Dead Monsters: $\log(M_\star/M_\odot) \sim 10^{11.5}$ quiescent galaxies at cosmic high noon

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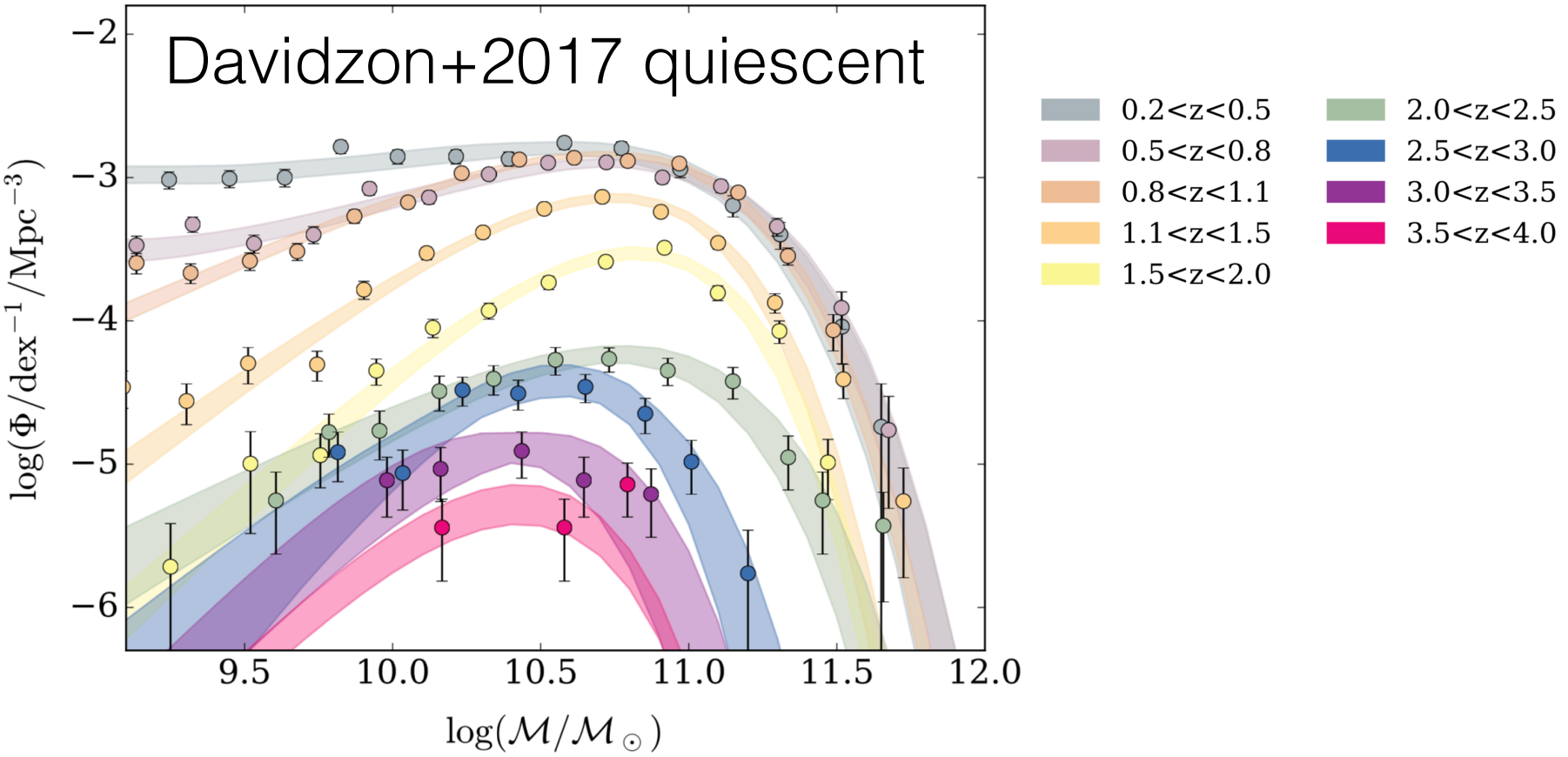
GURPREET


LIZ

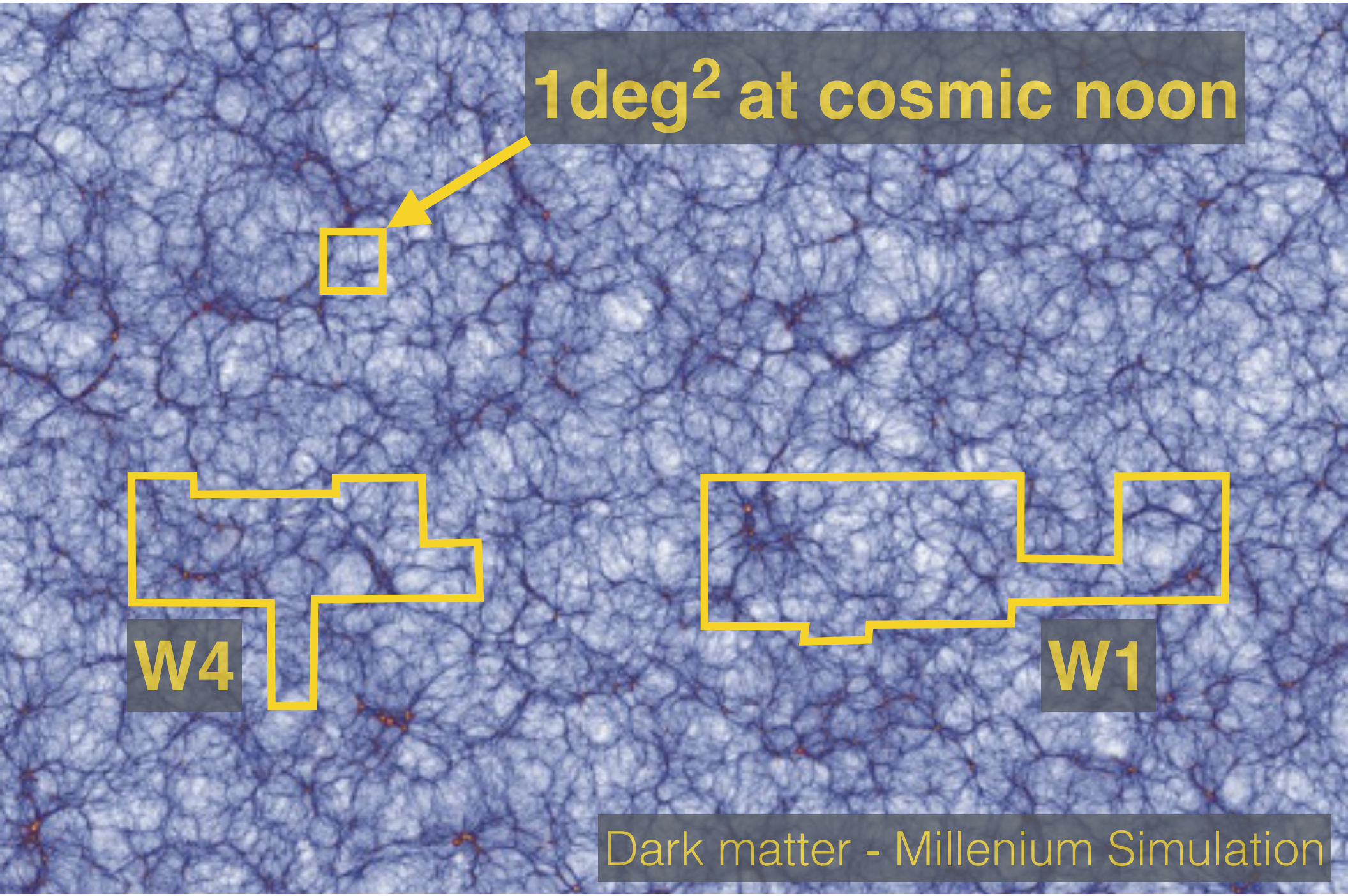
Goal:

Reconnaissance
of the most extreme,
ultra-massive
quiescent population
at cosmic noon

Variance is a problem (1): Sample Variance

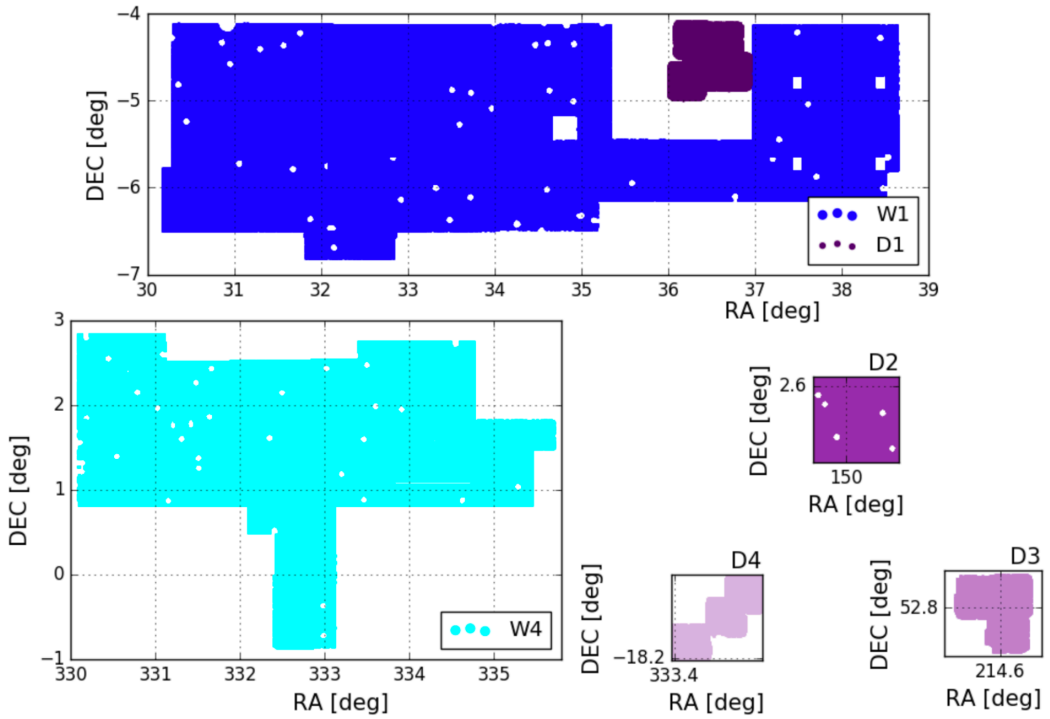


Variance is a problem (2): Cosmic Variance



Large-area K-selected sample

CFHTLS Wide and Deep fields + K-band



27.6 deg²

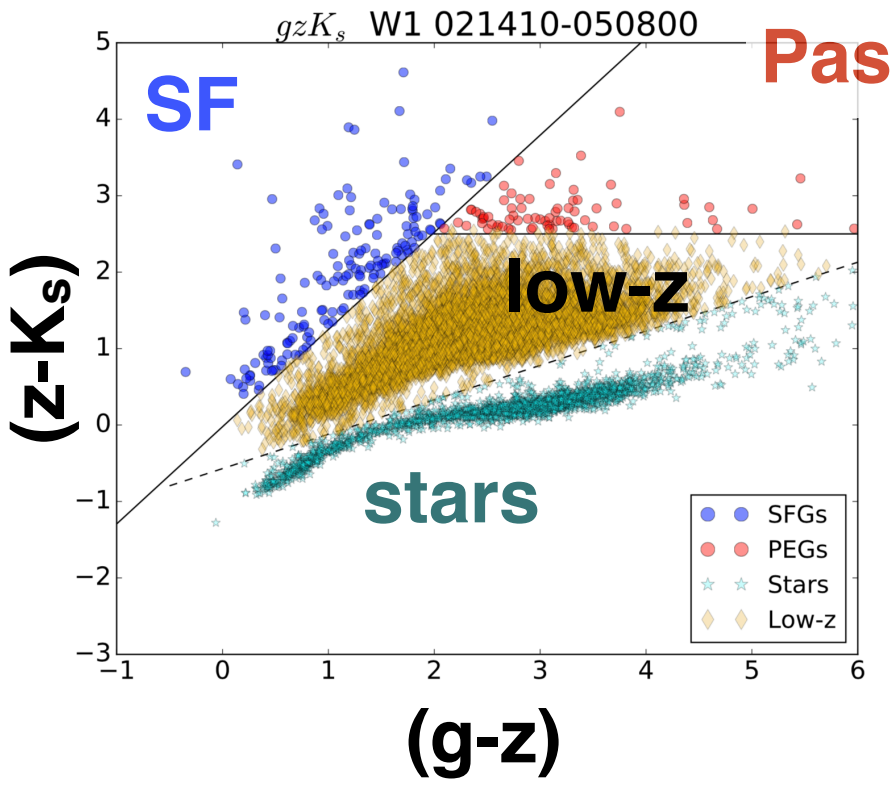
25.1 deg² to K_{lim}=22AB (VIPERS-MLS, Moutard+16)

2.5 deg² to K_{lim}=24AB (WIRDS, Bielby+12)

27.6 deg² in total

Object selection

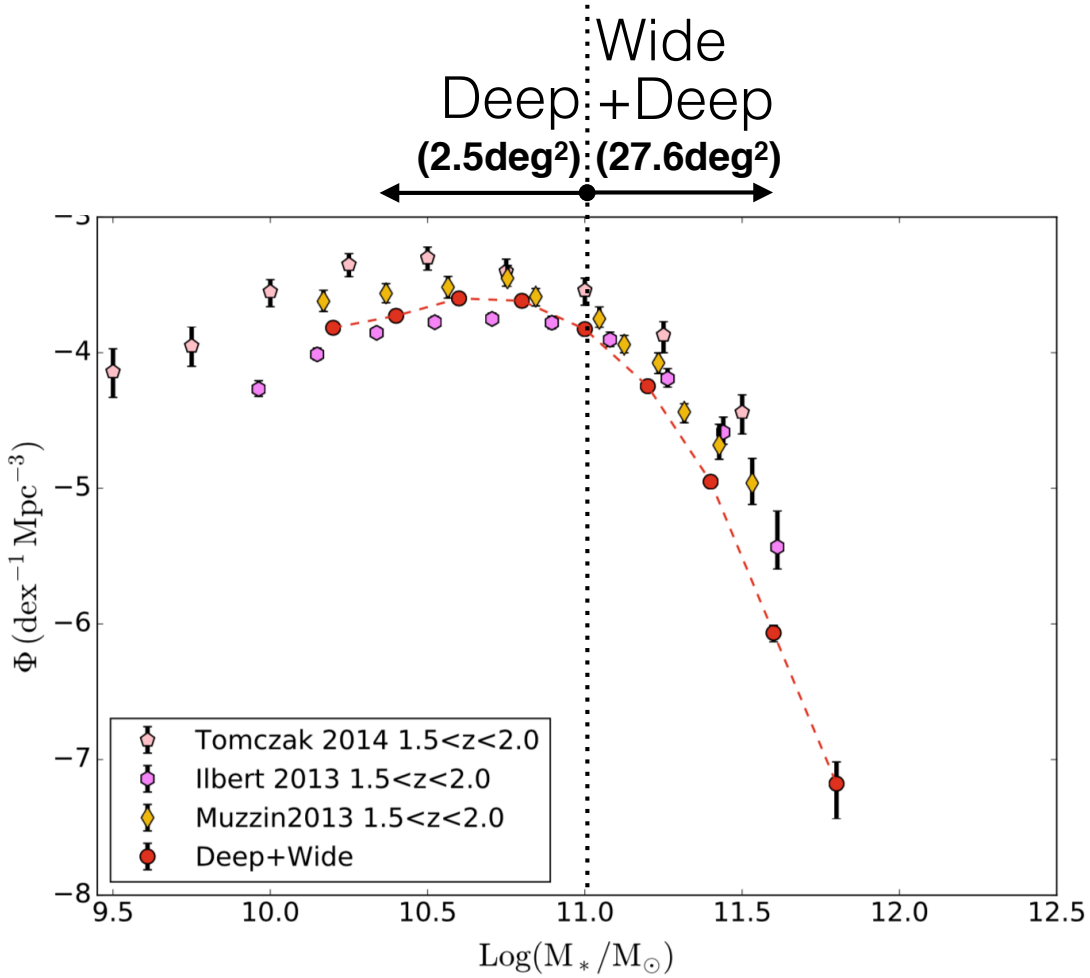
BzK technique (Daddi+04) adapted to CFHT gzK_s filters



Passive <z>=1.6

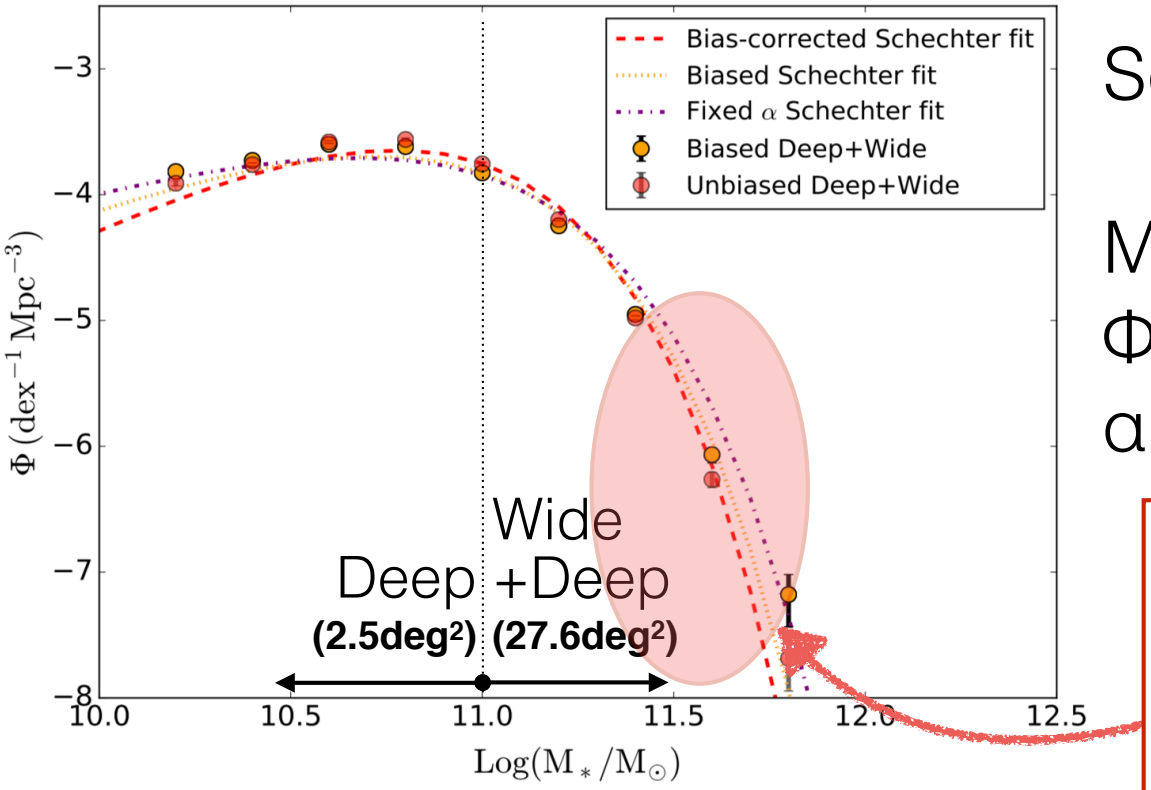
3% of our data

Quiescent galaxy SMF at z~1.6



N(z) and K mag to M_{stars} conversion calibrated with COSMOS multi-band photo-z & SEDs catalog of Muzzin+13

Quiescent galaxy SMF at z~1.6



Schechter function fit:

$M^* = 10.59 \pm 0.02\ M_\odot$

$\Phi^* = 2.35 \pm 0.05 \times 10^{-4}\ Mpc^{-3}$

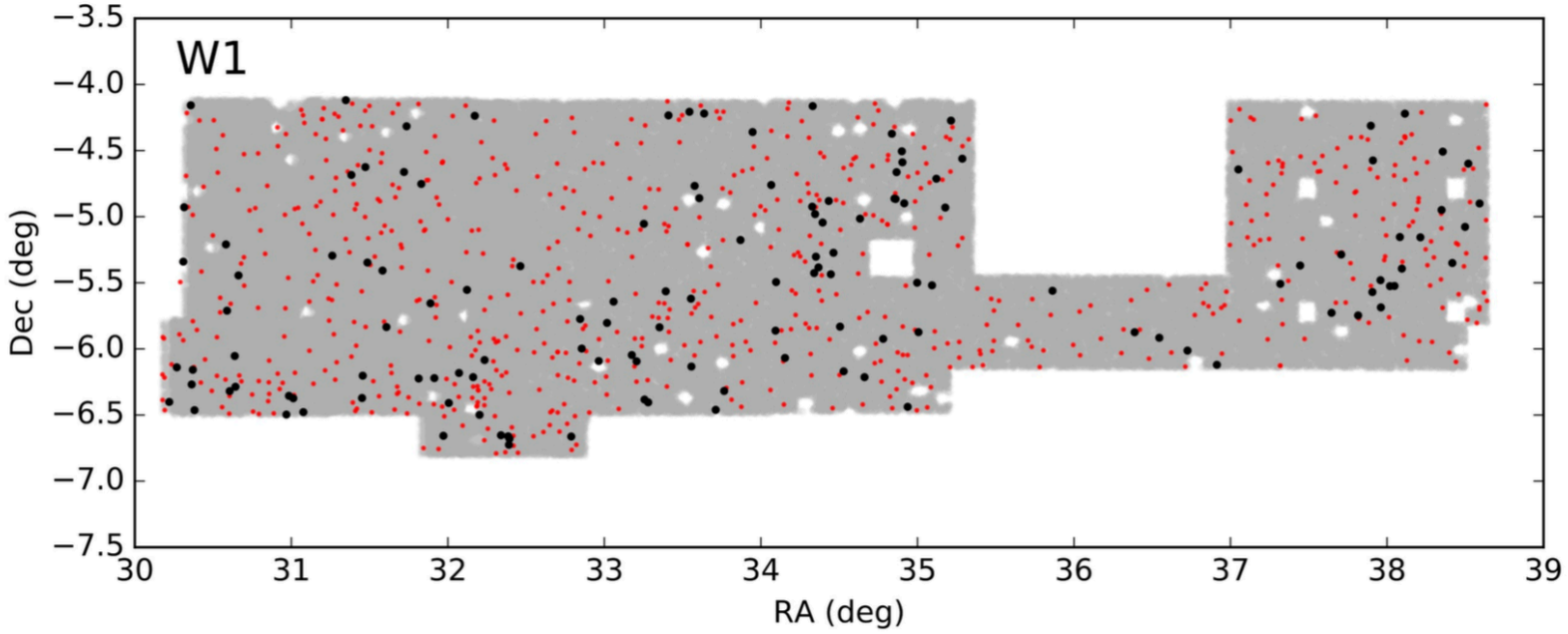
$\alpha = 0.54 \pm 0.08$

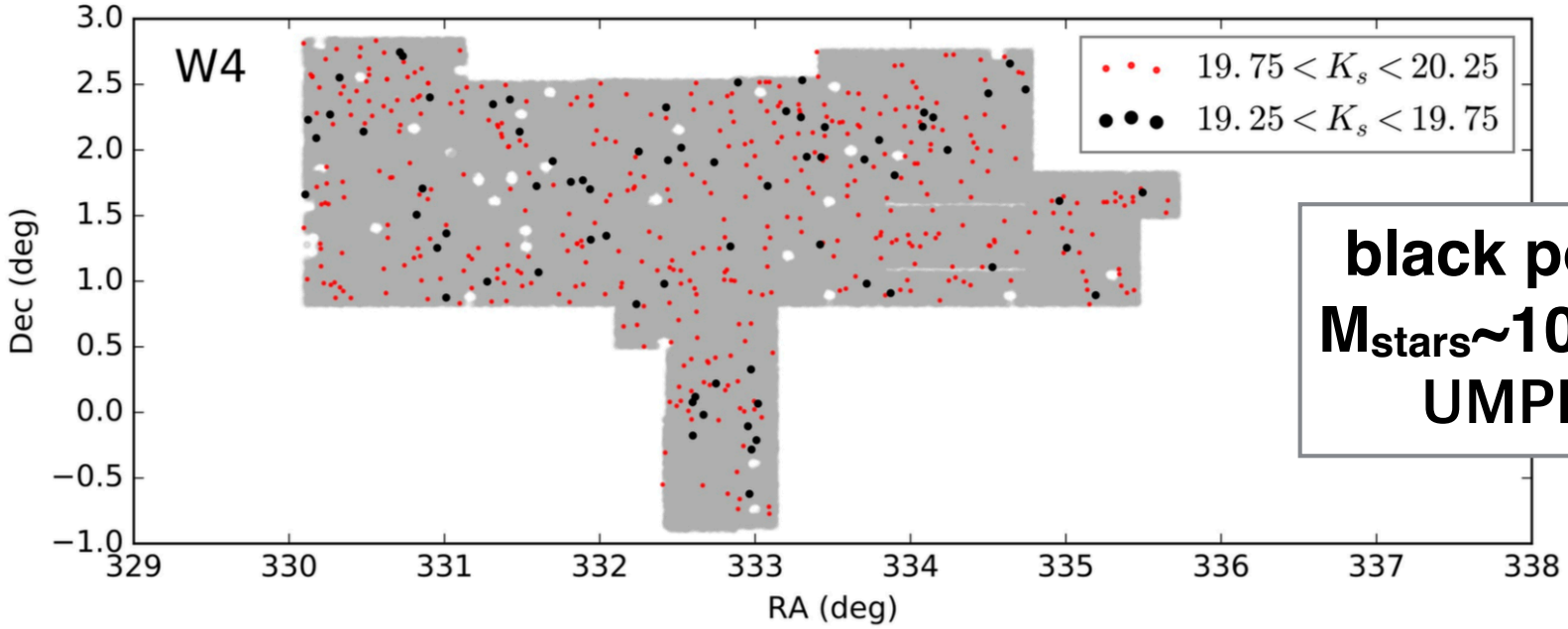
$M_{stars} \sim 10^{11.5} M_\odot$
Ultra-Massive Passive Galaxies
"UMPEGs"

SMF very well represented by Schechter function over a wide range of mass, including very high mass

➜ Mass-quenching mechanism already established by z~1.6 and universal since then

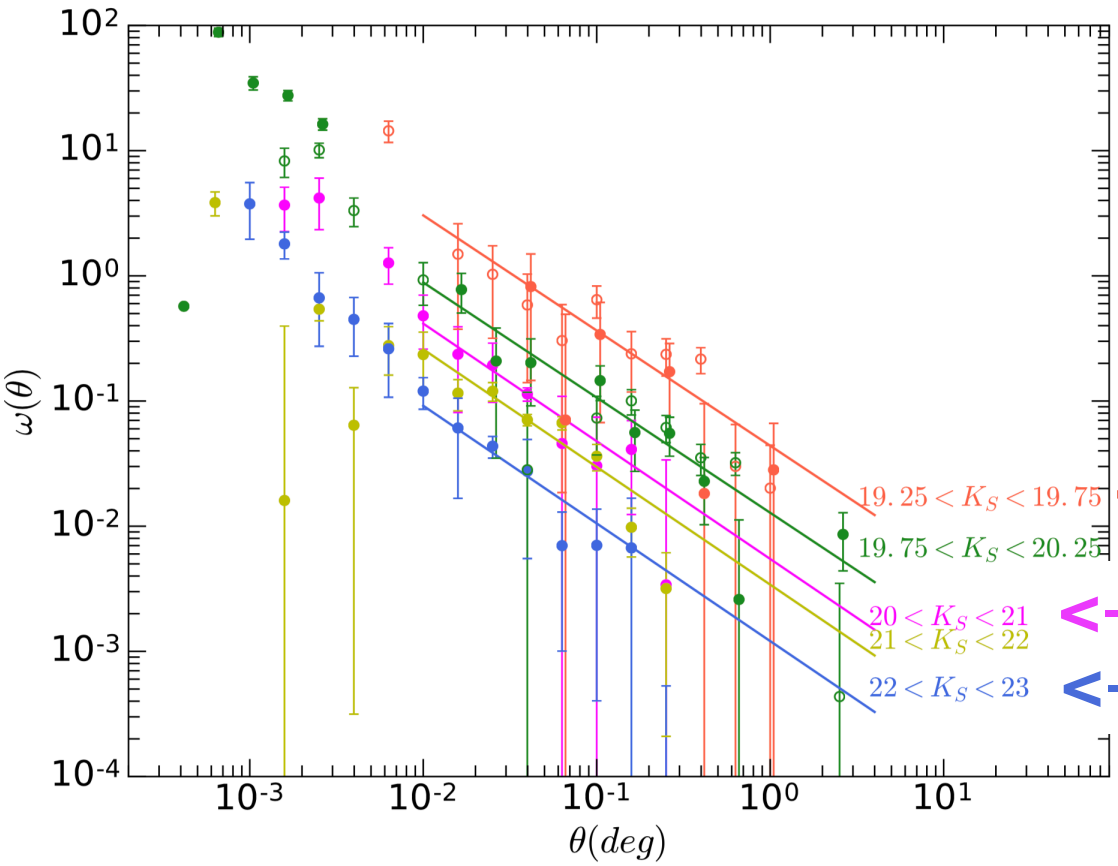
Clustering





black points:
M_{stars}~$10^{11.5}$ $M_\odot$
UMPEGs

Clustering



<—M_{stars}~$10^{11.5}$ $M_\odot$ (UMPEGs)

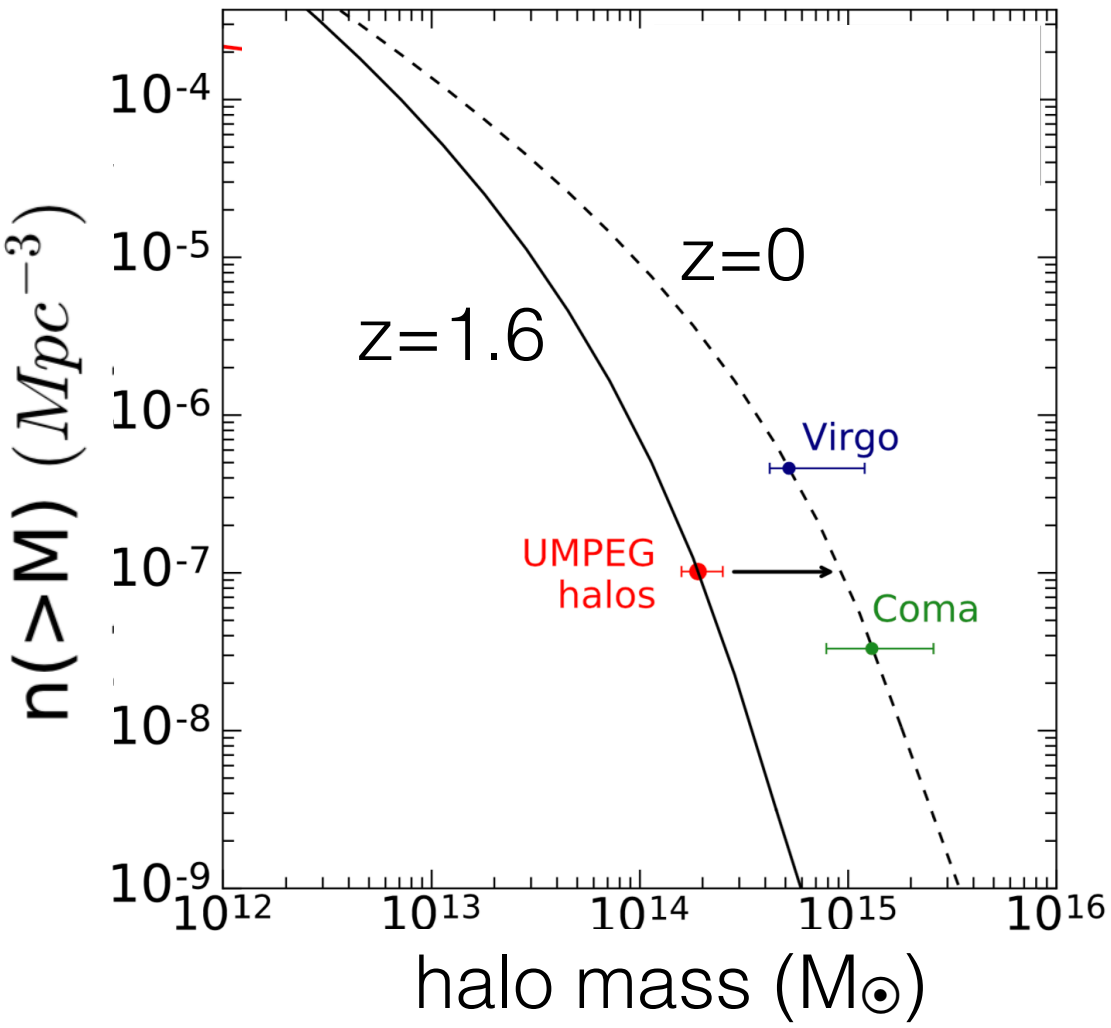
<—M_{stars}~$10^{11.1}$ $M_\odot$

<—M_{stars}~$10^{10.5}$ $M_\odot$

after Limber inversion, UMPEGs have:
$r_0 = 30.9 \pm 5.3\ h^{-1}$ Mpc

➜ DM halos of UMPEGs: $M_{halo} \sim 10^{14.2}\ M_\odot$

What halos are they in?



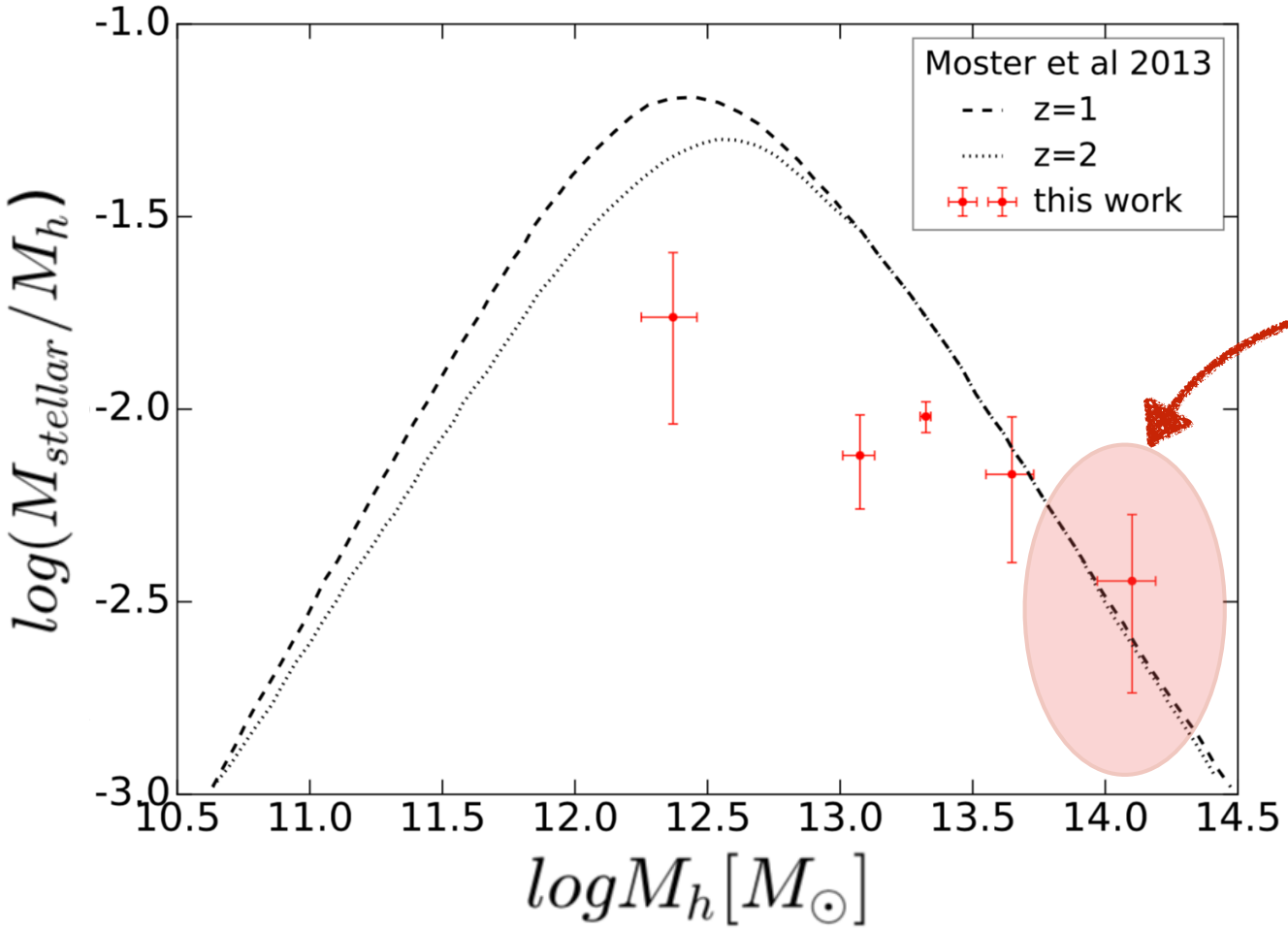
1. UMPEGs at z~1.6 are in DM halos that will become massive clusters by z=0

2. Occupation fraction:

only ~1/8 such z~1.6 halos host an UMPEG

➜ the other ~7/8 halos may have a star-forming central or multiple large, but not *ultra*-massive, "bits" (galaxies)

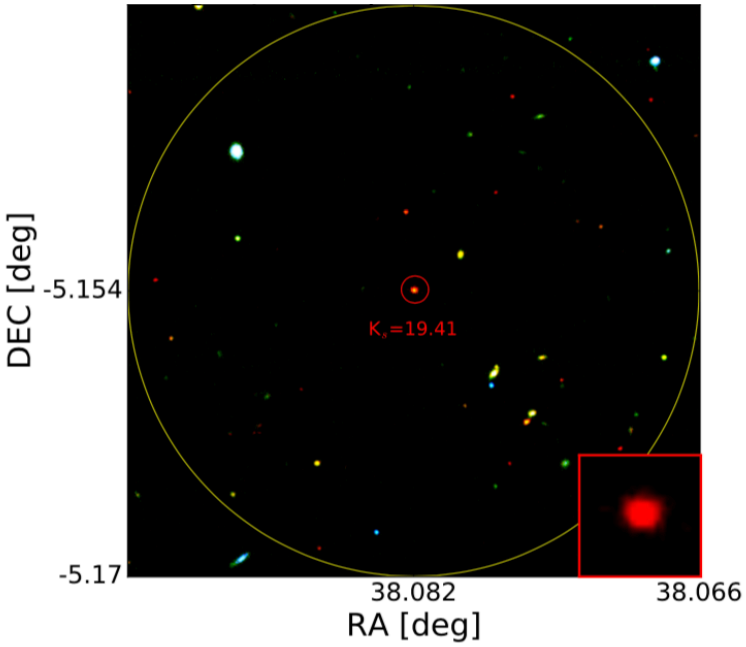
Stars-to-DM ratios

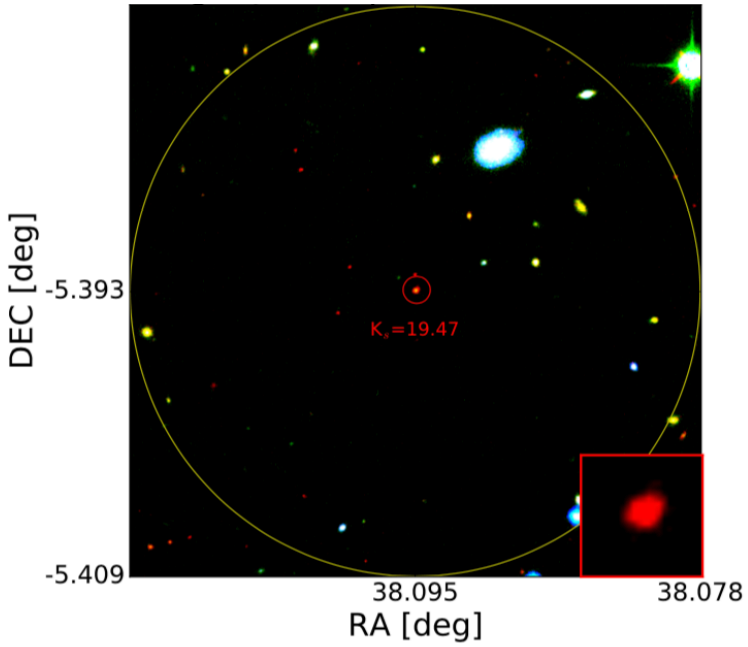


M_{stars} ~$10^{11.5}M_\odot$ UMPEGs

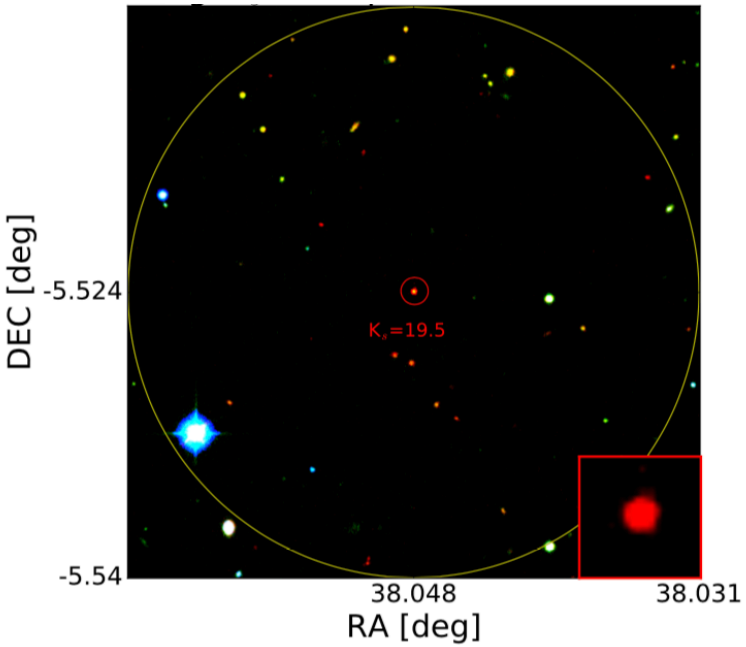
star formation processes are inefficient in UMPEGs
(in agreement with expectations)

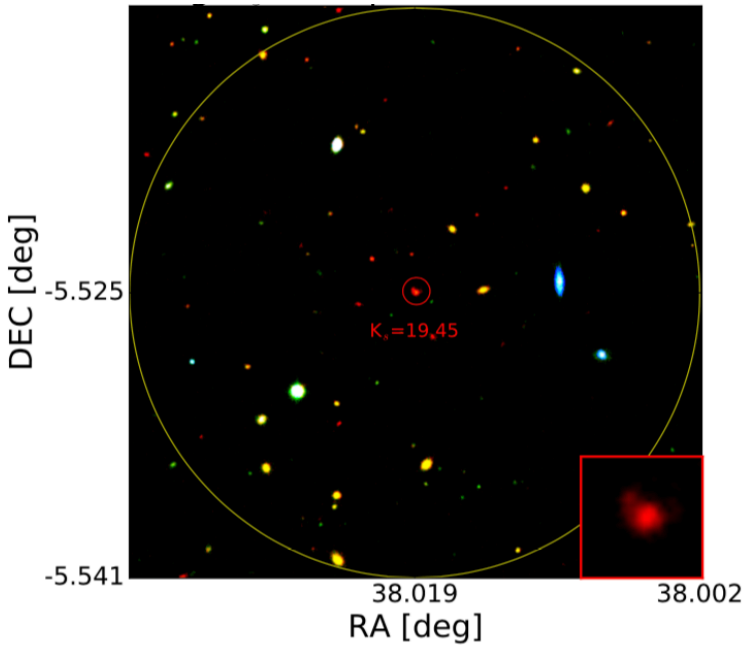
Environments





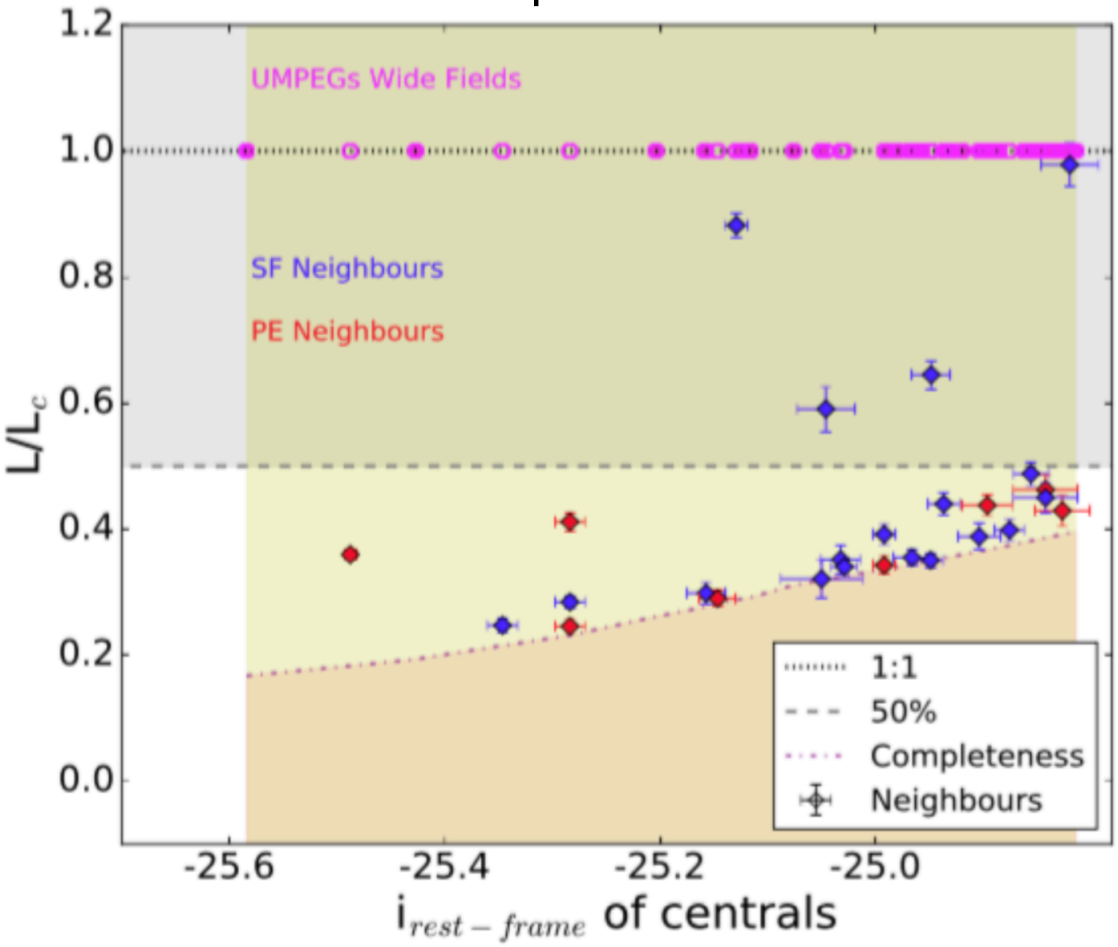
1Mpc





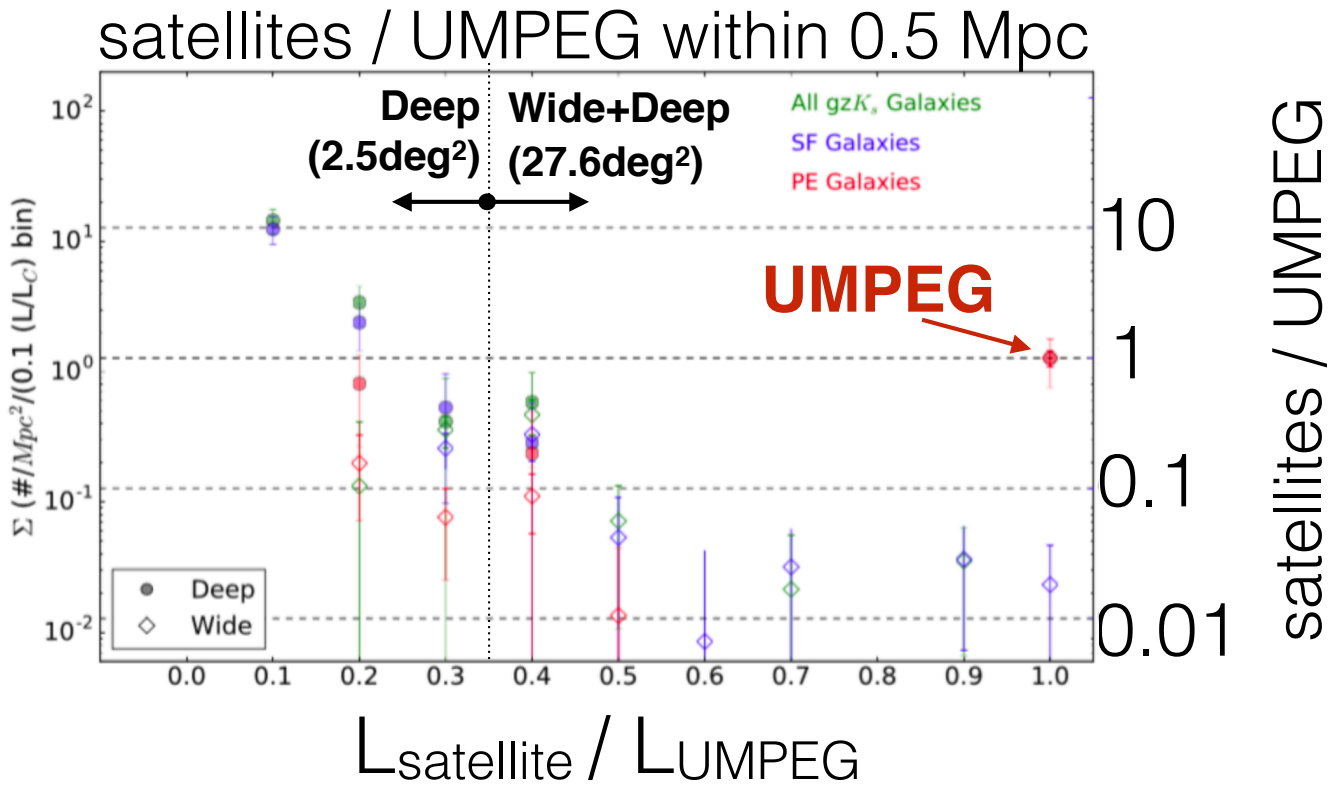
Environments

companion gzK galaxies
within 0.5 Mpc of our UMPEGs:



➜ Most UMPEGs have no massive companions (even before statistical back/fore-ground subtraction)

Environments



Growth by minor mergers: Assume const. mass/K-mag ratio and merger timescales from simulations (Kitzbichler+08, Jiang+07)

➜ ~13% mass growth per Gyr due to (minor) mergers

(at this rate, a $10^{11.5} M_\odot$ UMPEG would grow to $10^{12} M_\odot$ at z=0)

Summary

1. Large sample of ultra-massive passive galaxies (UMPEGs M_{stars}~$10^{11.5}M_{\odot}$) from 27.6deg^2 via *BzK*-like selection

2. Clustering: UMPEGs associated with M_{halo}~$10^{14.2}M_{\odot}$ halos
   ➜ these halos are progenitors of massive (~$10^{15}M_{\odot}$) clusters by z=0
3. Very few massive satellites, growth possible by *minor* mergers
   ➜ ~13% mass growth per Gyr
   ➜ UMPEGs may be direct progenitors of (some) z~0 massive cluster BCGs

4. Only one in 8 UMPEG halos ($10^{14.2}M_{\odot}$) has an UMPEG
   ➜ (only) 1 of 8 ultra-massive halos hosts a quiescent BCG progenitor

➜ Some z~0 massive cluster BCG progenitors may already be observed as quiescent ultra-massive galaxies at cosmic high noon