Extragalactic Science with DECam
Galaxy Evolution at z< 1

Jennifer Lotz
STScI

- what do we know about z<1 universe?
- unsolved problems
- DECam advantage
- the low surface brightness universe

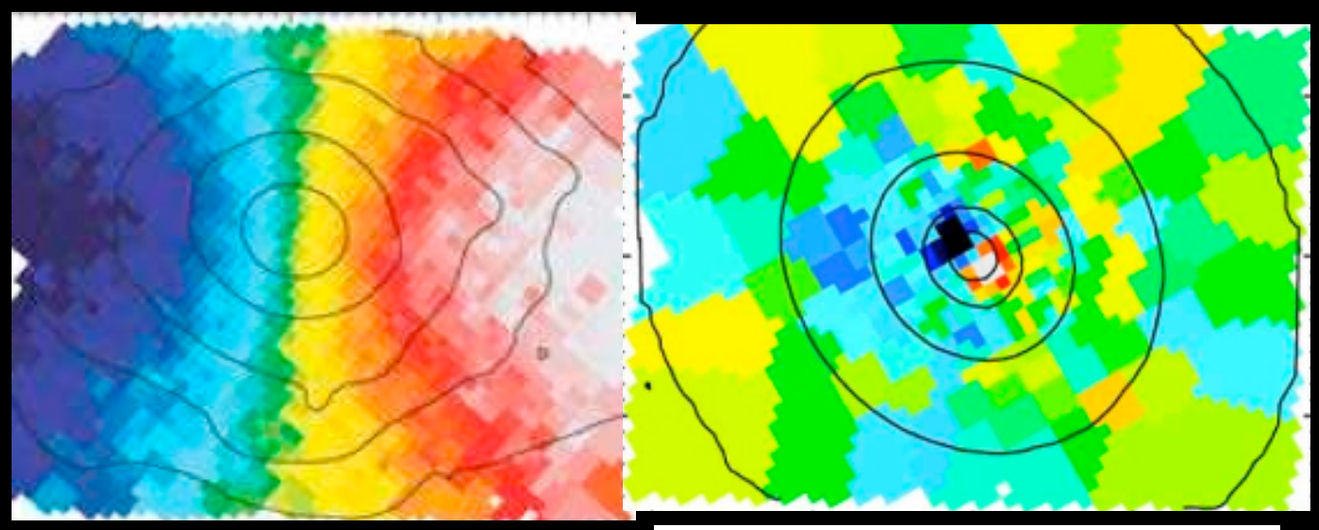
What have we learned at z<1?

- blue disks (red spheroids) were more (less) common in past
- most z<1 star-formation occurs in disk galaxies
- galaxy merger rate evolves modestly
- typical AGN are in massive, bulge-dominated galaxies

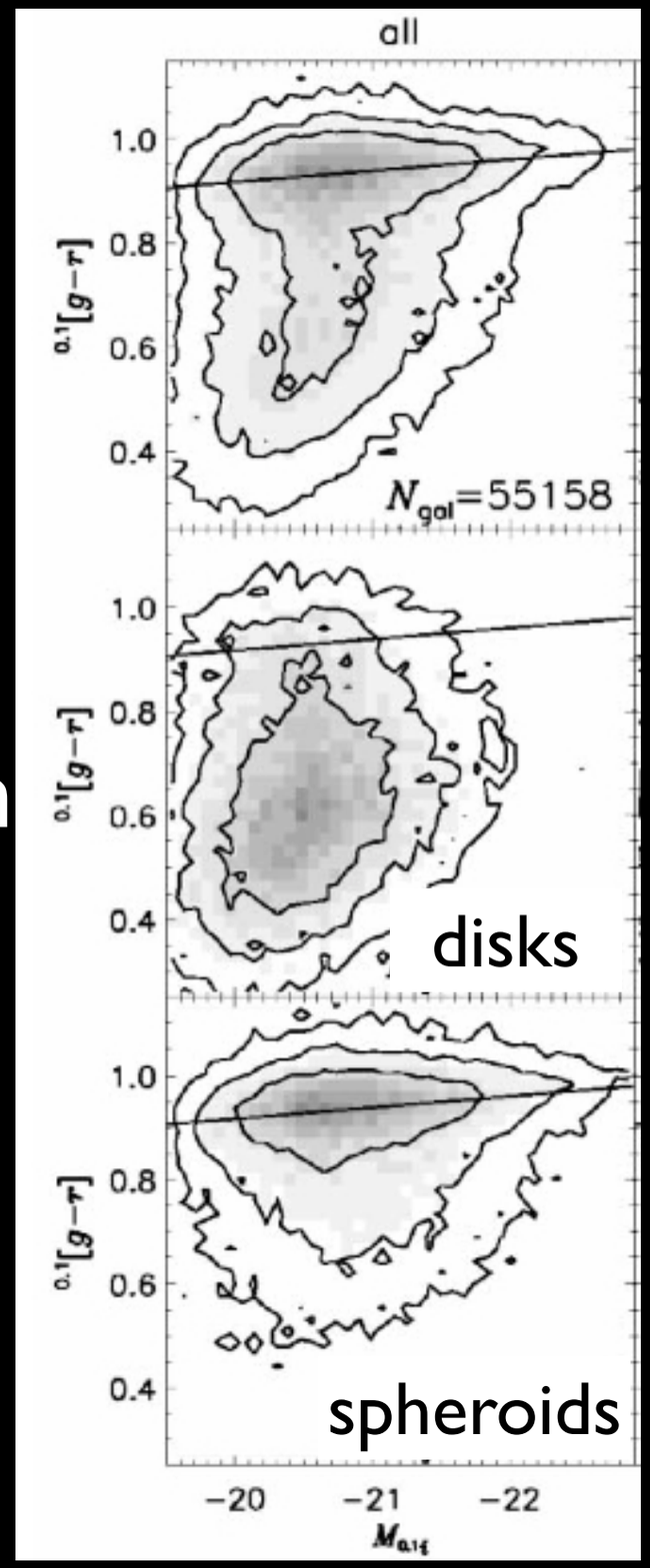
Morphology

Star-formation History

Assembly History

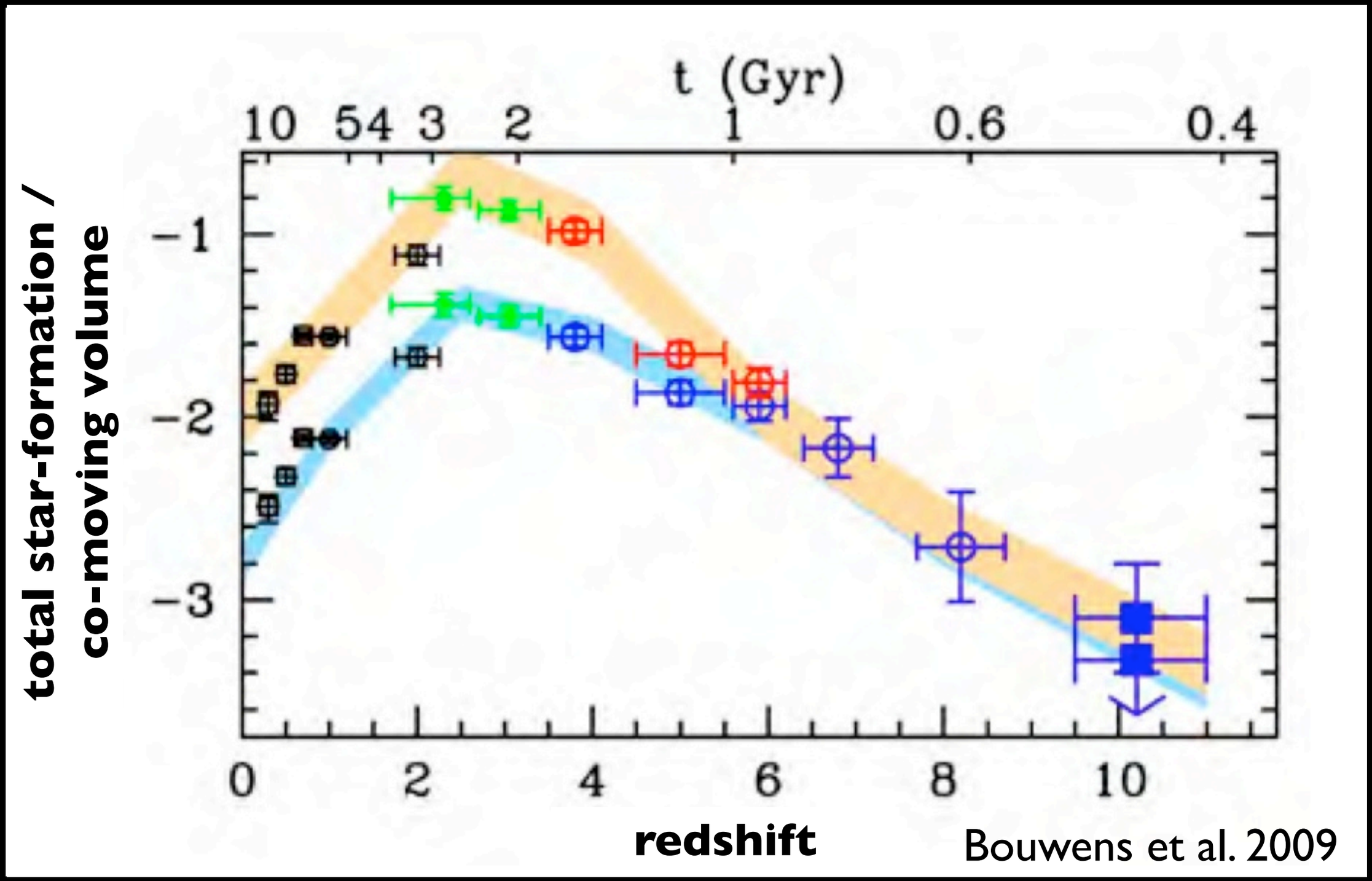


SAURON, ATLAS3d



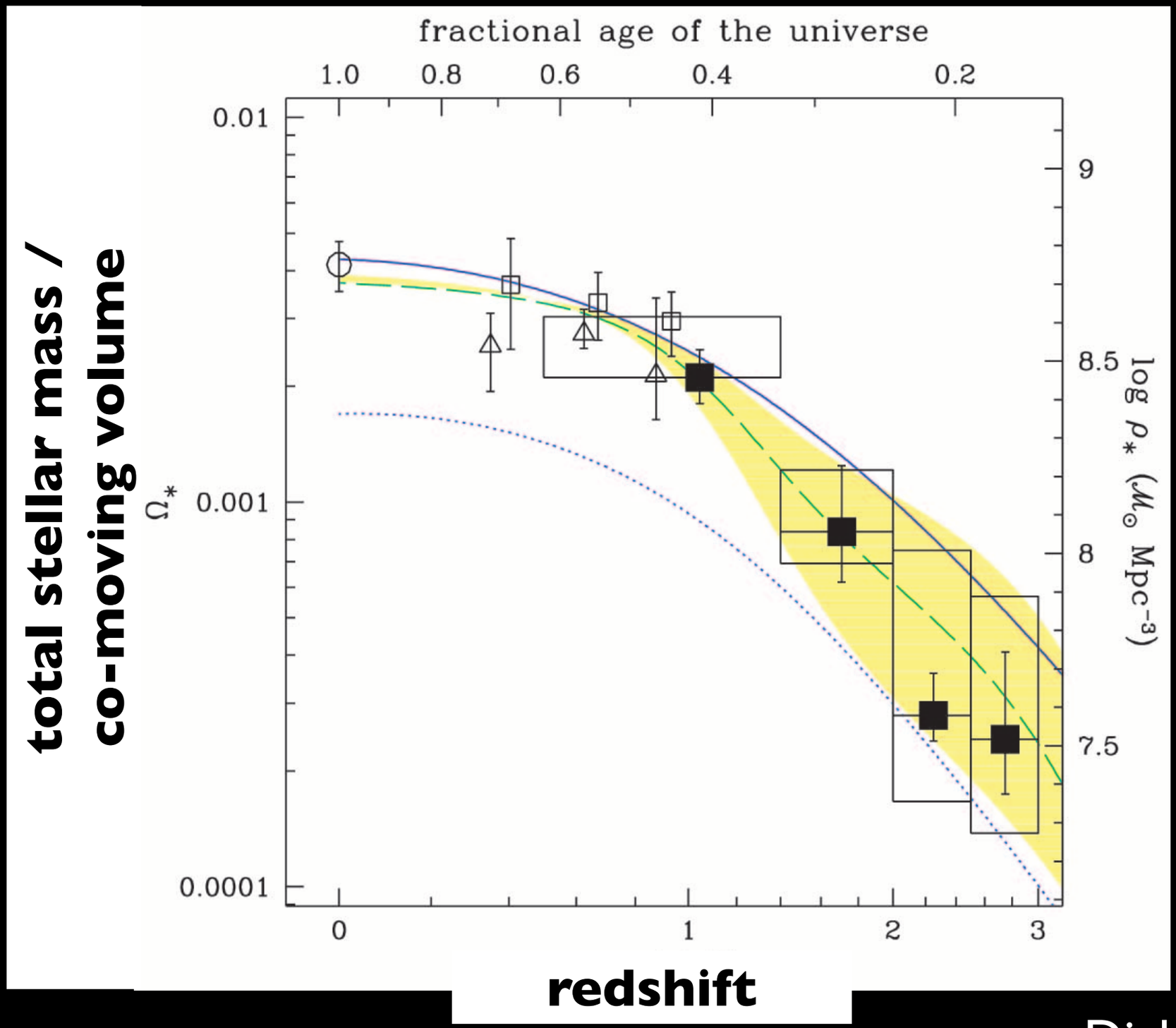
Hogg et al. 2004

Evolution in SFR density



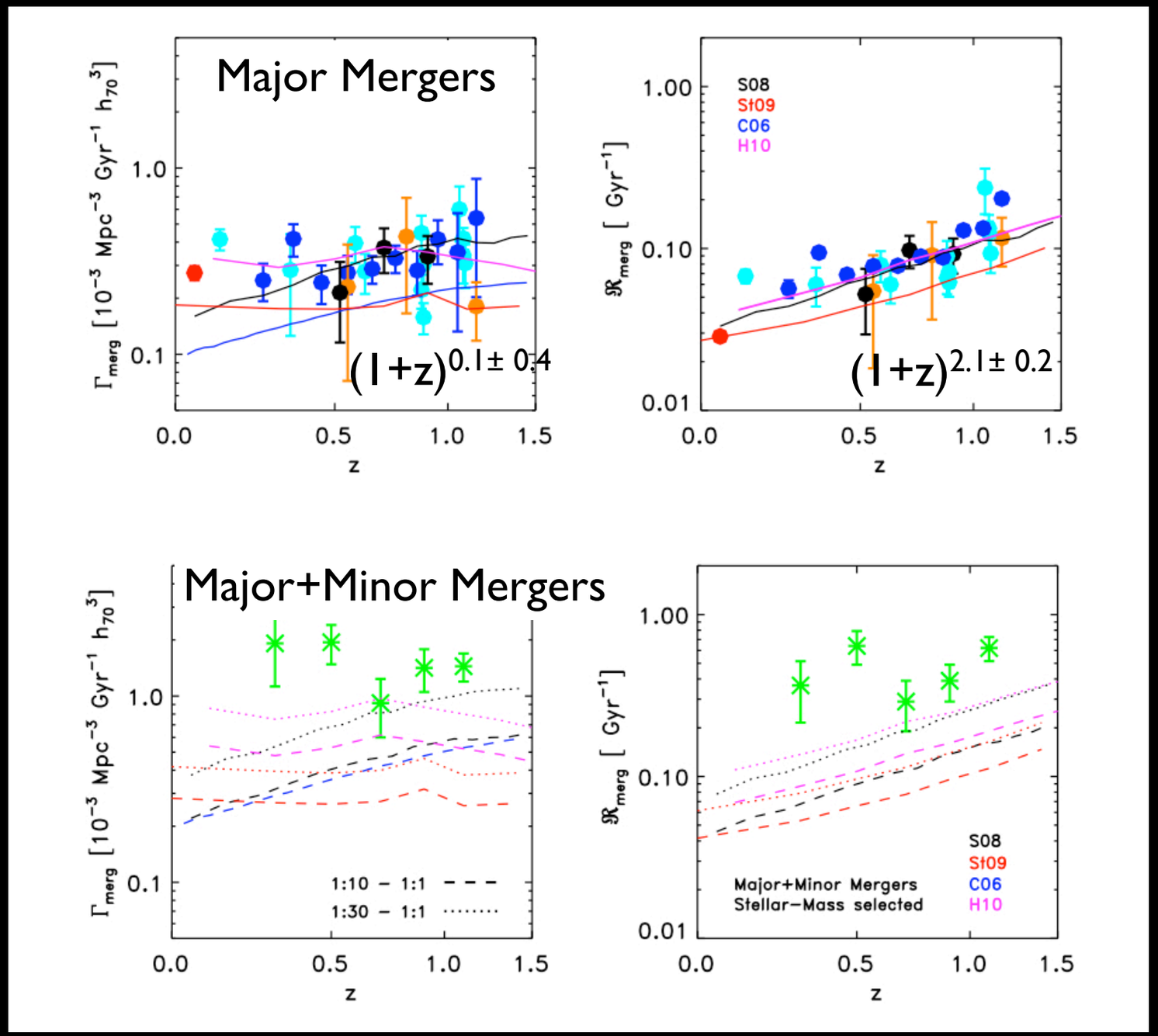
Bouwens et al. 2009

Evolution in stellar mass density



Dickinson et al. 2003

Evolution in the Galaxy Merger Rate



merger rate evolves modestly

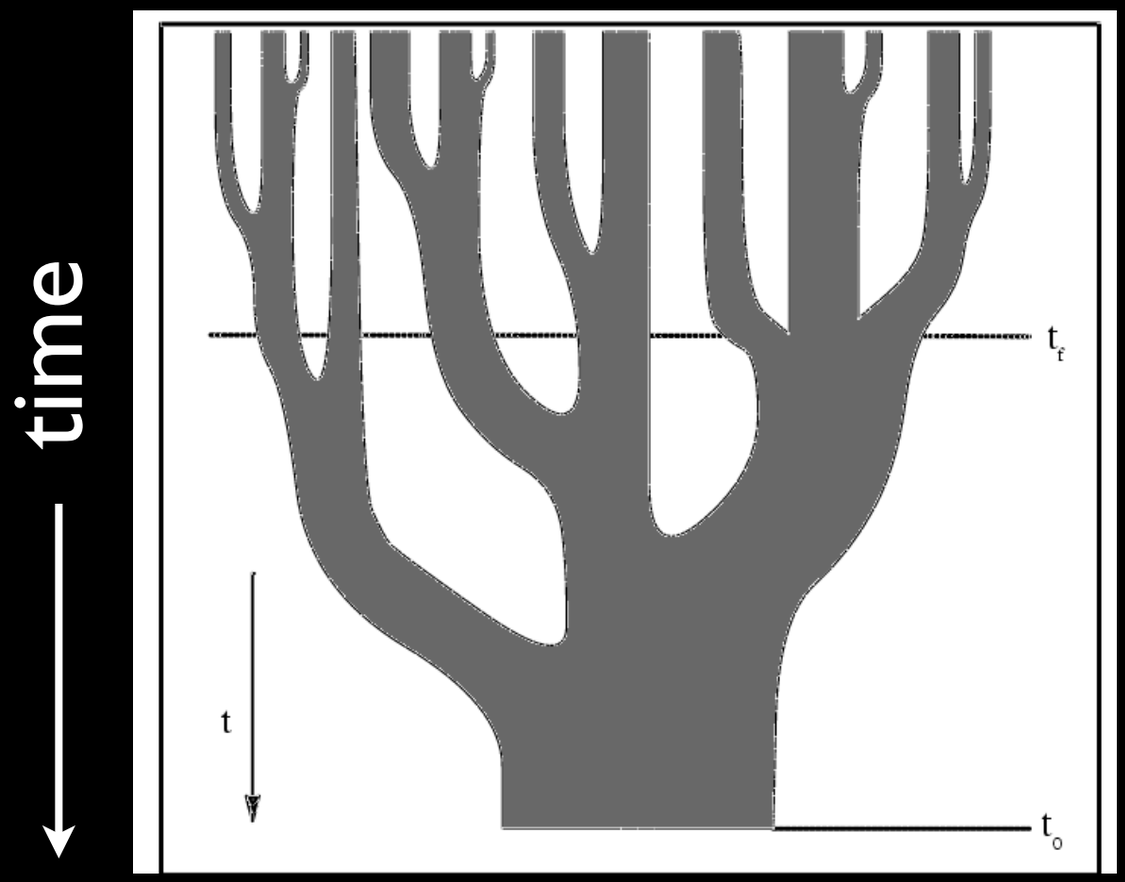
0.5-1 major merger per L* galaxy since z~1

1-3 minor mergers per L* galaxy since z~1

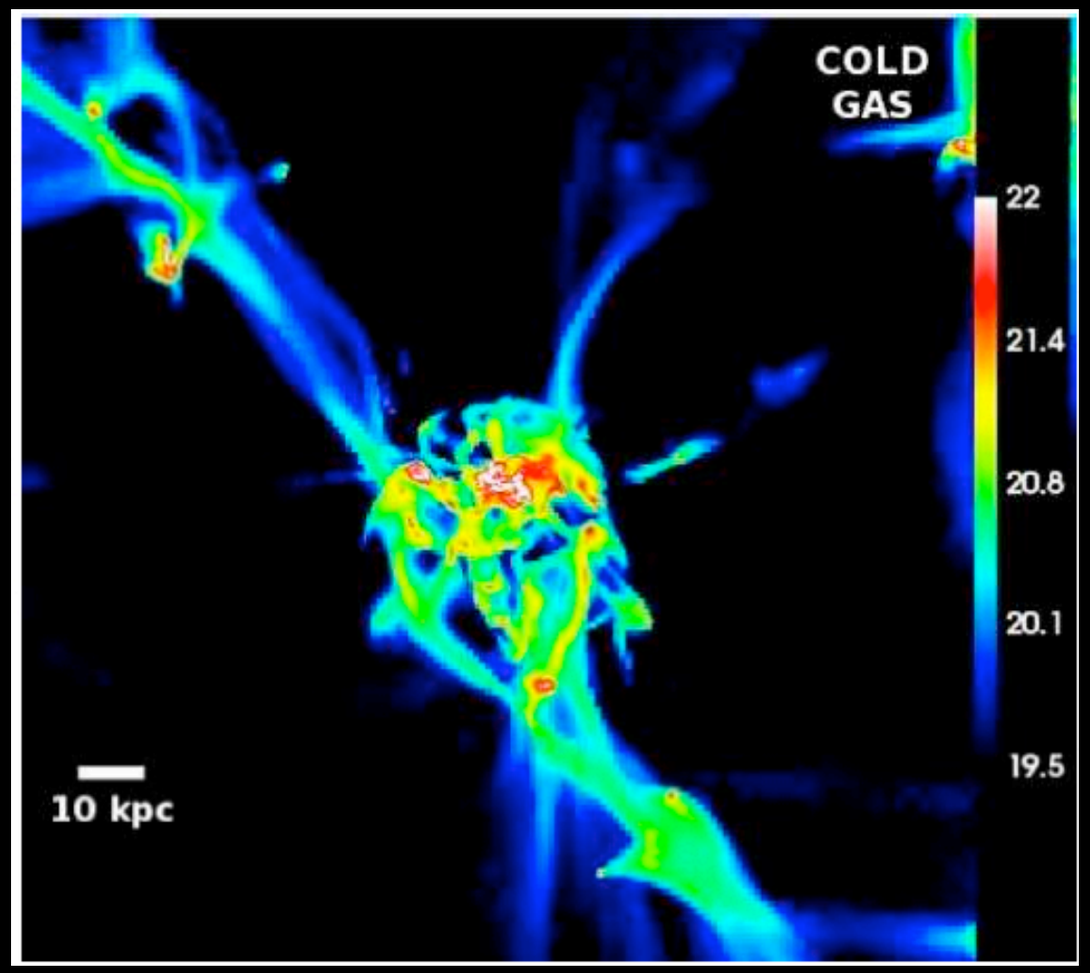
Lotz et al. 2011

How Do Galaxies Assemble?

galaxy mergers vs. gas accretion

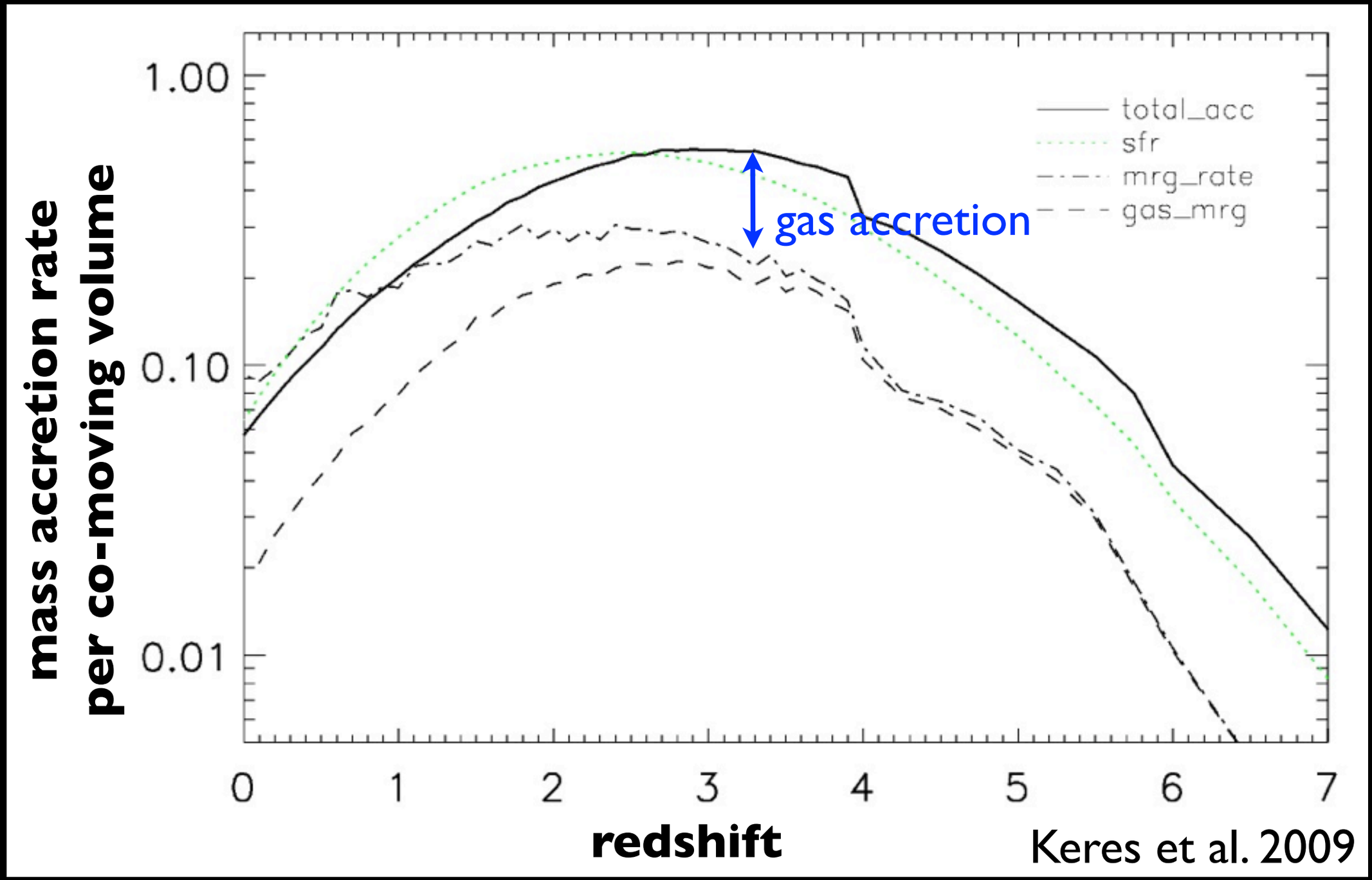


Lacey & Cole 1993



Ceverino et al. 2009

theory: mergers v. gas accretion

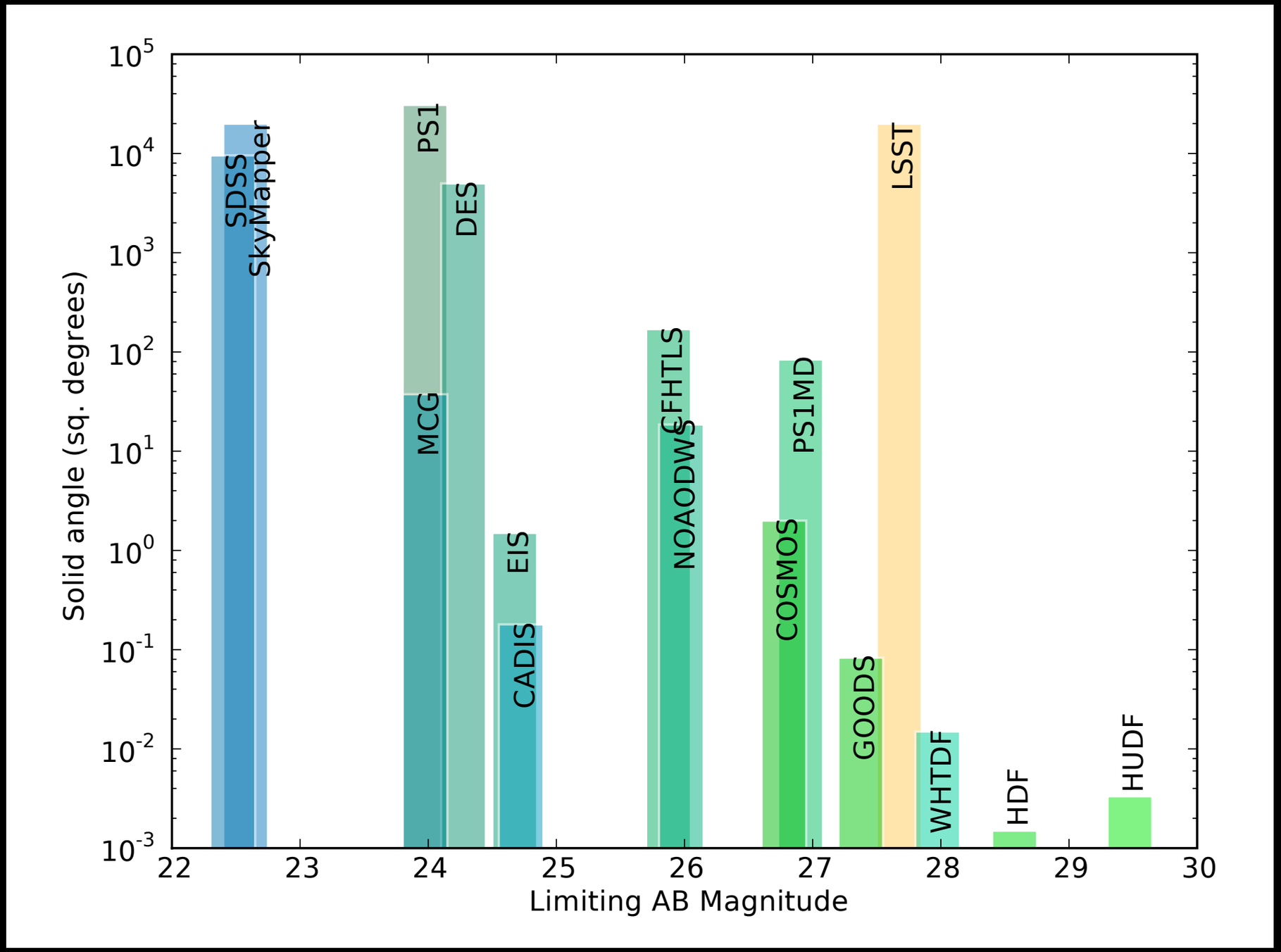


Keres et al. 2009

Unsolved problems in galaxy evolution

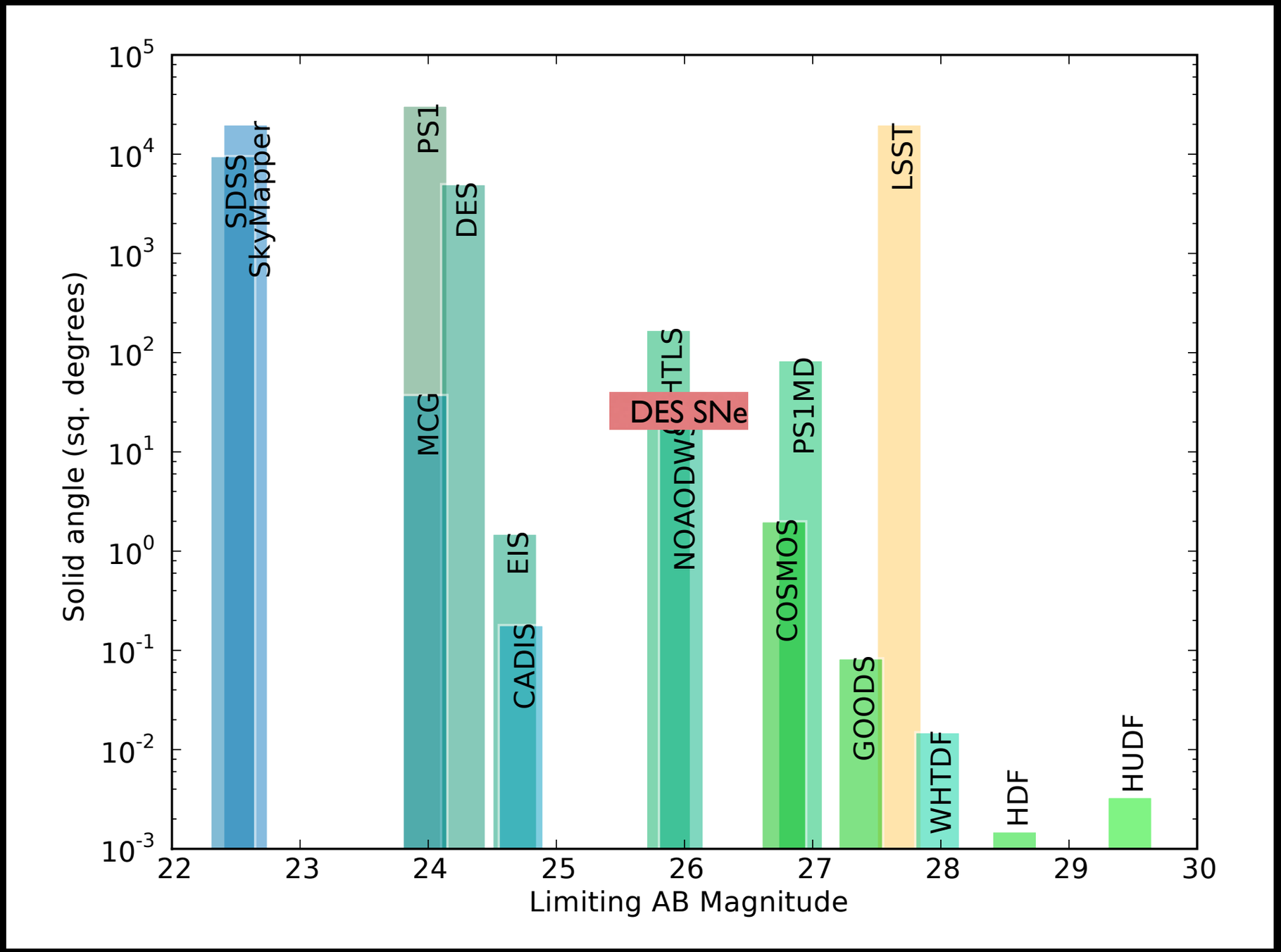
- inside-out growth of disks and spheroids: gas accretion and minor mergers
- quenching + spheroid formation
- assembly of the most massive galaxies
- survival of the smallest galaxies

Deep/Wide Extragalactic Surveys



LSST Science Book

Deep/Wide Extragalactic Surveys



LSST Science Book

DECam advantages

field of view: statistics, large objects

depth: distant objects, low-surface brightness

y-band: better photz, stellar masses

what DES will not do:

- very deep fields (except for SNe fields but no y)
- special places (local galaxies, nearby clusters)
- special filters (u, narrow-band)

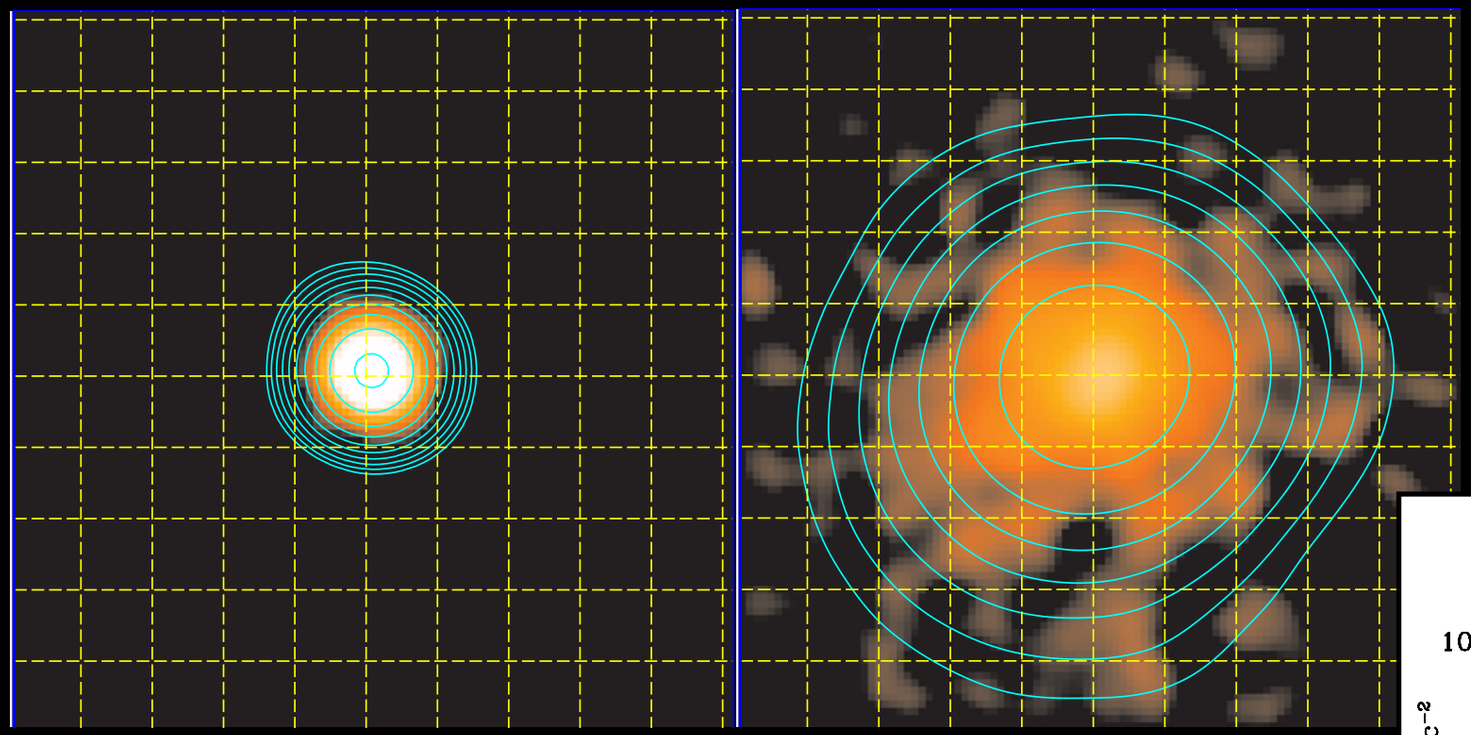
Unsolved problems in galaxy evolution

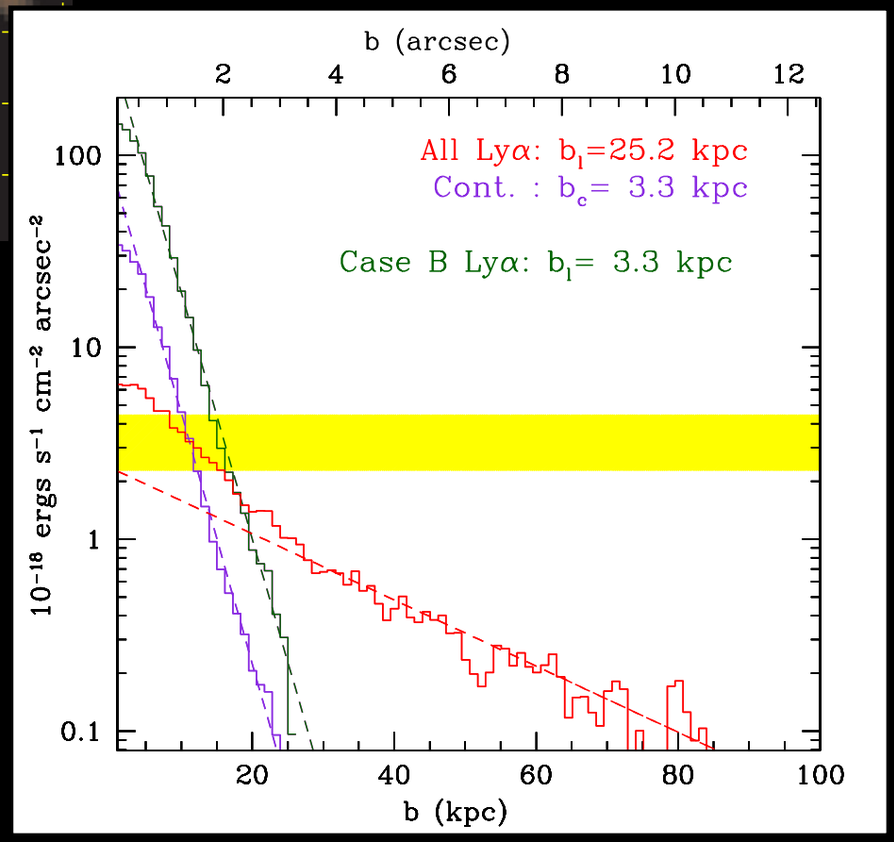
- inside-out growth of disks and spheroids: gas accretion and minor mergers
- quenching + spheroid formation
- assembly of the most massive galaxies
- formation + survival of the smallest galaxies

  ⇒ low-surface brightness universe

  μ ~ 27-29 mag per sq arcsec

Ly-alpha halos: scattering or accretion?



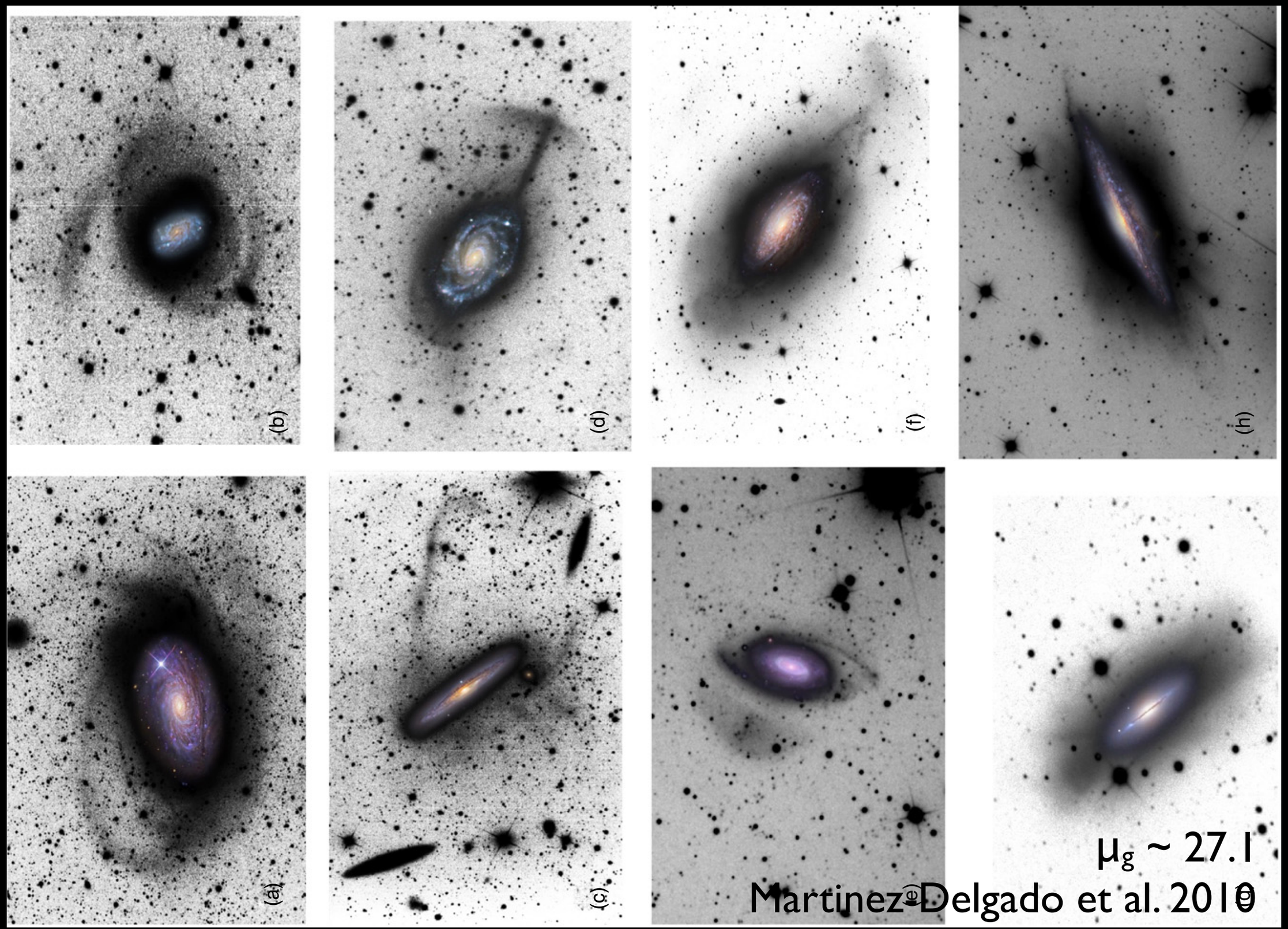


stack of 92 z~3 LBGs
LRIS NB over 0.04 sq degrees
~3 fields x 10 hr exptime on Keck
need to go 10x deeper to see fluorescence?

DECam (+u, NB) for 4 sq degrees,
100x more objects in stack?

Steidel et al. 2011

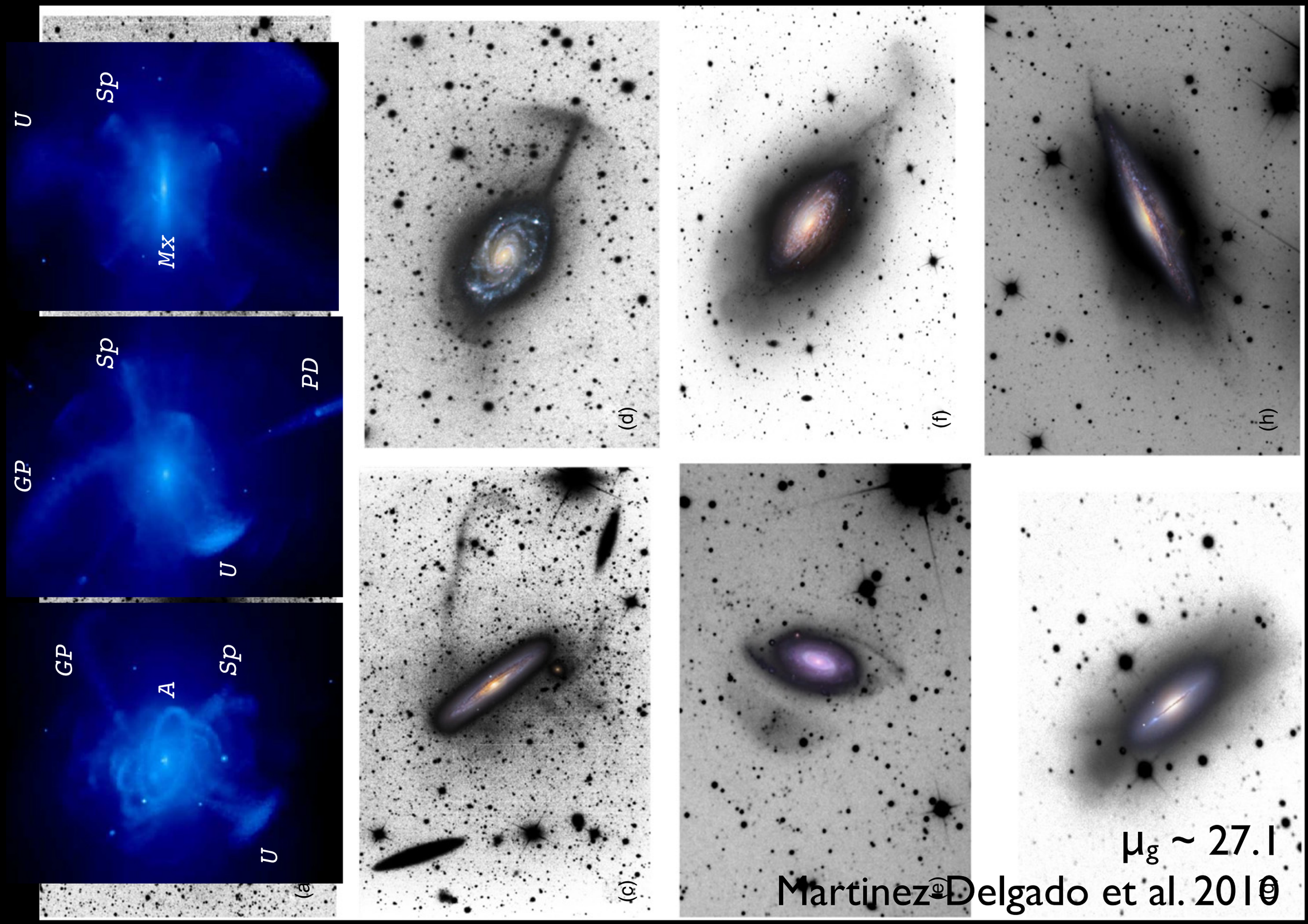
Outer halos of local disk galaxies



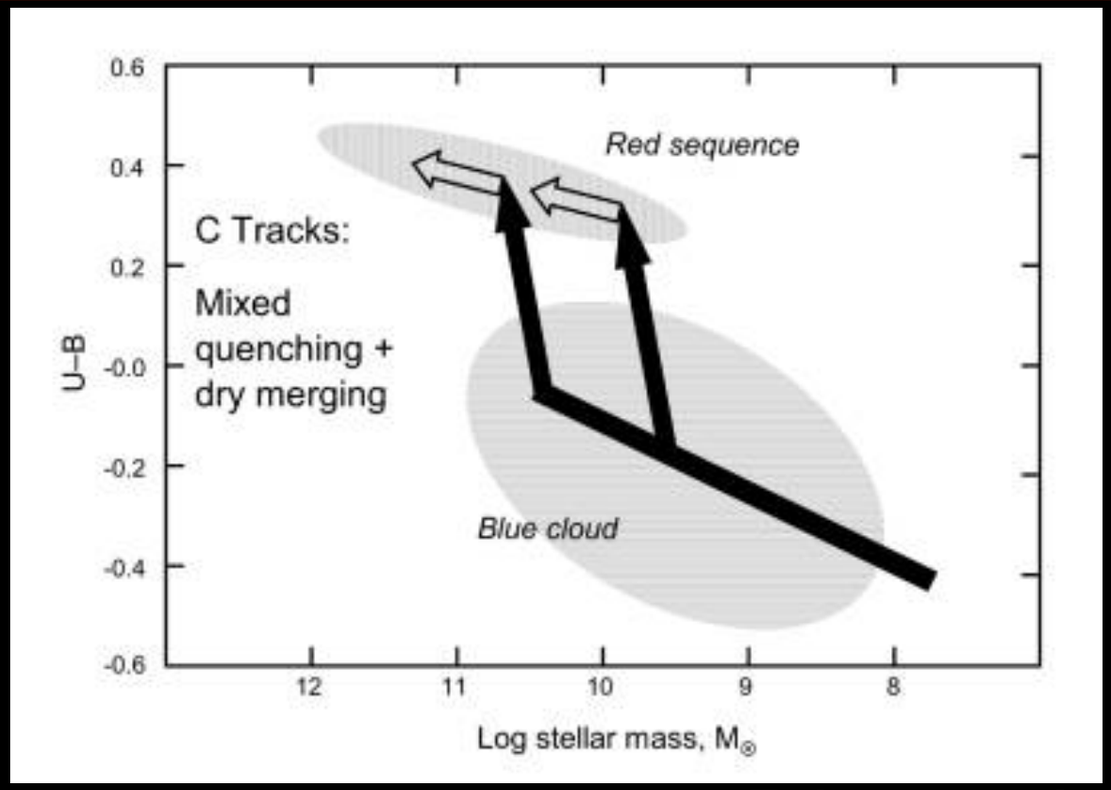
$\mu_g \sim 27.1$

Martinez-Delgado et al. 2010

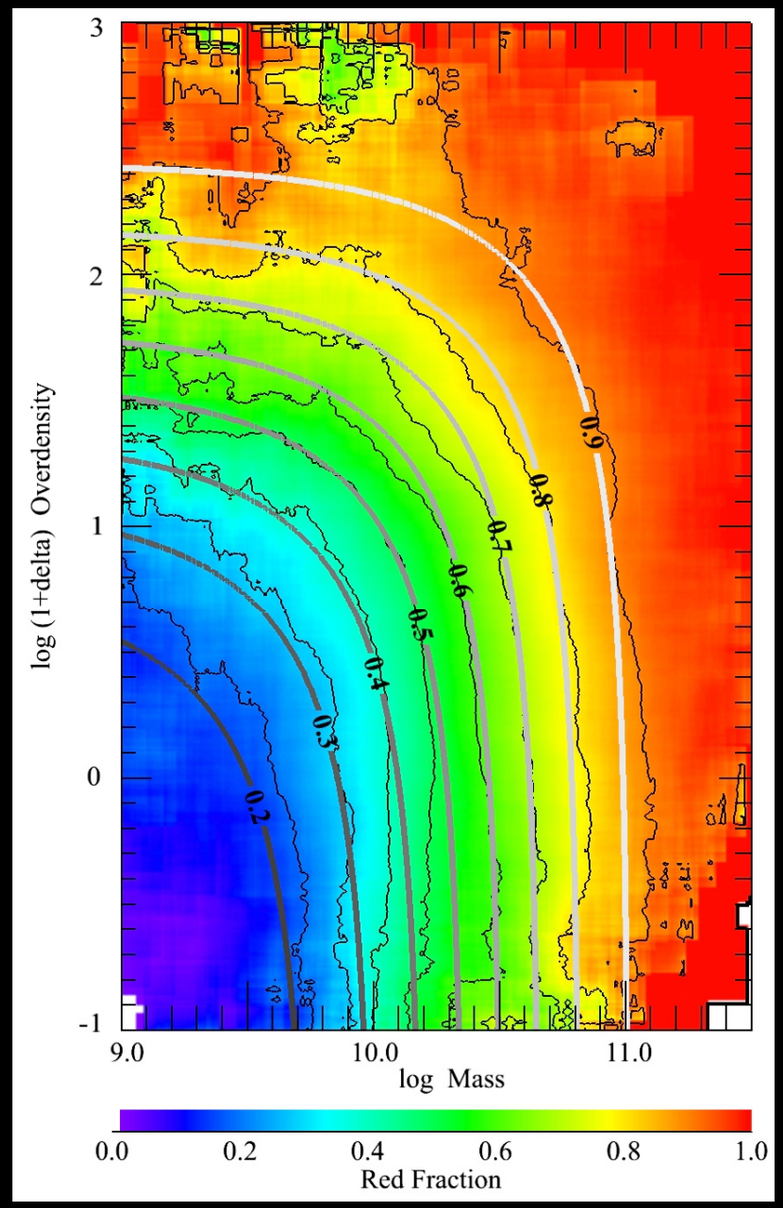
Outer halos of local disk galaxies



Quenching - environment, mass, AGN

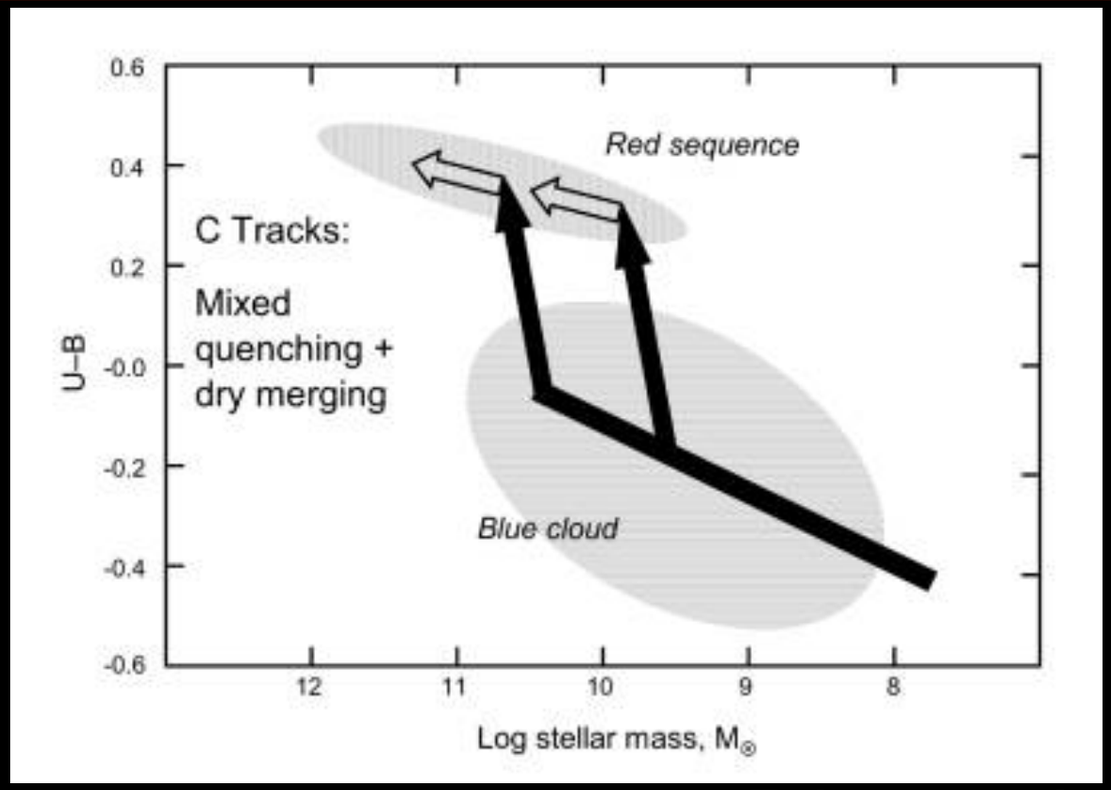


Faber et al. 2007

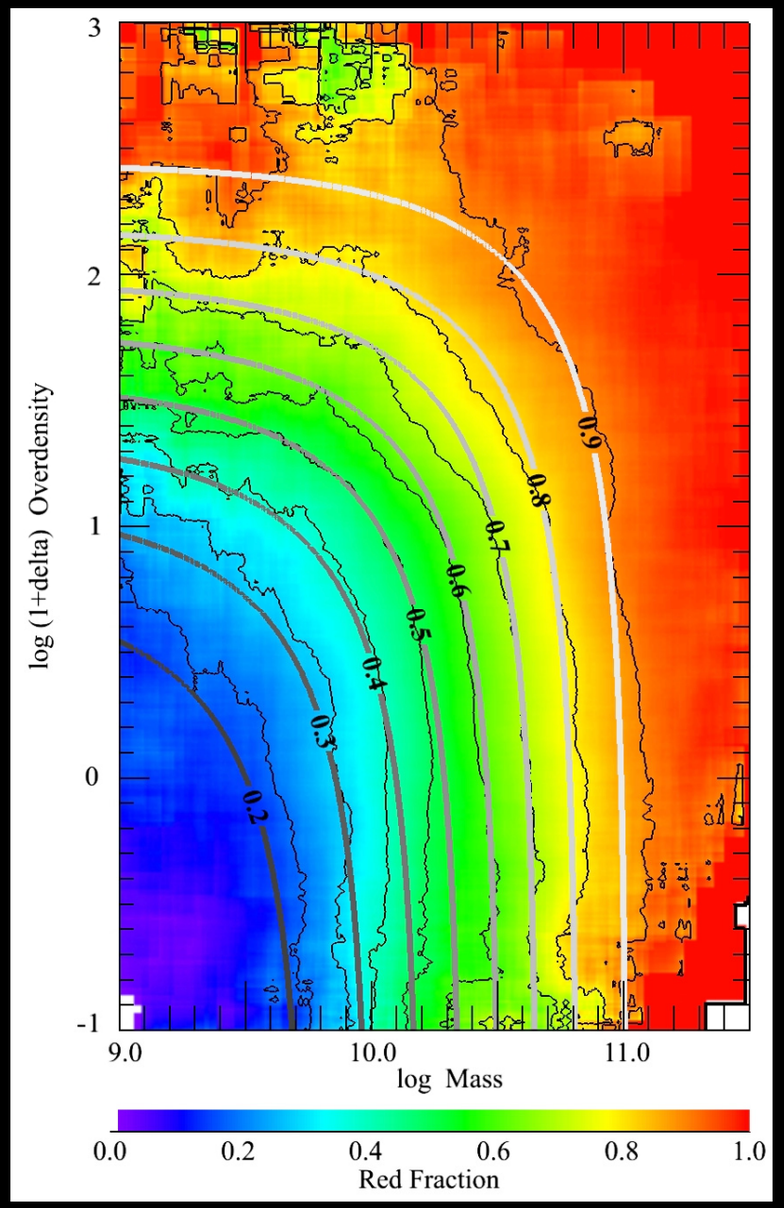


Peng et al. 2010

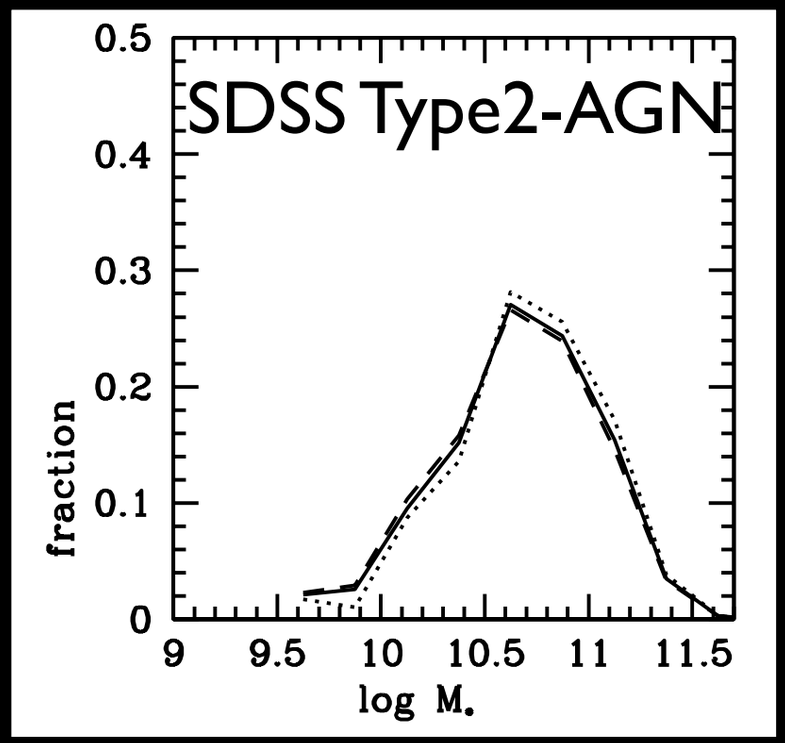
Quenching - environment, mass, AGN



Faber et al. 2007

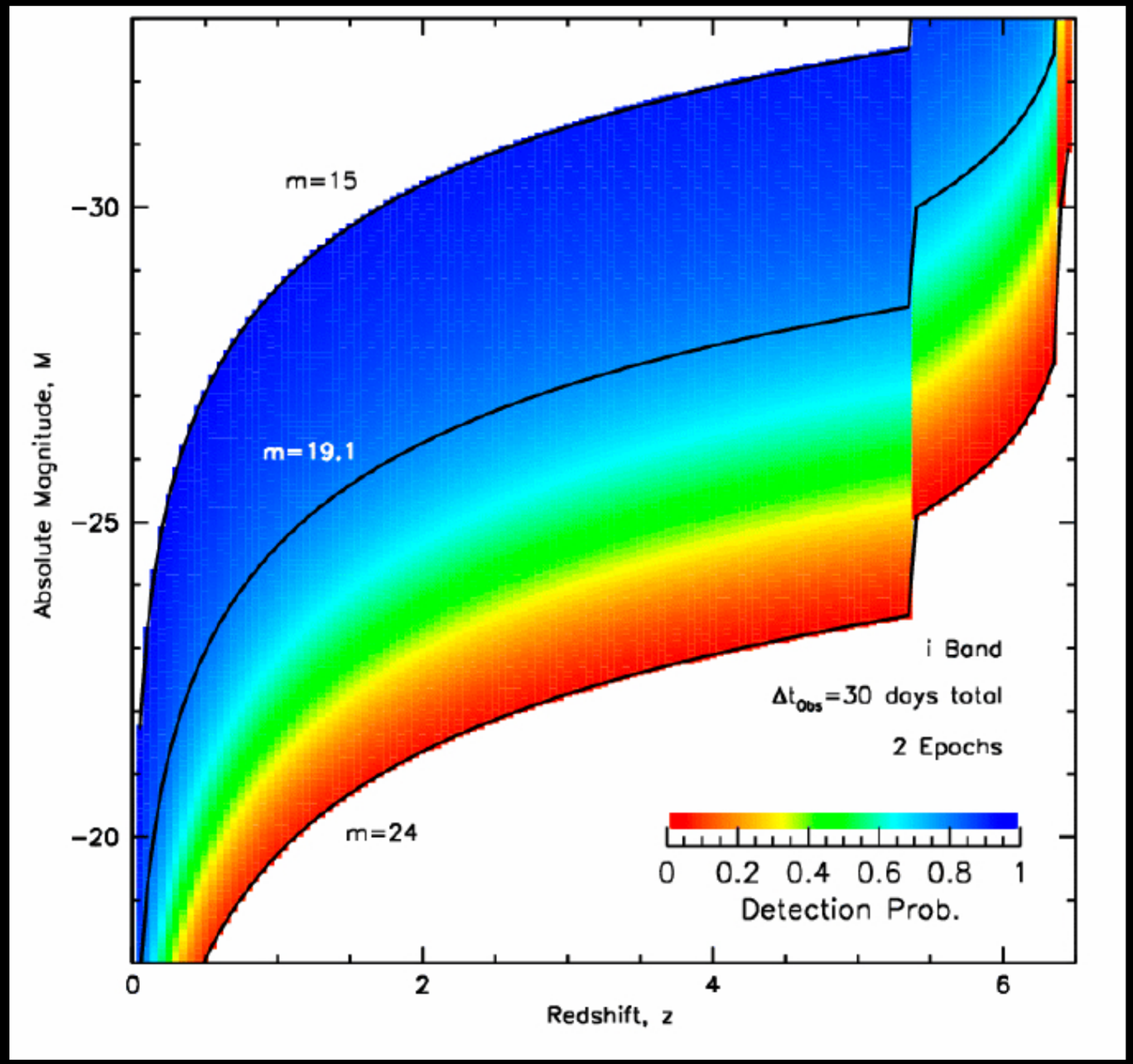


Peng et al. 2010



Heckman et al. 2004

Quenching - environment, mass, AGN



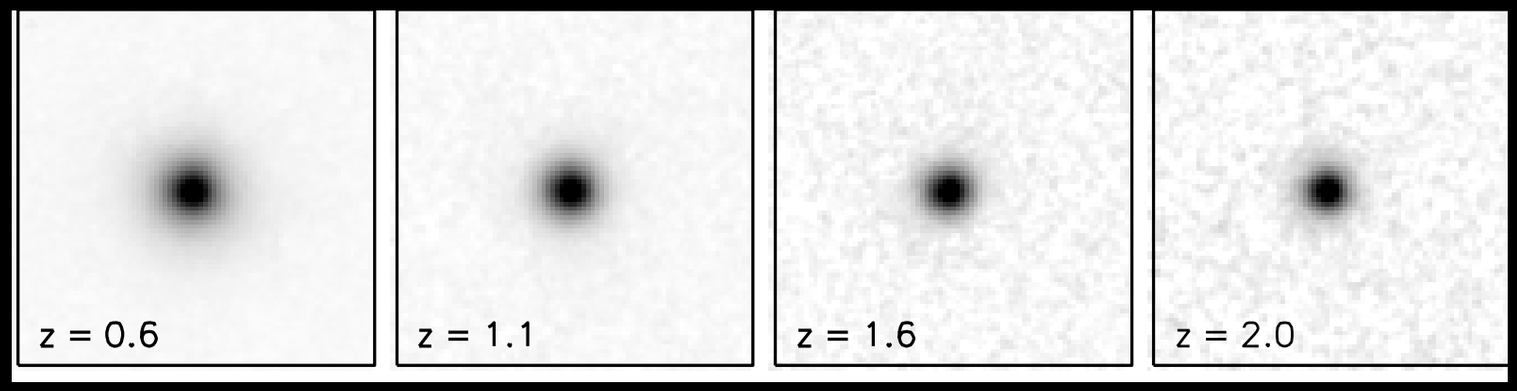
AGN variability is detectable for i < 24 objects in 2-epoch, dt =30 days

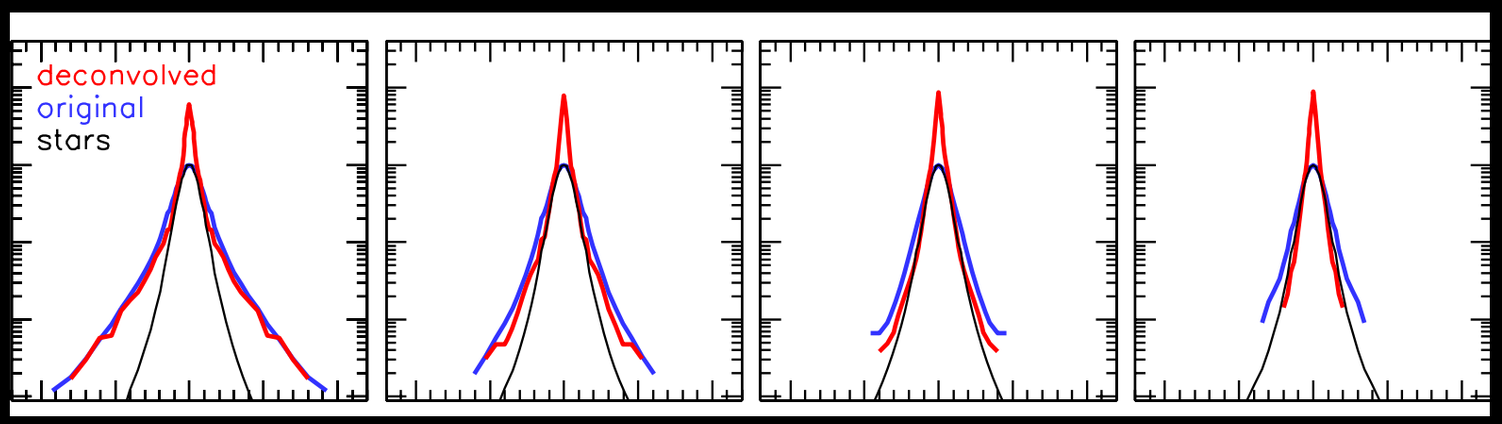
what is correlation of AGN with stellar mass, environment, color?

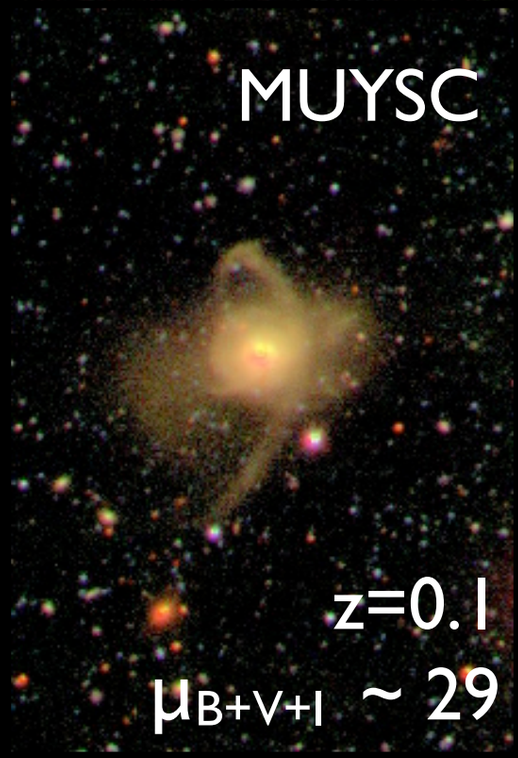
LSST Science Book

Spheroid galaxy assembly

spheroidal galaxies grow outer envelopes from z~2
via ‘dry’ or minor mergers?

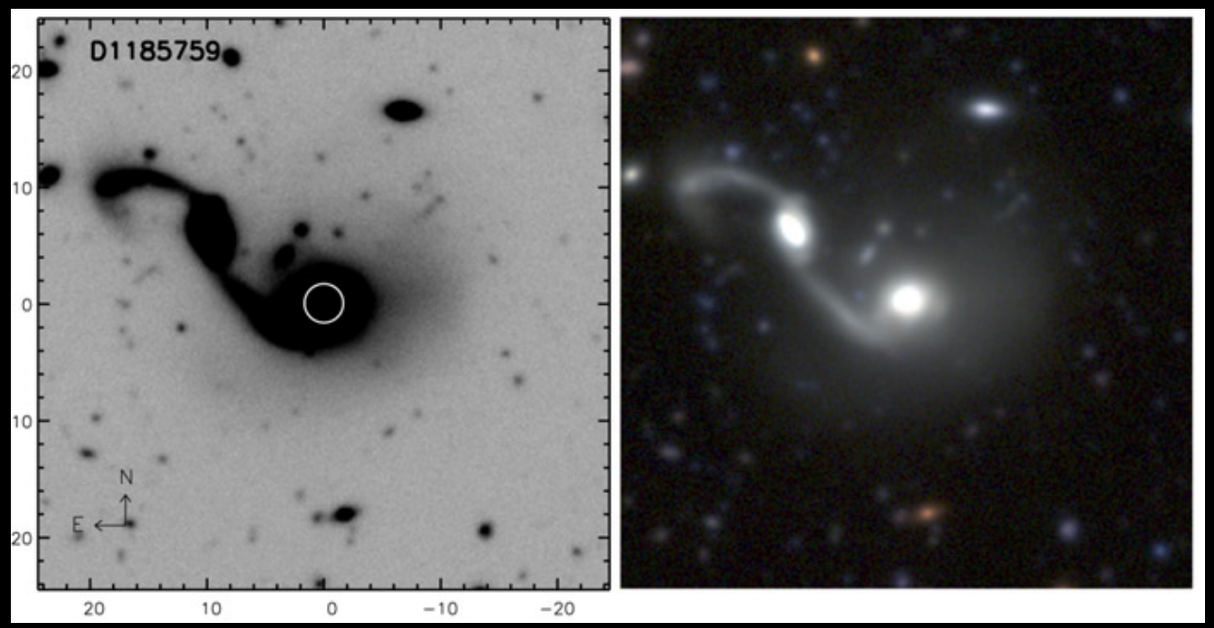


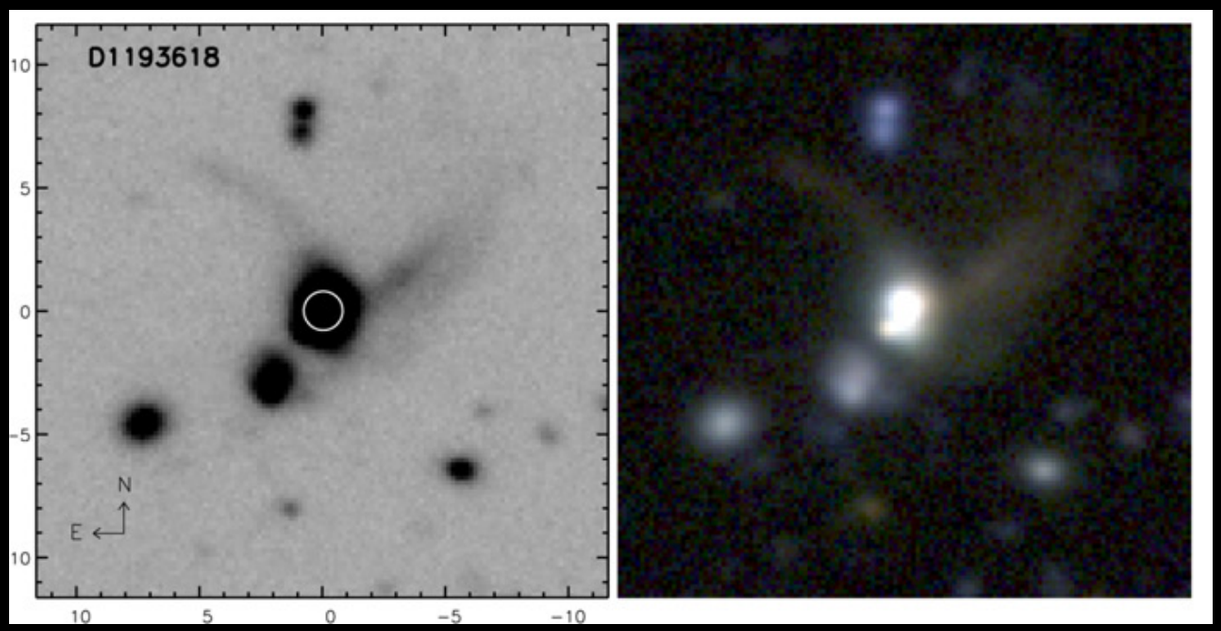




van Dokkum 2005, 2010; LSST Science Book

Distant major mergers

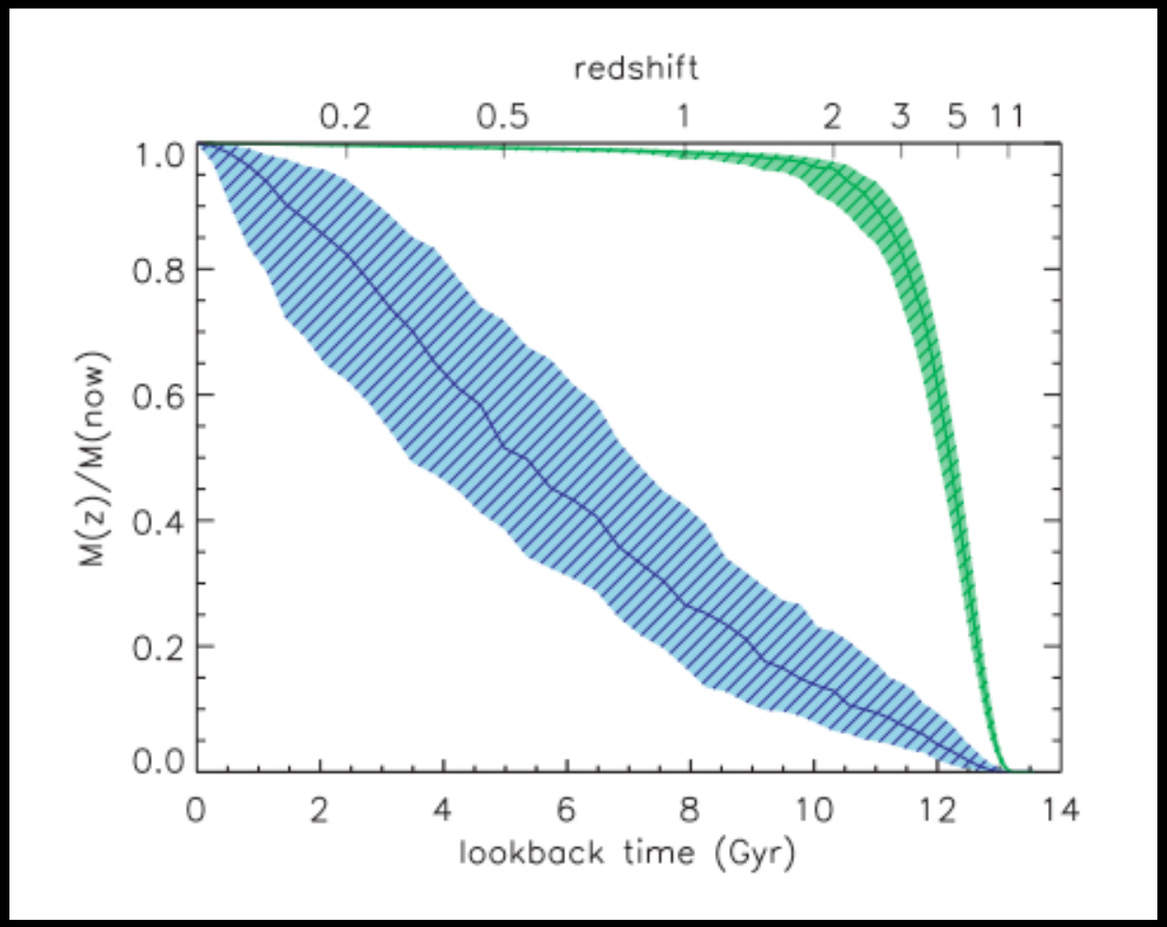




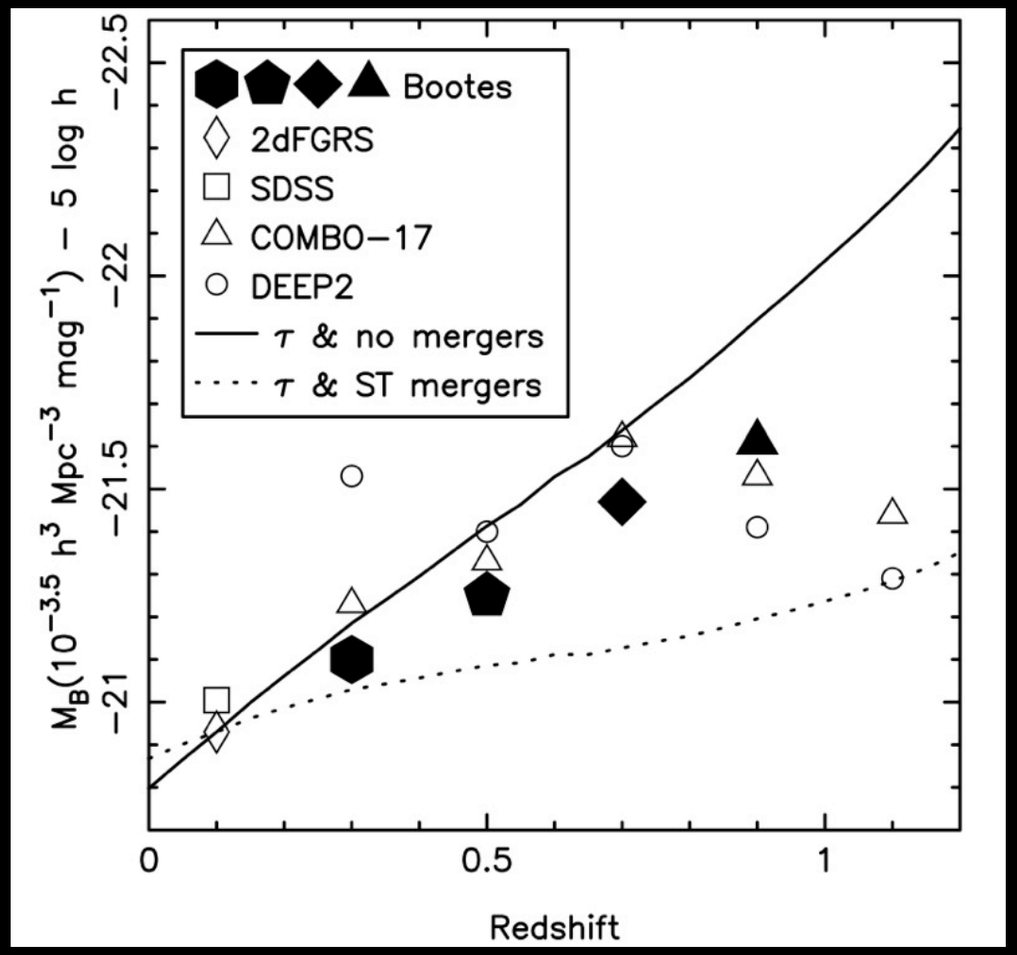
CFHTLS Deep
i-band exptime ~ 30 hours
μ_i ~ 29 mag/sq arcsec

~1500 interactions to z~1
found in 2 sq degrees
Bridge et al. 2010

Brightest Cluster Galaxy Formation



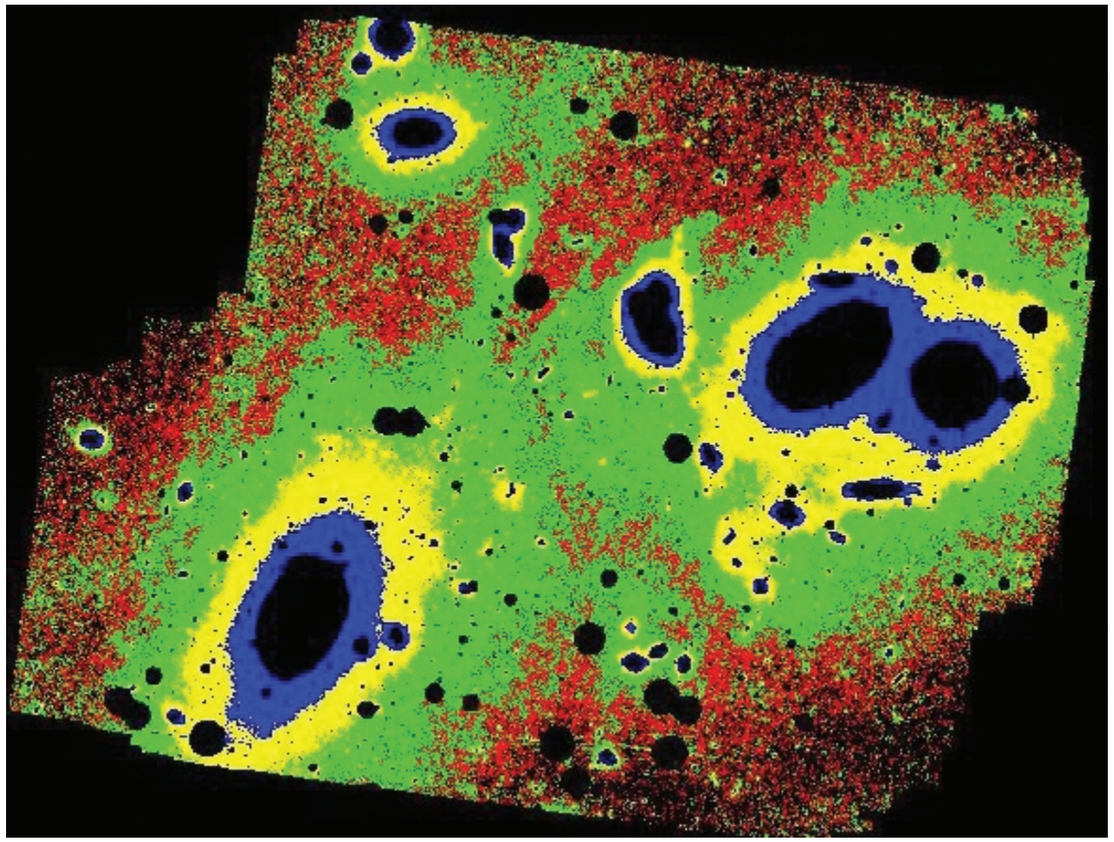
de Lucia & Blaziot 2007



Brown et al. 2007

why don't very massive galaxies grow at z<0.7 ?

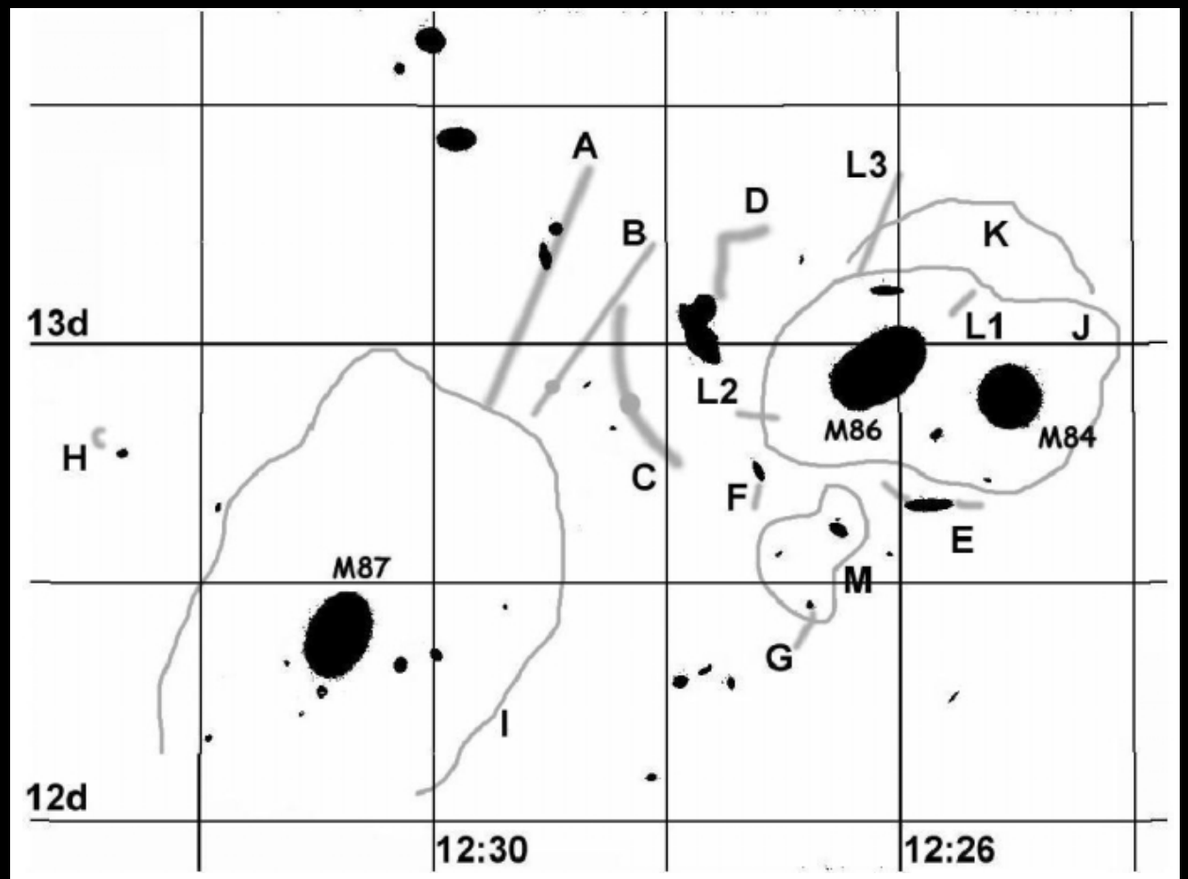
IntraCluster Light in Virgo



~2 degrees

μ_V ~ 25–26 μ_V ~ 26–27

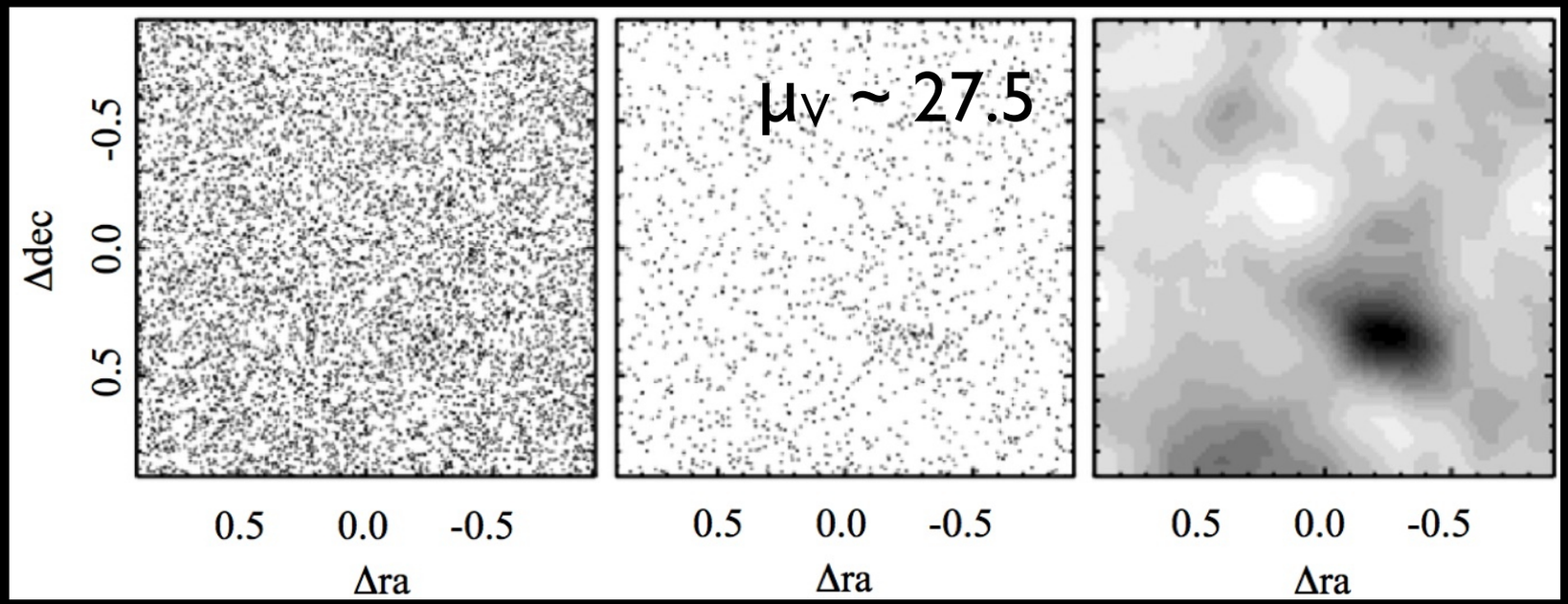
μ_V ~ 27–28 μ_V ~ 28-29



Mihos et al. 2005

Ultra-faint dwarf galaxy detection

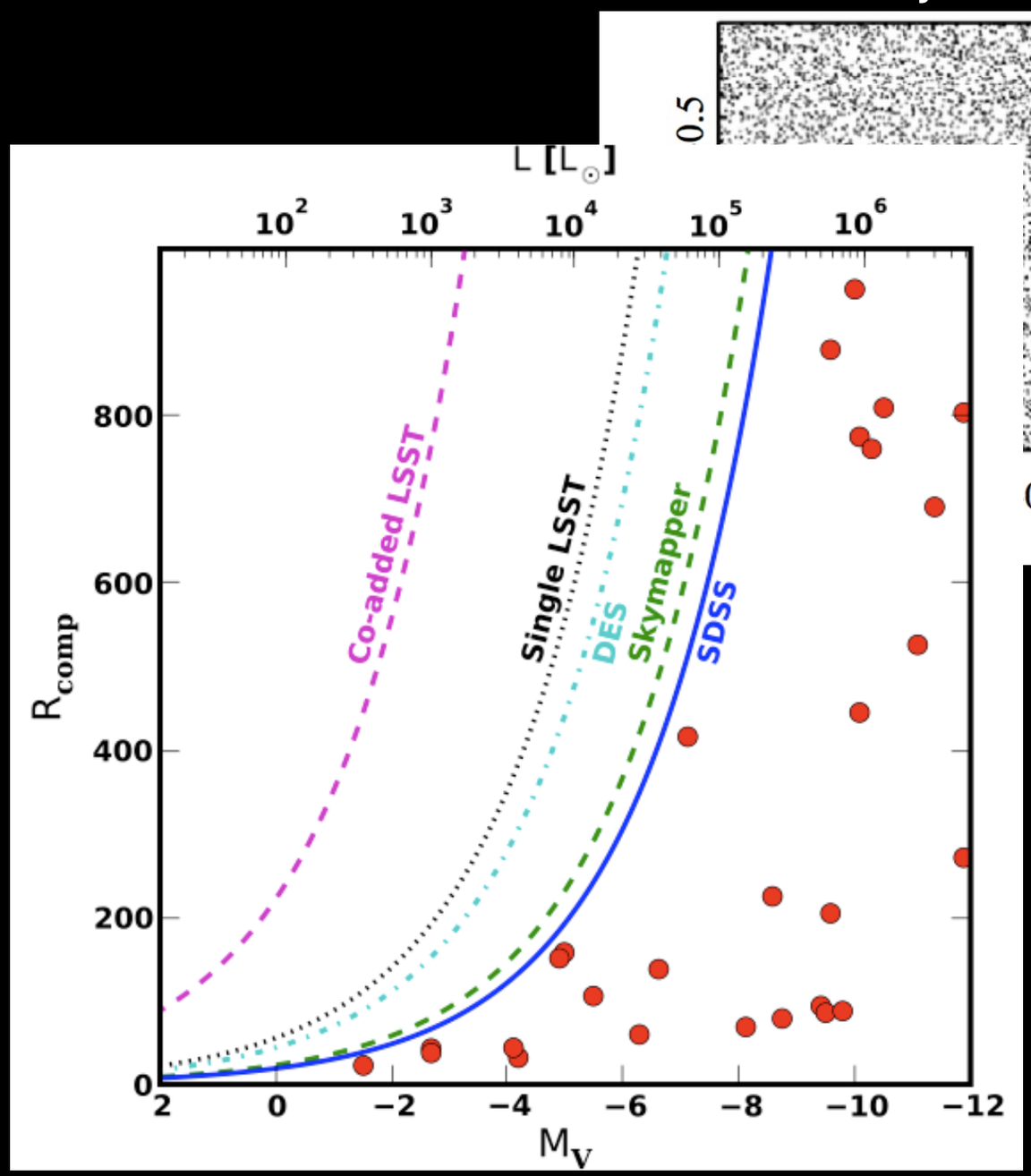
Ursa Major I dwarf satellite, M_V = –5.5, d =100 kpc

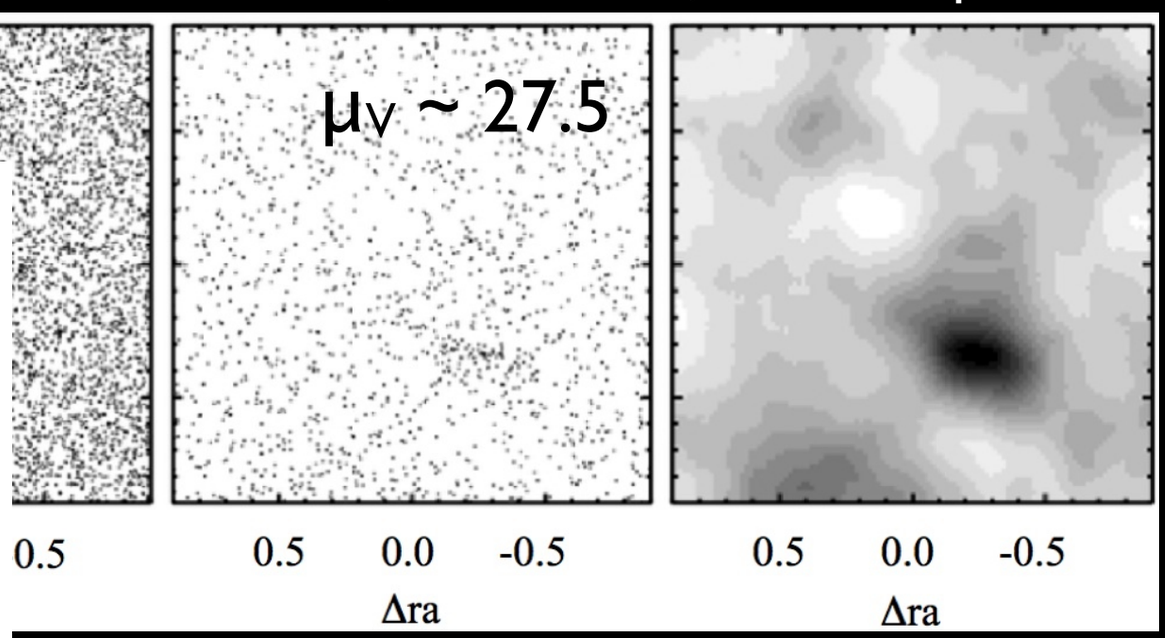


Tollerud et al. 2008 / Willman et al 2009/ LSST Science Book

Ultra-faint dwarf galaxy detection

Ursa Major I dwarf satellite, M_V = –5.5, d =100 kpc





search for ultra-faint dwarfs in southern sky

Tollerud et al. 2008 / Willman et al 2009/ LSST Science Book

Summary

‘sweet spot’ for low-surface brightness universe
μ ~ 27-28 mag per sq arcsec (~10-20 hours of exptime)

distant galaxies -- stacking to examine outer halos

nearby galaxies/clusters -- deep, targeted observations

ultra-faint dwarfs -- blind search, deep follow-up