ENVIRONMENTAL PROPERTIES OF z~[1-3] AGN AND STARFORMING GALAXIES: THE Spitzer VIEW ON CLUSTERING EVOLUTION

M.Magliocchetti (INAF-OATS & ESO)

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LAYOUT OF TALK

1) Selection criteria for 24μm-detected galaxies @z=2
2) Properties of sources
3) Clustering analysis (2D and 3D) at z@2 and z@1
4) Results on LSS evolution, host masses and occupational properties of z~2 vs z~1 galaxies.

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Work based on MIPS (Fadda et al. 2006) + IRAC (Lacy et al. 2005) + KPNO (Fadda et al. 2004) observations of the First Look Survey
[FLS 2.5° x 2° centred at 17h 18m, +59° 30′]

AND

UKIDSS DR1

NEW!!!

N.B. PRIMARY SELECTION 24μm

The Moral of the Tale

Considered two samples of $F_{24\mu m}$>0.35-0.4mJy galaxies at z>~1.6 and 0.6<z<1.2 with similar selection criteria → **30-35% AGN**

A) z>1.6 sources v.strongly clustered: **r_0~15 Mpc**; hosted by v.massive halos $M>10^{13}\ M_{sun}$ and common (~0.5-20 galaxies per halo).

B) For sources in 0.6<z<1.2 sample **r_0~7 Mpc;** hosted by less massive structures $M>10^{11.7}\ M_{sun}$ and rare.

⇓

DIFFERENT OBJECTS: AGN/SB activity moves to lower M at lower z → COSMIC DOWNSIZING

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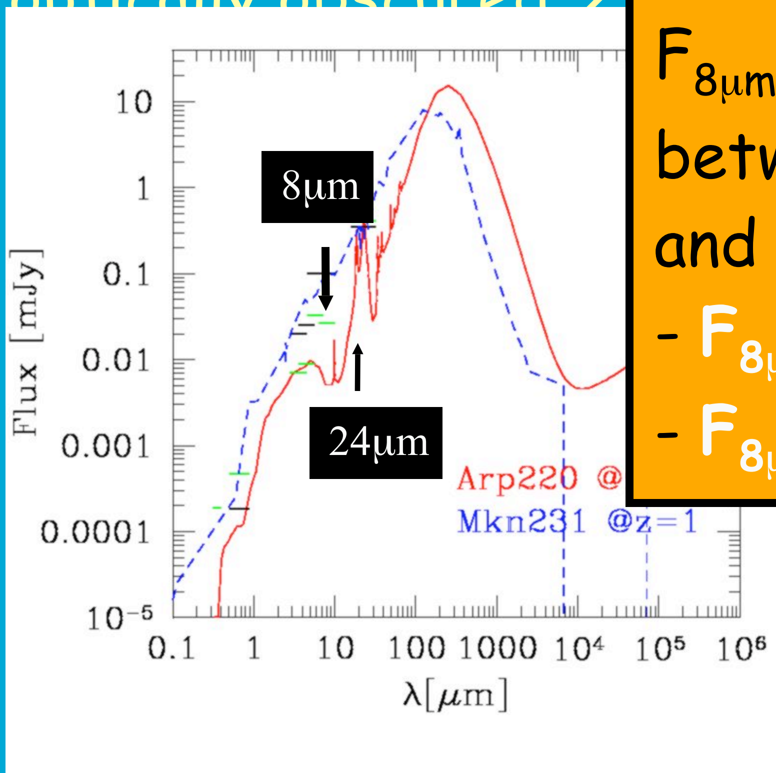
DIFFERENT OBJECTS: AGN/SB activity moves to lower M at lower z → COSMIC DOWNSIZING

C) EVIDENCE FOR CLOSE ENCOUNTES/MERGING CONNECTED TO AGN/SB ACTIVITY (esp at z~1)

The FLS sample:

on 2.85 sq. deg. with MIPS+IRAC+KPNO data select 510 sources with $F_{24\mu m}$>0.35 mJy and R>25.5 (KPNO limit - optically obscured→ high z)



$F_{8\mu m}/F_{24\mu m}$ optimal to discern between obscured AGN-dominated and SB-dominated sources.

- $F_{8\mu m}/F_{24\mu m}$>0.1 109 candidate **AGN**
- $F_{8\mu m}/F_{24\mu m}$<0.1 401 candidate SB

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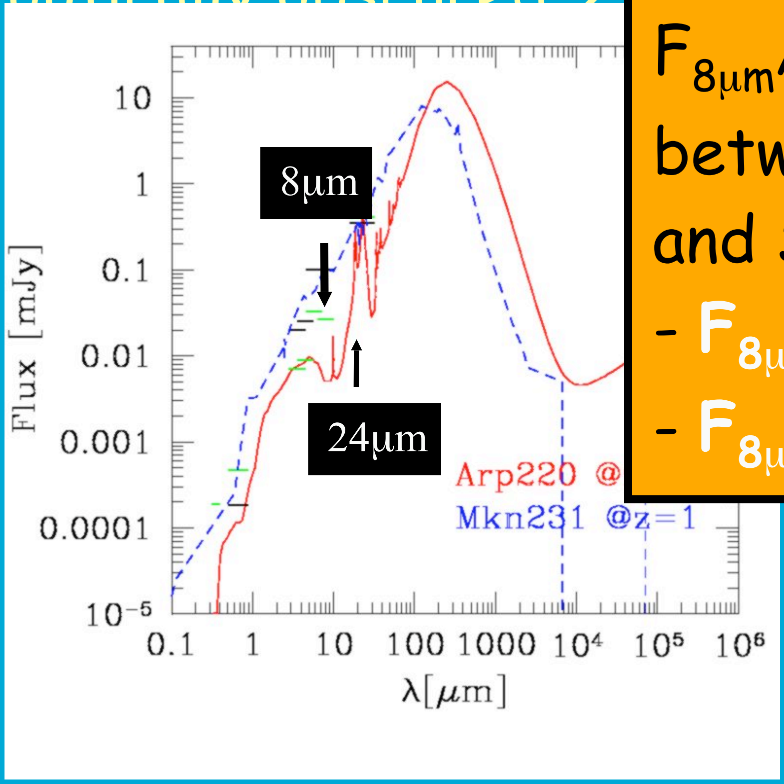

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- $F_{8\mu m}/F_{24\mu m}$ ... AGN
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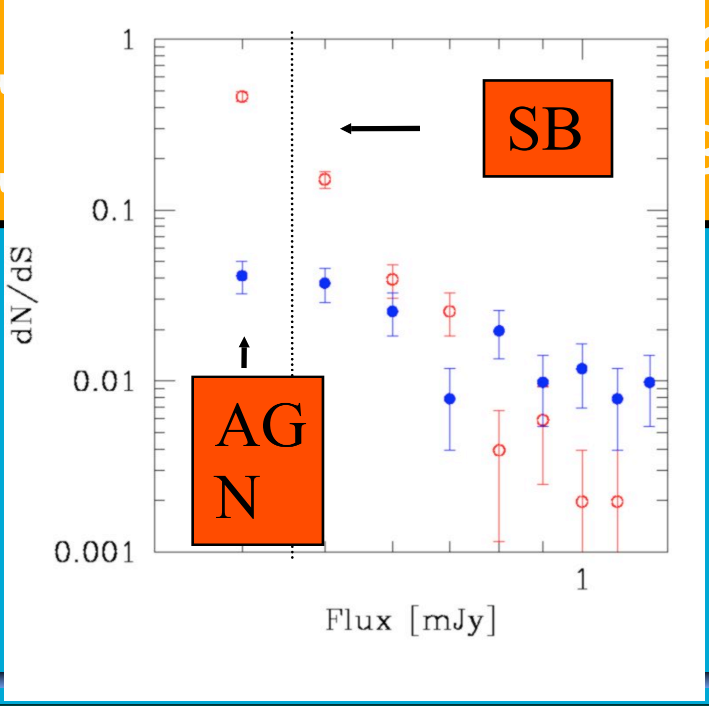

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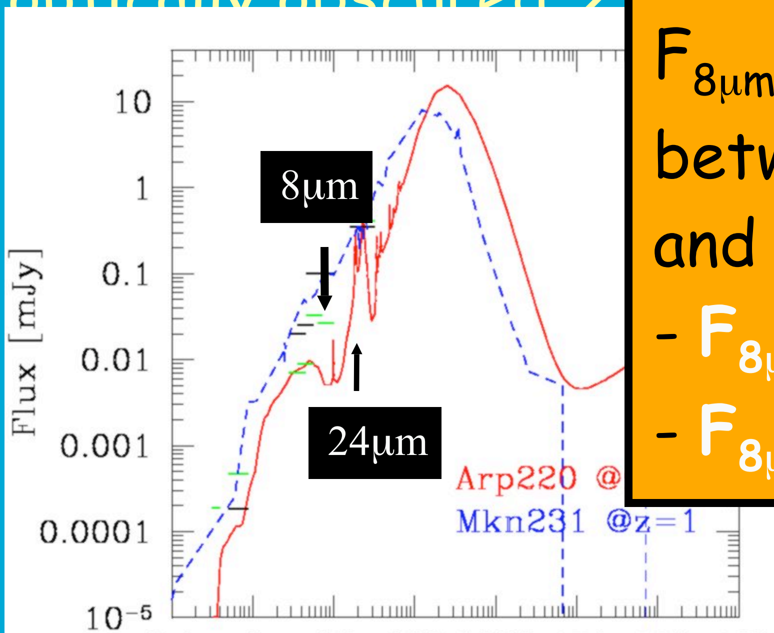

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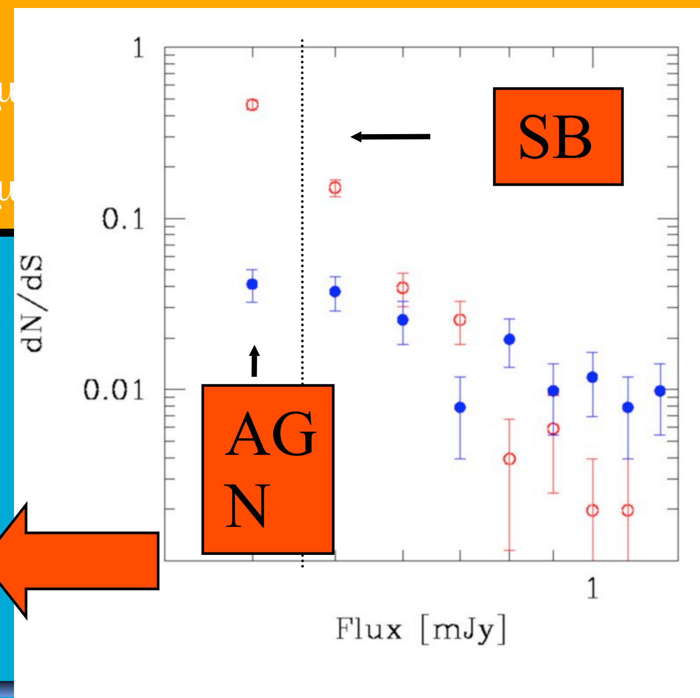
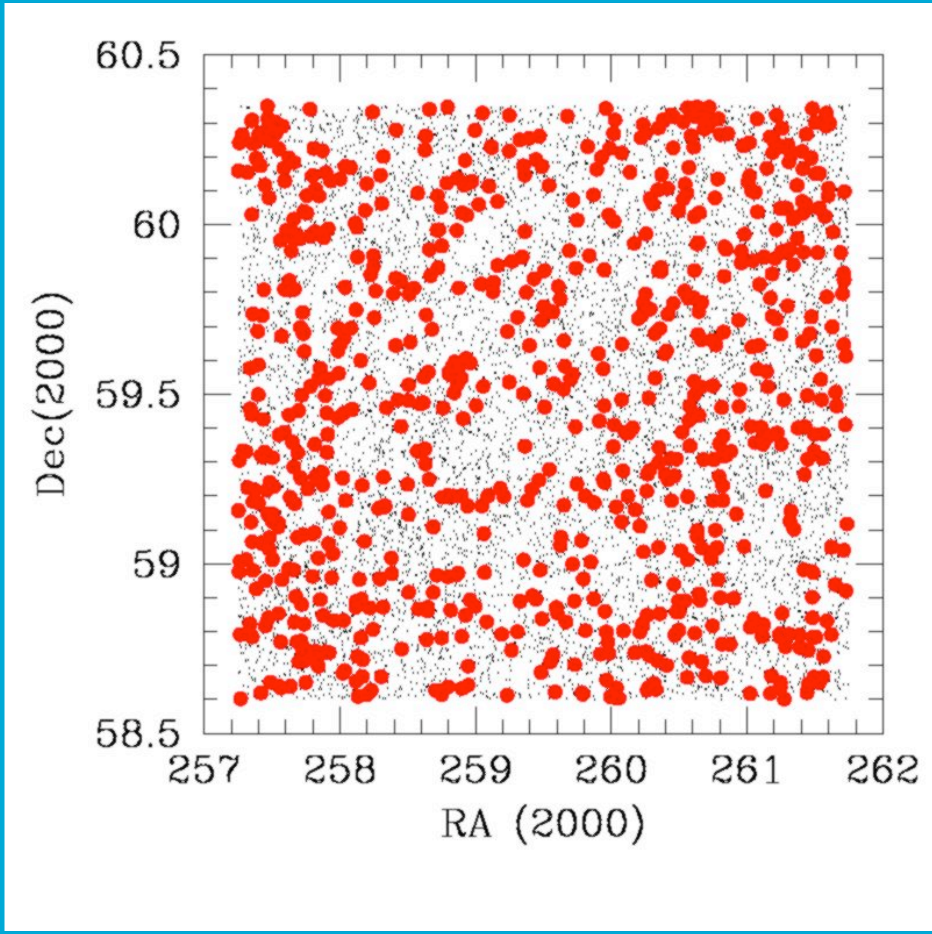


AGN mainly found for $F_{24\mu m}$ > 0.8 mJy. SB dominate the fainter 24μm counts (cfr. Brand et al.2006).

PROJECTED DISTRIBUTION OF $F_{24\mu m}$>0.35 mJy; R>25.5 Spitzer SOURCES in the FLS



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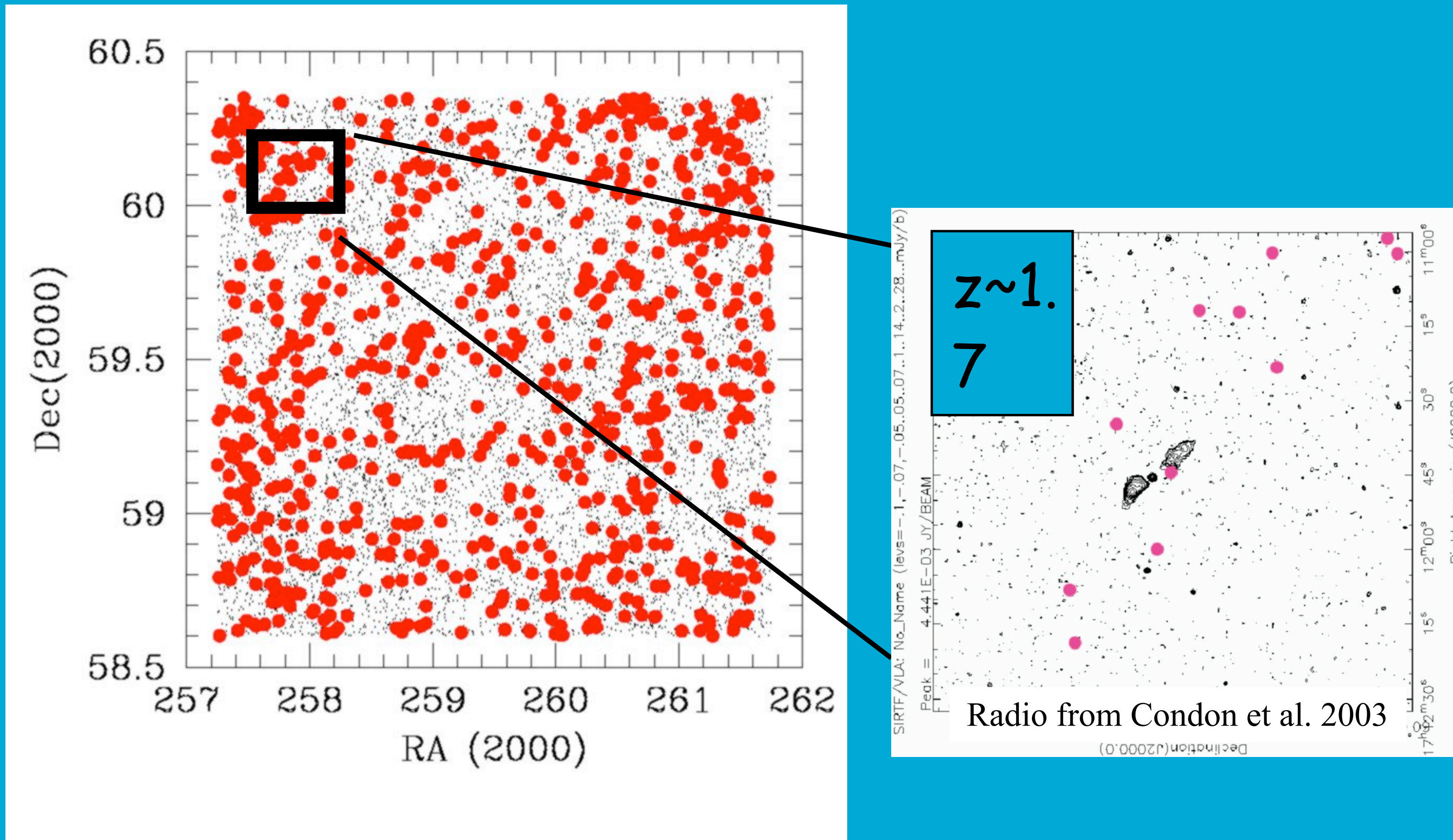

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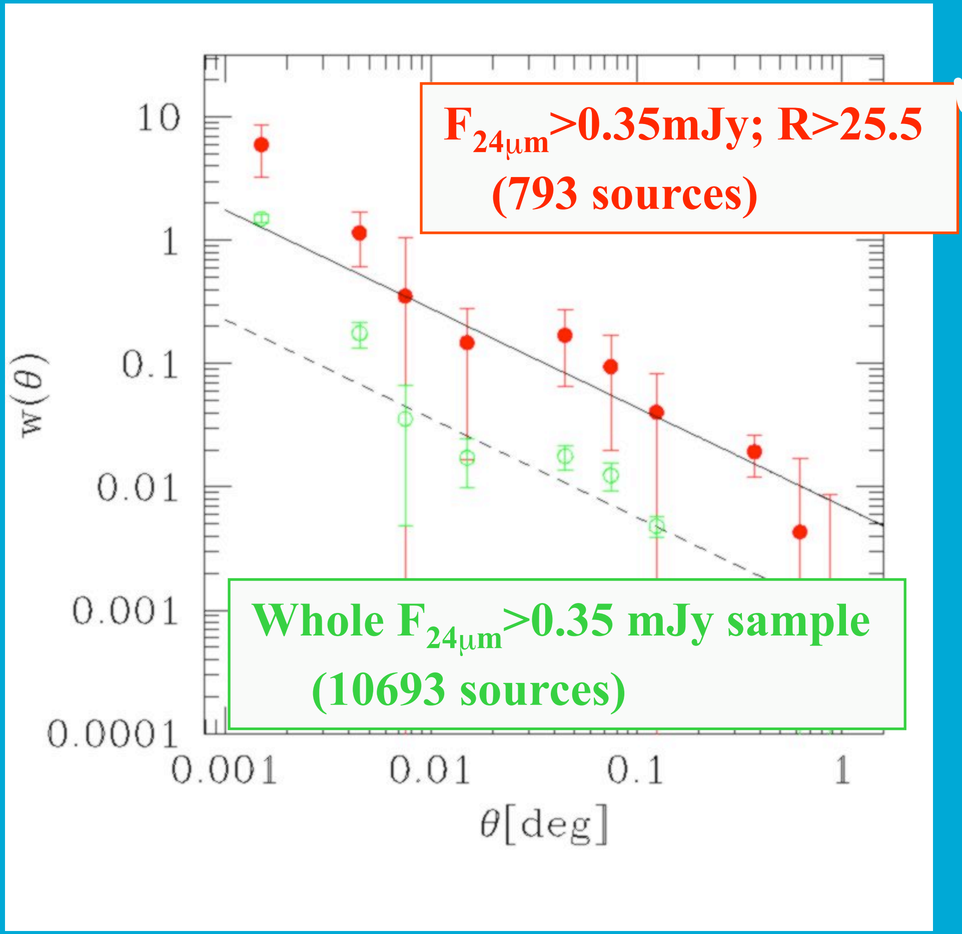
THE FLS TWO-POINT ANGULAR CORRELATION FUNCTION



Chosen estimator:

$w(\theta)=4\ DD\ RR/(DR)^2-1$

(Hamilton 1993)

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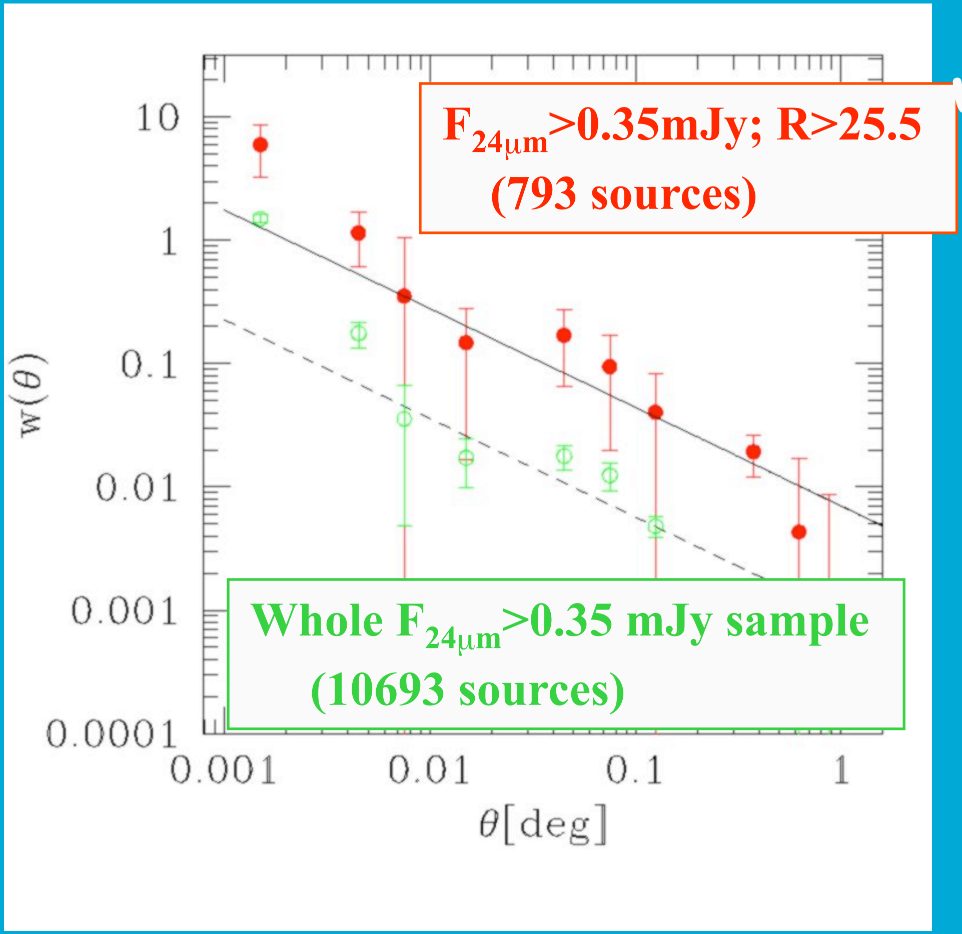

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Parametrize as

$w(\theta)=A\ \theta^{(1-\gamma)}$

For R>25.5

γ=1.8 (fixed)

A=(7±2) 10^{-3}

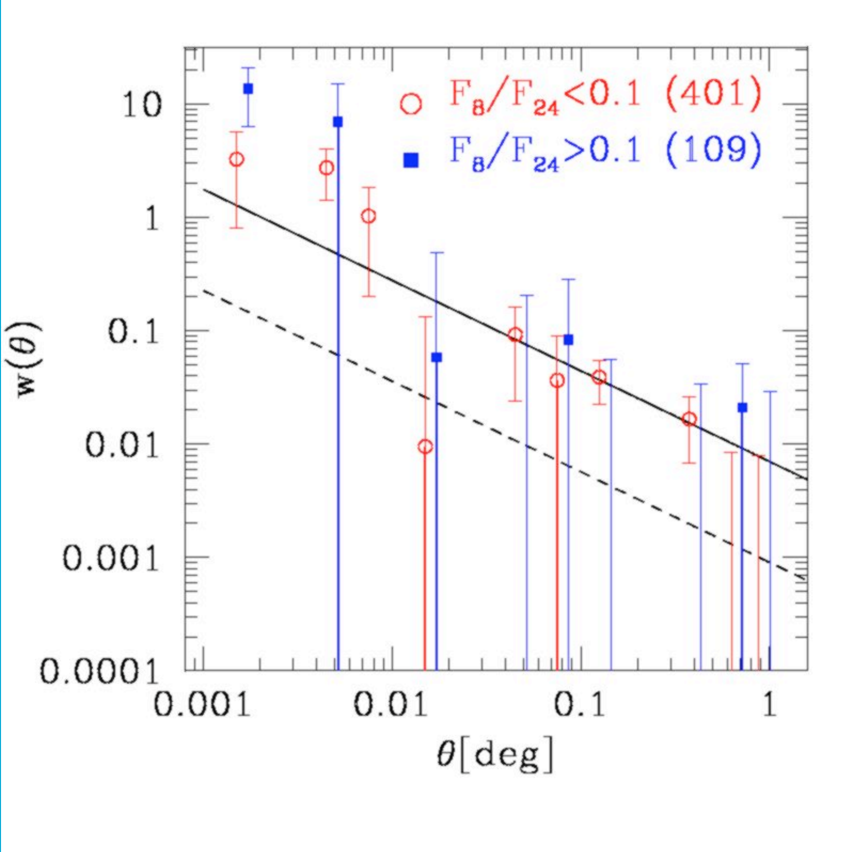
~ x 10!

Whole sample

A=(9±2) 10^{-4}

Not possible to estimate w(θ) for only AGN candidates (too few objects). However…

AGN vs SB candidates on IRAC+MIPS area



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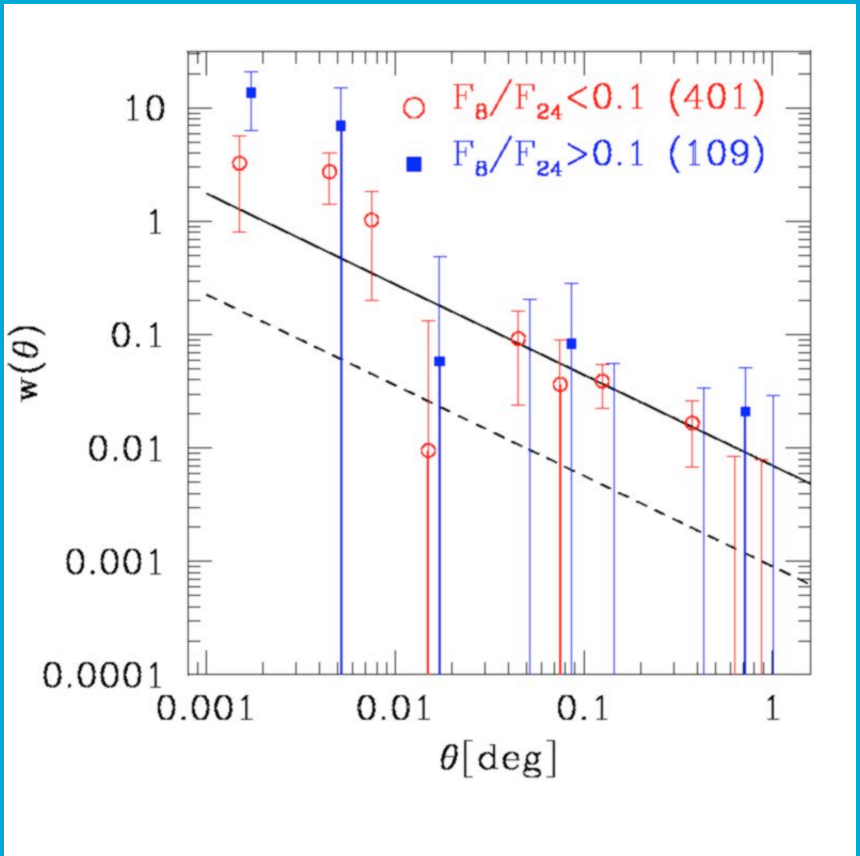

Both AGN and SB compatible with total R>25.5 signal→
Most likely belonging to same structures

REDSHIFT DISTRIBUTION OF OBSCURED 24μm-SELECTED GALAXIES

1) Template SED set them in range z=[1.6-2.7] (PAH → 24μm)
2) IRS spectroscopy for a number of smaller subsamples all converge to z=[1.7-2.6] (Weedman et al. 2006; Pope et al. 2006; Yan et al. 2005 and 2007; Houck et al. 2005)
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number counts of obscured 24μm-selected galaxies

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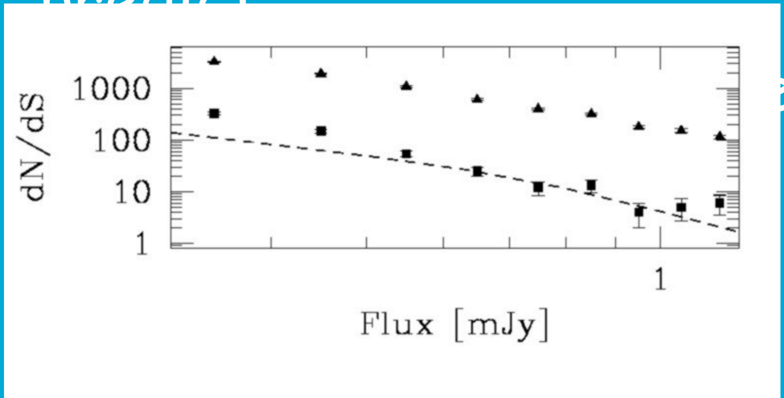

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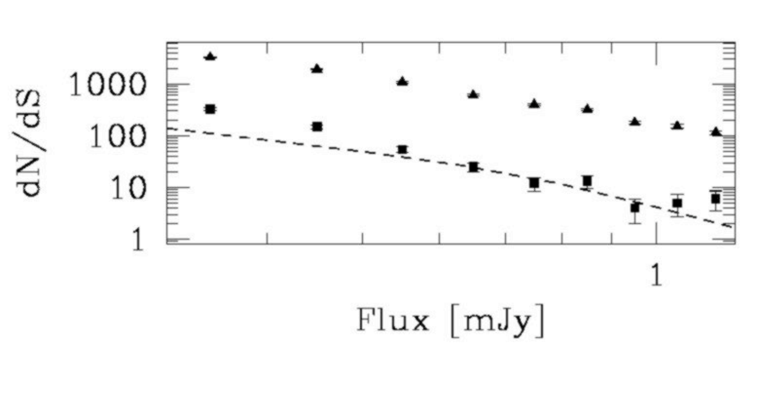
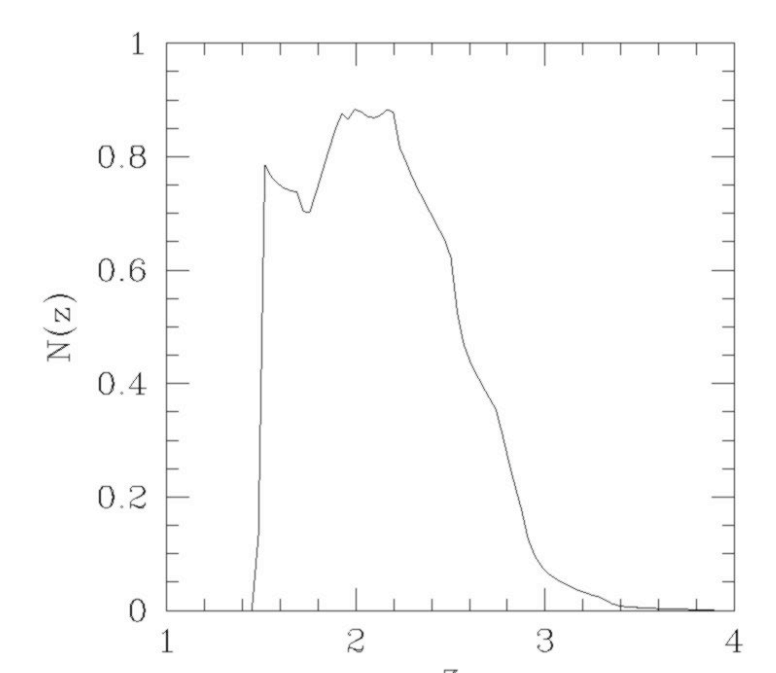
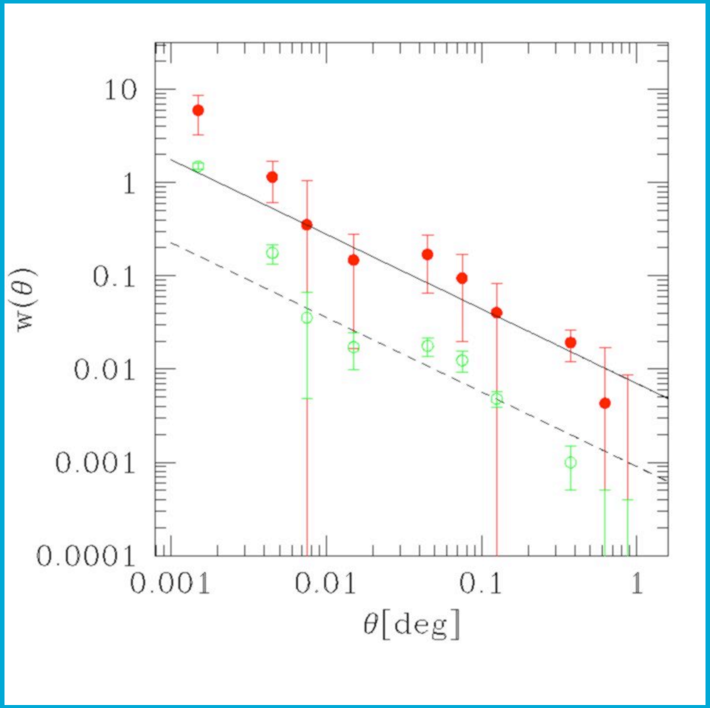




From Granato et al. 2004

3D CLUSTERING PROPERTIES



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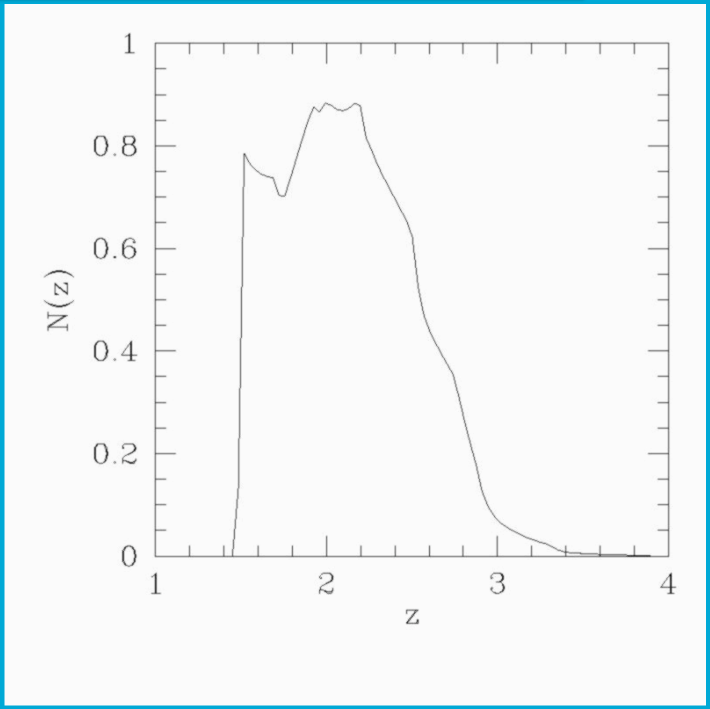

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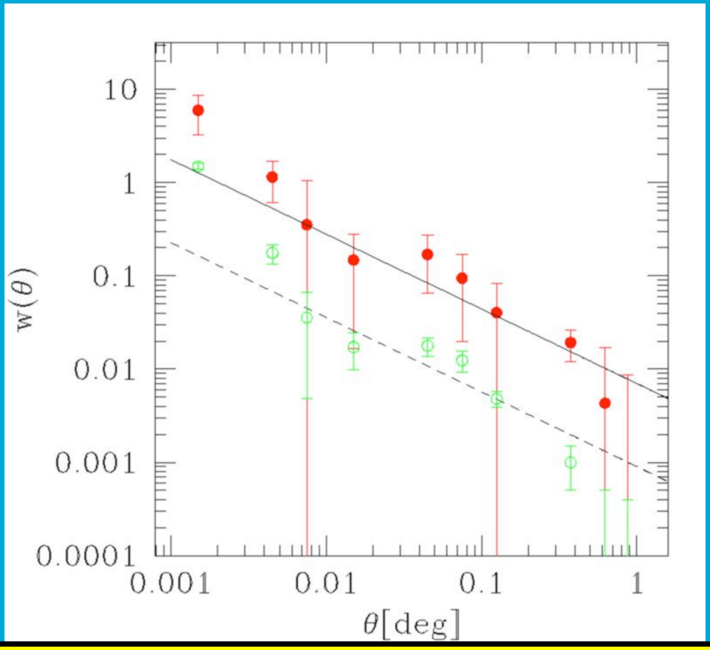

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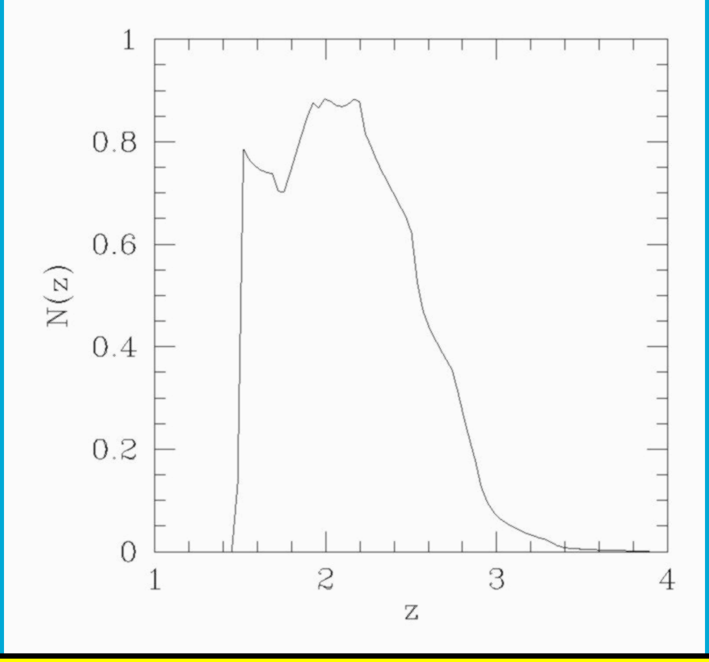
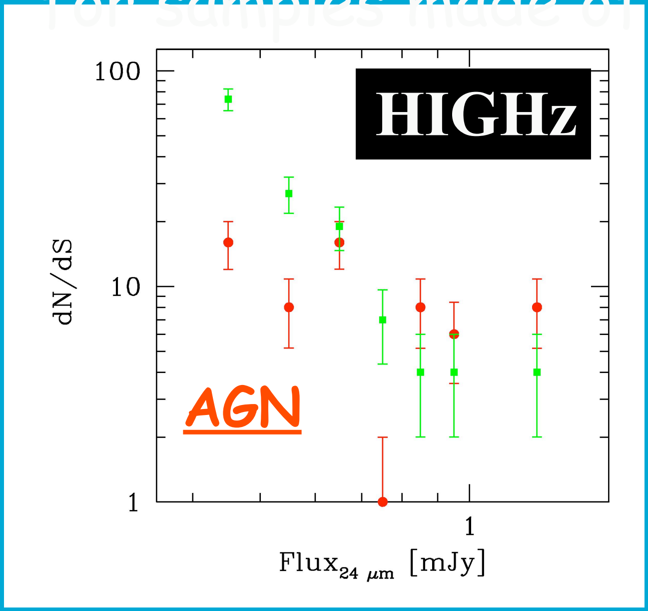


By deprojecting via Limber equation, for $\xi(r)=(r/r_0)^{-\gamma}$ we get **$r_0=15.2^{+2.3}_{-2.6}$ Mpc** (~14.0 Mpc for top-hat distribution with z=[1.6-2.7]; γ=1.8).

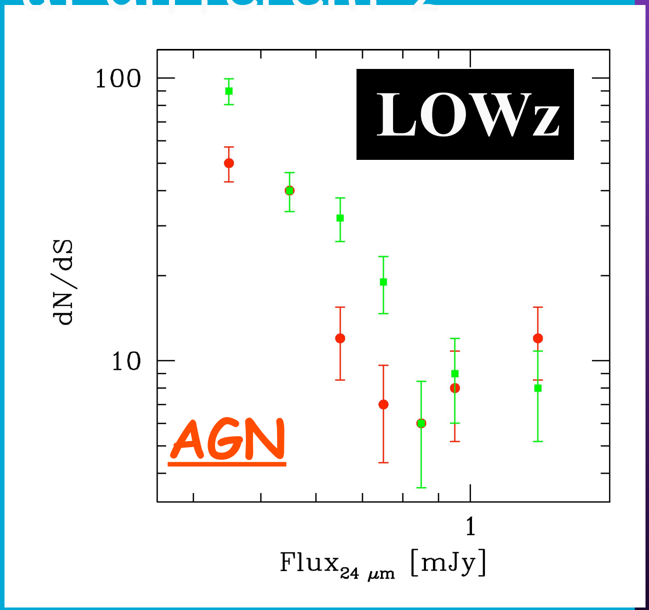
Very strongly clustered (cfr locally Radio Galaxies and Clusters) → see also Farrah et al. (2006)

THE UKIDSS DR1 Sample

- 5σ completeness for F24μm>=0.4 mJy (1041 galaxies)
- Photometric redshifts for 97% of sources
- Allows investigation of evolution in clustering properties for samples made of similar galaxies at different z



210 sources with z> 1.6



350 sources with 0.6<z<1.2

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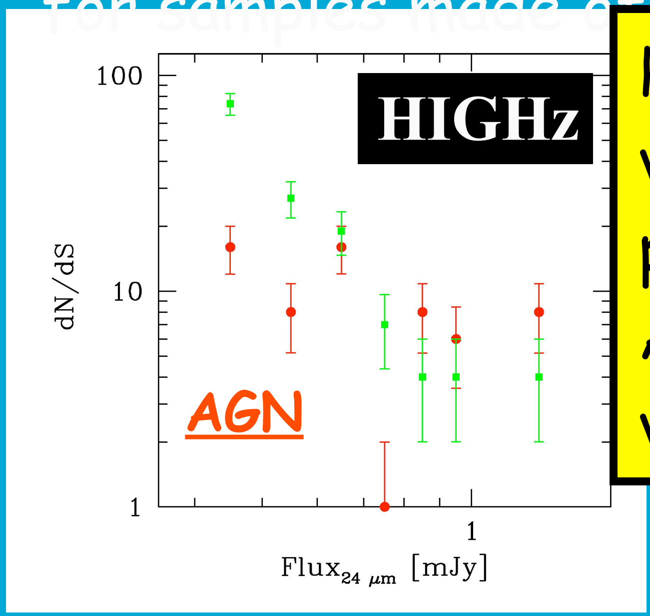
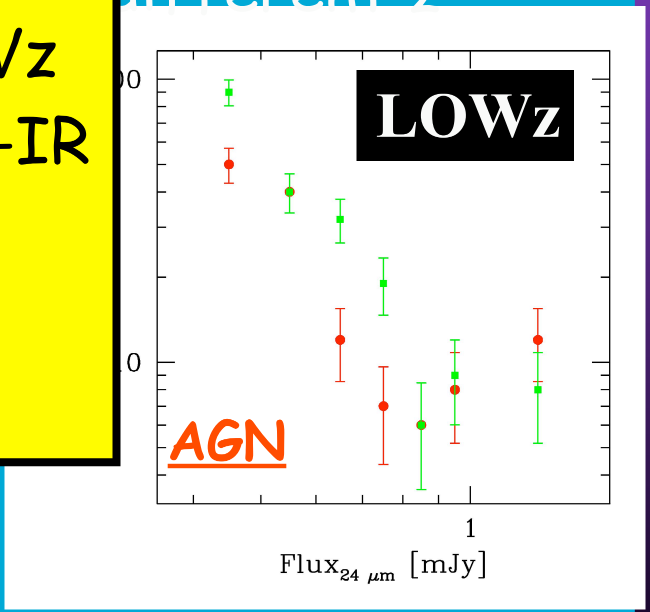


HIGHz and LOWz very similar mid-IR properties and AGN (~30-35%) vs SF mixture



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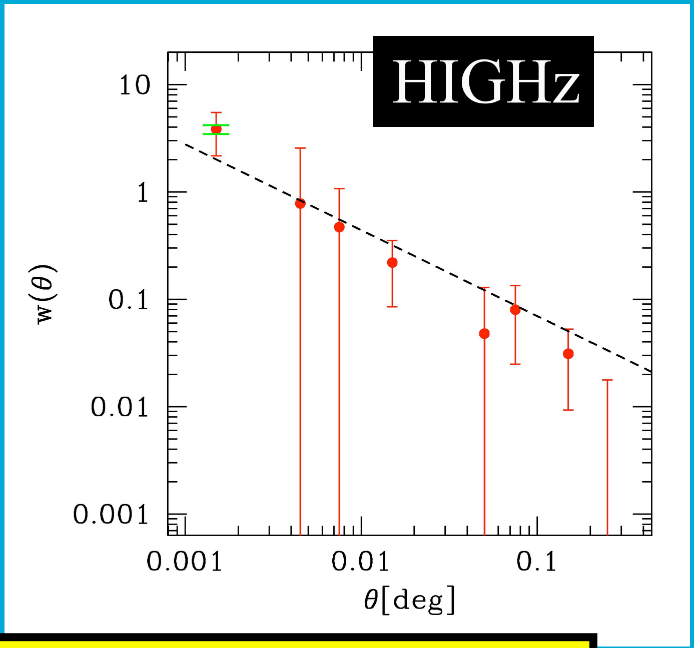
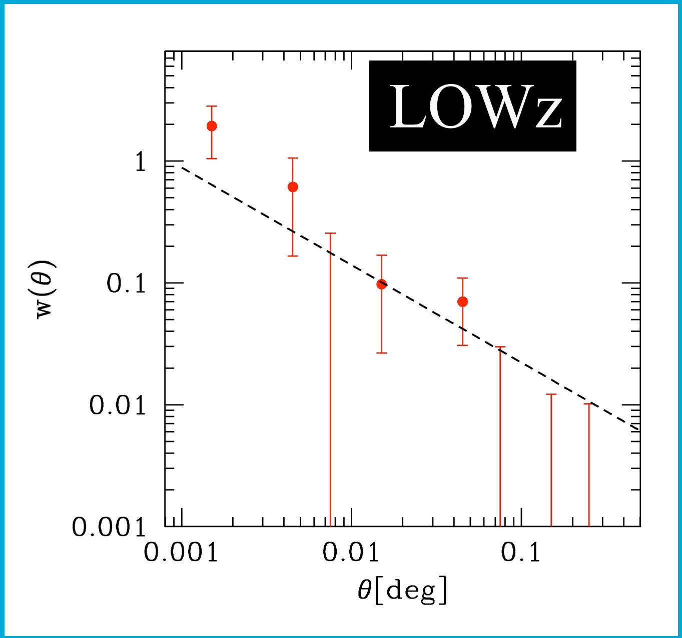
THE UKIDSS CORRELATION FUNCTION(s)



$$w(\theta)=A\ \theta^{(1-\gamma)}$$

$$A=(10.0\pm3.5)\ 10^{-3}$$



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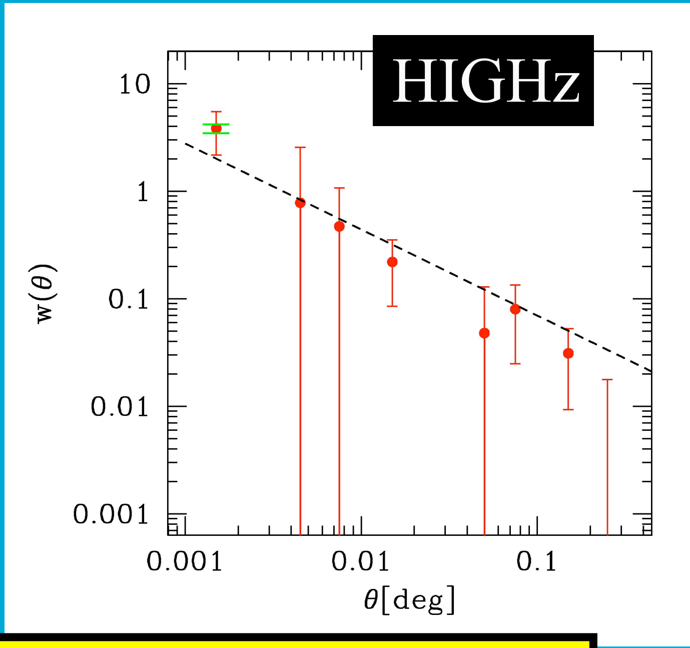

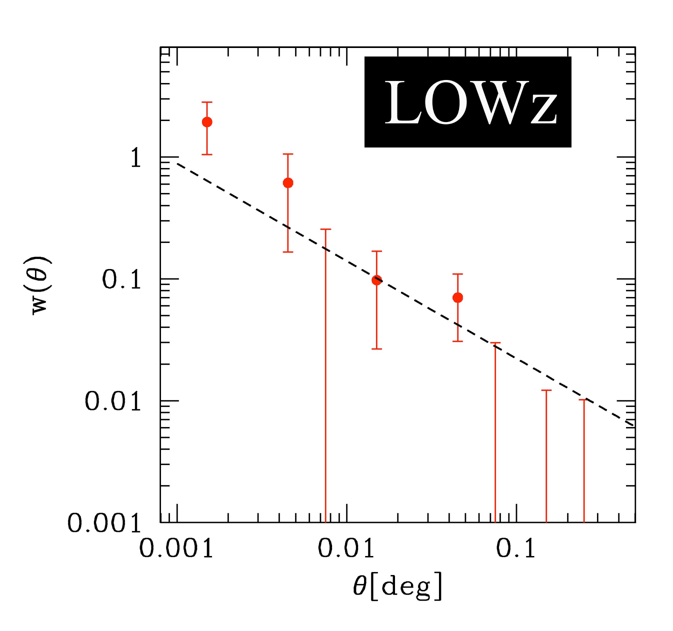

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Photo N(z)

$r_0=15.9\pm3.5$ Mpc

(cfr FLS R>25.5 $r_0\sim15$ Mpc)

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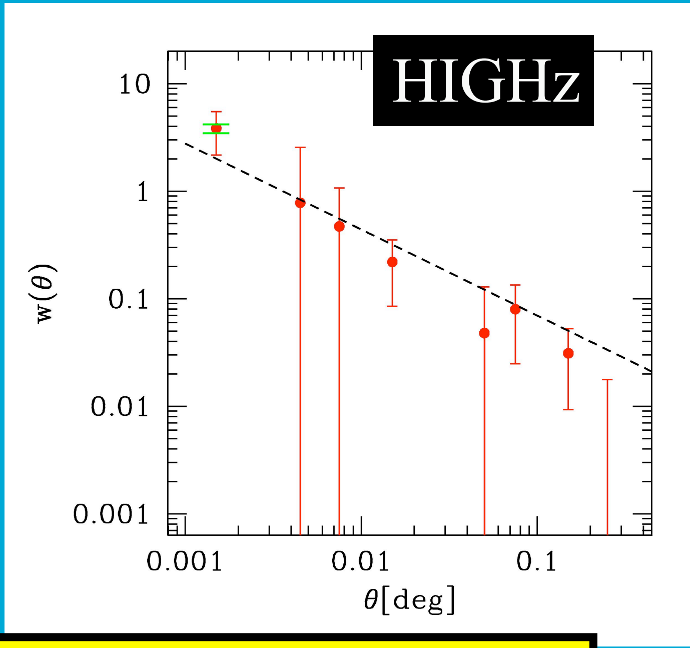

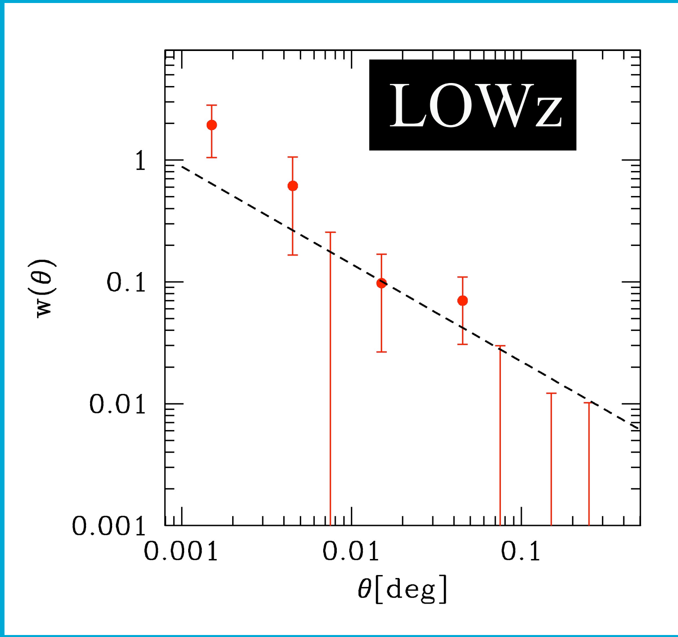

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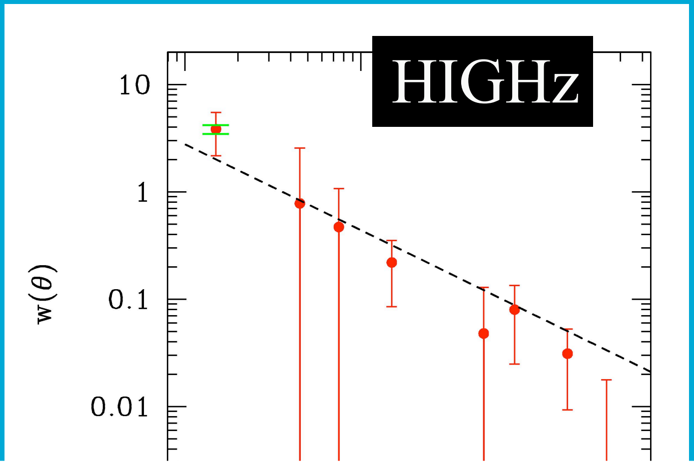
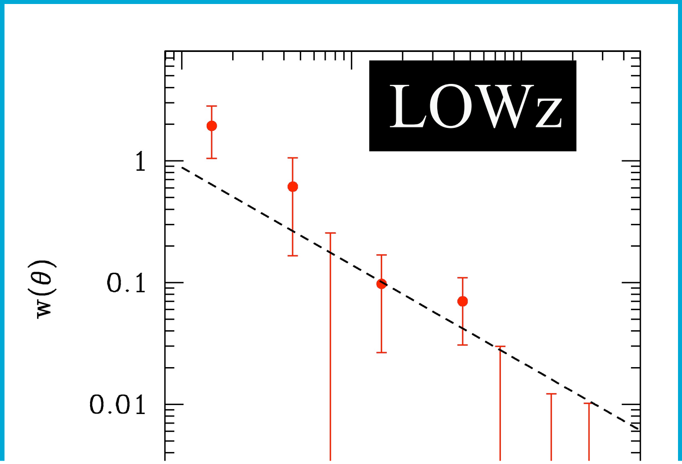




GALAXIES at z>1.6 MUCH MORE STRONGLY CLUSTERED THAN THEIR LOW-z COUNTERPARTS!

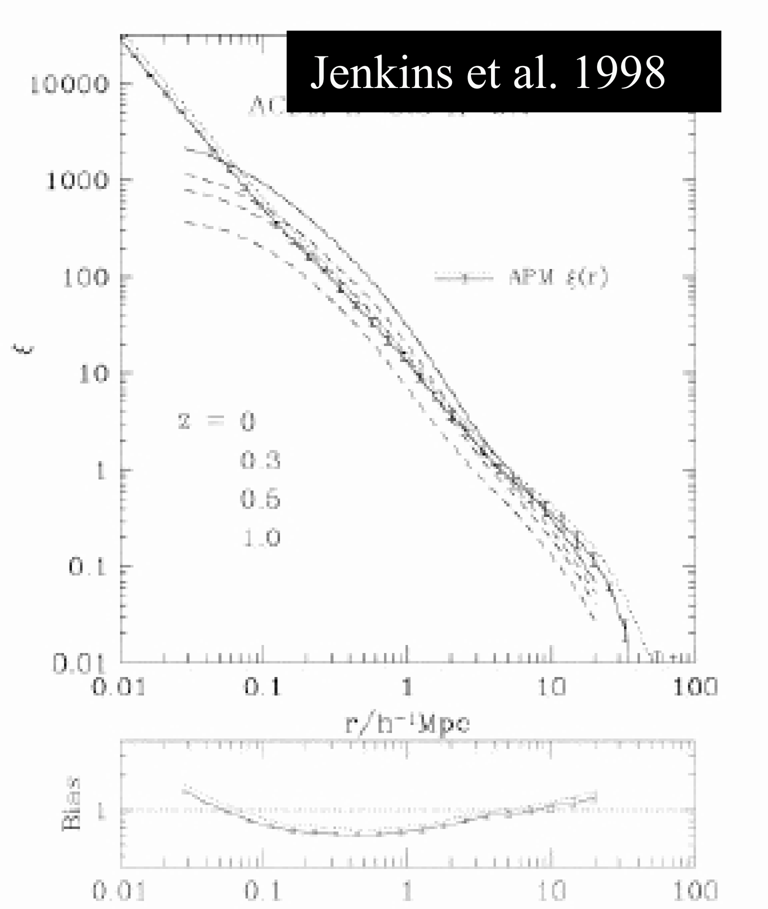
Photo N(z)

r_0=15.9±3.5 Mpc
(cfr FLS R>25.5 r_0~15 Mpc)

r_0=7.0 ± 1.8 Mpc

CLUSTERING VS ASTROPHYSICAL PROPERTIES

Correlation Function of astrophysical objects different for different sources and different from CF dark matter → **BIAS**



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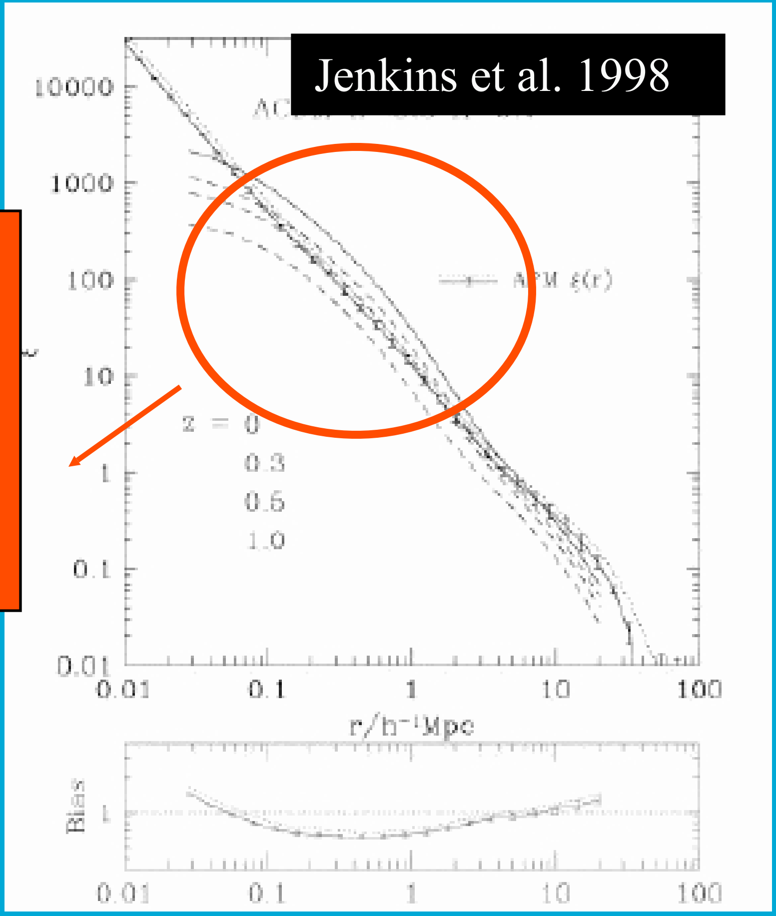
On Small Scales (non linear)
GALAXY BIAS: CF determined by distribution of sources within haloes → allows determination of some astrophysical properties



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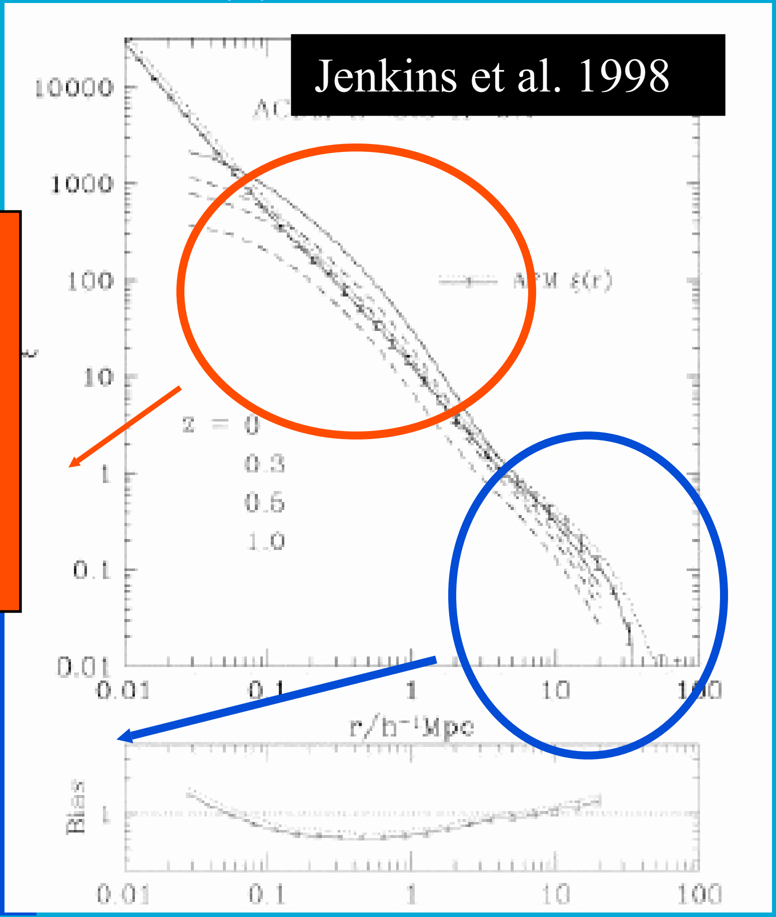
Correlation Function of astrophysical objects different for different sources and different from CF dark matter → **BIAS**

On Small Scales (non linear) GALAXY BIAS: CF determined by distribution of sources within haloes → allows determination of some astrophysical properties

On Large Scales (linear) HALO BIAS: more massive haloes more strongly clustered → allows estimates of mass of host haloes



THE HALO APPROACH:

evaluate contribution of both galaxies within same halo and in different halos

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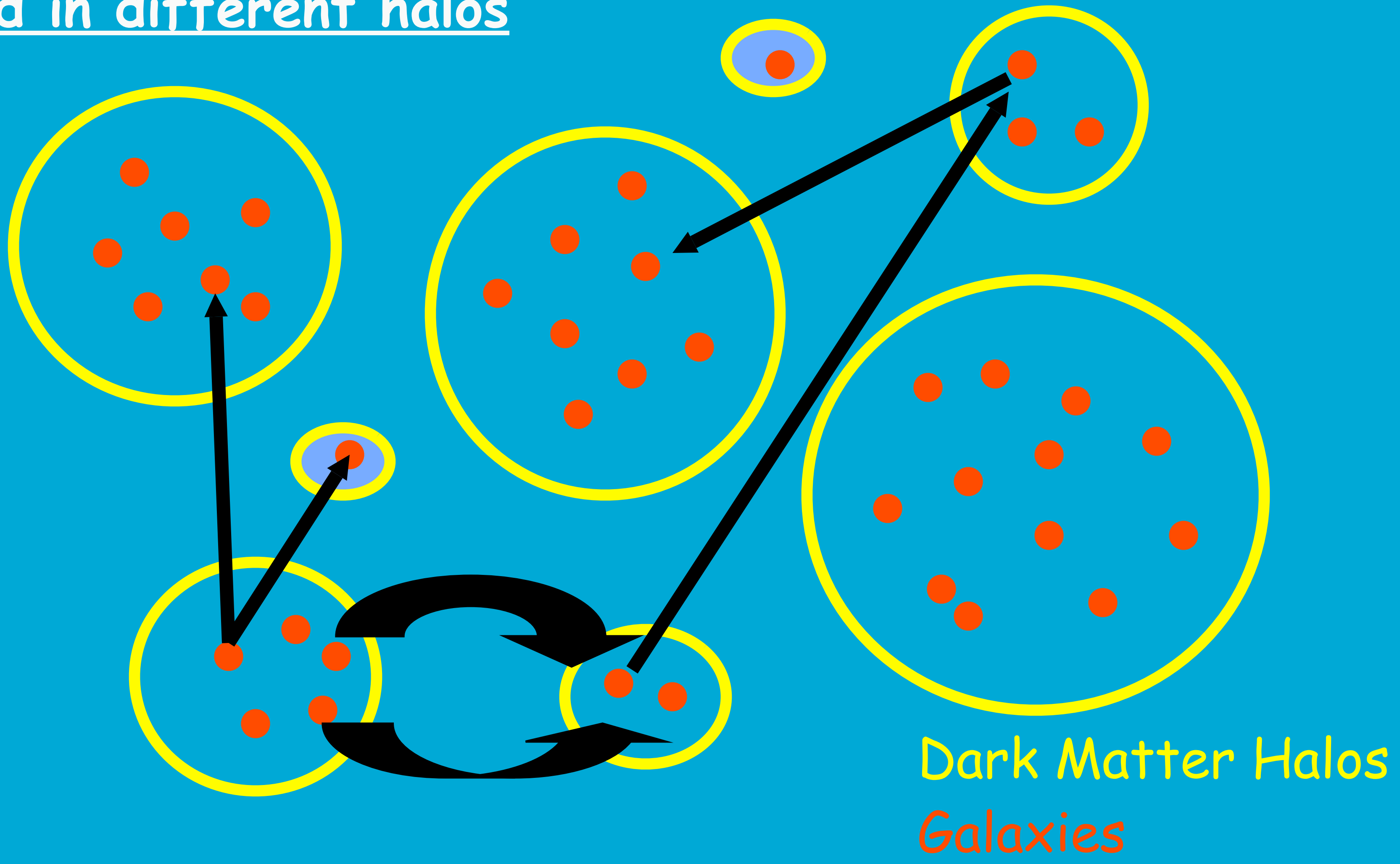

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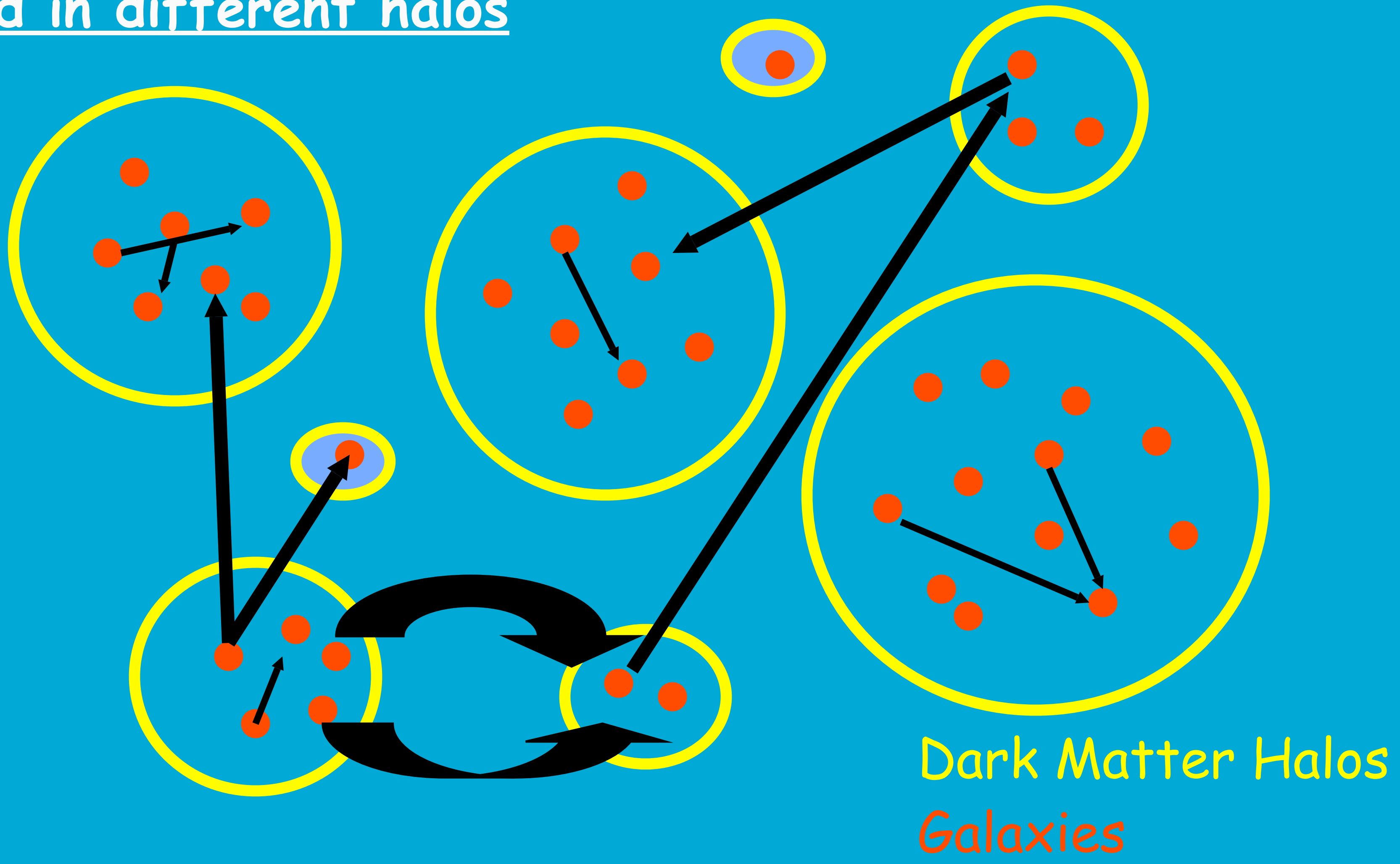
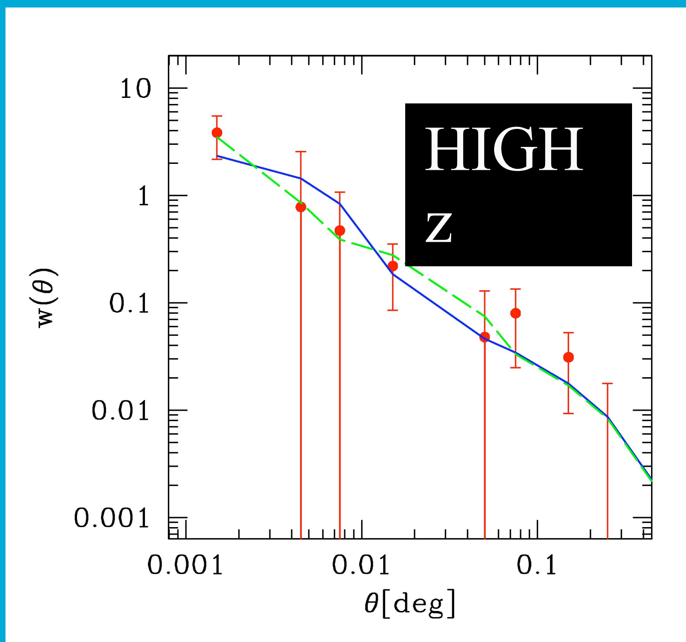
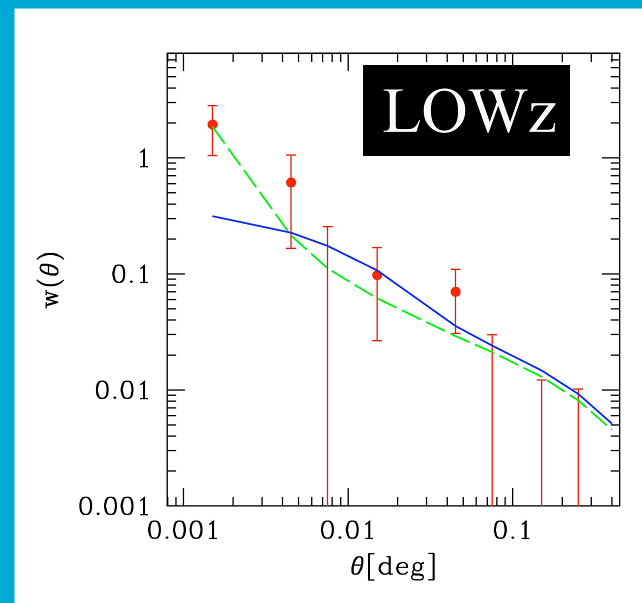


DETERMINATION OF ASTROPHYSICAL PARAMETERS

1) Populate haloes with $\langle N \rangle = N_0 \, (M/M_{min})^{\alpha}$ occupational law

2) Consider $w(\theta)$ + limit on observed number density +NFW.





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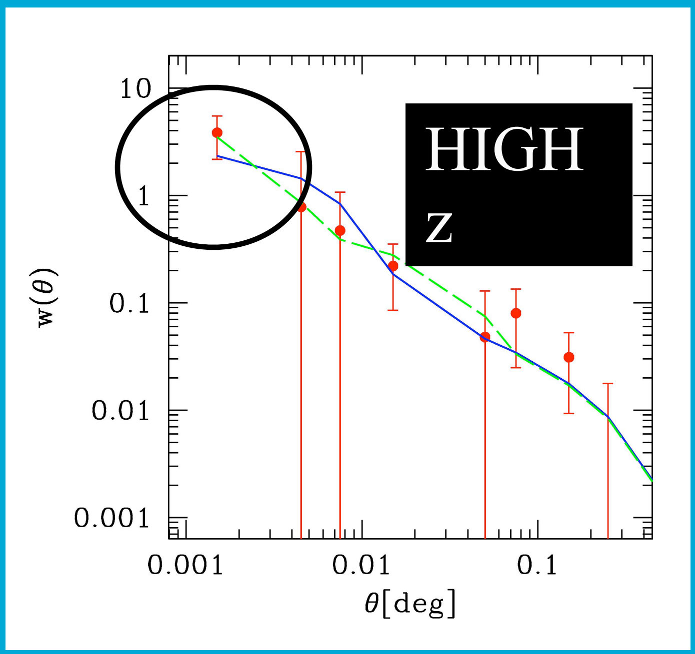

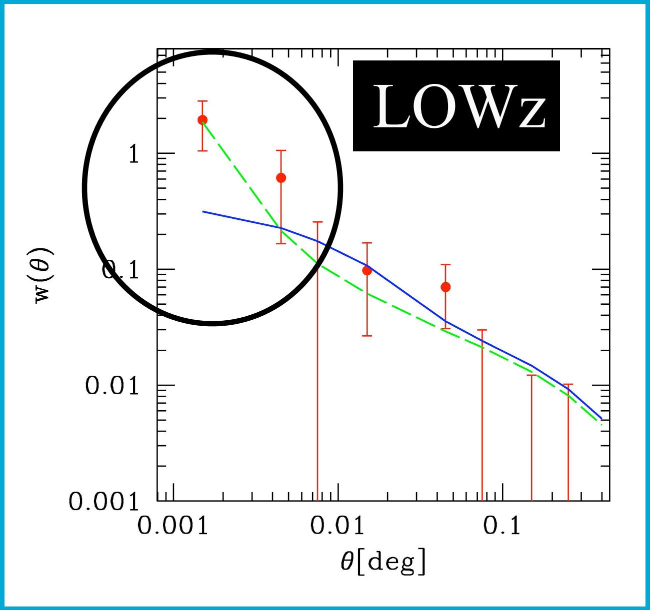

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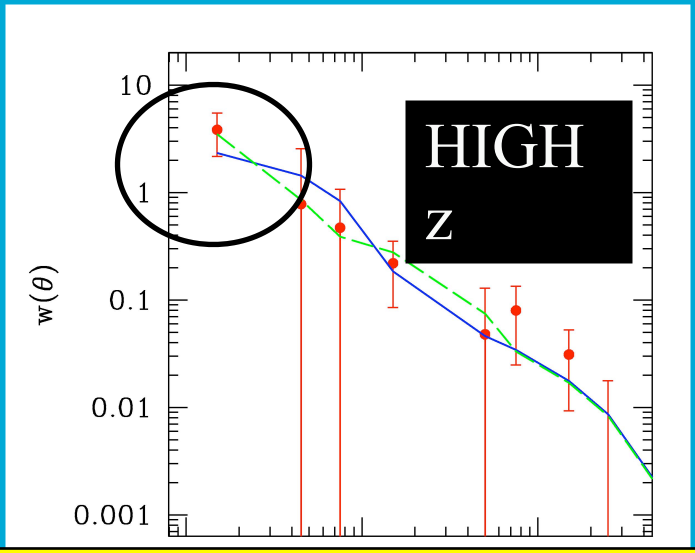

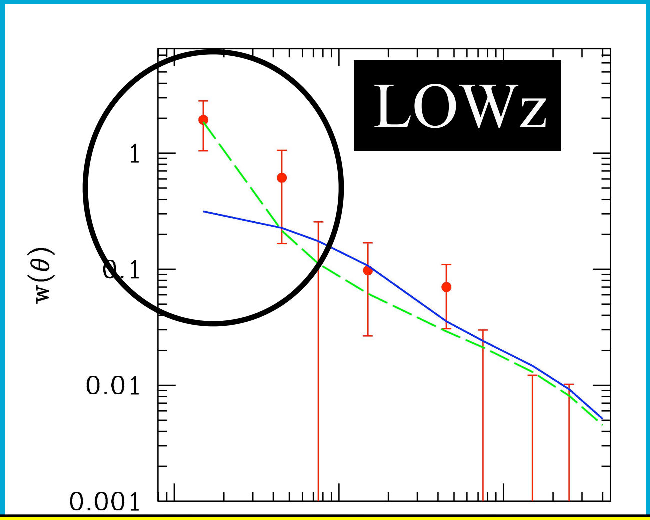

Large-scale OK but for both HIGHz and LOWz smooth galaxy distributions do not fit small-scale points.
Need $\rho \sim r^{-3}$, more concentrated than DM→
→SIGNATURE FOR CLOSE ENCOUNTERS/MERGING?

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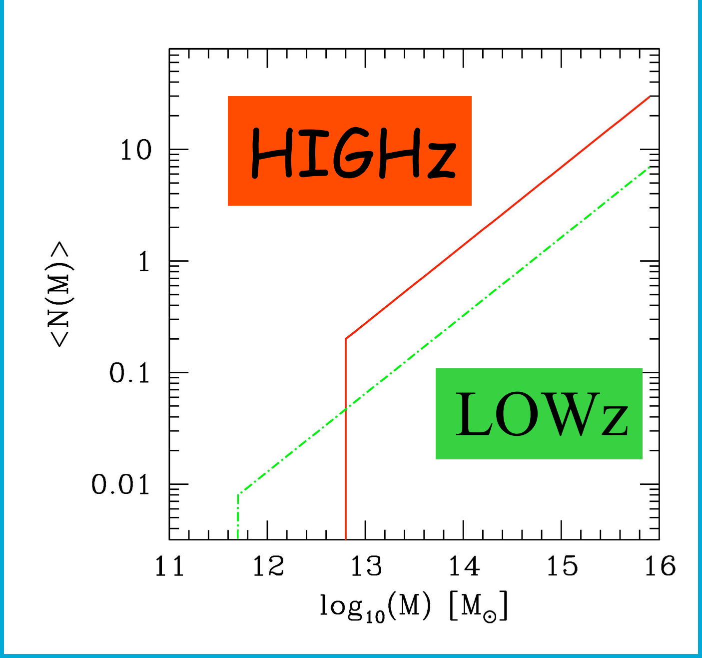

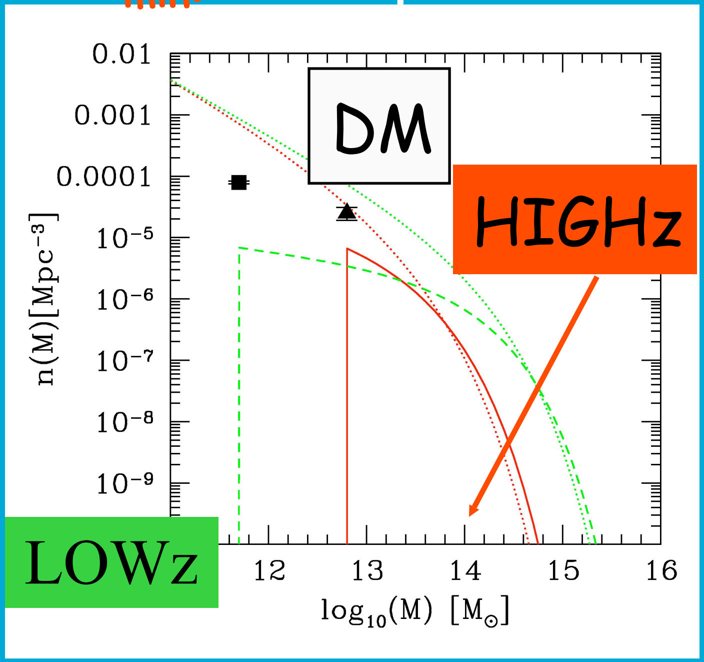

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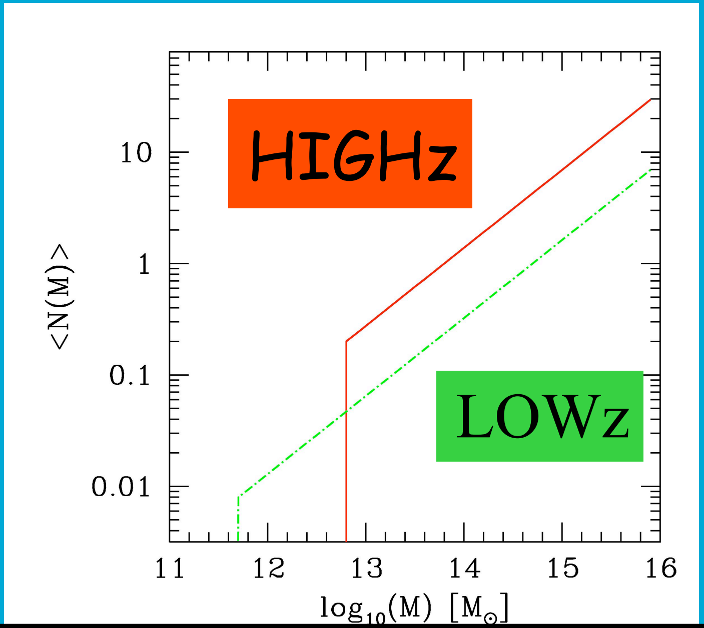

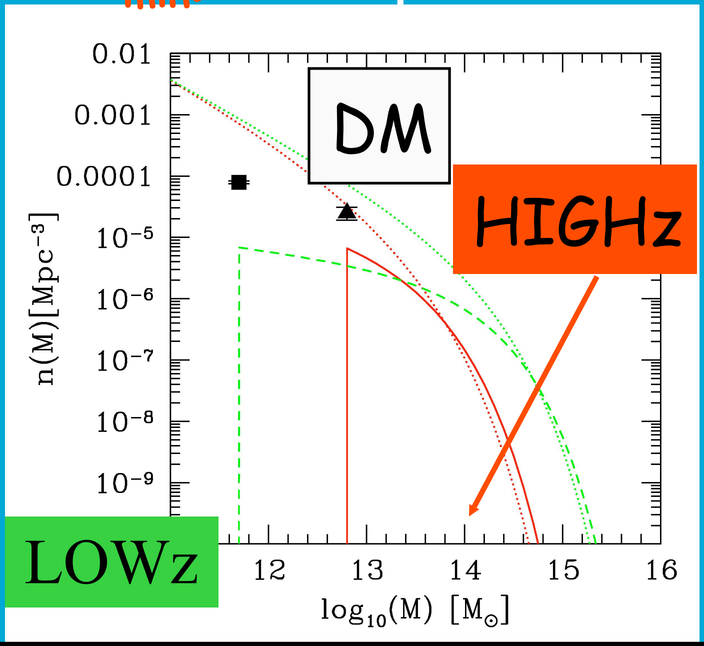

High-z: $M_{min} \sim 10^{13}$ M_{sun} → HOSTED BY V. MASSIVE HALOES; $N_0 \sim 0.5$; N(M)=[0.5-20] → QUITE COMMON

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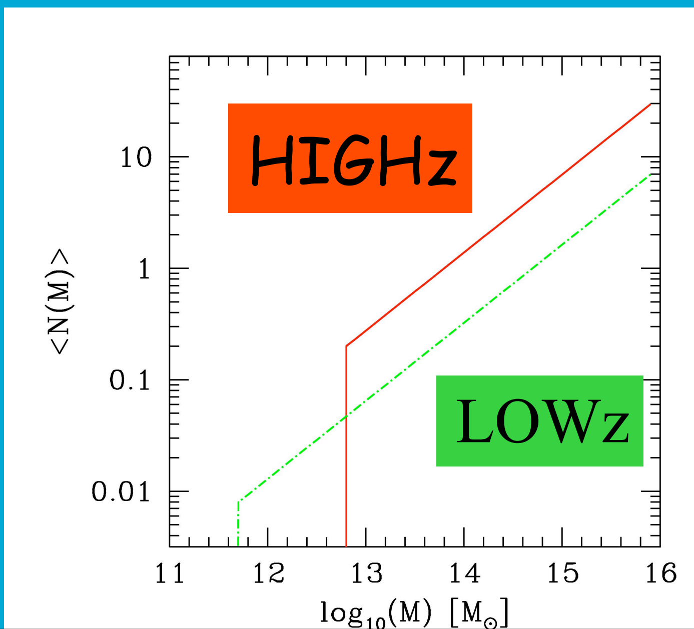

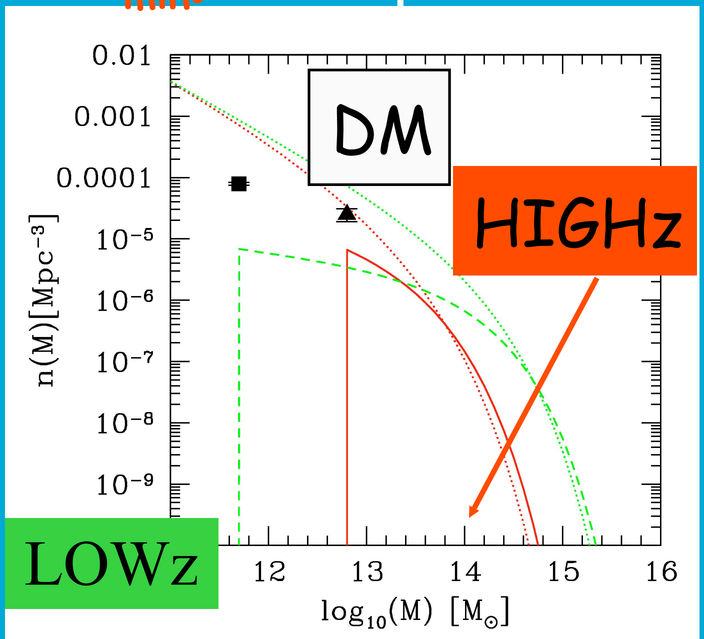

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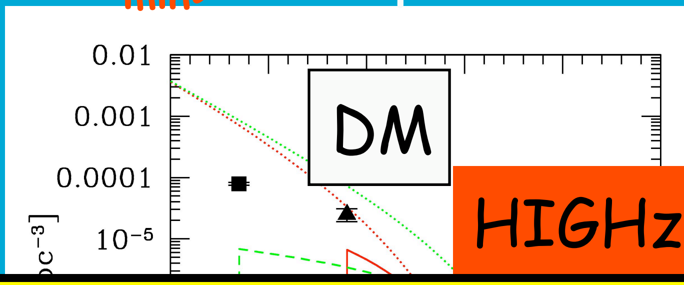
Low-z: $M_{min} \sim 10^{11.7}\ M_{sun}$ →HOSTED BY SMALL HALOES; $N_0 \sim 0.005$; N(M)=[0.002-6] → VERY RARE

DETERMINATION OF ASTROPHYSICAL PARAMETERS

1) Populate haloes with $<N>=N_0\ (M/M_{min})^{\alpha}$ occupational law



Despite similar selection criteria objects at z>1.6 and 0.6<z<1.2 very different from each other. AGN and SF activity segregated to much smaller mass systems at lower redshift

→ **COSMIC DOWNSIZING**

High-z: M_{min}~10^{13} M_{sun} → HOSTED BY V. MASSIVE HALOES; N_0~0.5; N(M)=[0.5-20] → QUITE COMMON

Low-z: M_{min}~$10^{11.7}$ M_{sun} →HOSTED BY SMALL HALOES; N_0~0.005; N(M)=[0.002-6] → VERY RARE

CONCLUSIONS: FLS+UKIDSS

1) On basis of $F_{8\mu m}/F_{24\mu m}$ ratios AGN mainly found for $F_{24\mu m}$> 0.8 mJy. SB dominate the counts at fainter fluxes. At both z~1 and z~2 AGN ~30-35% of total.

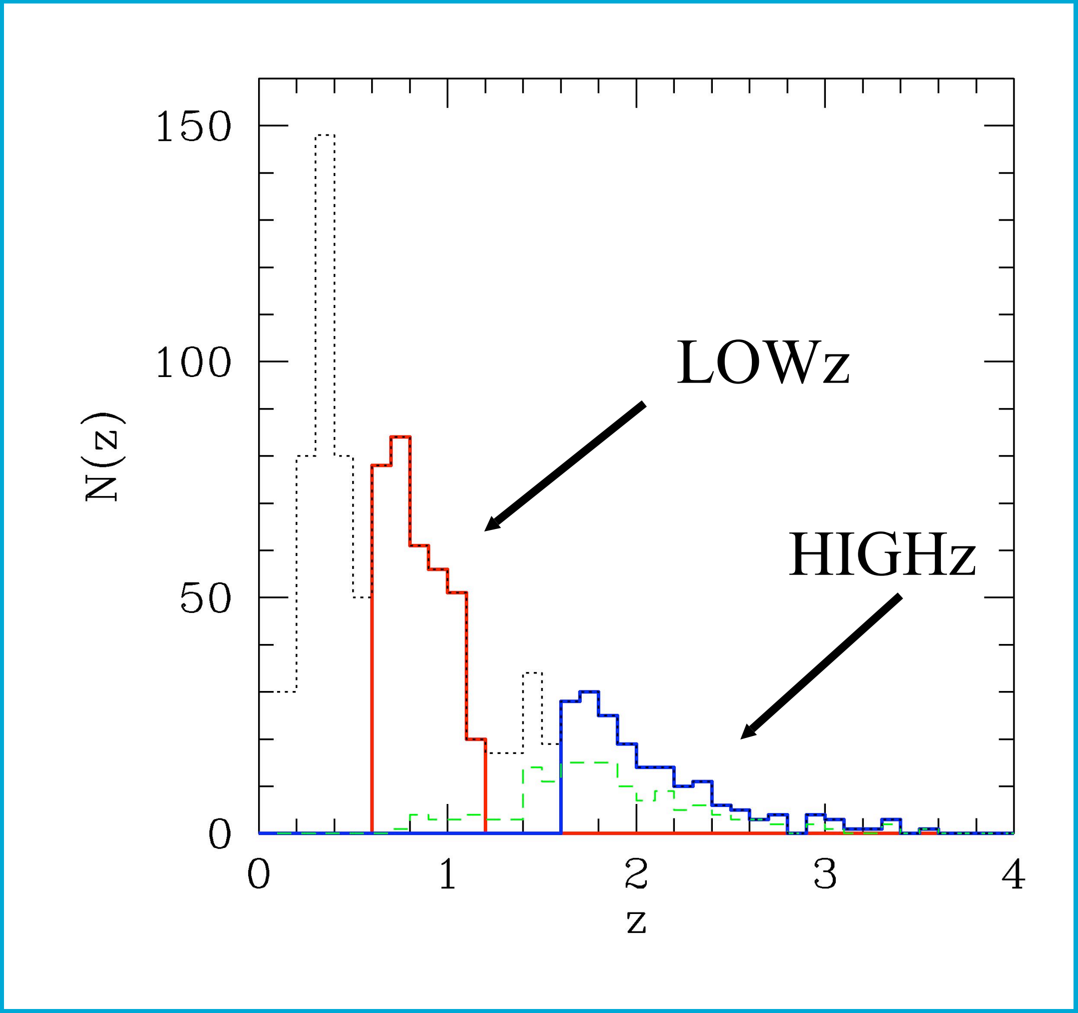
2) Both R>25.5 and z>1.6 sources v.strongly clustered: **r_0~15 Mpc** (→ same population). Sources hosted by v.massive halos **$M>10^{13}$ M_{sun}** and also quite common (~0.5 galaxies per halo at smallest masses).

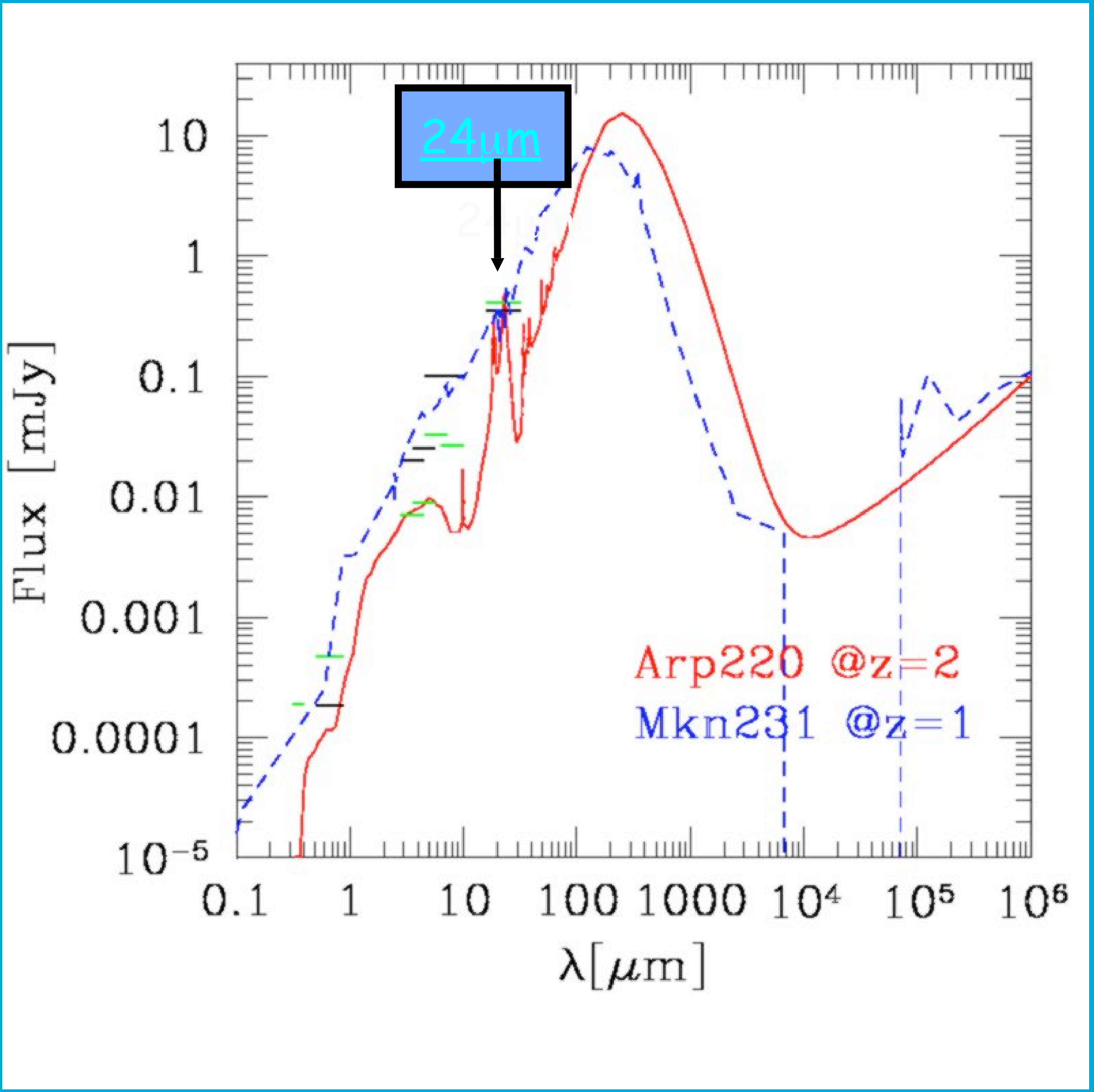
3) Sources 0.6<z<1.2 much less clustered: **r_0~7 Mpc.** Hosted by less massive structures **$M>10^{11.7}$ M_{sun}** and v. rare within these systems (~0.002-0.01 per halo at the smallest masses).

4) Despite photometric similarities 2)+3) → low-z and high-z galaxies very different. AGN and SF activity shifted to low masses for lower z → **EVIDENCE FOR DOWNSIZING**

5) Galaxies more concentrated towards halo centres than DM and z~0 counterparts. Signature for close encounters /merging associated to enhanced AGN + SF activity?

N(z) of F24μm>0.4 mJy UKIDSS SOURCES




24μm
Flux [mJy]
10
1
0.1
0.01
0.001
0.0001
10^{-5}
0.1
1
10
100
1000
10^4
10^5
10^6
λ[μm]
Arp220 @z=2
Mkn231 @z=1