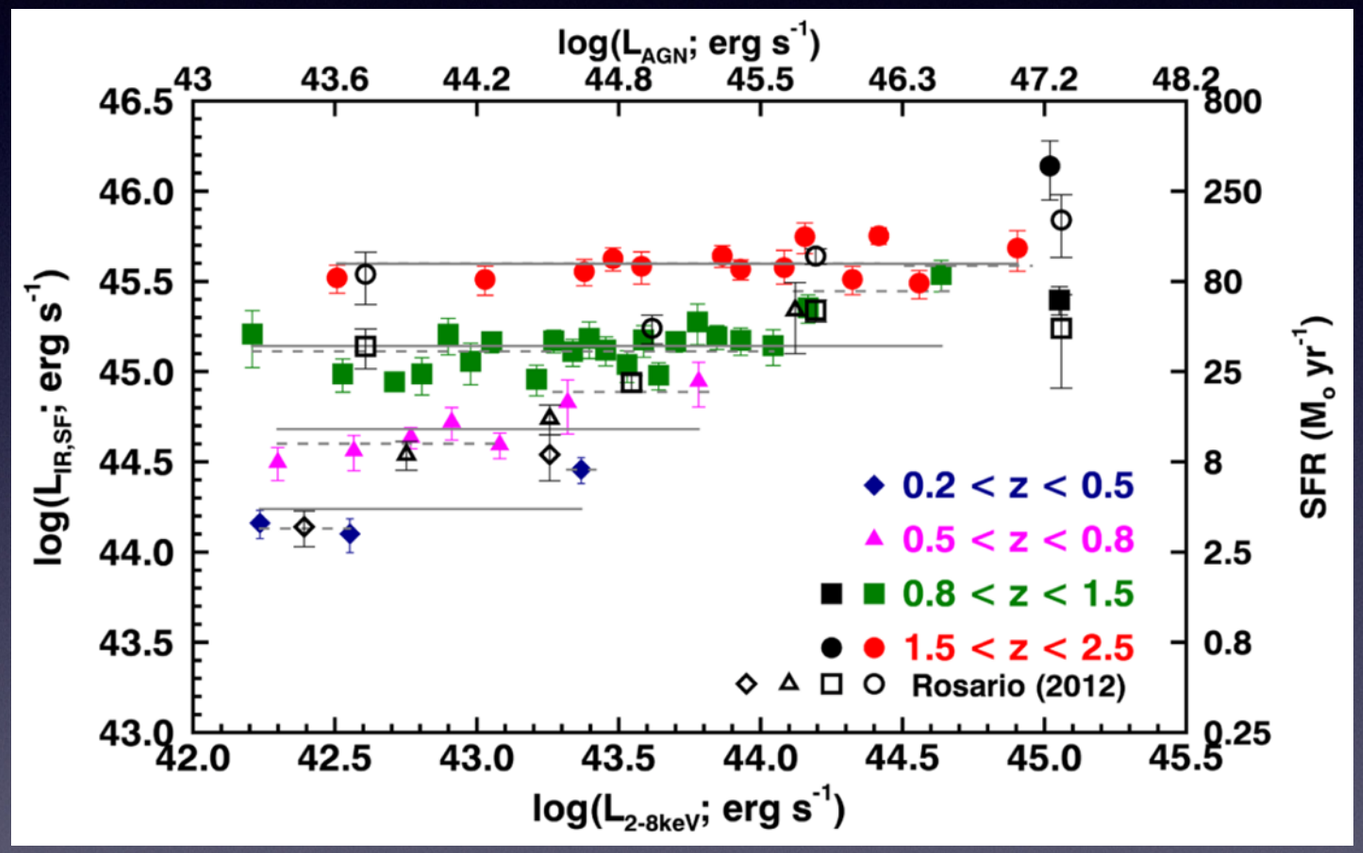


Nandra+2007

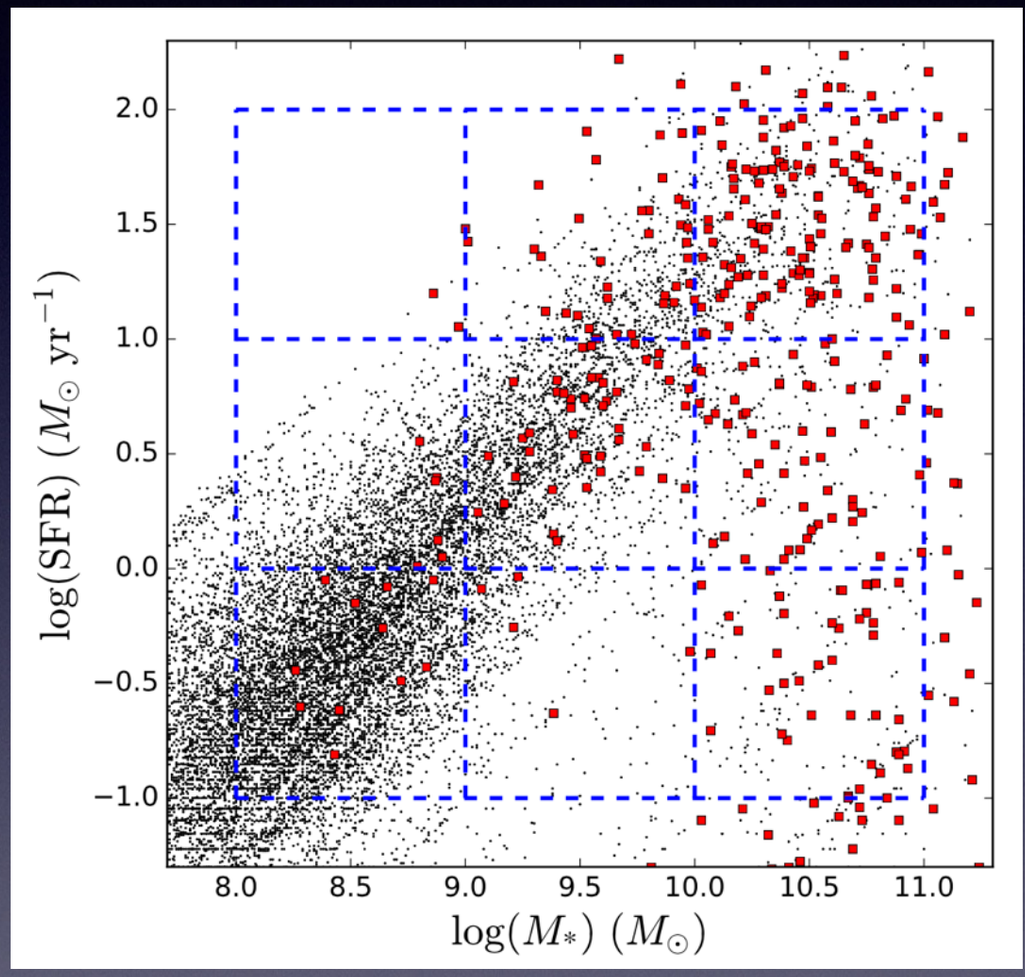


Aird+2012

AGNs are enhanced in green-valley galaxies?



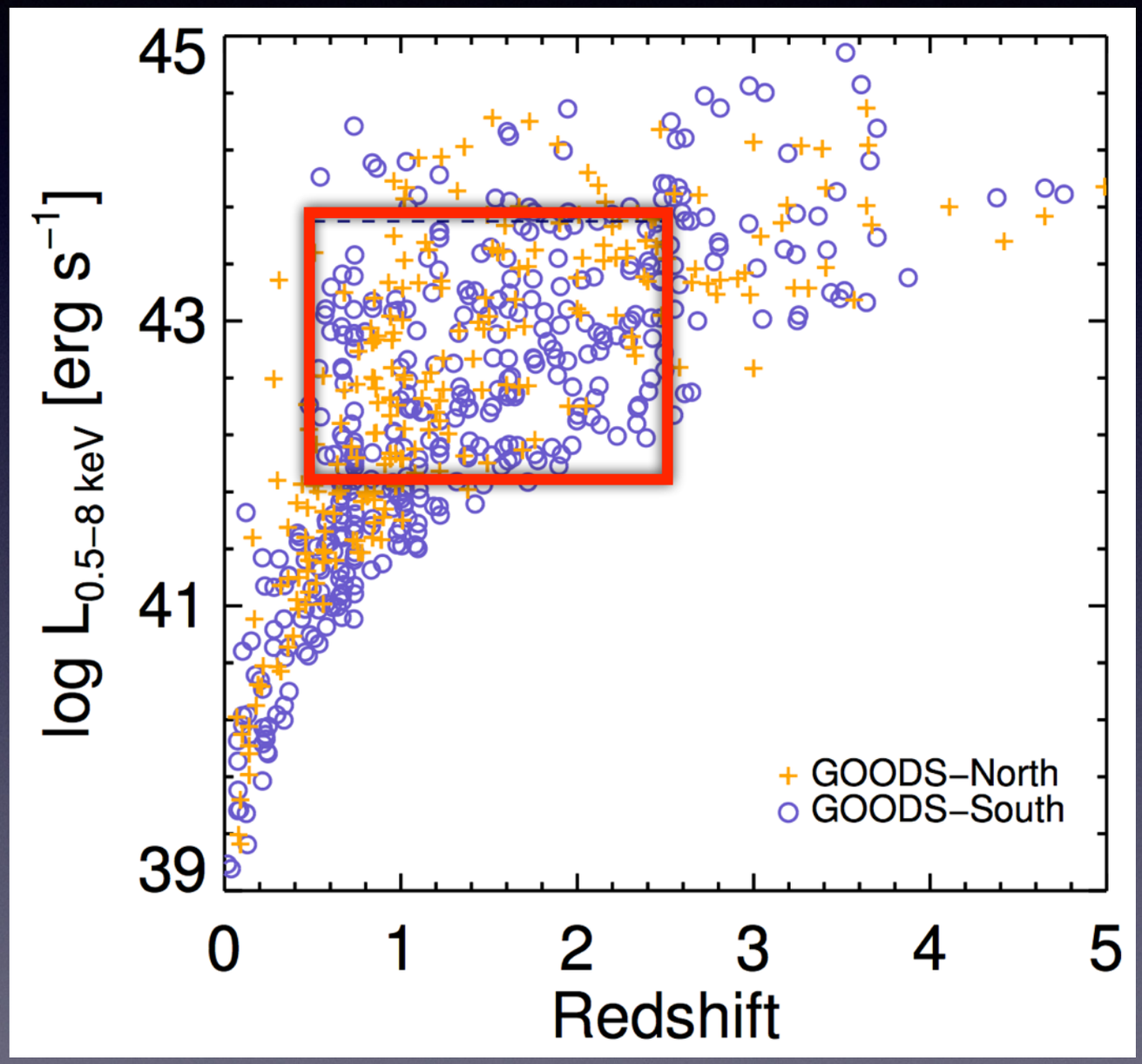
Stanley+2015



Yang+2017

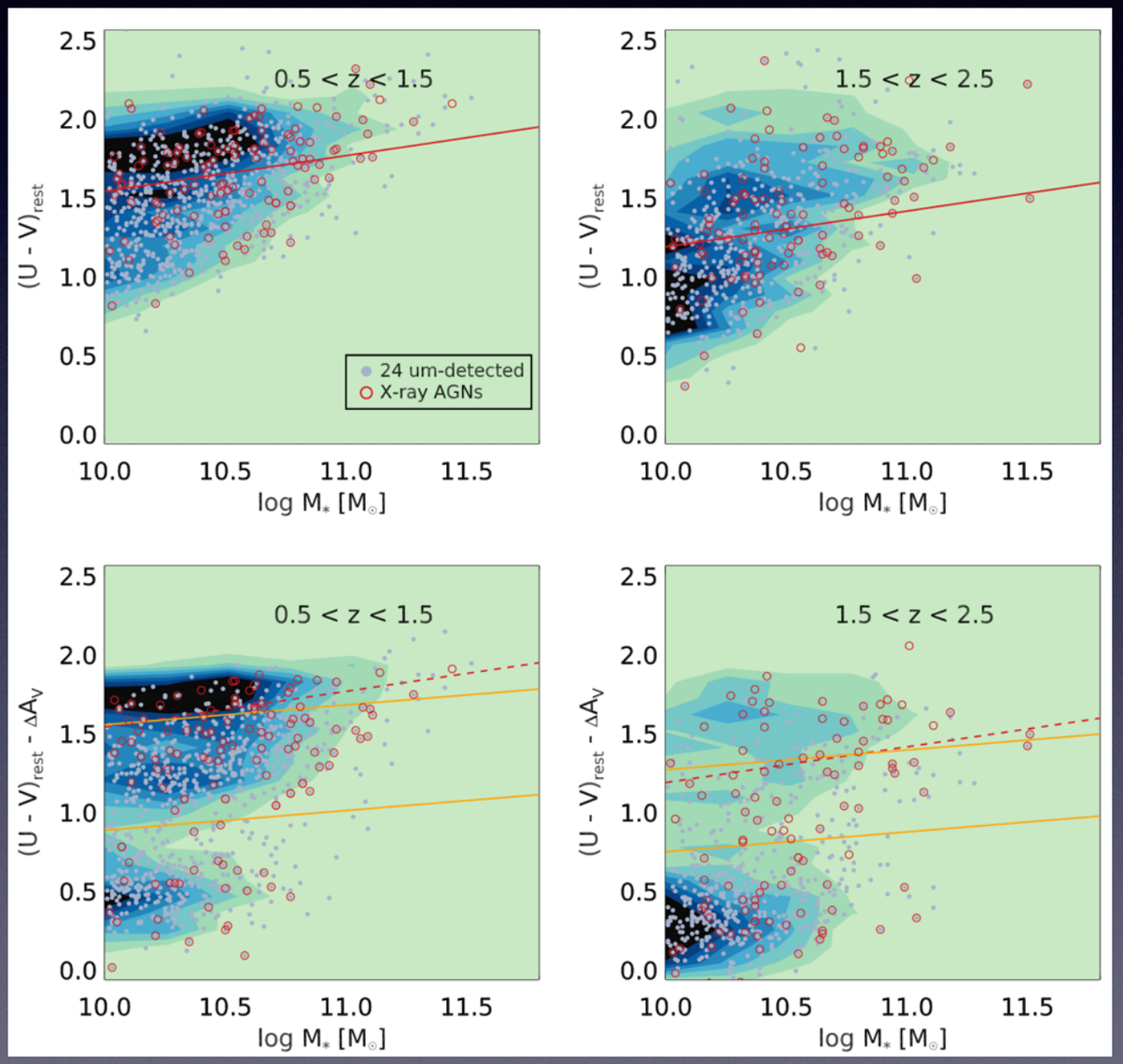
AGN-star formation connection

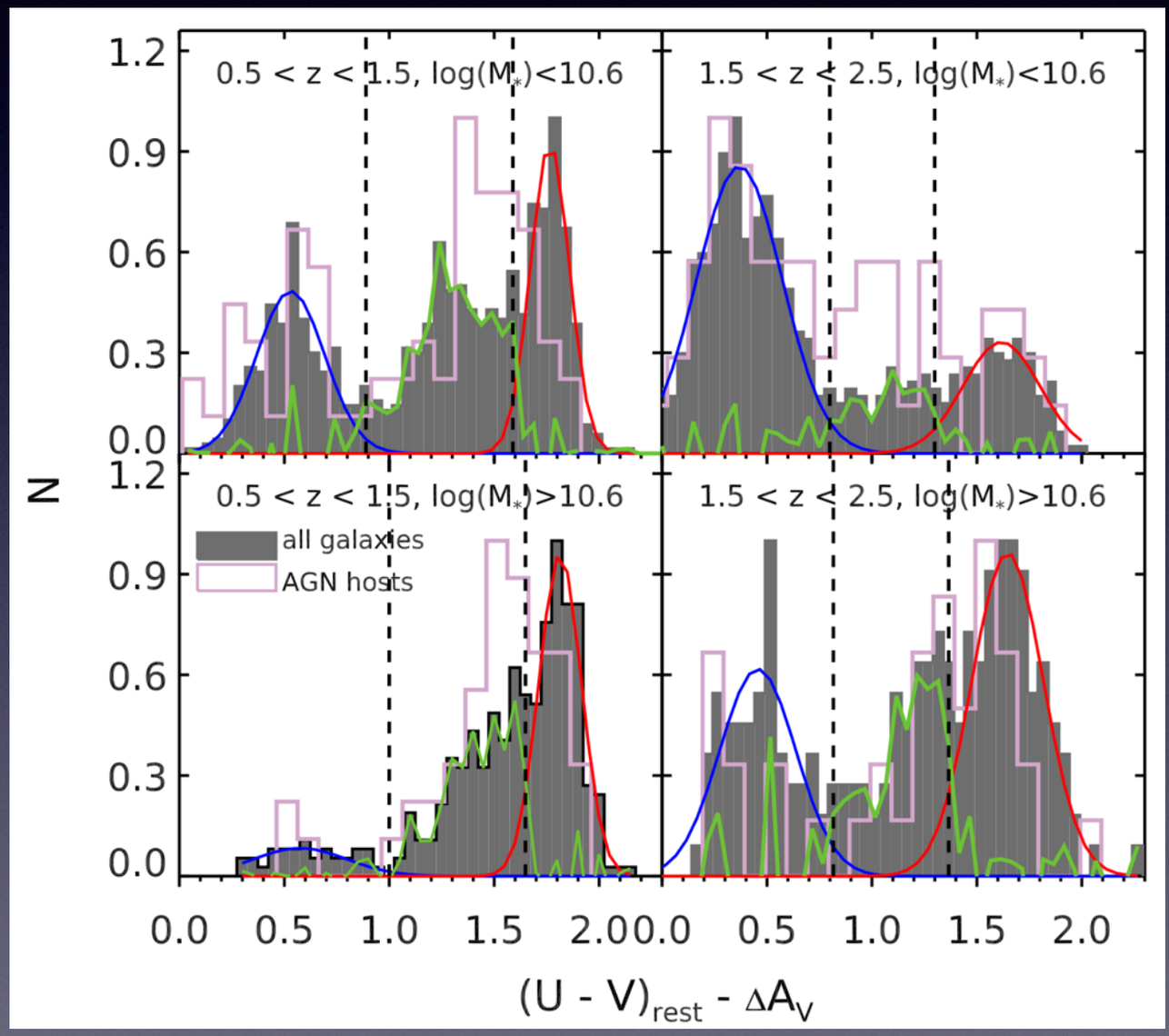
This study: Moderate-luminosity X-ray AGNs in massive galaxies at 0.5 < z < 2.5



GS + GN (3D-HST), Lx~10^42-44 erg/s

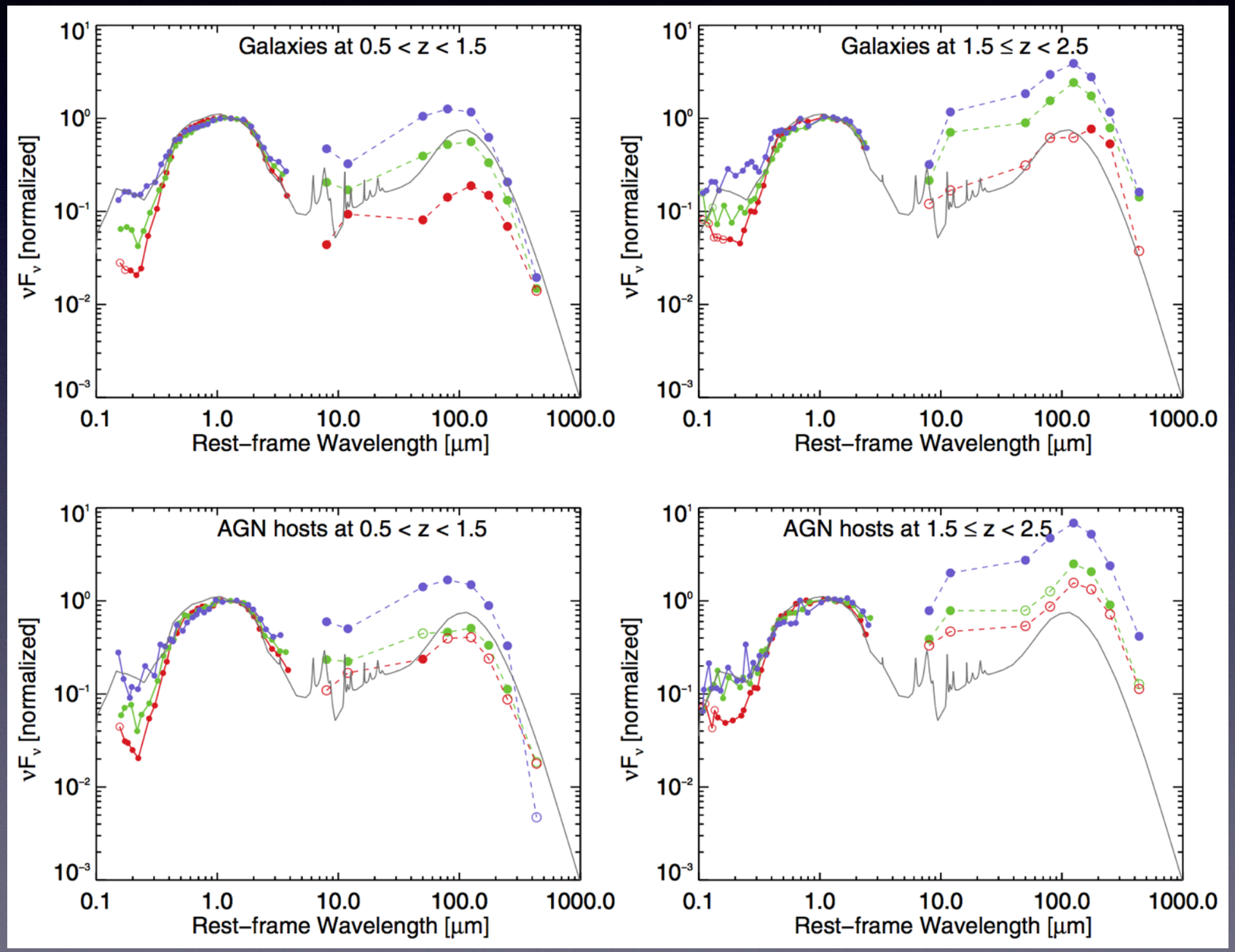
Red, green, and blue galaxy classifications



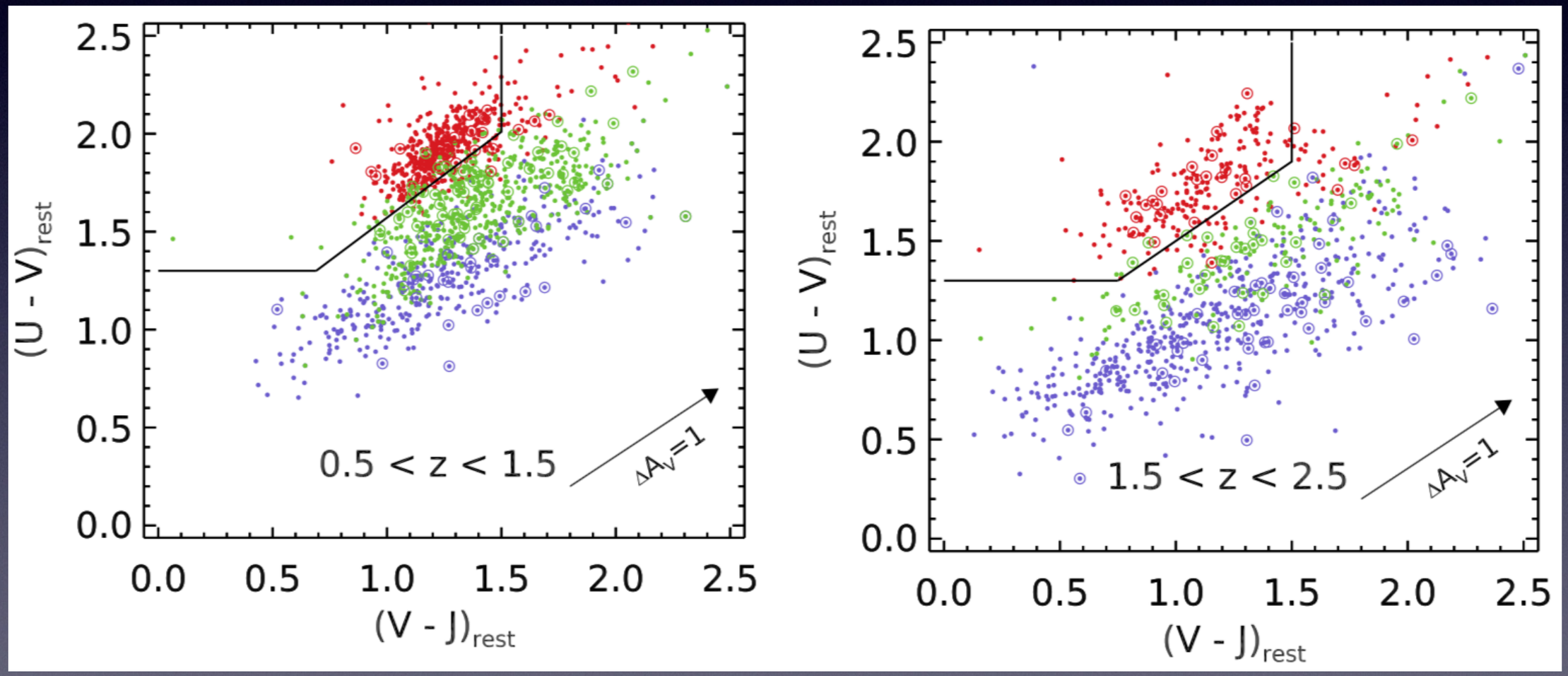


extinction-corrected rest-frame U-V colors

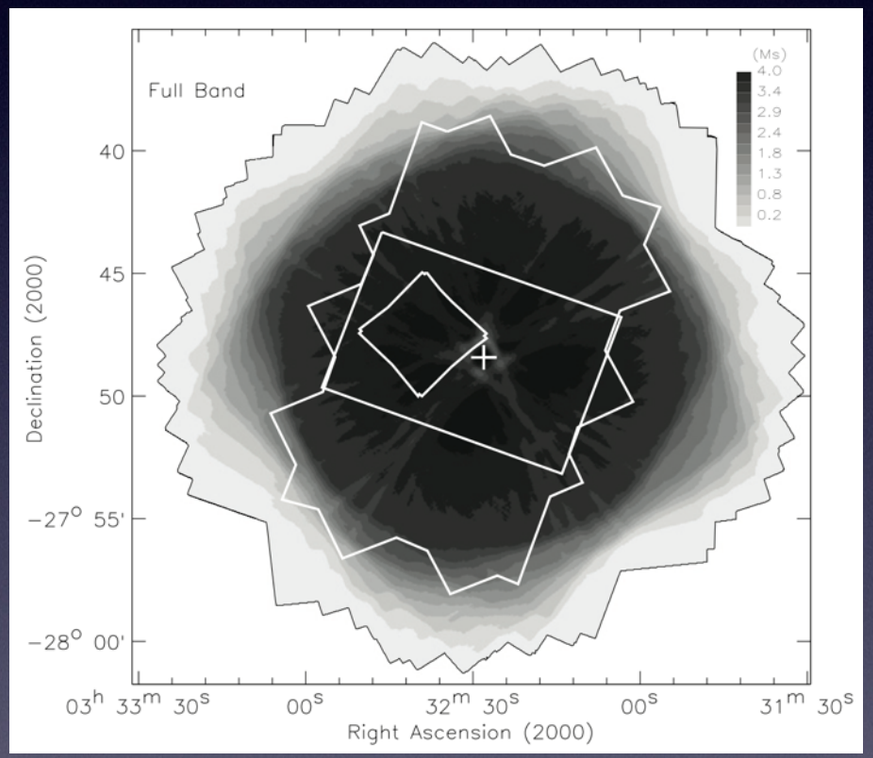
Average SEDs of red, green, and blue galaxies and AGNs

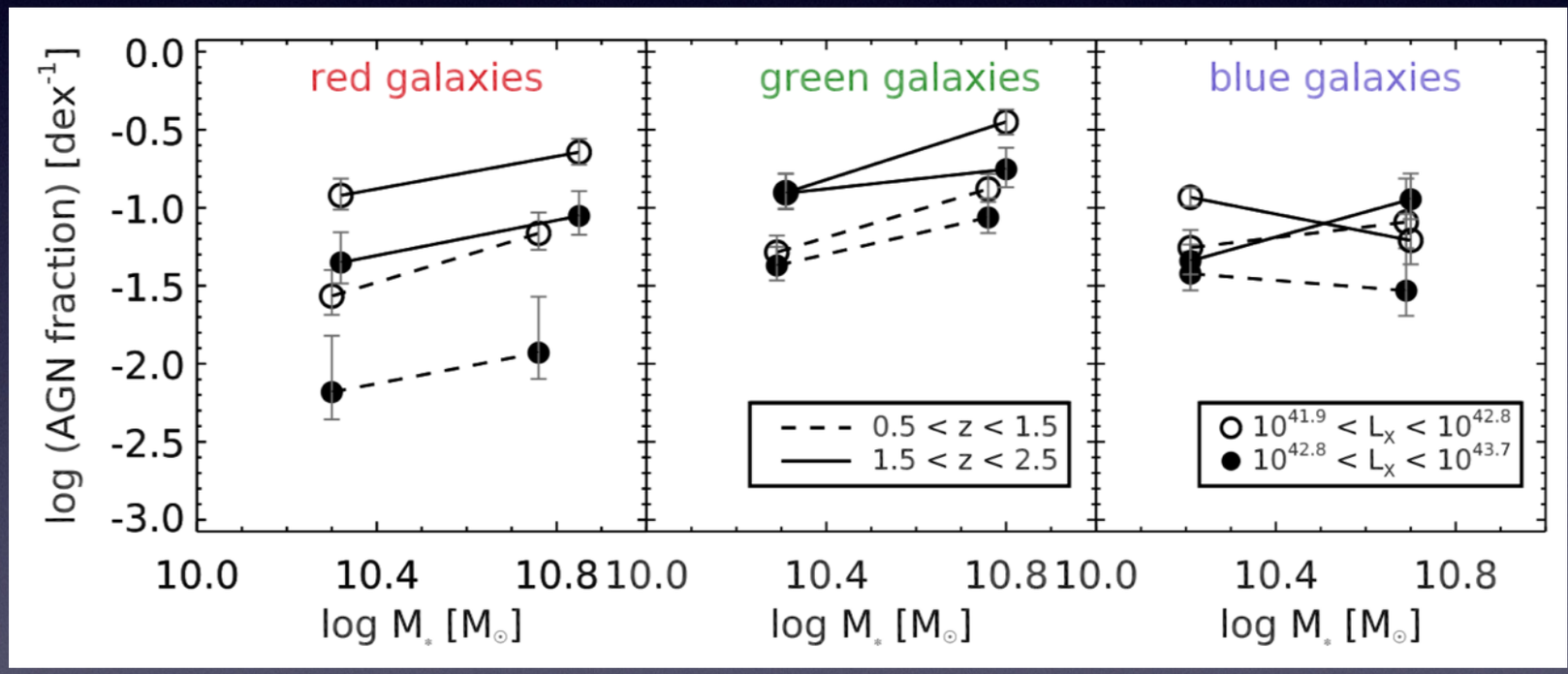


Compared to the UVJ diagram



AGN fraction: Incompleteness correction



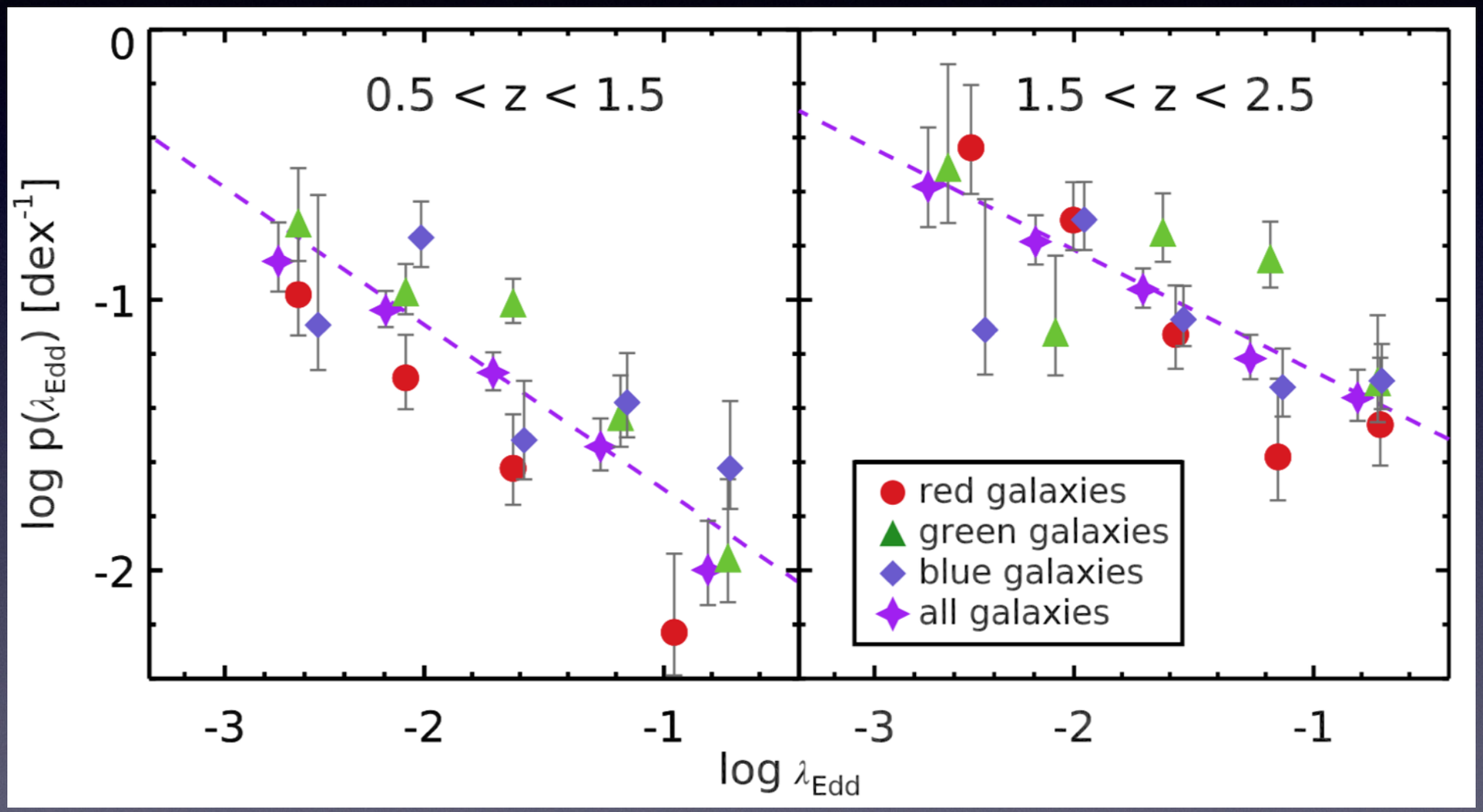


$$\text{AGN fraction} = \frac{1}{N_{\text{gal}}} \sum_{i}^{N_{\text{X}}} w_i$$

~Vmax correction

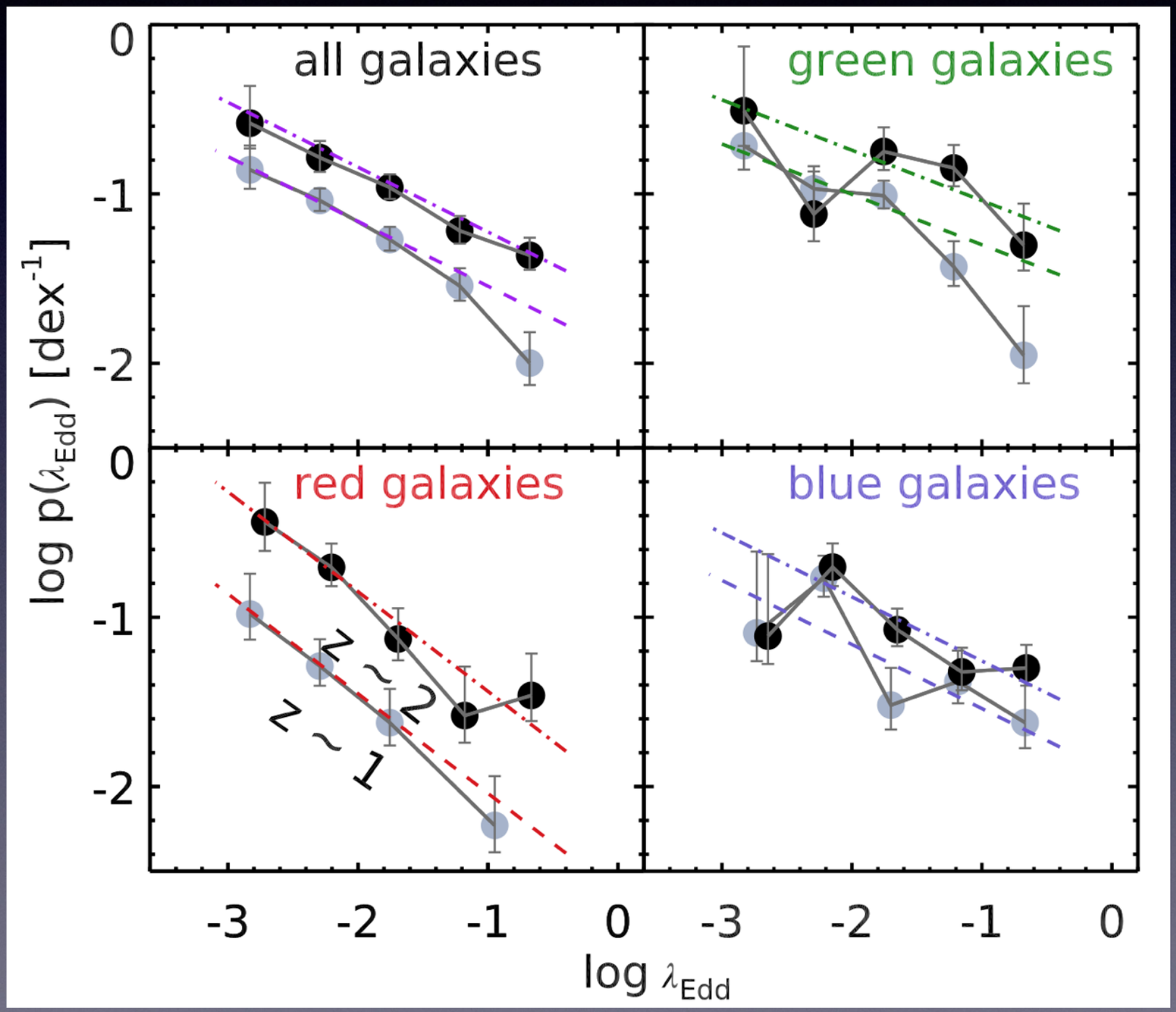
A rapid evolution of the AGN fraction in red galaxies:
~30% of the most massive, red galaxies host an X-ray AGN at z~2

Eddington ratio distribution

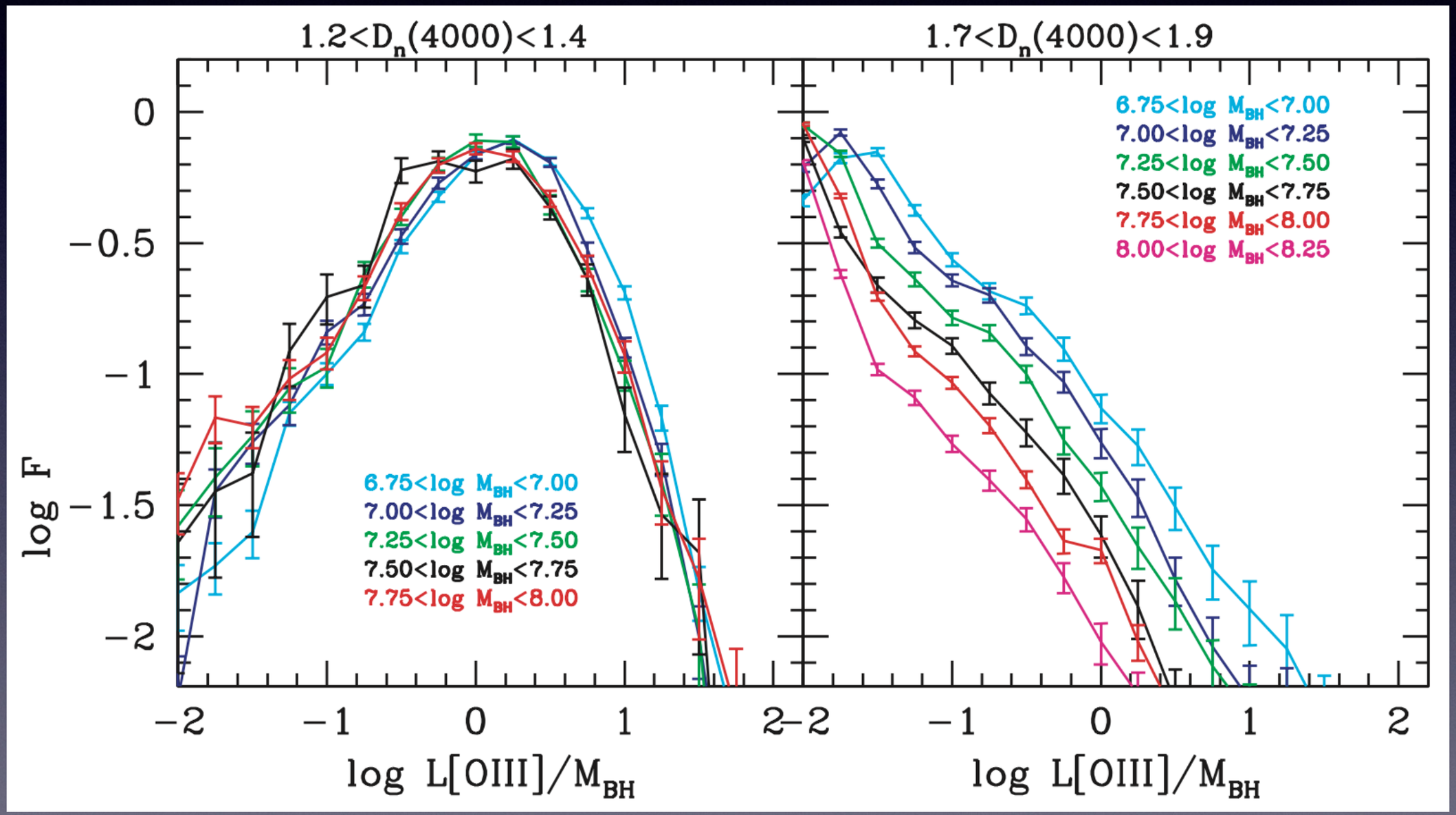


$$\lambda_{\rm Edd} = \frac{L_{\rm bol}}{L_{\rm Edd}} = \frac{\eta L_{\rm X}}{1.26\times10^{38}\left(\frac{M_{\rm BH}}{M_\odot}\right)} = \frac{\eta L_{\rm X}}{1.26\times10^{38}\left(\frac{\mu M_*}{M_\odot}\right)}$$

Eddington ratio distribution

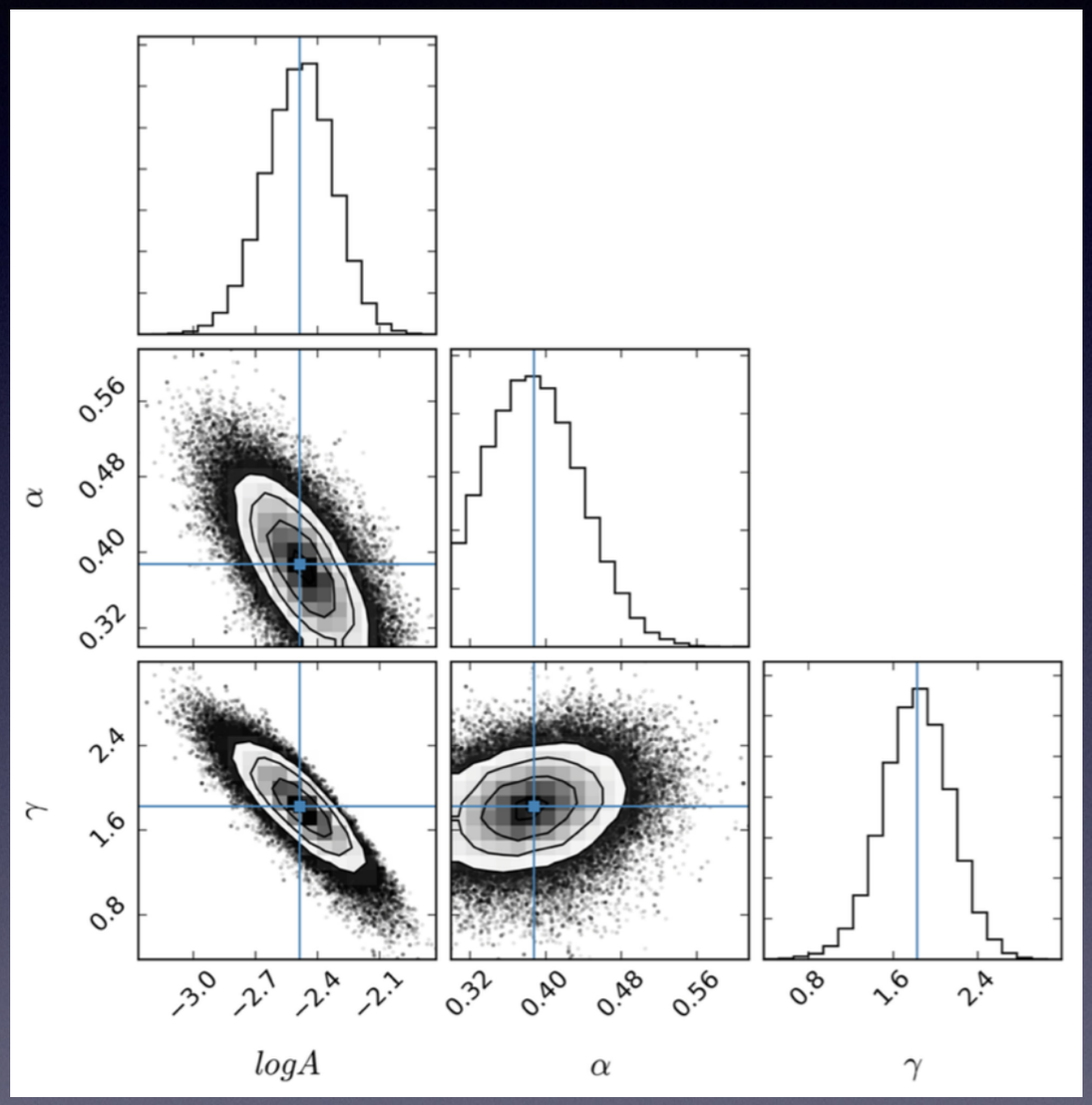


Compared to z~0?



Kaufmann+2009

Maximum Likelihood fitting

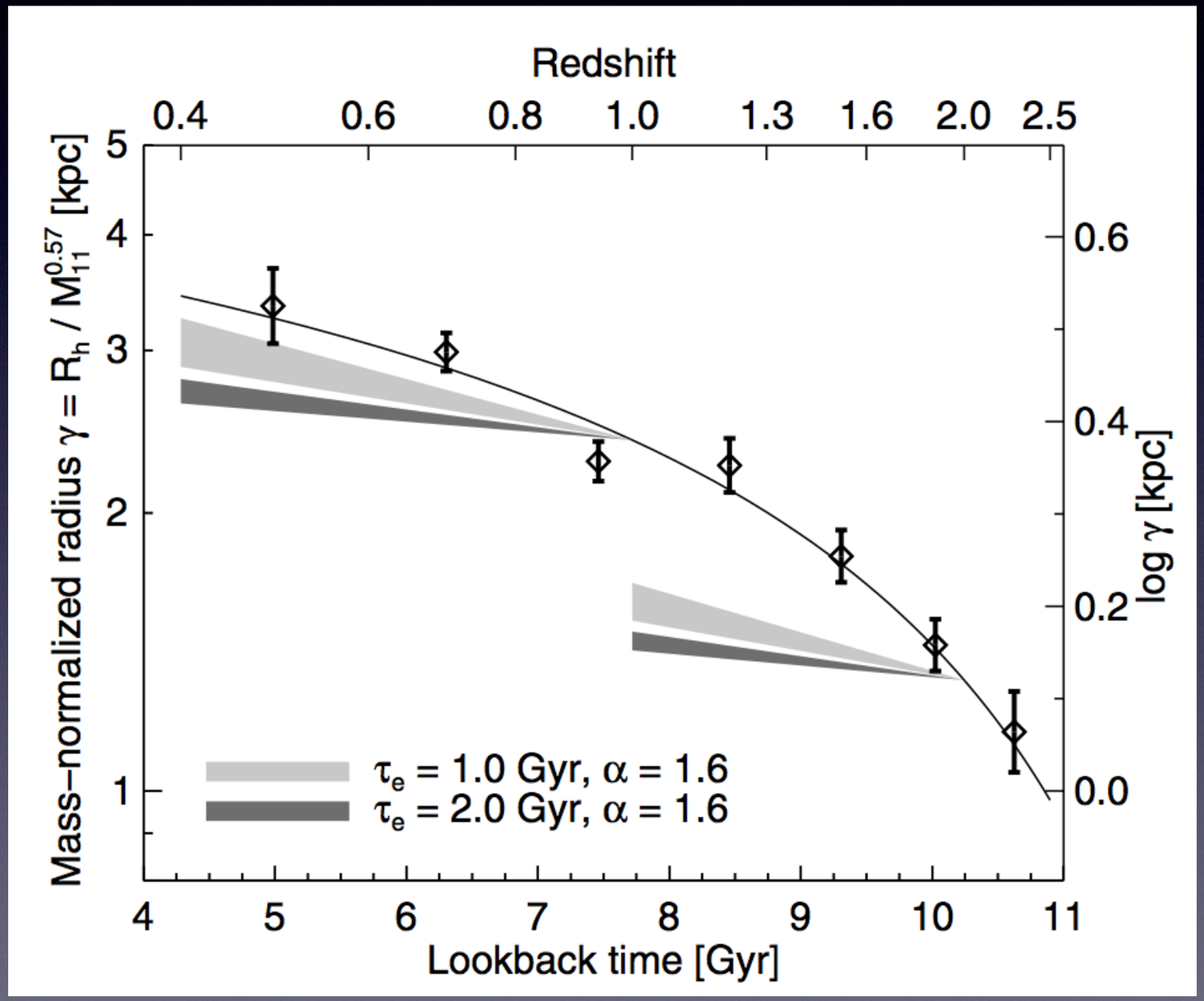


$$p(\lambda_{\rm Edd})\ {\rm dlog}\,\lambda_{\rm Edd} = A\left(\frac{\lambda_{\rm Edd}}{\lambda_{{\rm Edd}_{\rm cut}}}\right)^{-\alpha}(1+z)^{\gamma}\ {\rm dlog}\,\lambda_{\rm Edd}$$

$$\mathcal{N} = \sum_{j=1}^{N_i^{\rm gal}} \int_{\lambda^j_{{\rm Edd}_{min}}}^{\lambda^j_{{\rm Edd}_{\rm max}}} p(\lambda_{\rm Edd} \mid \mathcal{M}_j, z_j)\ {\rm dlog}\,\lambda_{\rm Edd}$$

$$p(\lambda_{\rm Edd})\ {\rm d}\log\lambda_{\rm Edd} \sim \lambda_{\rm Edd}^{-0.4}(1+z)^{1.8}\ {\rm d}\log\lambda_{\rm Edd}$$

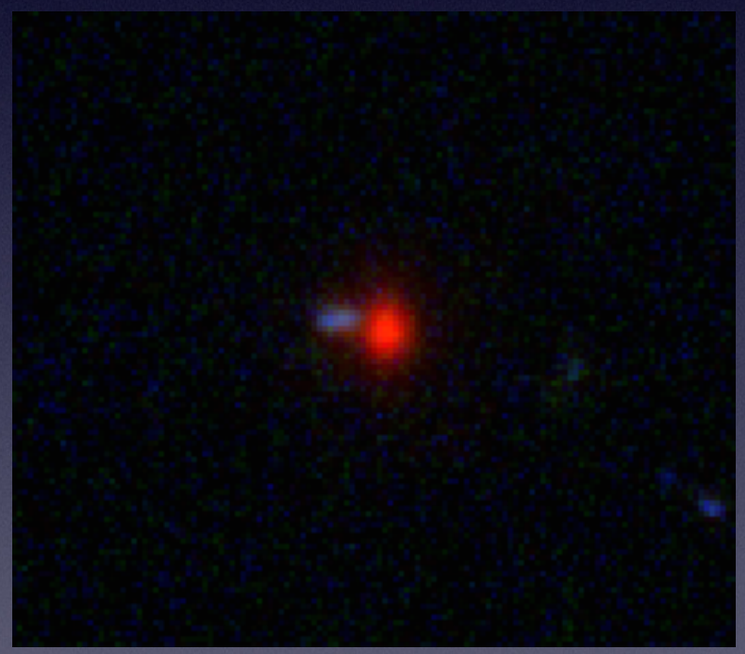
Implications: maintenance-mode feedback and size evolution of quiescent galaxies



Newman+2012

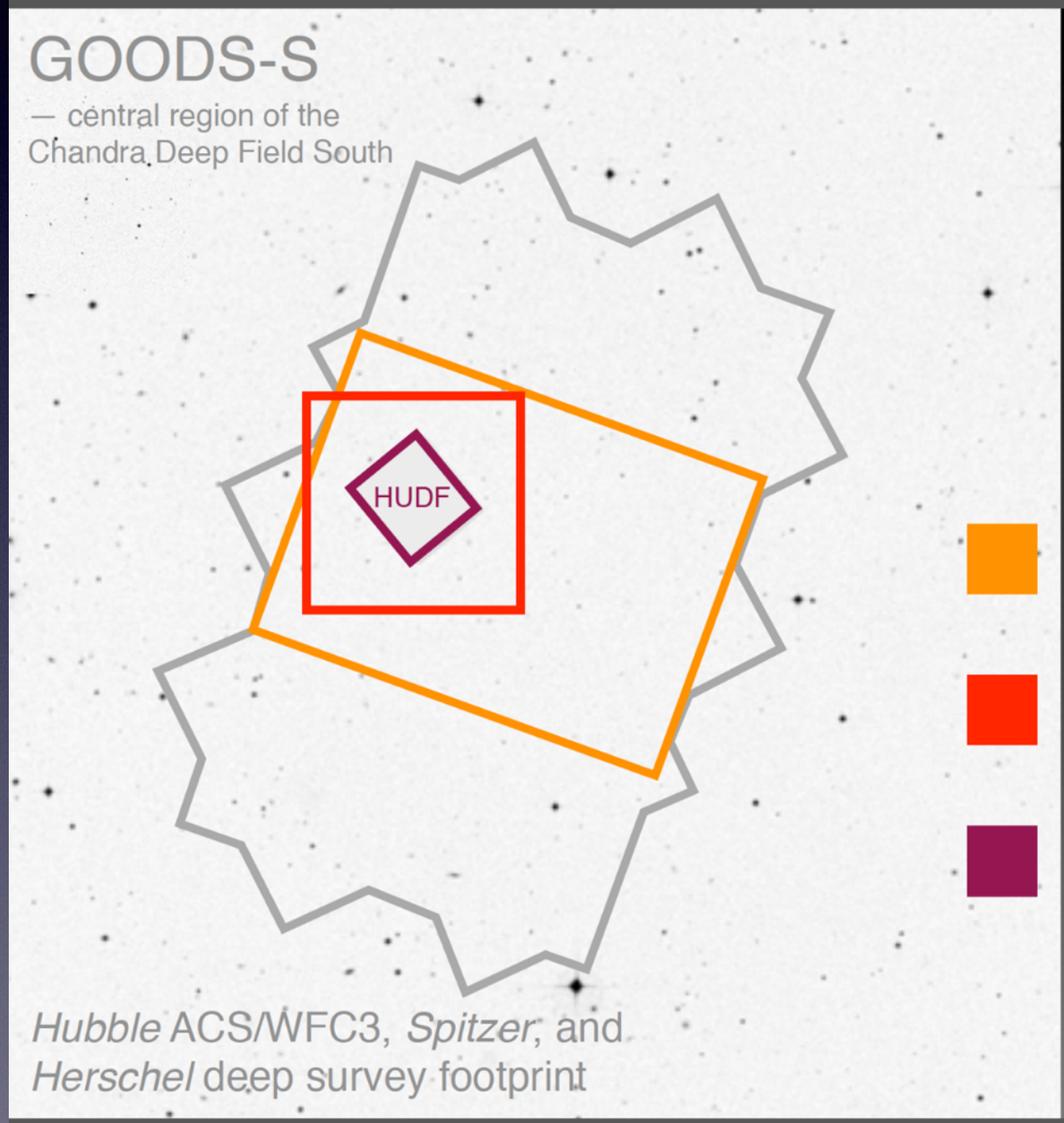
Next: What are the origins of the X-ray AGNs in red galaxies?

- morphologies/structures, environment
- star formation properties, gas content



One more thing

ALMA deep surveys in GOODS-S



ALMA 'wedding cake' surveys in GOODS-S

— three nested ALMA blank-field surveys to capture distant SFGs

GOODS-S ALMA — PI: Elbaz
68 sq. arcmin, 256 GHz, 128 uJy/beam rms

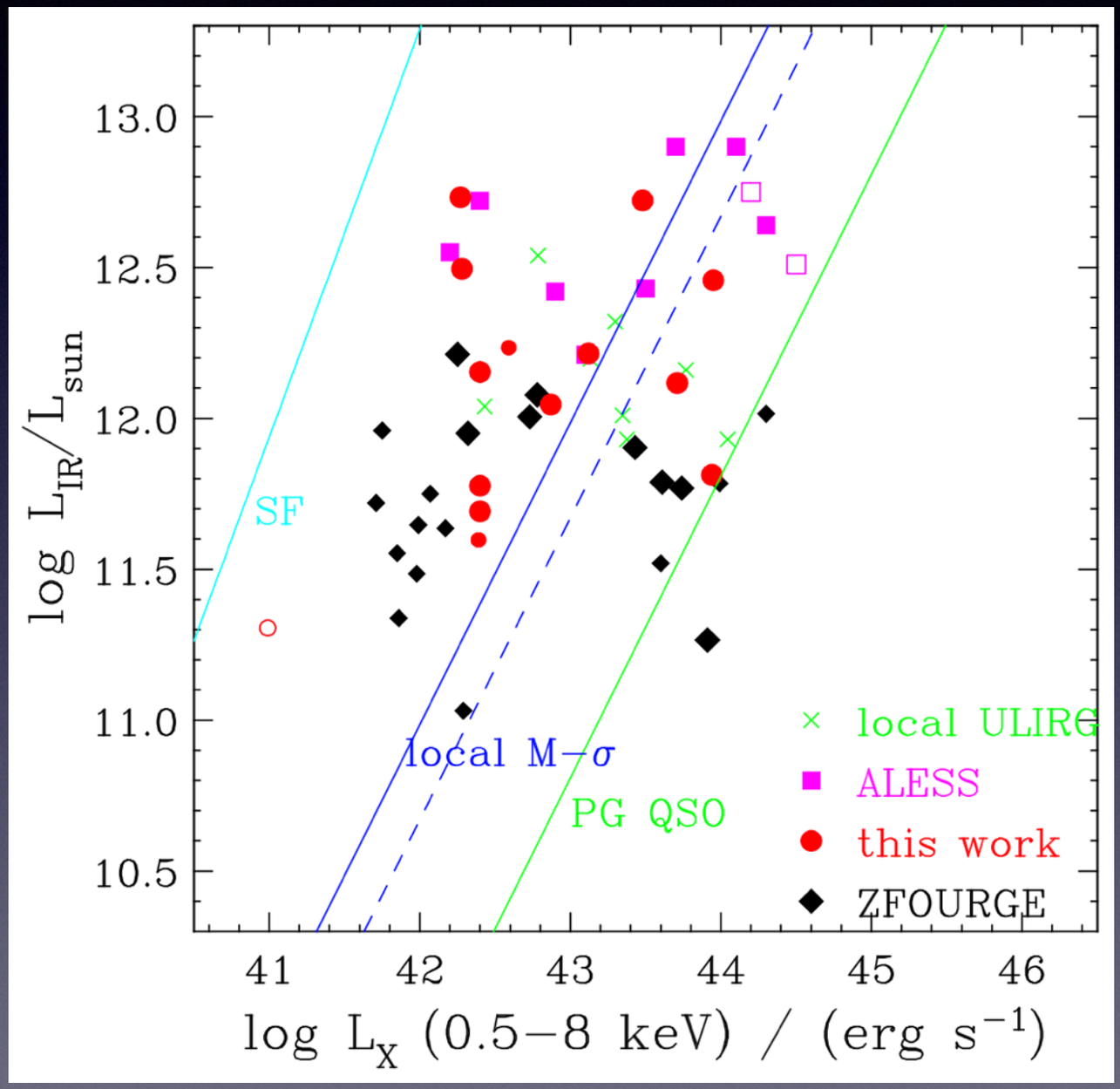
ALMA-JVLA — PI: Kohno
23 sq. arcmin, 271 GHz, 60 uJy/beam rms

ALMA HUDF — PI: Dunlop
4.5 sq. arcmin, 220 GHz, 29 uJy/beam rms

ALMA Deep Field published in Dunlop, WR+16;
Elbaz data delivered; Kohno observations taken.
Walter+16 line scan is the 1' area within the HUDF

cf. K. Kohno

A surprisingly high X-ray AGN fraction in ALMA-1.3mm sources at 1.5 < z < 3



~88% down
to S_1.3mm > 0.6 mJy

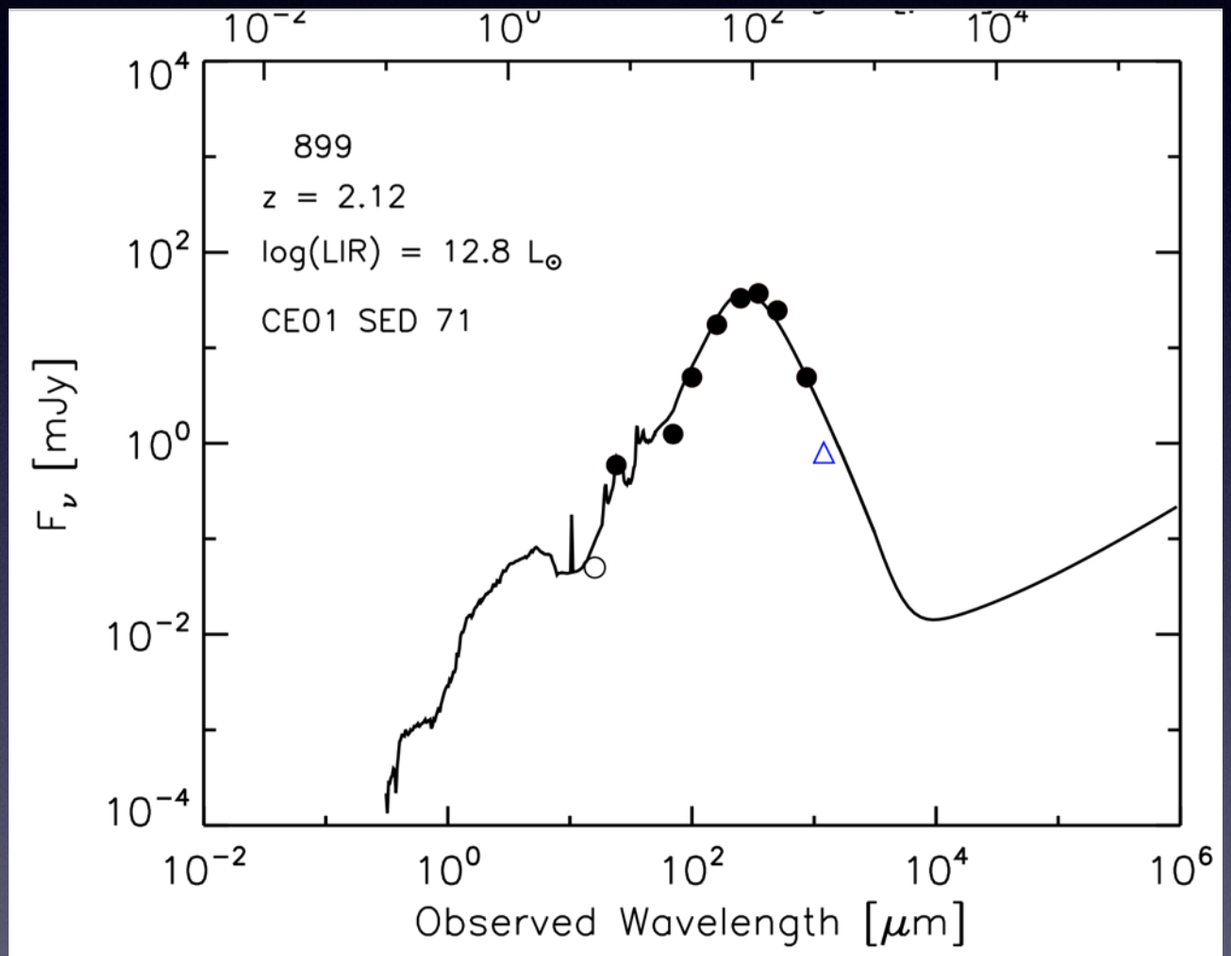
Ueda+2017 and the
GOODS JVLA-ALMA survey team, submitted

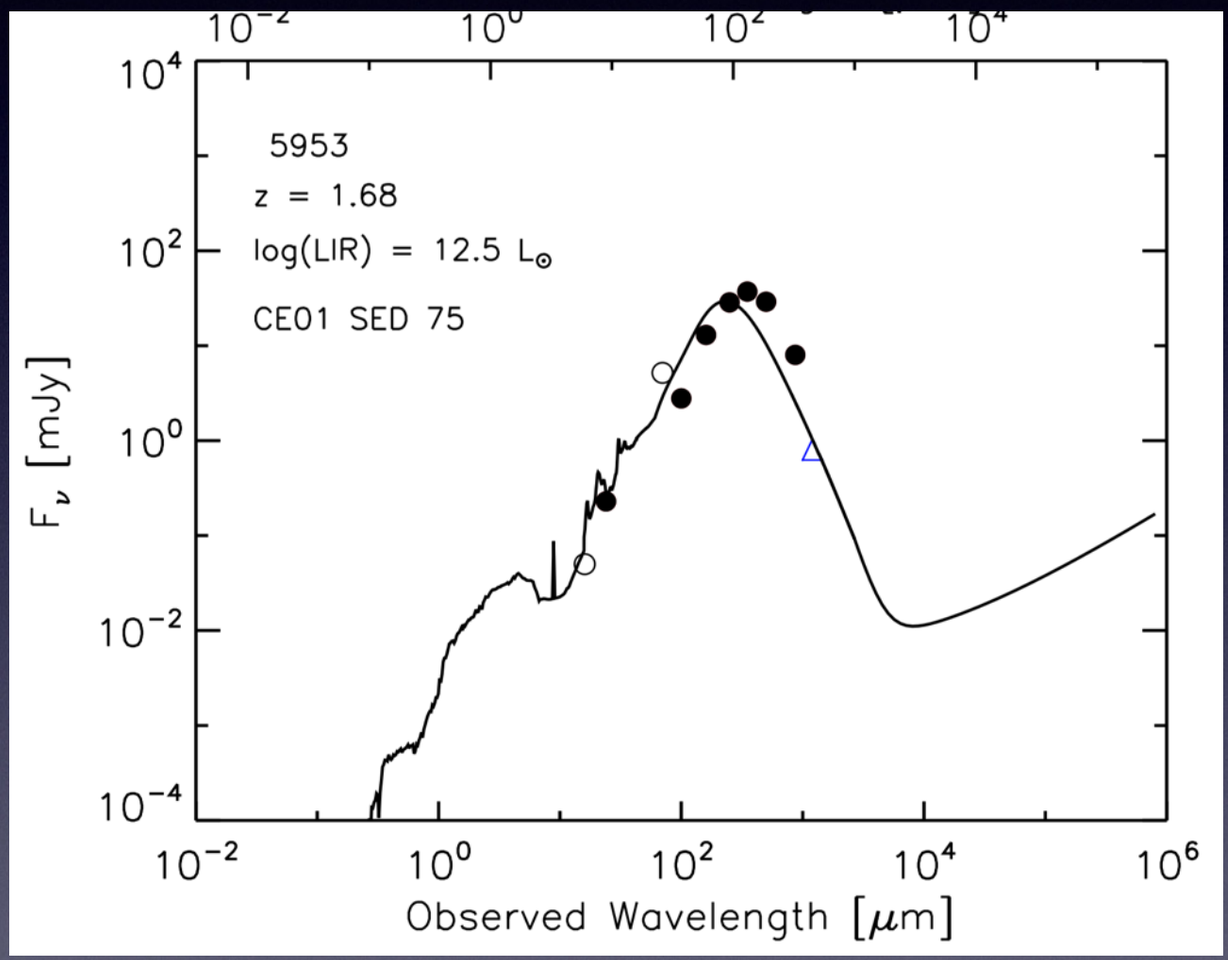
A new Herschel catalog in GOODS fields

- based on positions in the H-band images (directly linked to CANDLES IDs)
- PACS photometry: newly generated images combining all the available data with state-of-art softwares
- SPIRE photometry: improve flux measurements for (potentially) bright sources by putting constraints on (potentially) faint sources

Wang et al., in preparation

Example Far-infrared SEDs of ALMA-870um sources (Wiklind+2014) in GOODS-South





wrong photo-z, spec-z is z=2.06

Ten times more 500um sources compared to previously released Herschel catalog (Elbaz+2011);
More accurate measurements of L_IR, T_dust, and M_dust;
Independent constraints on photometric redshifts.

Summary

- We show that both the AGN fraction at fixed stellar mass (or Eddington ratio) and its evolution with redshifts are dependent on host colors: most notablely, red galaxies have the lowest AGN fraction at z<1, yet with most rapid evolution with redshift; green galaxies show the highest AGN fraction across all redshifts.

- We are finalizing a new Herschel catalog in GOODS fields (linked to CANDELS IDs) with a significantly larger number of SPIRE-detected sources compared to previous release.