Obscured AGN: Star formation histories of intermediate-z AGN

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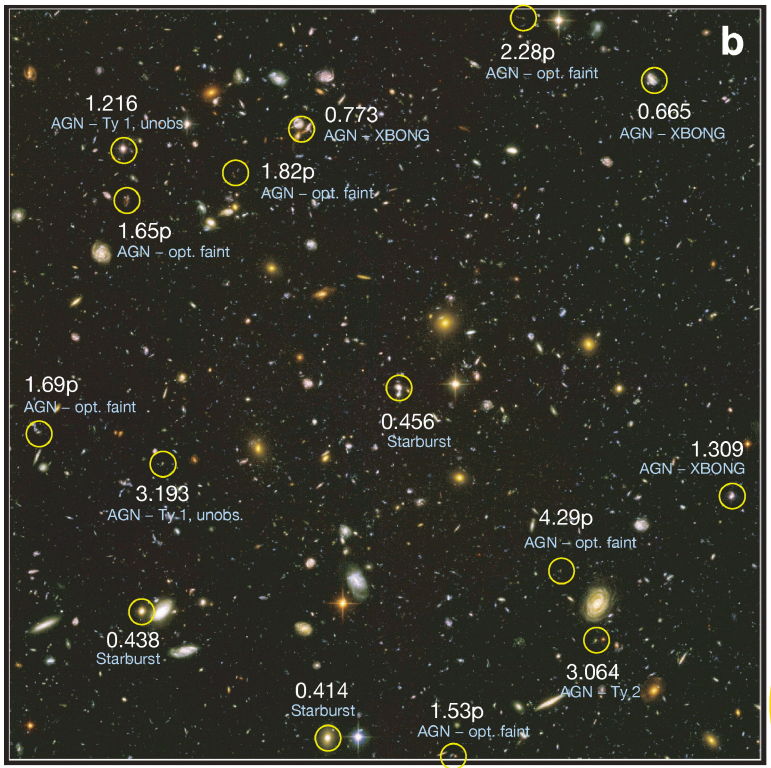
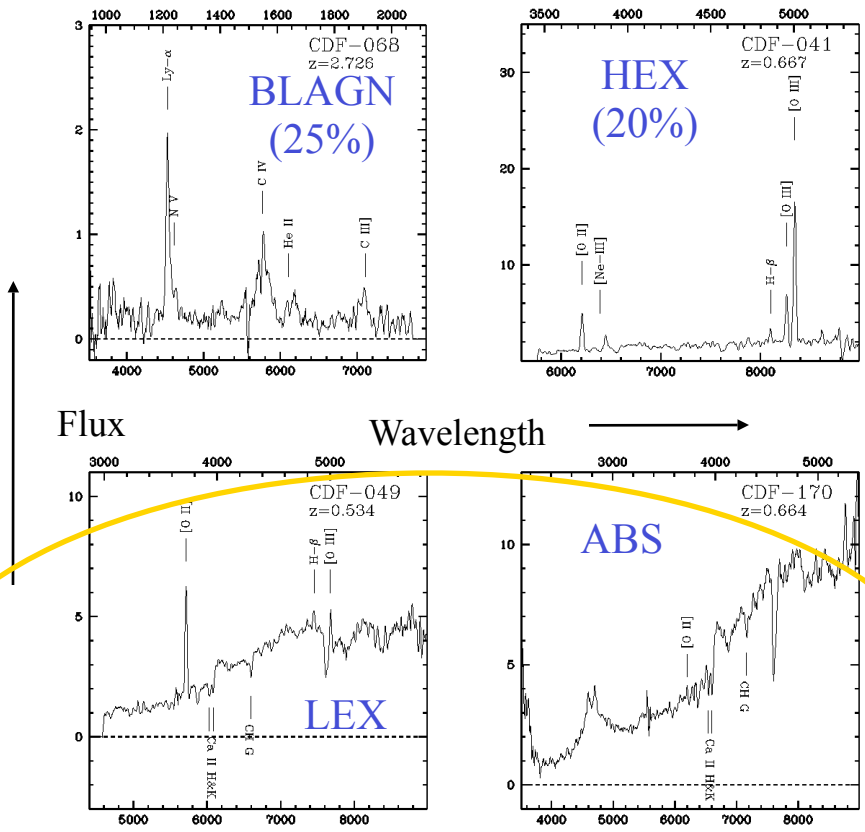
Why X-ray selected AGN appear optically dull?

AGN are sources of luminous X-ray emission, and at cosmological distances AGN are routinely selected from deep X-ray (<10keV, with Chandra and Newton-XMM) exposures



Review by Brandt & Hasinger (2005)

Optical spectroscopy from Szokoly et al. (2004)

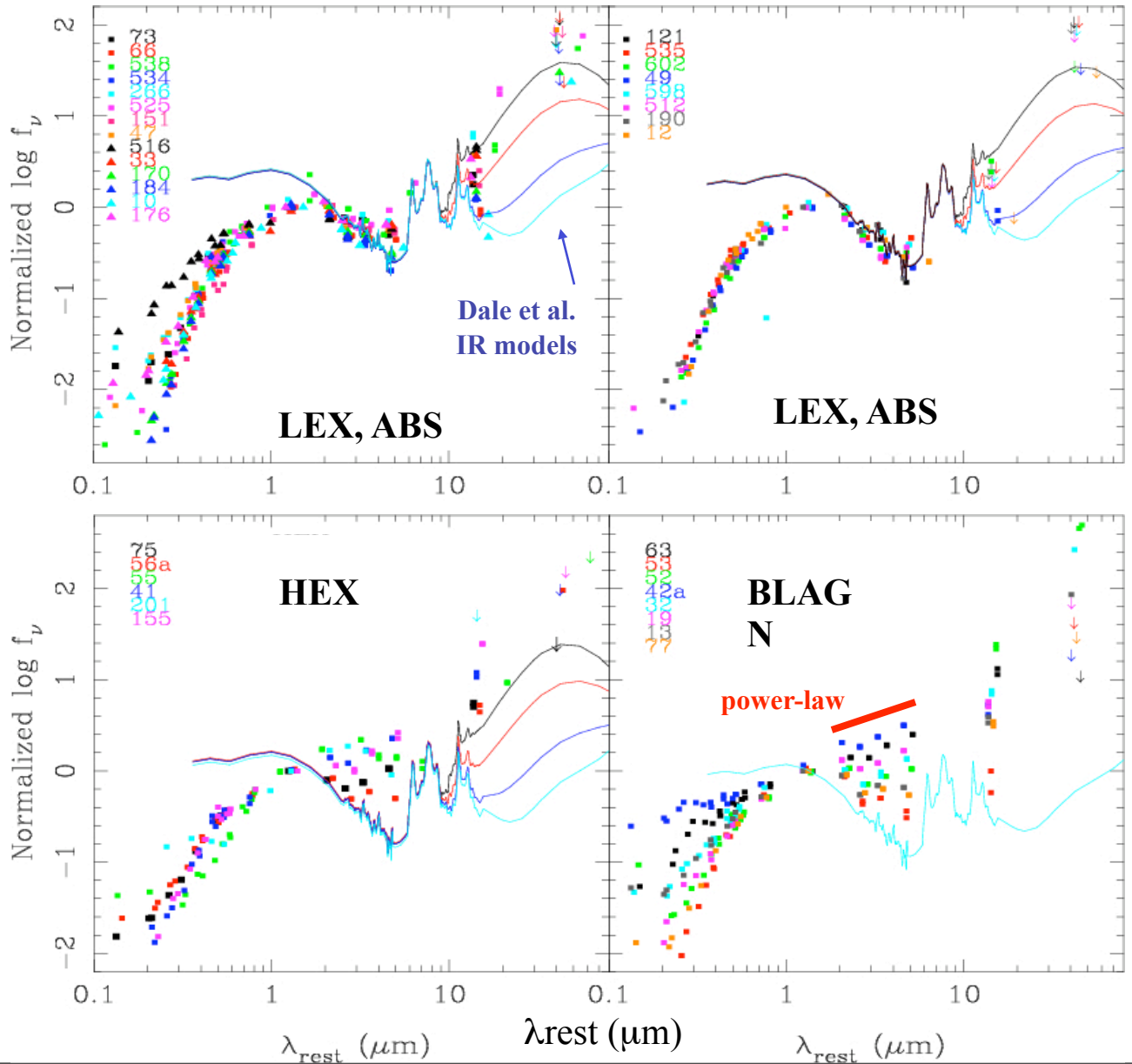


No evidence for accretion in optical spectra

50% Optically Dull AGN

Spectral Energy Distributions of X-ray sources

Rigby et al. (2006), Alonso-Herrero et al. (2004, 2007, in preparation)



~75% of LEX, ABS (optically-dull) AGN at z<0.8 have rest-frame UV-near-IR SEDs dominated by stellar emission

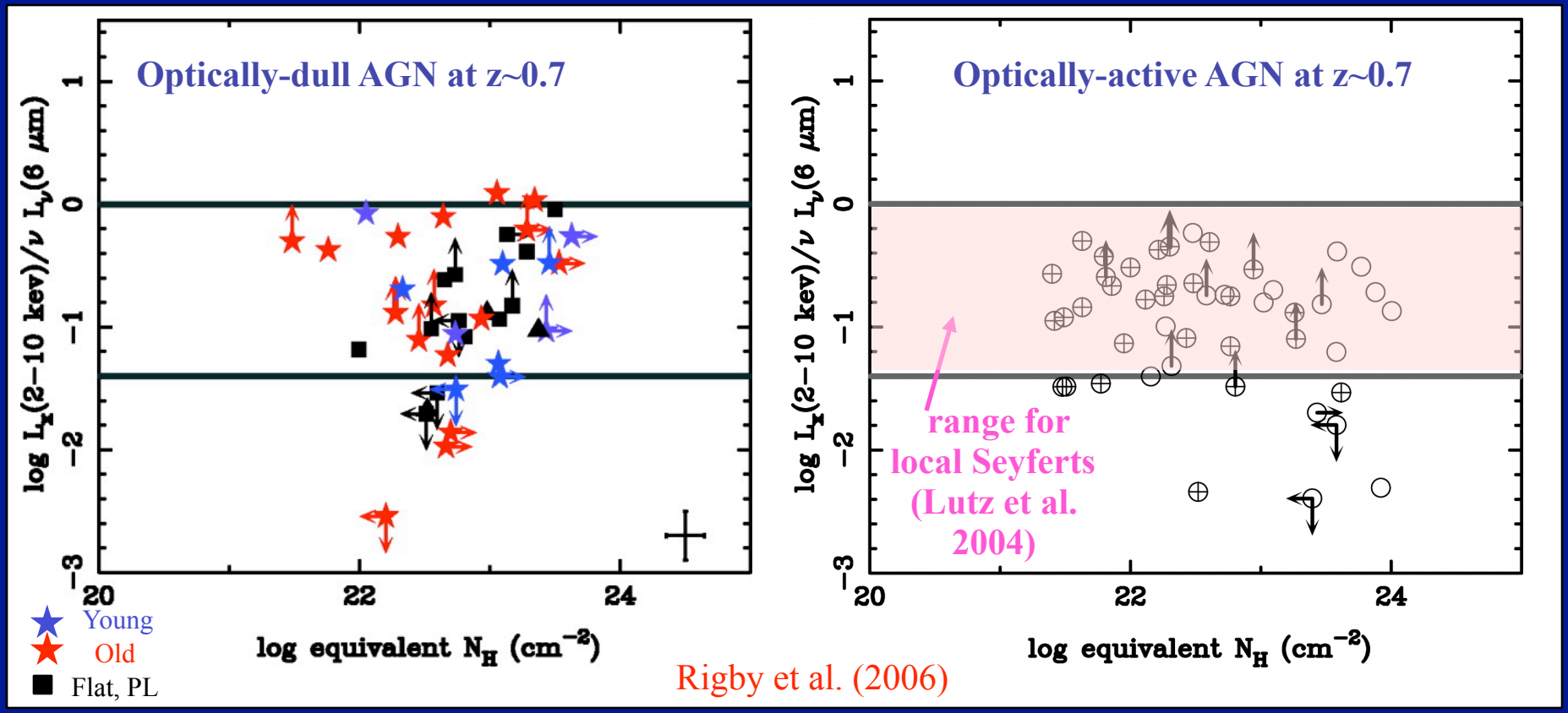
~25% of LEX, ABS have IR flat or power-law SEDs

Optically-bright AGN have rest-frame near and mid-IR SEDs contaminated by the AGN emission!

Possible explanations for Optical ¨Dullness¨

50% X-ray selected AGN in cosmological surveys show no evidence for high-excitation lines typical of AGN (in local universe only 10-20%):

(1) Weak ionizing continua: NO -- as L_X/L_{IR} vs N_H similar to local Seyfert galaxies



Rigby et al. (2006)

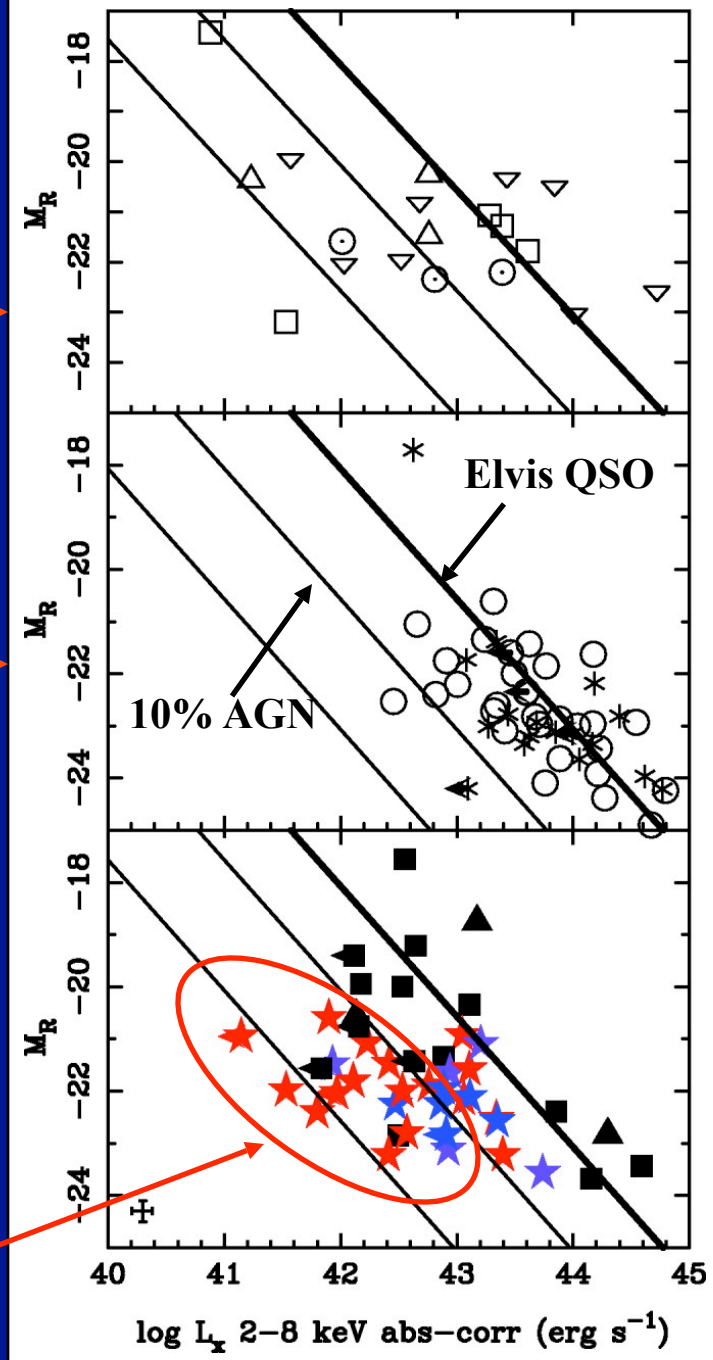
(2) Dilution of AGN emission by host galaxy (Moran et al. 2002)

Local weak line AGN

Optically active (BLAGN, HEX) in CDF-S

Optically-dull AGN in CDF-S

Host galaxy dilution responsible for up to 50% of optically dull-AGN

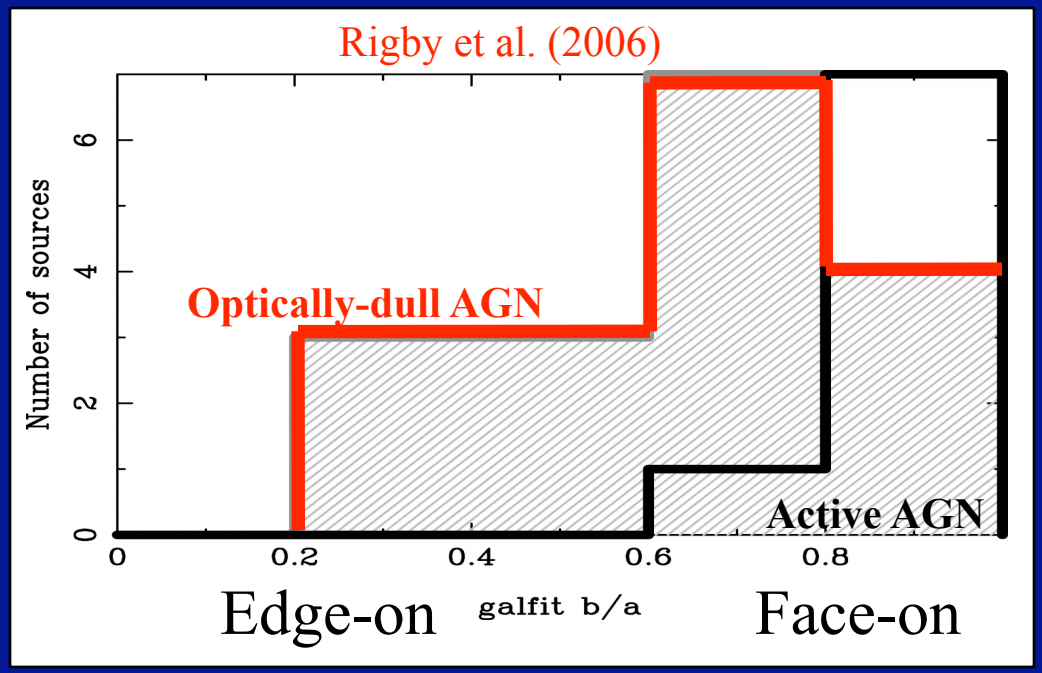


Rigby et al. (2006)

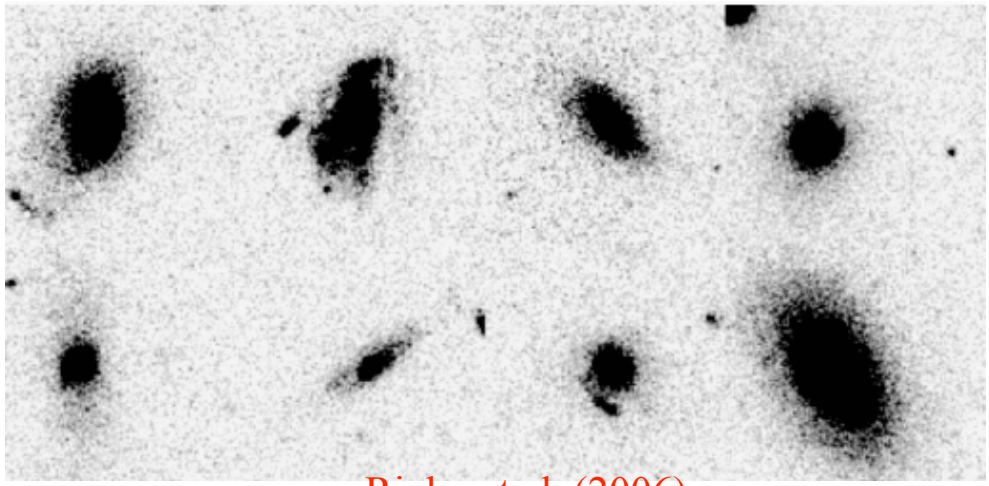
(3) Obscuration by host galaxy (on kpc scales) hides the narrow-line region

X-ray sources with optical AGN emission lines are hosted by nearly face-on spirals or spheroids

Optically-bright AGN, in particular BLAGN, tend to have point-like nuclear morphologies (see also Barger et al. 2005)



ACS morphologies of optically-dull AGN 0.5<z<0.8

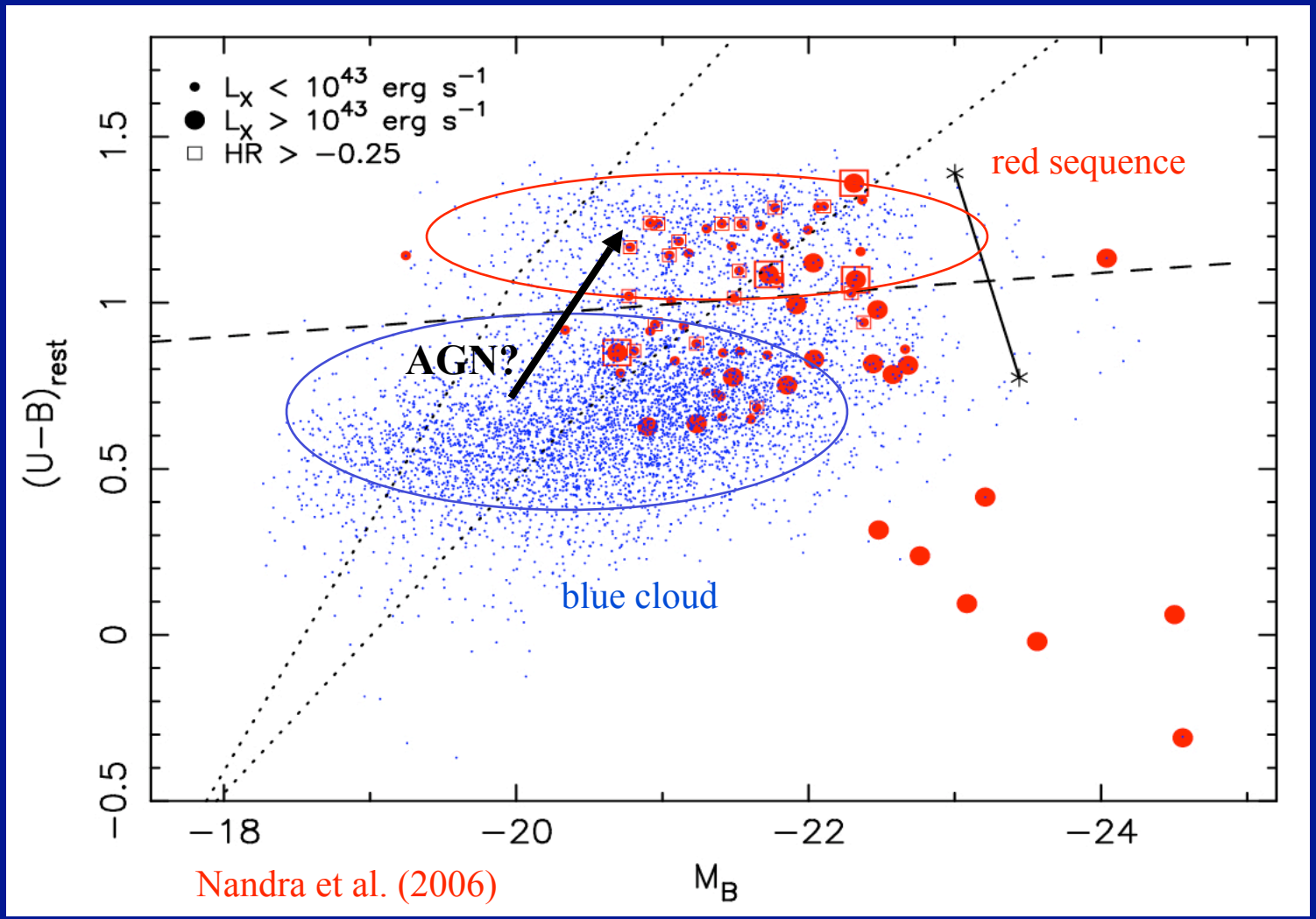


Rigby et al. (2006)

Optically-Dull AGN have host galaxies with a range of inclination angles. Host galaxy may also be responsible for soft X-ray column densities!

Star Formation Histories of AGN at 0.5<z<1.4

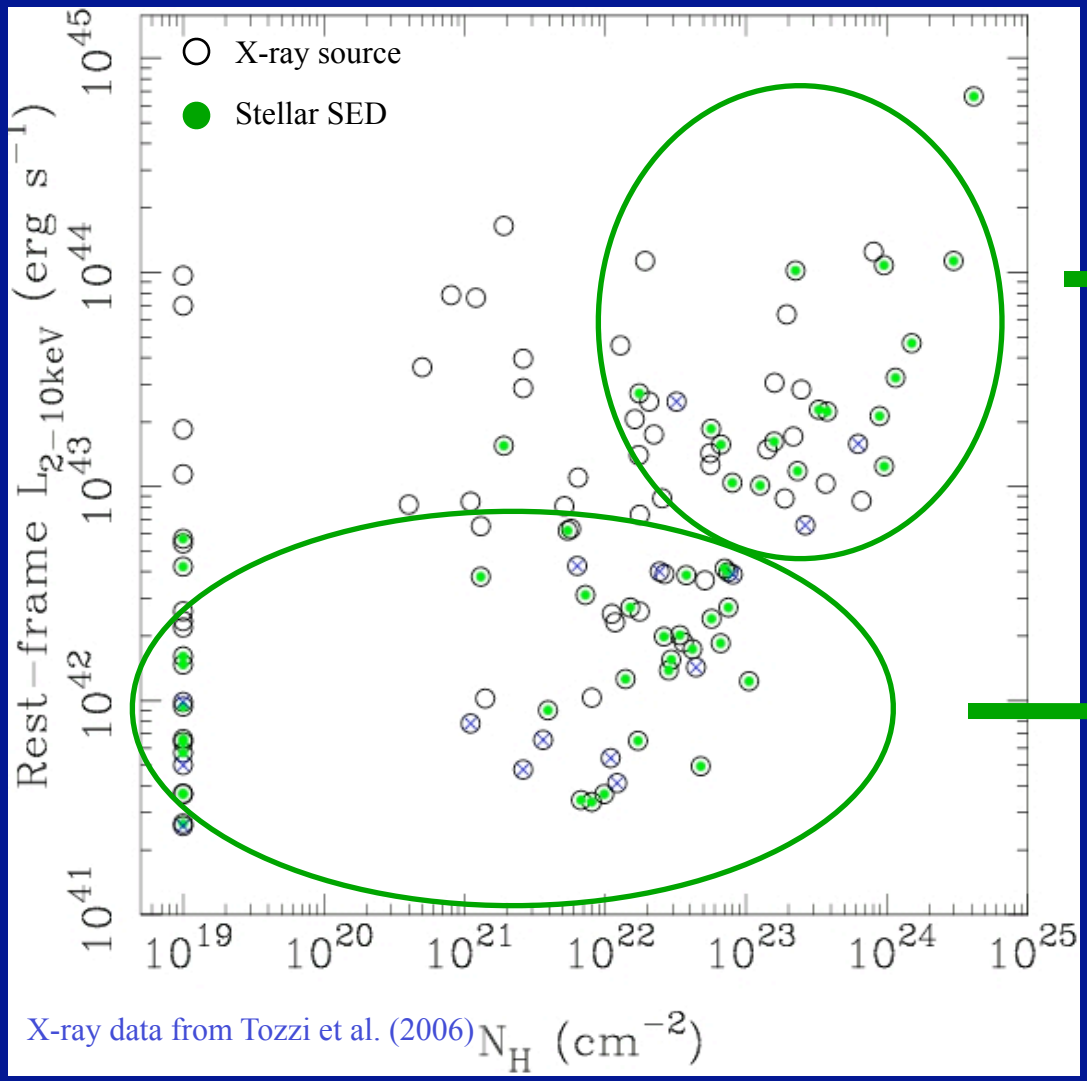
X-ray sources at 0.6<z<1.4 in EGS located in a distinct region of the color-magnitude diagram: transition region where star-forming galaxies move into the red sequence -> AGN feedback quenches star-formation?



X-ray properties of AGN with stellar-dominated SEDs

AGN sample: 52 (out of 114 detected by IRAC) X-ray sources in GOODS-South have stellar-dominated SEDs (prominent 1.6μm bump)

SED Data: UV, optical, NIR, Spitzer (IRAC 3.5-8μm, MIPS 24, 70μm)



X-ray data from Tozzi et al. (2006)

Luminous X-ray AGN with large N_H (type 2)

Less luminous X-ray AGN show a range of N_H (type 1 and type2)

Alonso-Herrero et al. (2007)

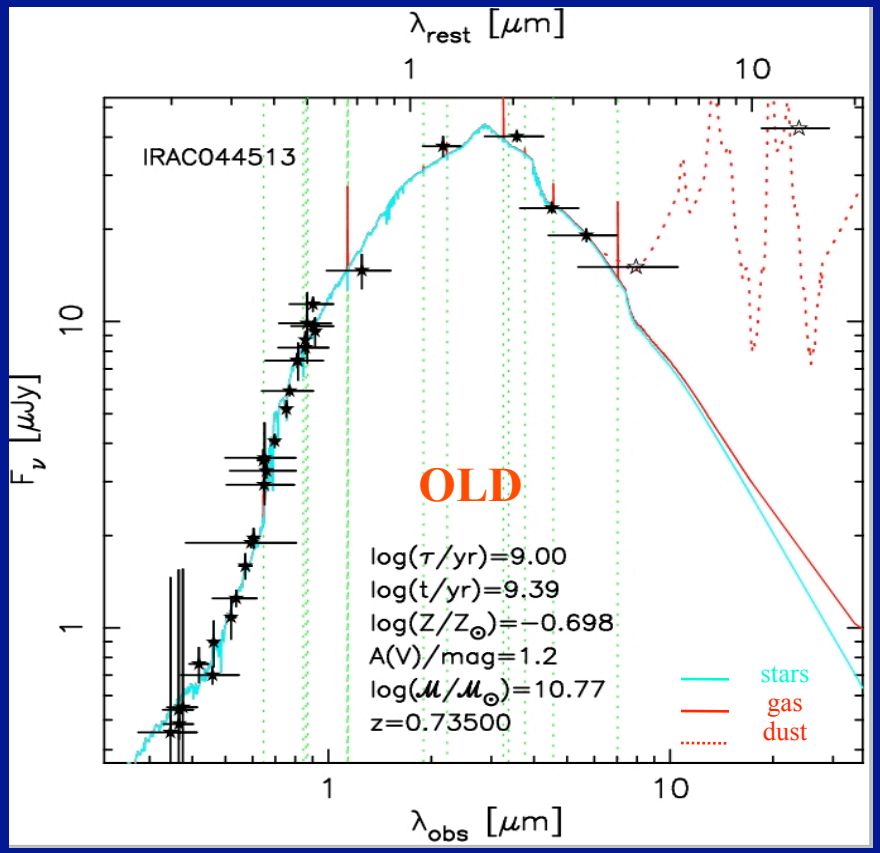
SED modelling of AGN host galaxies

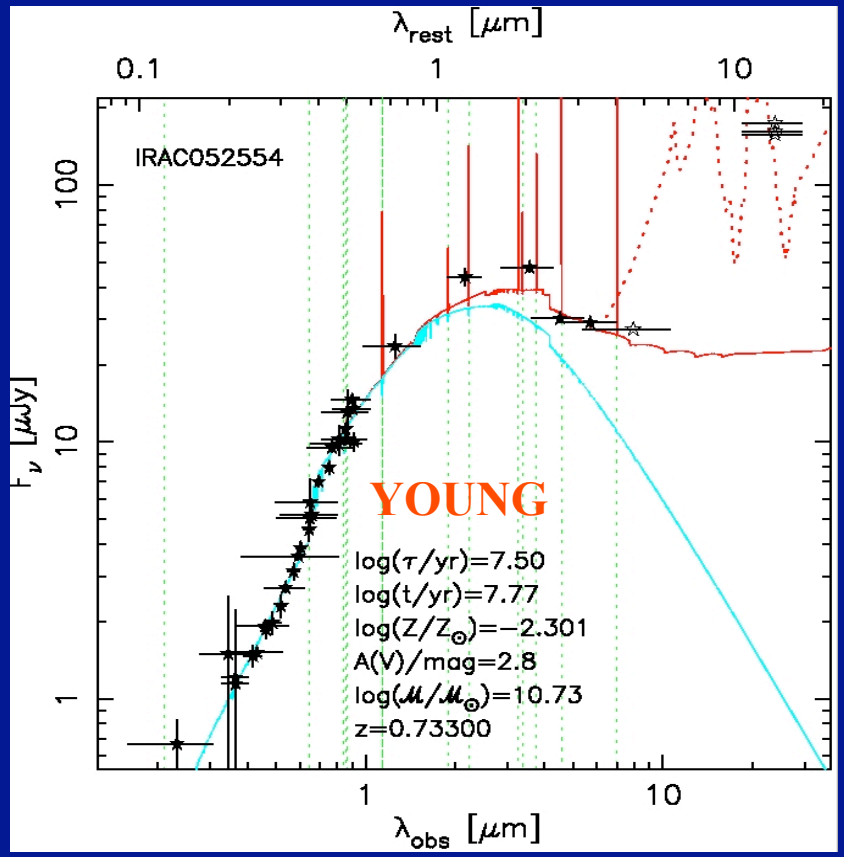
Stellar emission (λ<4μm): Salpeter IMF, Pegase (one or two stellar populations and exponential SFR) **+ gas emission**

-> ages, M_*(stellar mass), A_V, metallicities (and photo-z if needed)

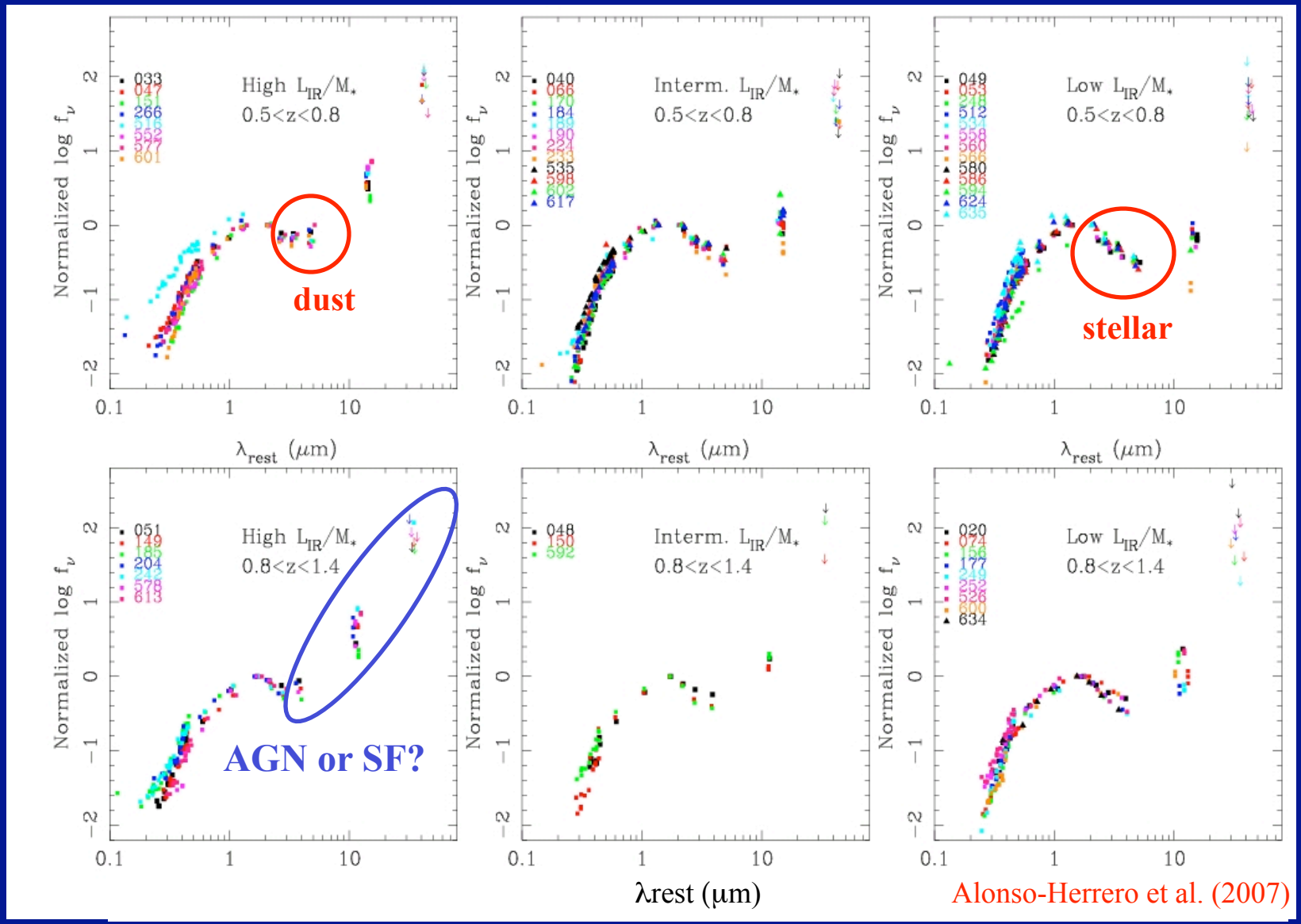
Infrared emission (λ>4μm): Chary & Elbaz models -> derive L_{IR} (8-1000μm)

Star Formation Rates: SFR= SFR(UV) + SFR(L_{IR})





See Pérez-González et al. (2007) for details on SED modelling



Alonso-Herrero et al. (2007)

~25% large L_{IR}/M_*

Mild mid-IR excesses

Bluer UV-optical SEDs

Younger stellar ages from SED fitting

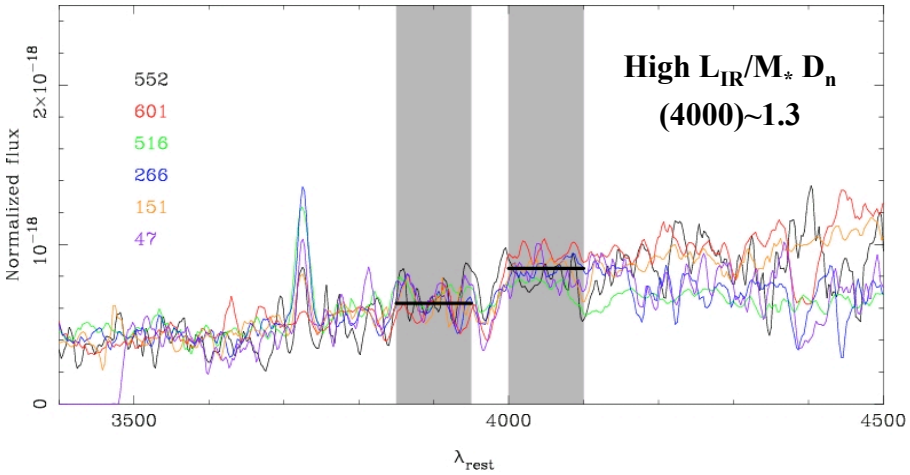
~50% low L_{IR}/M_*

λ<8μm emission stellar

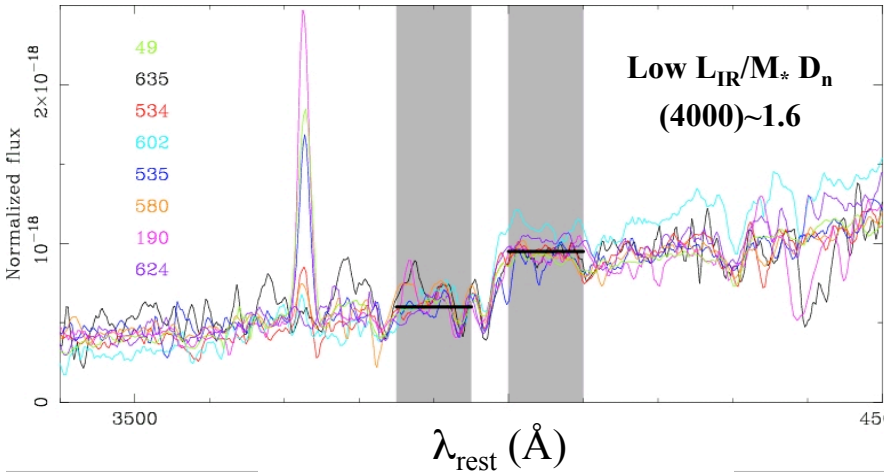
Redder UV-optical SEDs

Older stellar ages from SED fitting

Average stellar ages: 4000-Å break



Alonso-Herrero et al. (2007)



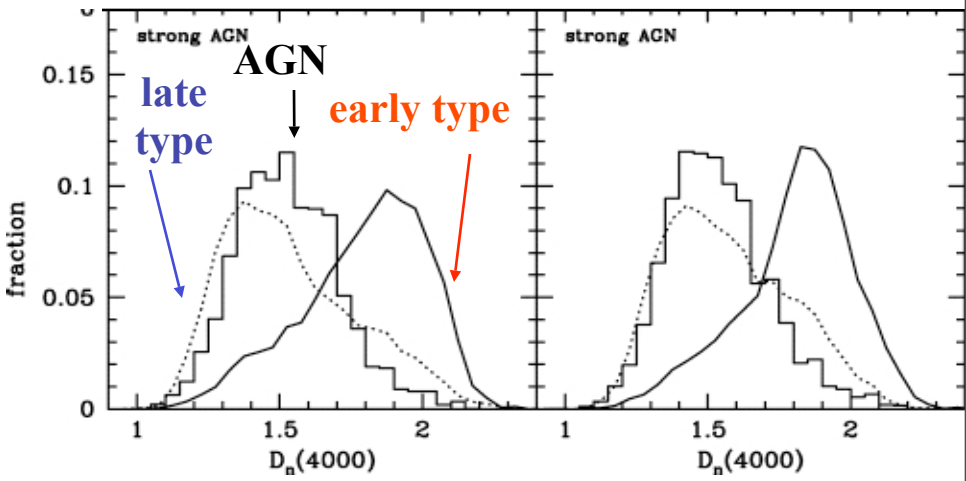
Spectra from Szokoly et al. (2004)

The mean stellar age of the host galaxies of X-ray selected AGN at z<0.8 indicate relatetively young populations and are similar to local AGN

Tendency for galaxies with high L_{IR}/M_* to show younger stellar populations

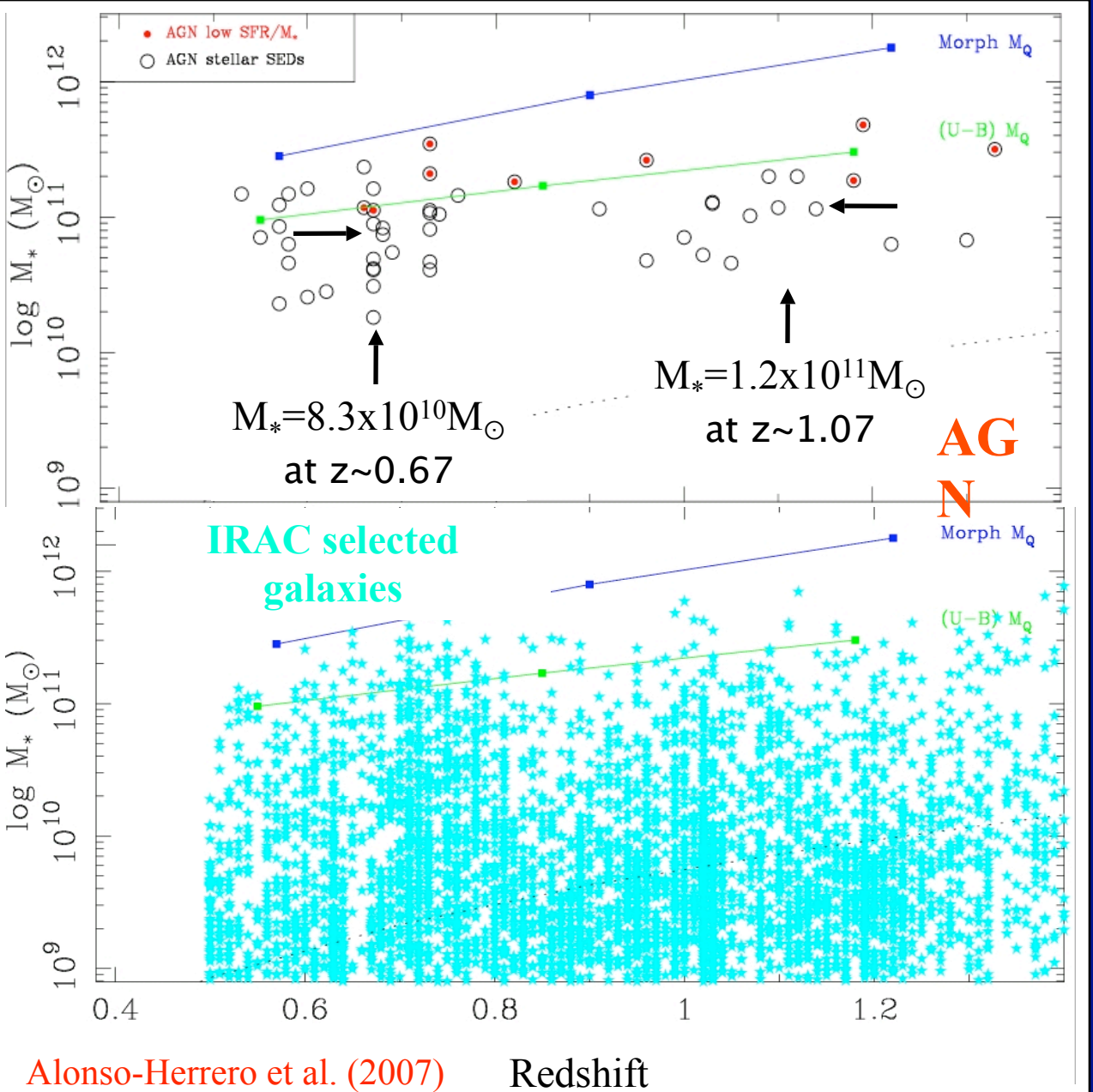
IR emission is mostly produced by star-formation

10.4<log M_*<10.8 10.8<log M_*<11.2



LOCAL AGN: Kauffmann et al. (2003)

Evolution of Stellar Masses of AGN at 0.5<z<1.4



Alonso-Herrero et al. (2007)

AGN reside in the most massive galaxies detected at similar redshifts

Cosmic "downsizing" of stellar masses of AGN hosts:

Local (z<0.3) M_* ~4-5x$10^{10}M_\odot$ (Kauffmann et al. 2003)

High-z M_* ~2x$10^{11}M_\odot$ (Kriek et al. 2006)

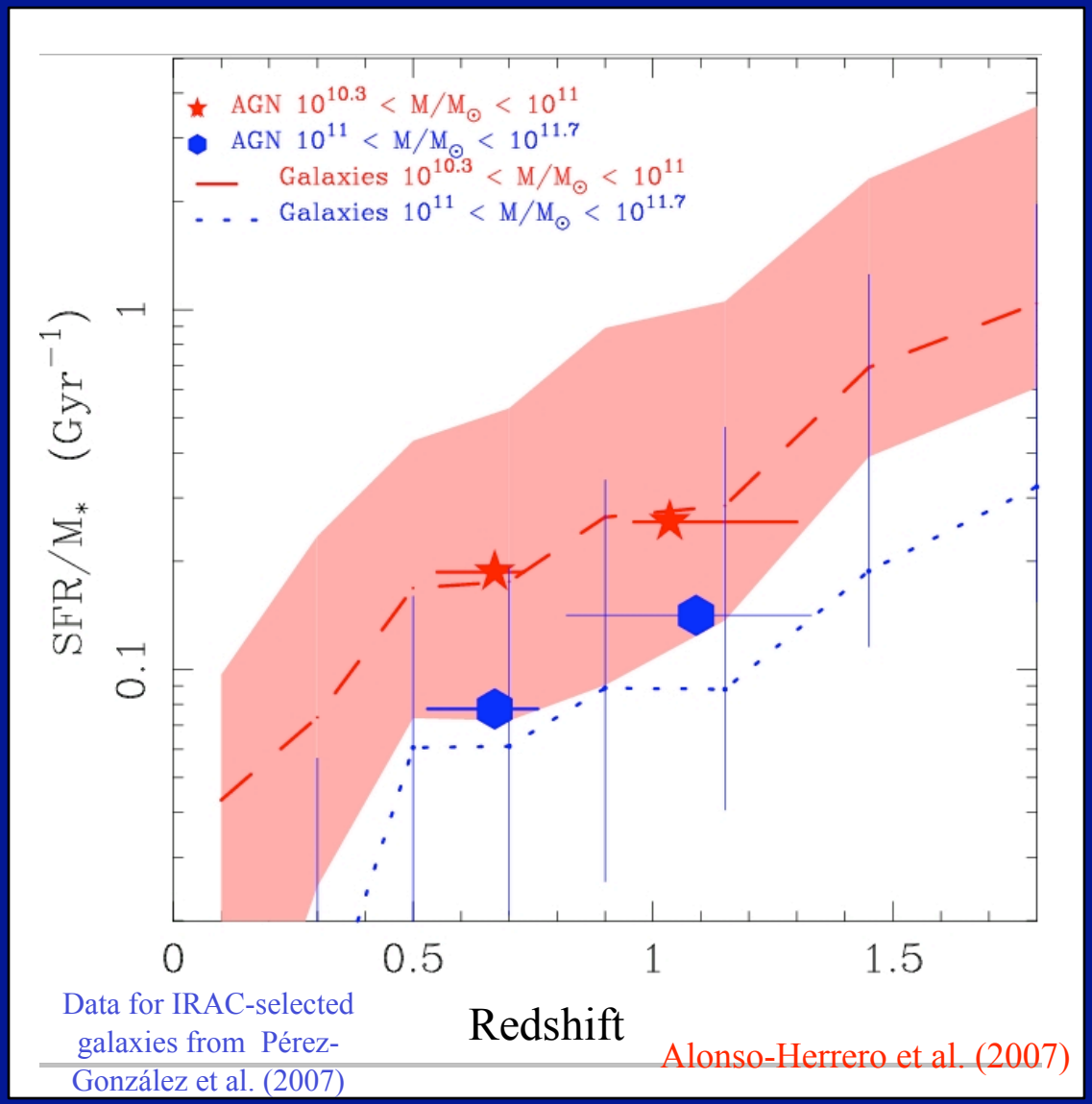
If optically-dull AGN representative of X-ray selected AGN

~25% of galaxies with M>$10^{11}M_\odot$ host an AGN

(see also Papovich et al. 2006)

and much higher if obscured AGN included (Daddi et al. 2007)

Evolution of Specific SFR of AGN and non-AGN



Data for IRAC-selected galaxies from Pérez-González et al. (2007)

Alonso-Herrero et al. (2007)

AGN at $0.5 < z < 1.4$ show similar median specific SFRs (SFR/M_*) to IRAC-selected galaxies at similar redshifts and with similar stellar masses

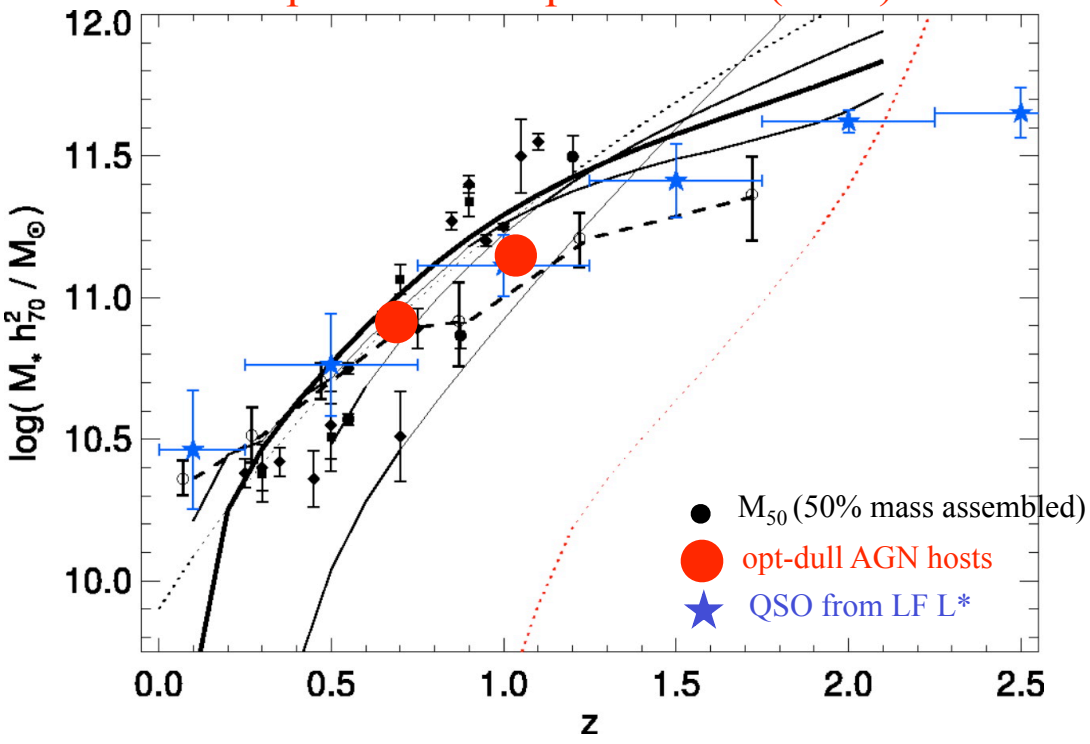
CAVEAT: unknown AGN contribution to mid-IR emission

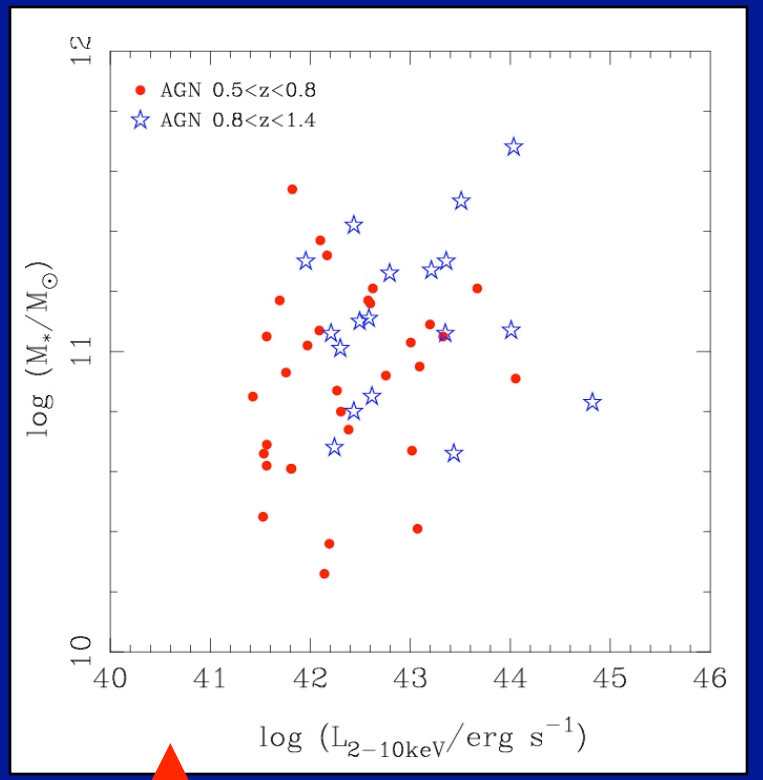
(For all AGN and IRAC selected galaxies if not detected at 24mm, SFR (IR) computed assuming fν(24μm) =60μJy)

Redshift Evolution of the Transition Mass

M_* of intermediate-z AGN host follow the same evolution as the QSO masses (from LF L* derived by Hopkins et al. 2007) and the transtion mass (characteristic mass at which galaxies move from the blue cloud to the RS)

Adapted from Hopkins et al. (2007)





No relation between M_* and absorption corrected 2-10keV L

Summary

- A large fraction of X-ray selected AGN at intermediate-z do not show optical spectroscopic evidence for accretion (optically-dull AGN)
- **Stellar emission** dominates the UV through near-IR emission allowing us to study their SF histories
- **Extinction** in the host galaxy and/or bright galaxy emission hide AGN emission lines
- AGN reside in the **most massive galaxies** detected at similar redshifts
- Cosmic downsizing of characteristic stellar mass (Salteper IMF assumed) of AGN host galaxies?

  Local (Kauffmann et al. 2003, Heckman et al. 2004): 4-6x$10^{10}M_{\odot}$ [optically selected AGN]

  Intermediate-z(this work): **8.3x$10^{10}M_{\odot}$ at z~0.7 and 1.2x$10^{11}M_{\odot}$ at z~1.1** [X-ray selected AGN]

  High-z (Kriek et al. 2006): 2x$10^{11}M_{\odot}$ [K-band selected]
- 4000-Å breaks imply relatively **young "average" stellar populations** (Dn(4000)<1.6) and 25% have UV-through-MIR SED that indicate strong star formation
- Median specific SFR (SFR/M_{*}) are similar to those of IRAC-selected galaxies of similar mass -> no evidence for the presence of AGN halting star formation (caveat: unknown contribution of AGN to mid-IR emission)
- The stellar masses of intermediate-z AGN in good agreement with those of QSO (derived from their LF) and the transition mass (both theoretical and observational) at which blue galaxies move to the red sequence