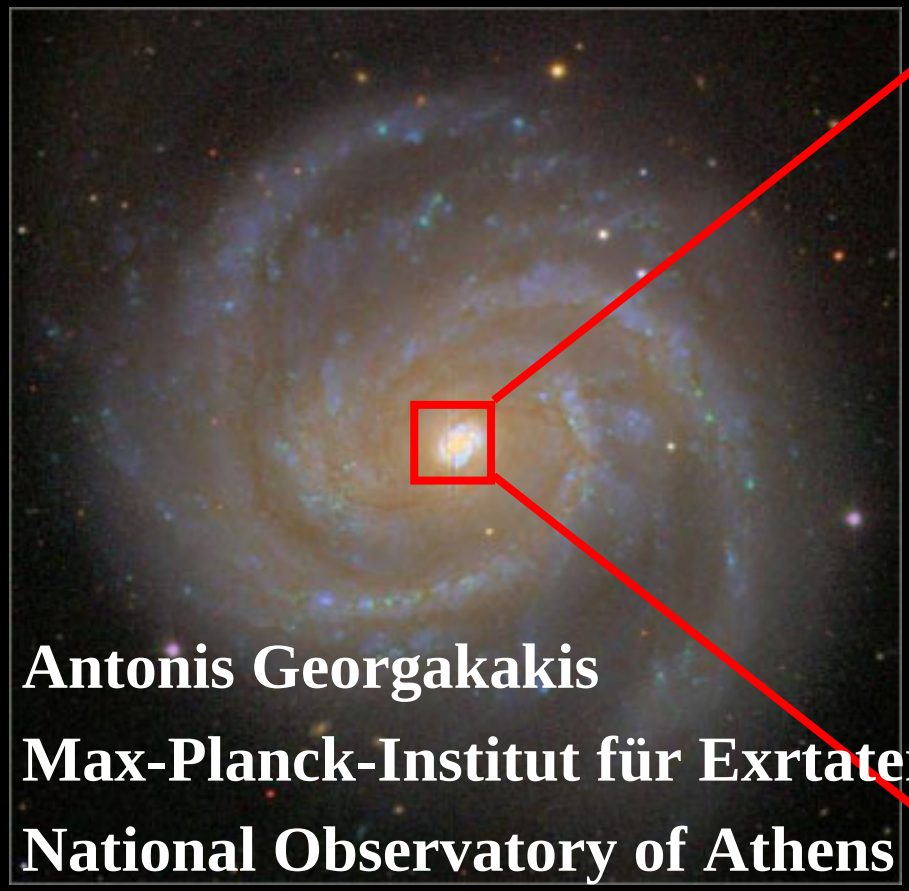
Observational constrains on the physical conditions of SMBH growth

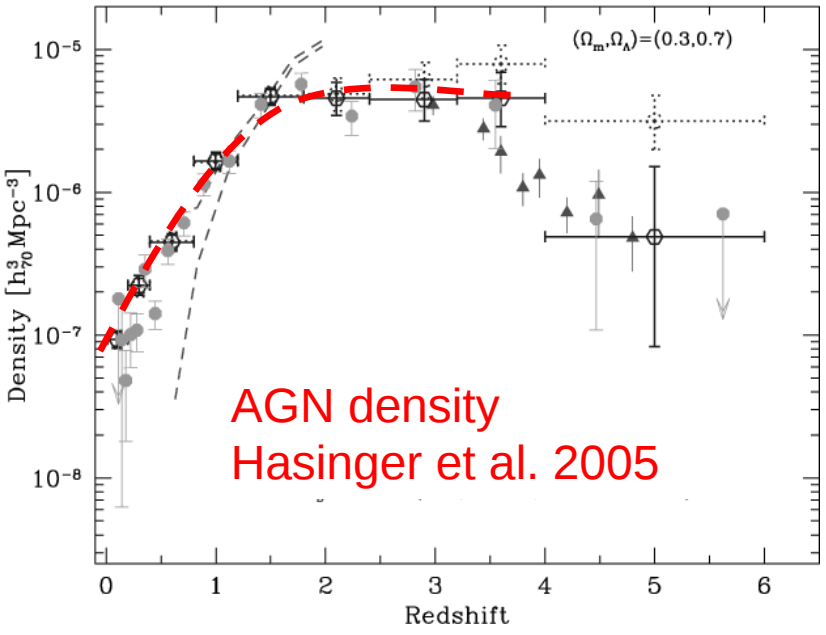


Antonis Georgakakis

Max-Planck-Institut für Exrtaterrestrische Physik

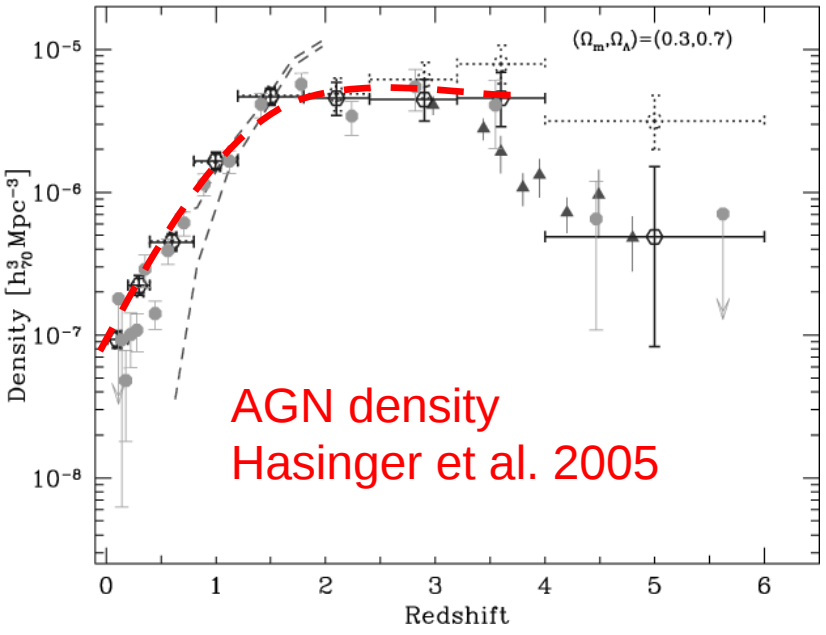
National Observatory of Athens

The physics of AGN evolution



- Rapid decline since *z*~1-2
- Broad plateau at z~2-4
- What is the physical process driving this evolution?
  - Smaller BHs at lower redshift
  - Decreasing accretion rate
  - Decline of gaseous mergers
  - Different accretion modes at different epochs

The physics of AGN evolution



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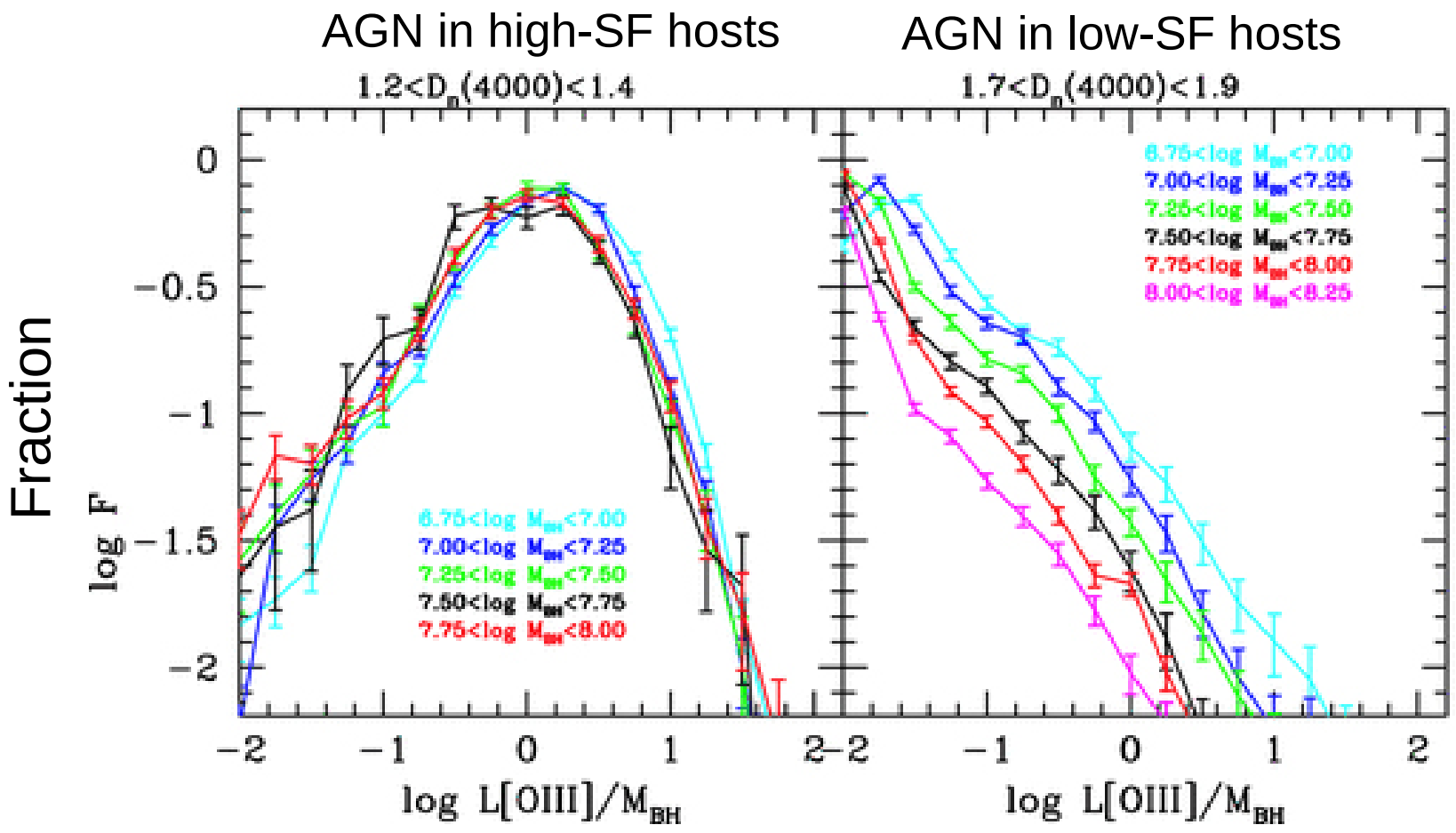
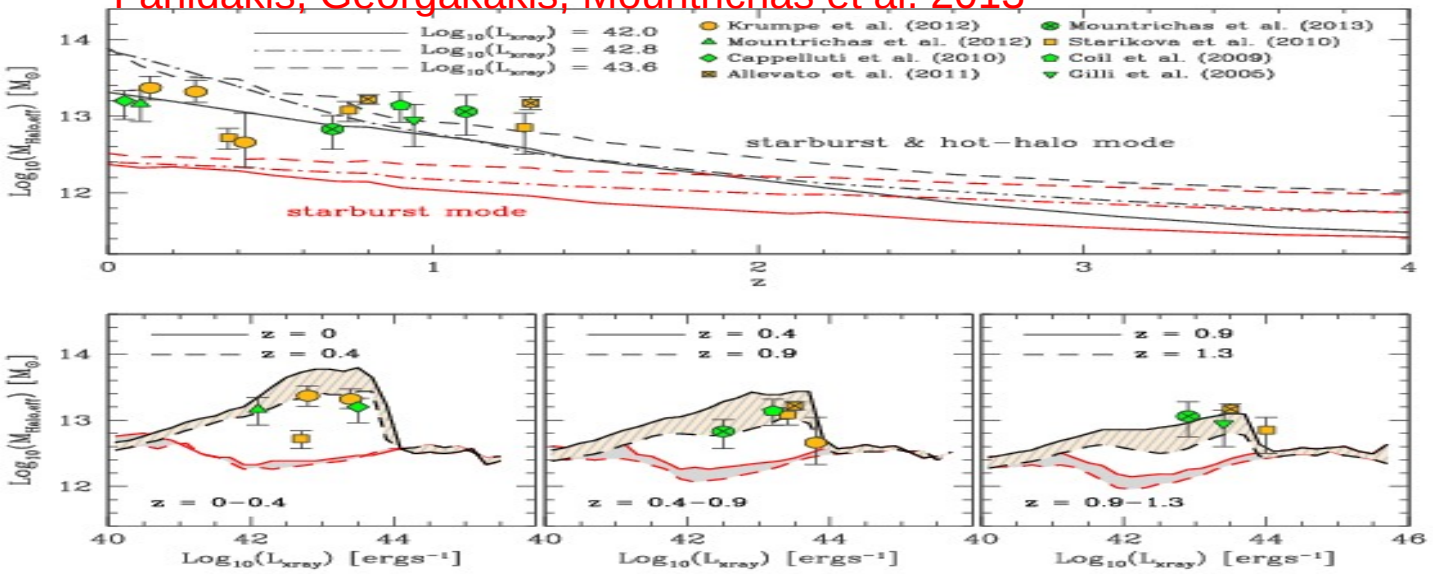
Black hole fuelling modes at z=0



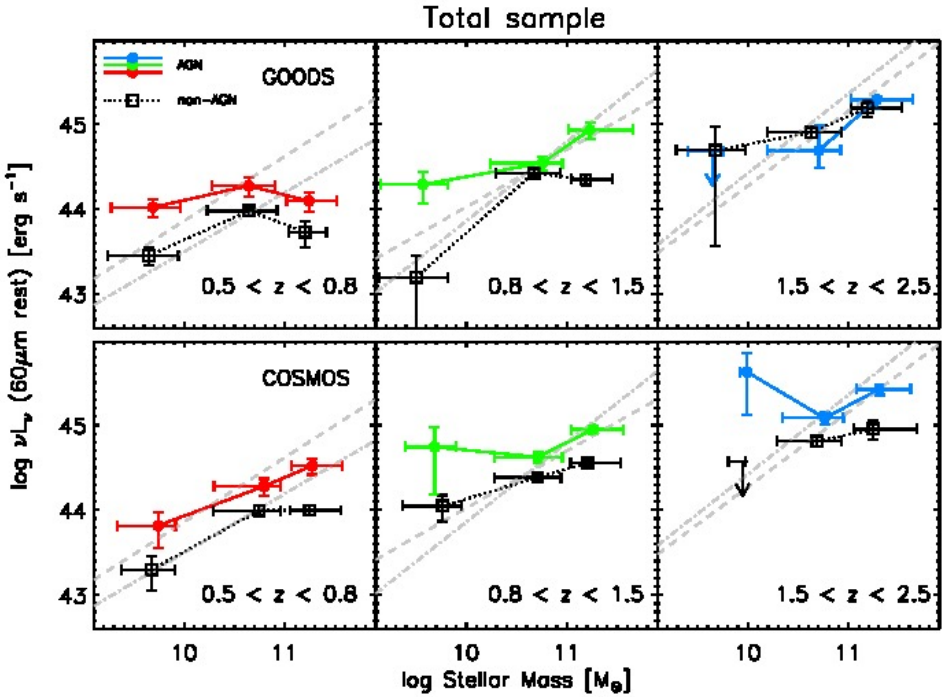
Kauffmann & Heckman 2009

Black hole fuelling modes to z=1

Fanidakis, Georgakakis, Mountrichas et al. 2013



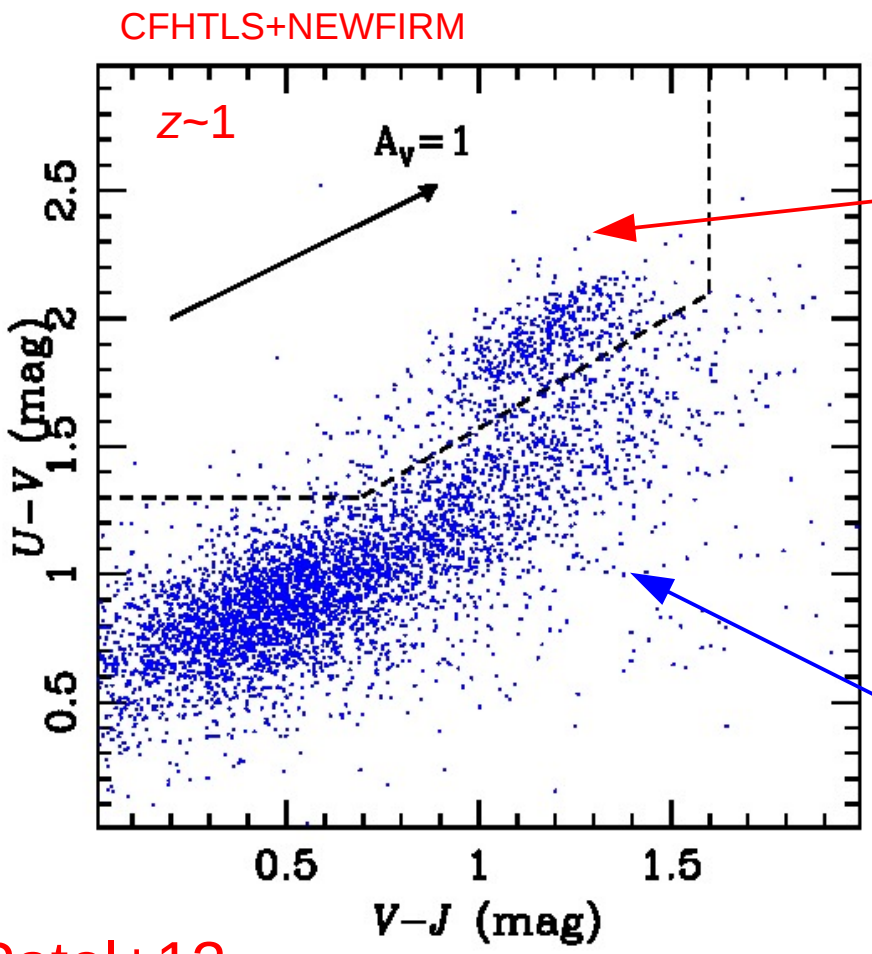
AGN hosts on the main sequence of SF galaxies



Santini+09

Rosario+11, Rosario+13, Mullaney+12

UVJ diagram



Quiescent galaxies

star-forming galaxies

Williams+09, Patel+12

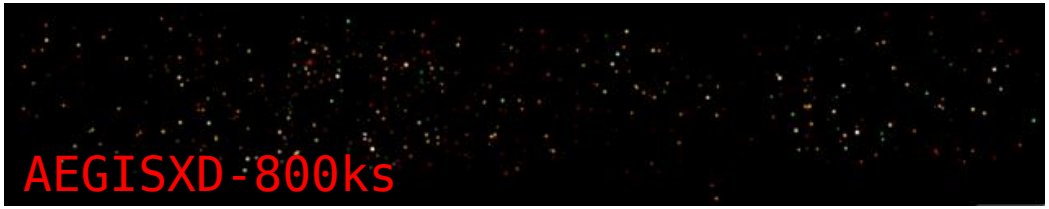
Multi-wavelength surveys

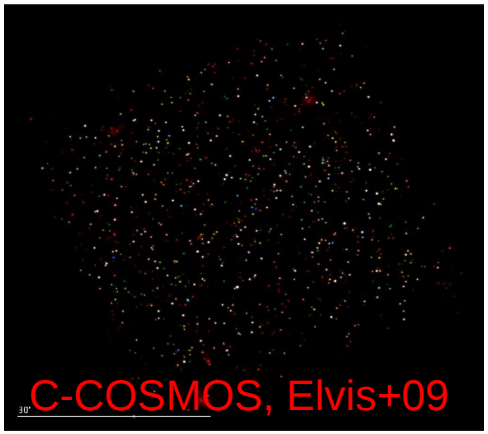
AEGIS-XD,

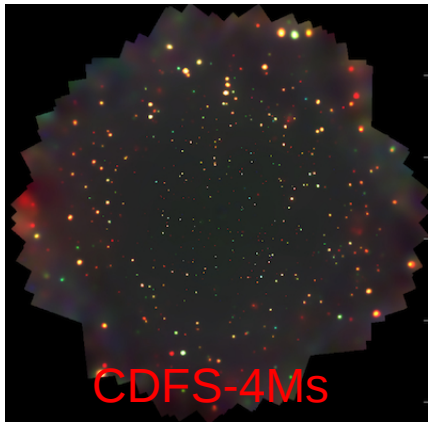
CDFS-4Ms

C-COSMOS:

- ✓ Chandra X-ray
- ✓ Optical/near-IR SEDs
- ✓ Large spec-z surveys
- ✓ HST (morphology)
- ✓ Spitzer mid/far-IR
- ✓ Herschel far-IR
- ✓ Sub-mm
- ✓ Radio (1.4GHz)



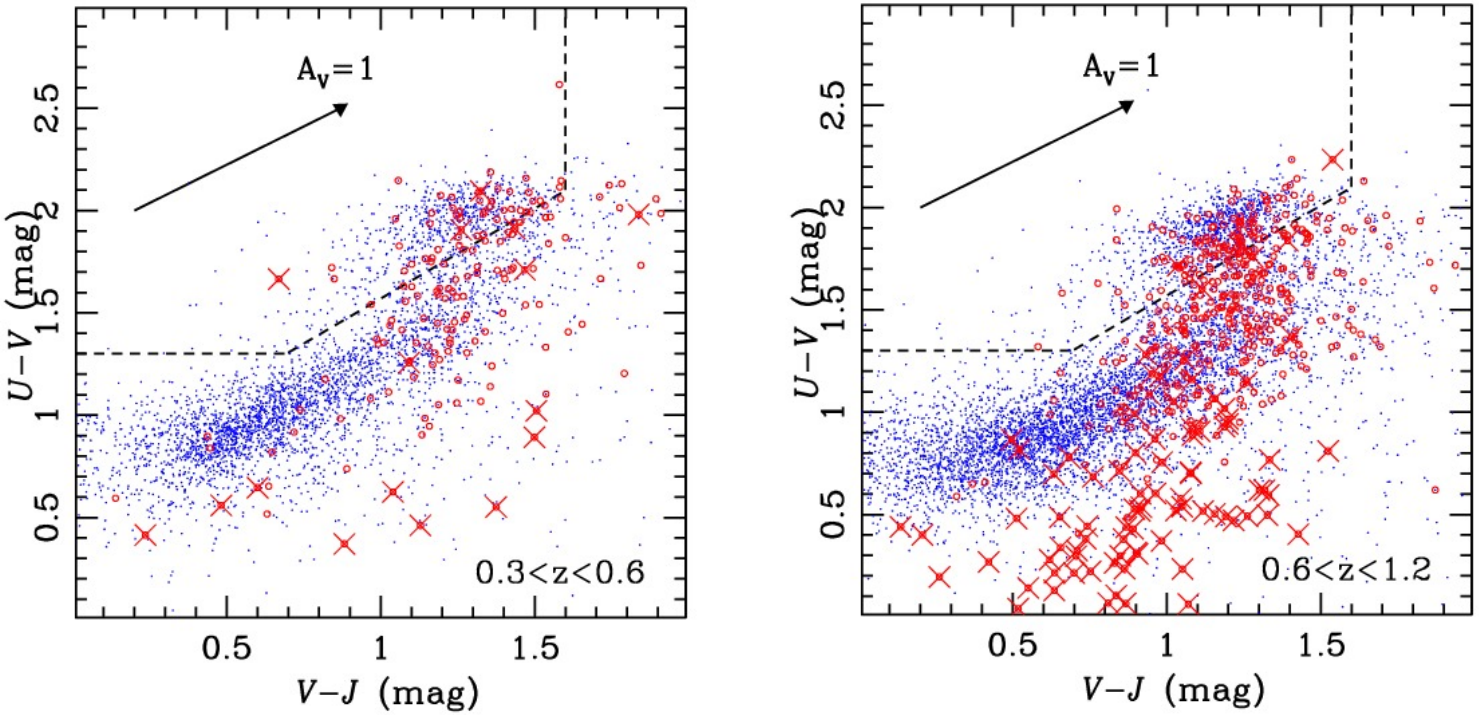




X-ray data re-analysed in a homogeneous way using methods described in Laird+09

X-ray AGN UVJ diagram

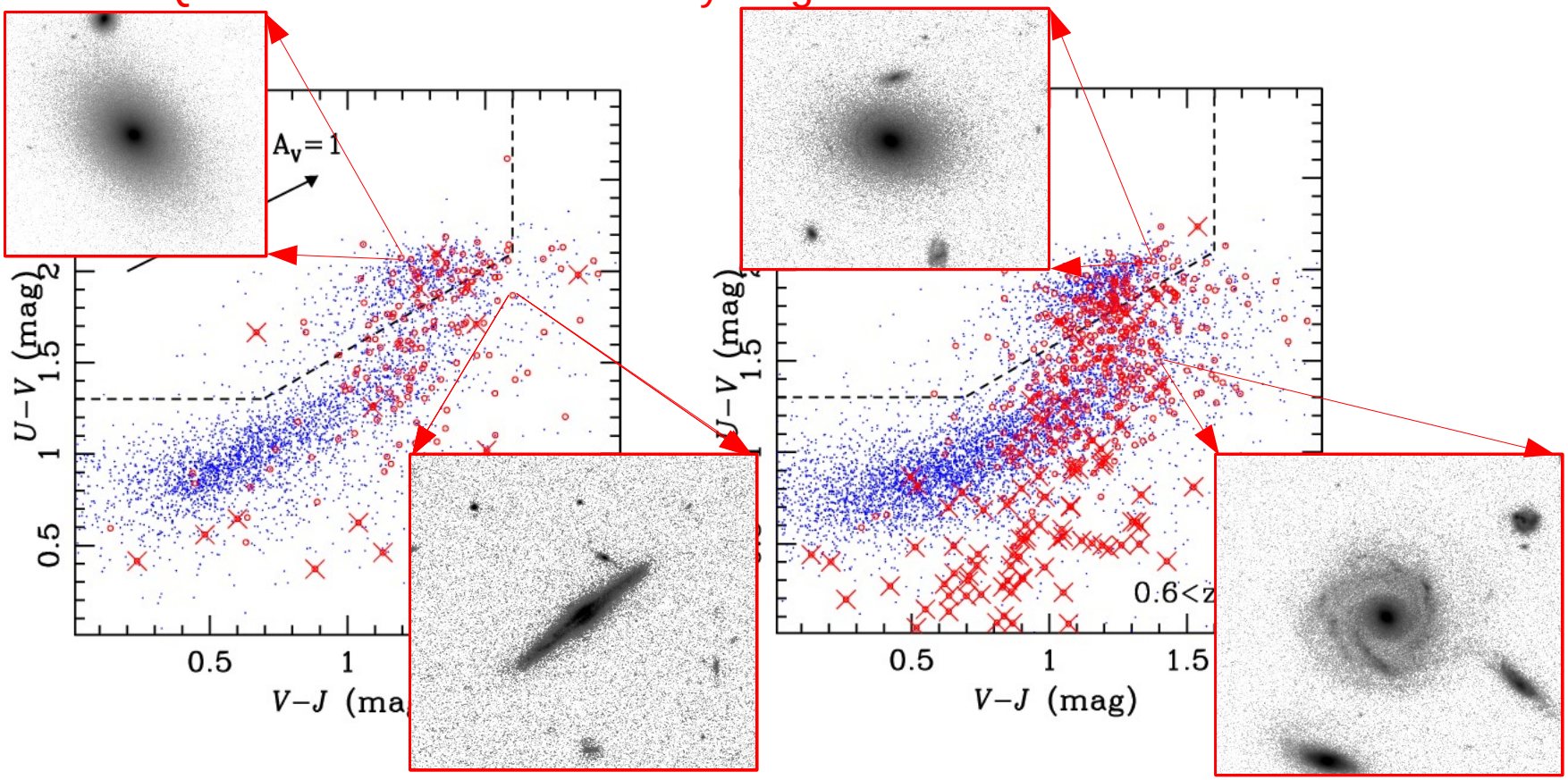
Georgakakis et al., in prep



Blue dots: galaxies
Red circles: X-ray AGN
Red crosses: BL X-ray AGN

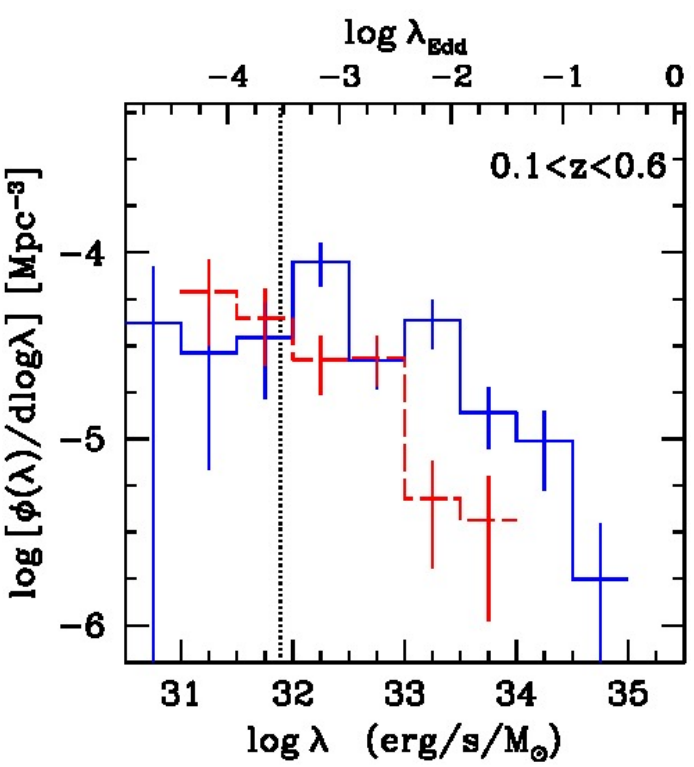
X-ray AGN UVJ diagram

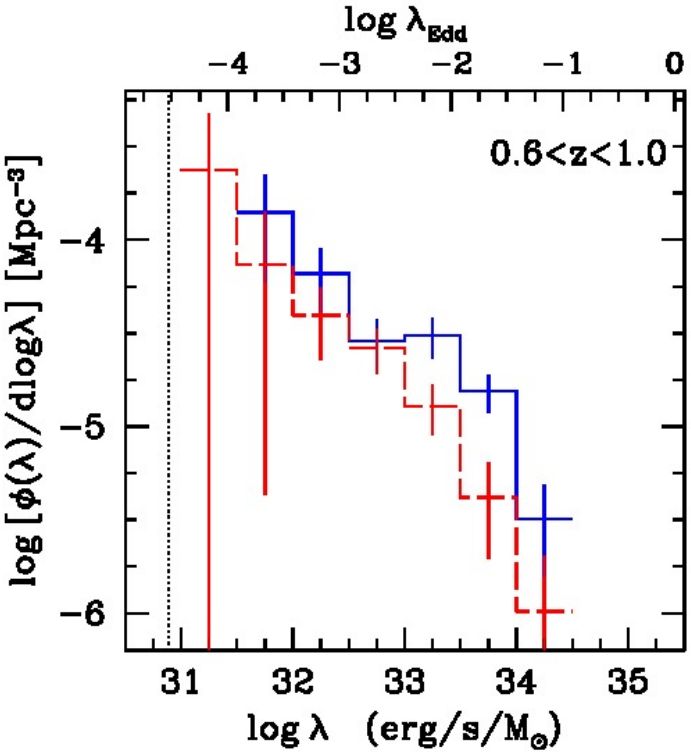
Quiescent AGN hosts: mostly bulges



Star-forming AGN hosts: 50% disks

Eddington ratio distributions





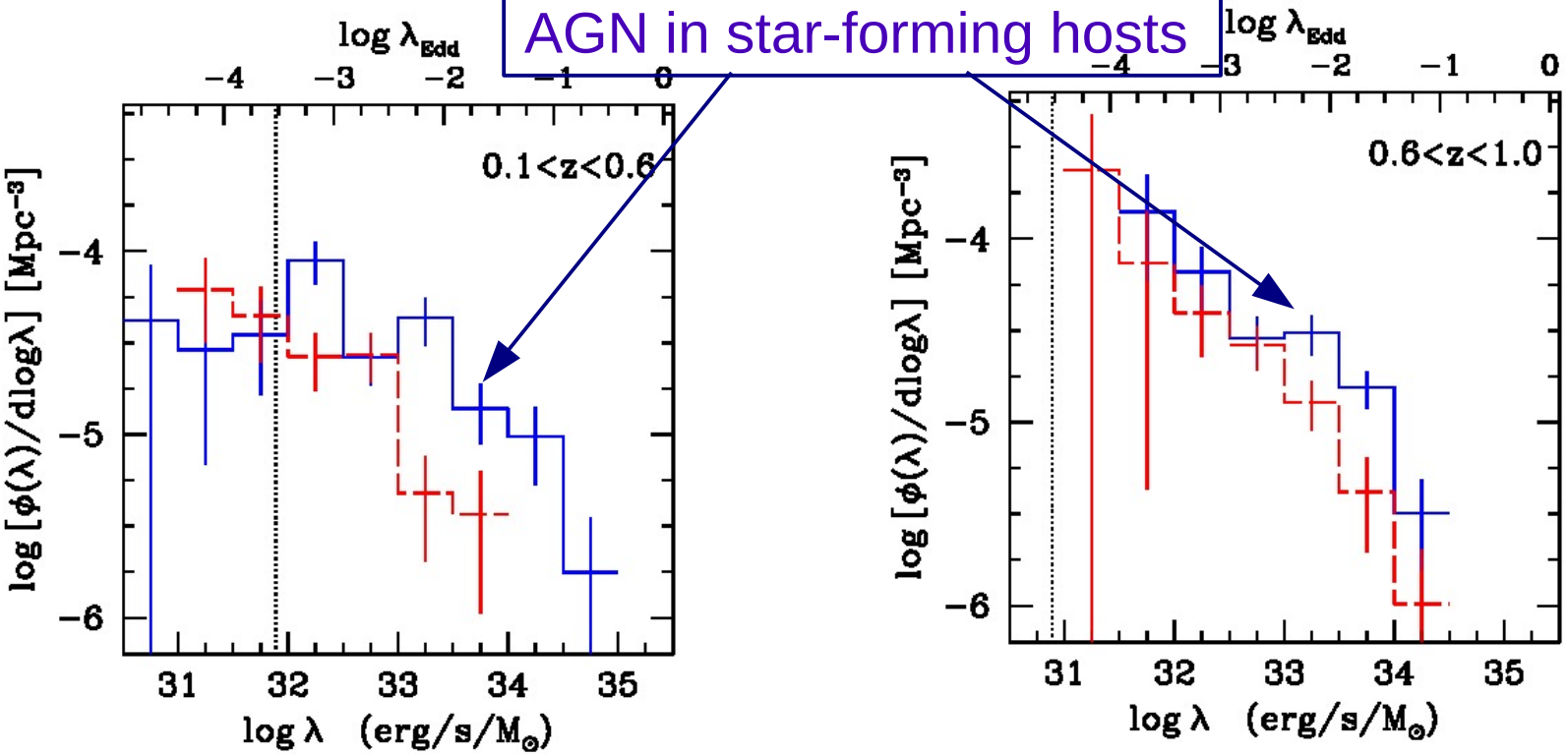
M_{BH}=0.002*M_{Bulge} (local scaling relation),

M_{bulge}~M_{Star} for bulges

M_{bulge}~0.5*M_{Star} for disks (i.e. typical for Sbc galaxies)

Eddington ratio distributions

High λ_{Edd} dominated by
AGN in star-forming hosts



M_{BH}=0.002*M_{Bulge} (local scaling relation),

M_{bulge}~M_{Star} for bulges

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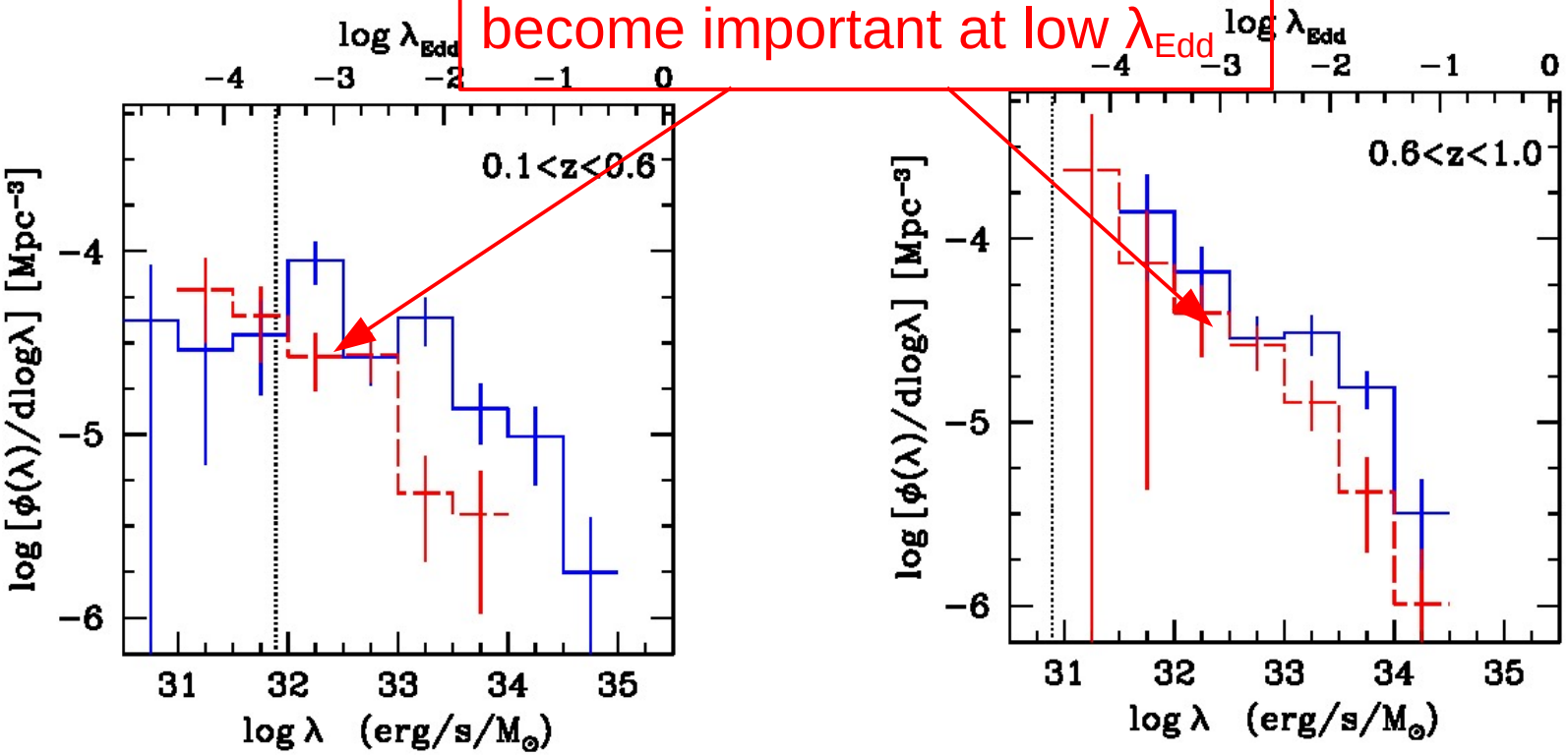
Eddington ratio distributions

AGN in quiescent hosts become important at low λ_{Edd}

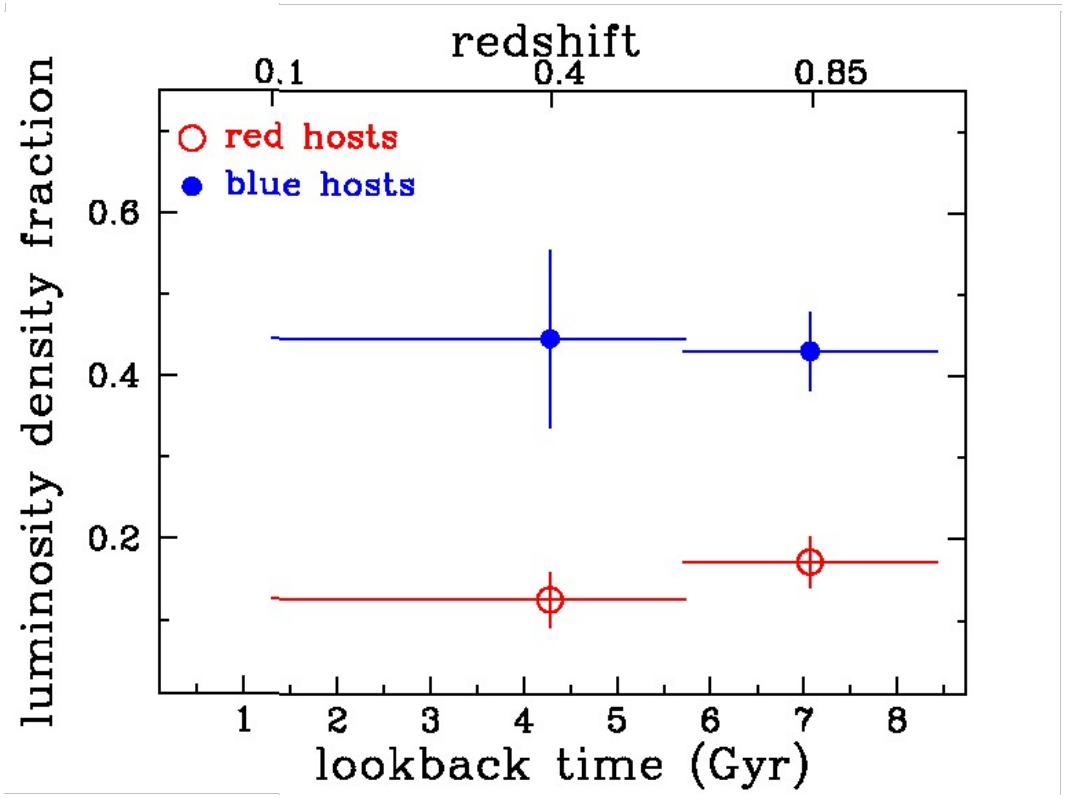


M_{BH}=0.002*M_{Bulge} (local scaling relation),

M_{bulge}~M_{Star} for bulges

M_{bulge}~0.5*M_{Star} for disks (i.e. typical for Sbc galaxies)

Accretion density split into quiescent and star-forming hosts



Bulk of accretion density associated with star-formation

Quiescent hosts: 15-20% of accretion density independent of redshift

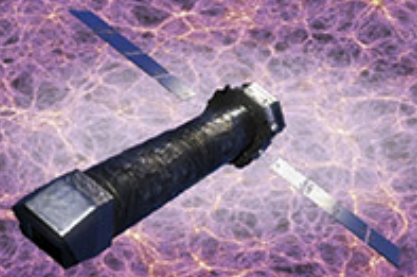
Georgakakis et al., in prep

Summary

- Evidence for two BH accretion modes to z~1
  - Star-forming hosts, include 50% disks, dominate at high Eddington ratios
  - Quiescent hosts, bulges, become important at low Eddington ratios.
- 15-20% of the accretion density at z<1 is associated with quiescent host. This fraction does not evolve with redshift

ATHENA +

REVEALING THE HOT AND ENERGETIC UNIVERSE



WHERE ARE THE HOT BARYONS AND HOW DO THEY EVOLVE?

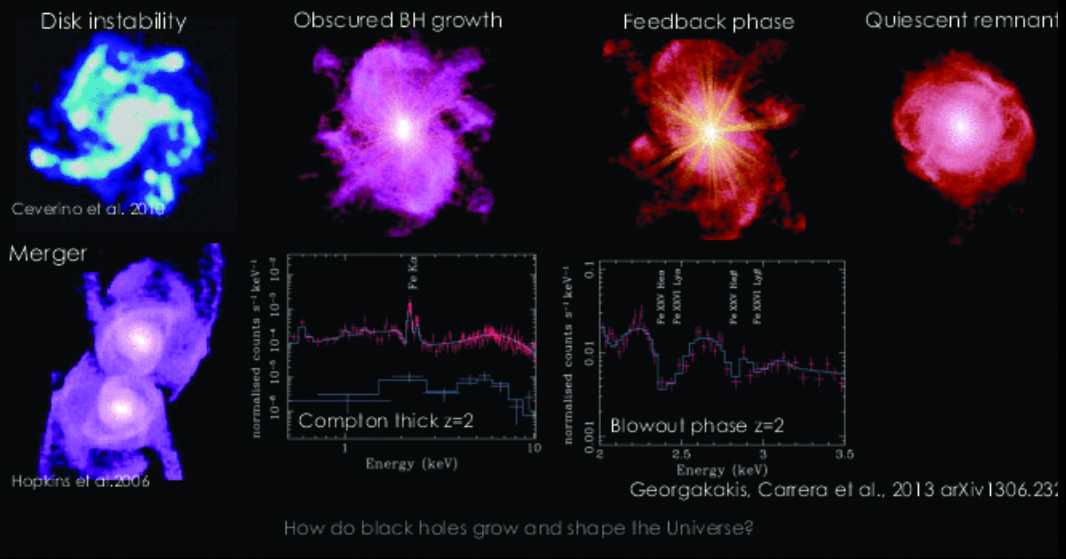
HOW DO BLACK HOLES GROW AND SHAPE THE UNIVERSE?

ASTROPHYSICS OF THE HOT AND ENERGETIC UNIVERSE

Europe's next generation X-RAY OBSERVATORY

Cosmic feedback: black hole and galaxy co-evolution

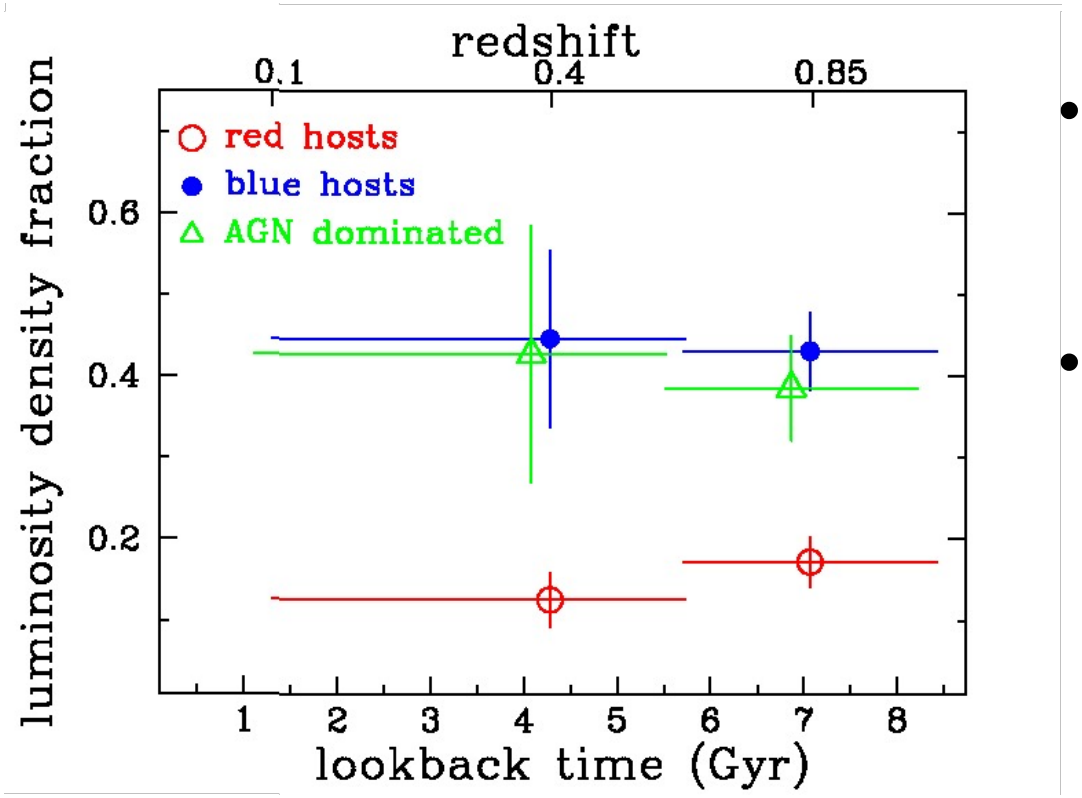
How much black hole accretion occurs in the most obscured environments?
How does this relate to the evolution of the host galaxy?



How do black holes grow and shape the Universe?

http://www.the-athena-x-ray-observatory.eu

Accretion density split into quiescent and star-forming hosts

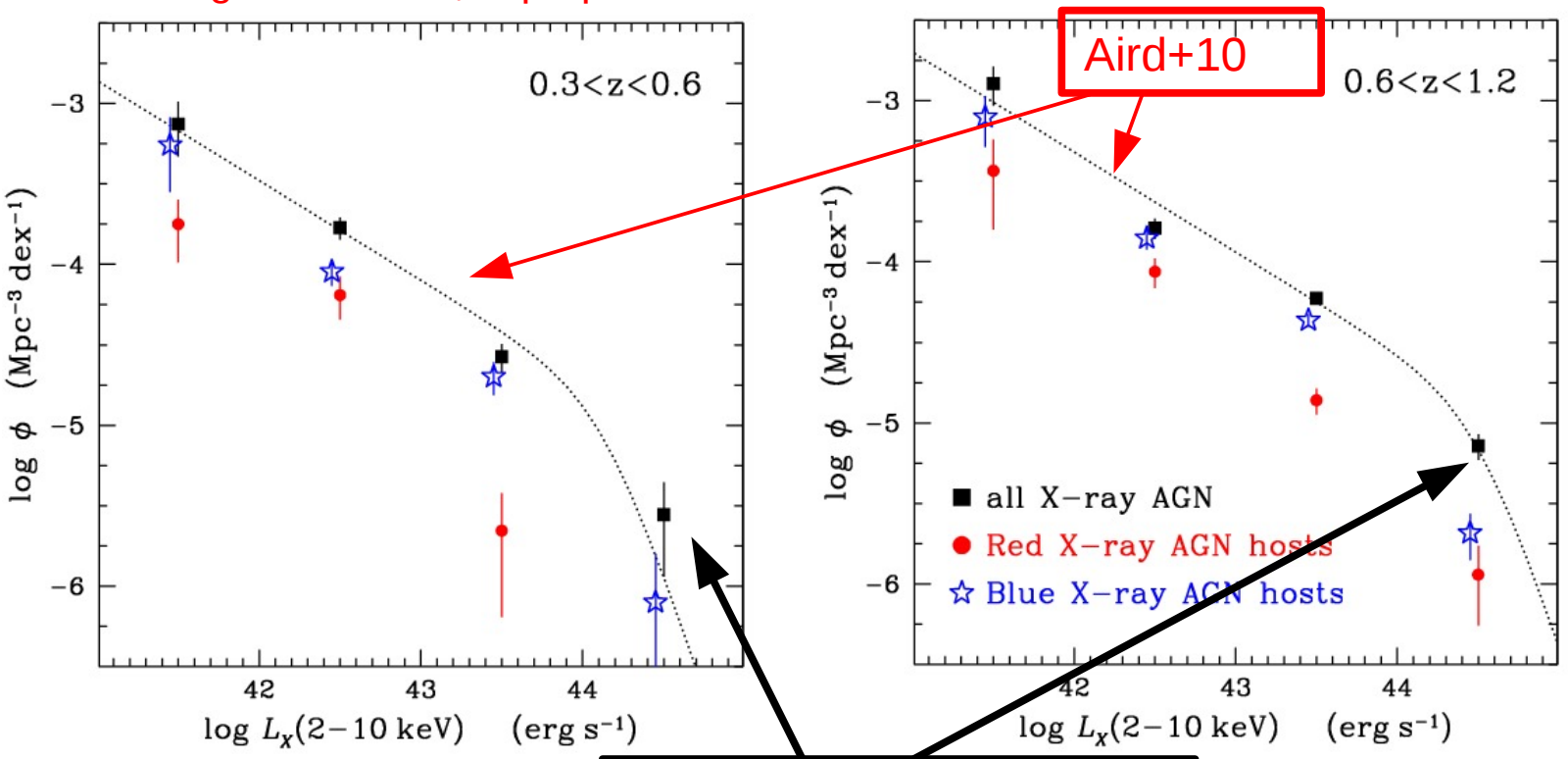


- Bulk of accretion density associated with star-formation
- Quiescent hosts: 15-20% of accretion density independent of redshift

Georgakakis et al., in prep

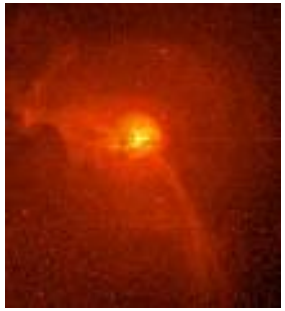
XLF split into quiescent and star-forming hosts

Georgakakis et al., in prep



GALFORM Semi-Analytic Model

GALFORM SAM: Bower et al. 2006, Fanidakis et al. 2011



Radio mode: Hot gas accretion (no mergers)

starburst mode: disk instabilities

starburst mode: Major mergers

Low Accretion Luminosity

High Accretion Luminosity

Low Redshift

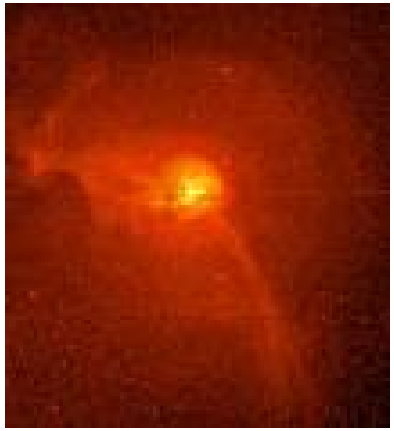
z~1

High Redshift

AGN fueling/triggering modes

Disk instabilities

Cold gas accretion
low mass BHs, high *M*dot
spiral morphology
young stars
low density regions



Radio mode accretion

Hot gas accretion
Massive BHs, low *M*dot
Massive ellipticals
evolved stars
high density regions

Major mergers

cold gas accretion
disturbed morphology
ongoing star-formation
Moderate density regions