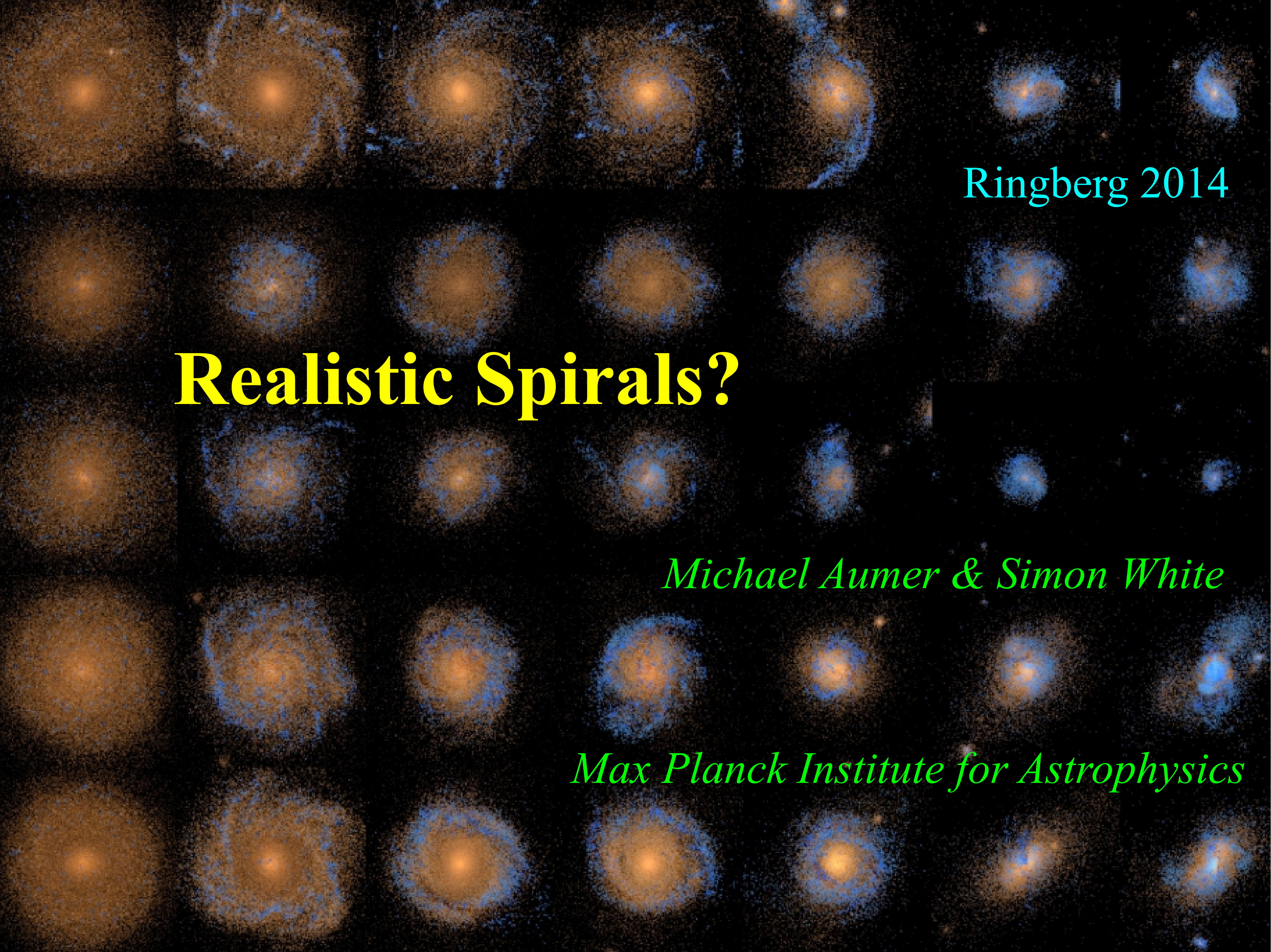


Ringberg 2014

Realistic Spirals?

Michael Aumer & Simon White

Max Planck Institute for Astrophysics

Gadget-based multiphase SPH

Scannapieco et al 2006, 2009

Particle i does not consider j as a neighbour if: $A_i > 50\, A_j$; $\underline{\mathbf{v}}_{ij} . \underline{\hat{\mathbf{r}}}_{ij} > -\, c_{ij}$
where $A \sim p\, \rho^{-5/3}$ is the entropic function and c is the sound speed

Diffuse gas does not "see" much denser gas $\longrightarrow$ avoids interface cooling, etc.

Full chemical evolution network and cooling rates

Wiersma et al 2009

SN Ia, SNII and AGB evolution following 9 heavy elements

Complex stellar feedback (no AGN)

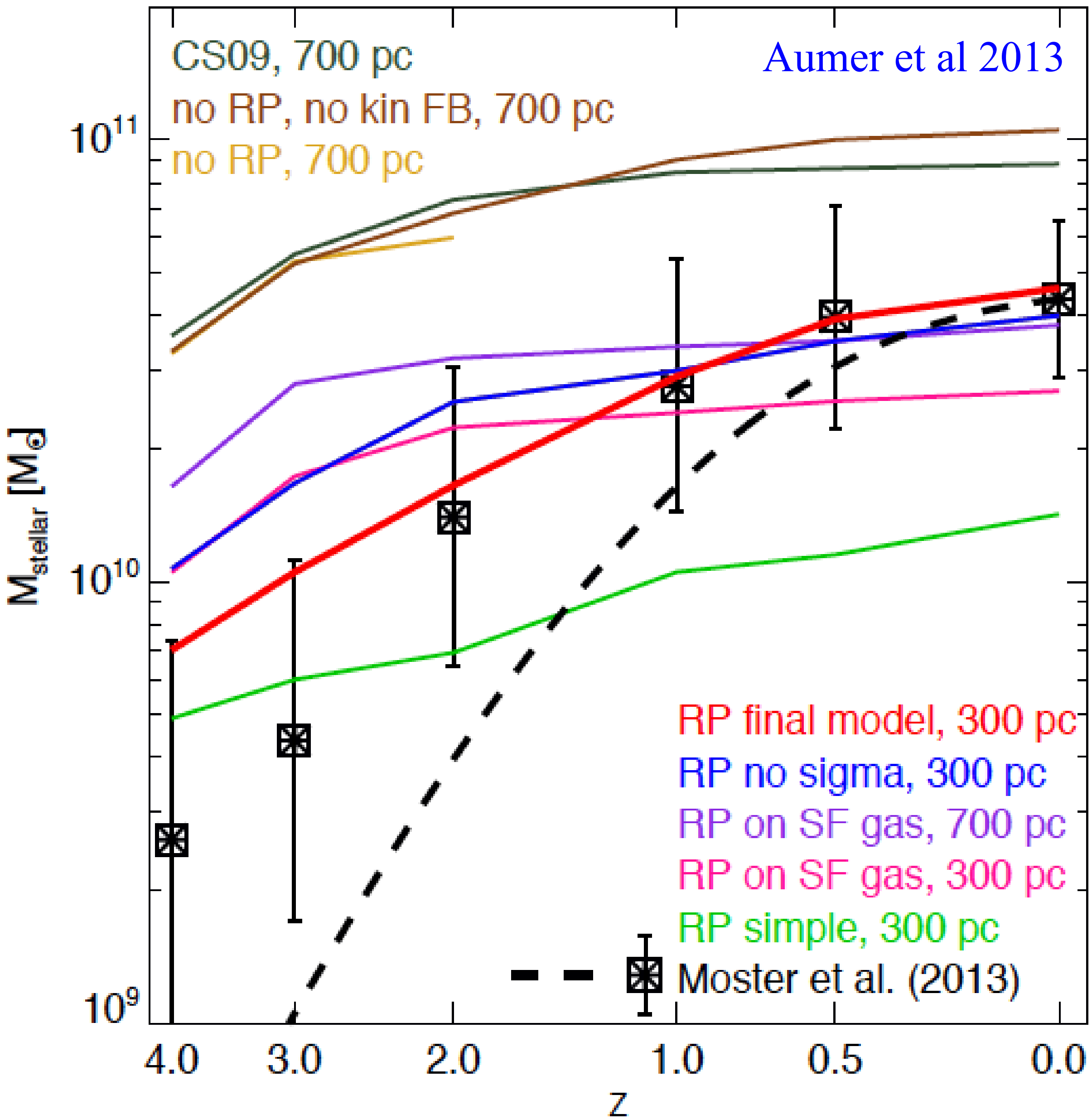
Thermal and kinetic feedback *separately* to hot and cold phases
Feedback to cold phase $\longrightarrow$ *promotion* to hot phase $\longrightarrow$ mass-loaded winds
"Radiation" feedback from young massive stars

<u>Metal diffusion</u> $\longrightarrow$ "subgrid" turbulent mixing $\longrightarrow$ no chemothermal instability

Four Aquarius halos also simulated by Scannapieco et al 2009
Twelve halos from the study of Oser et al (2010)

Halo	$M_{\rm vir}$ $[10^{10} M_\odot]$	$m_{\rm dm}$ $[10^{6} M_\odot]$	$m_{\rm gas}$ $[10^{5} M_\odot]$	Origin
6782-4x	17.03	3.62	7.37	LO
4323-4x	29.50	3.62	7.37	LO
4349-4x	30.28	3.62	7.37	LO
2283-4x	49.65	3.62	7.37	LO
Aq-B-5	70.35	1.50	2.87	CS
1646-4x	81.61	3.62	7.37	LO
1192-4x	100.03	3.62	7.37	LO
1196-4x	113.81	3.62	7.37	LO
0977-4x	129.56	3.62	7.37	LO
Aq-D-5	150.43	2.31	4.40	CS
Aq-C-5	151.28	2.16	4.11	CS
Aq-A-5	164.49	2.64	5.03	CS
0959-4x	164.54	3.62	7.37	LO
0858-4x	182.44	3.62	7.37	LO
0664-4x	213.74	3.62	7.37	LO
0616-4x	235.77	3.62	7.37	LO

Aumer et al 2013



Effects of feedback on the SFH of the Aquila halo

Updating metal production and cooling rates has no effect

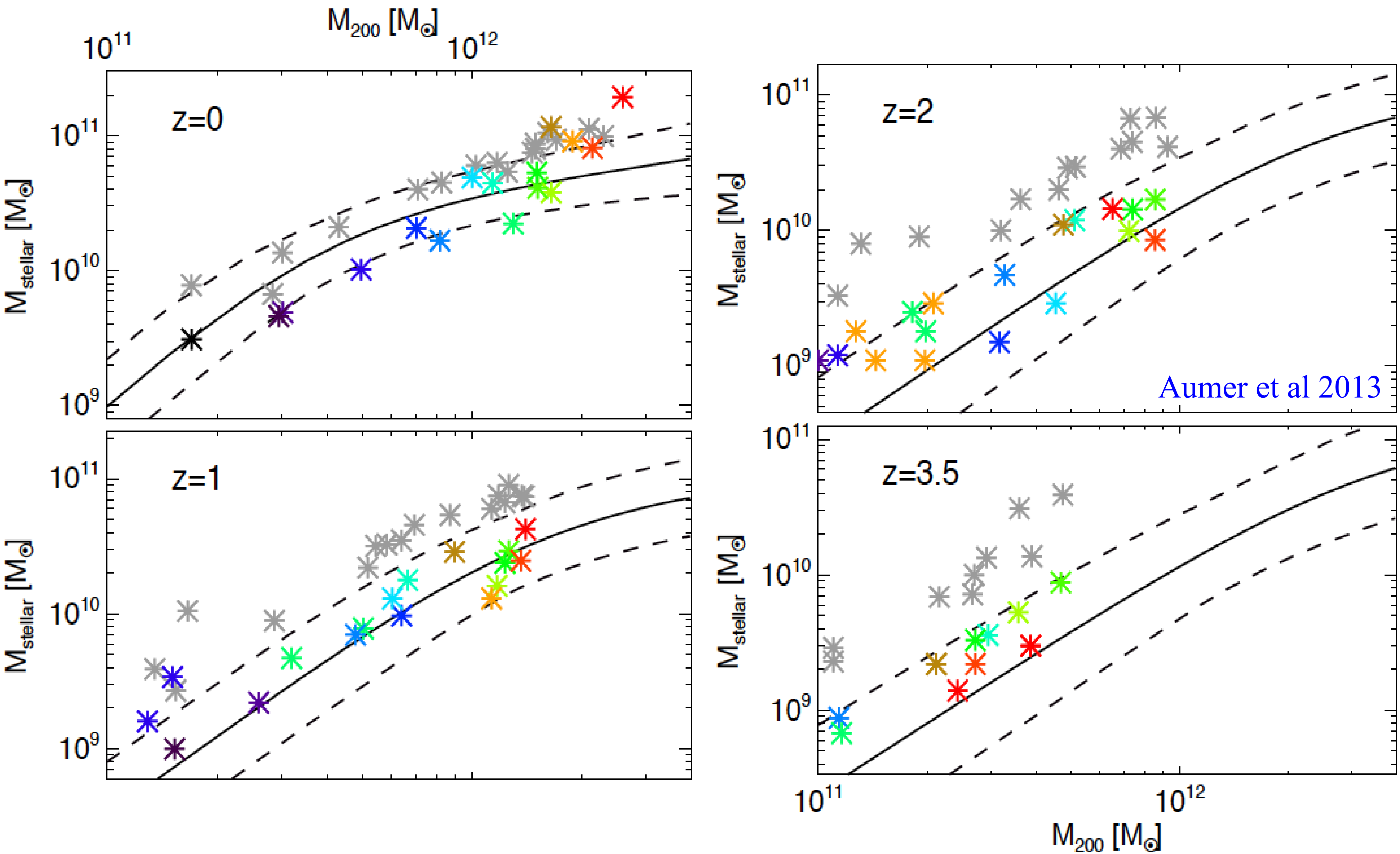
Including kinetic FB has no effect in this particular case

Including early "radiation" FB has a large effect

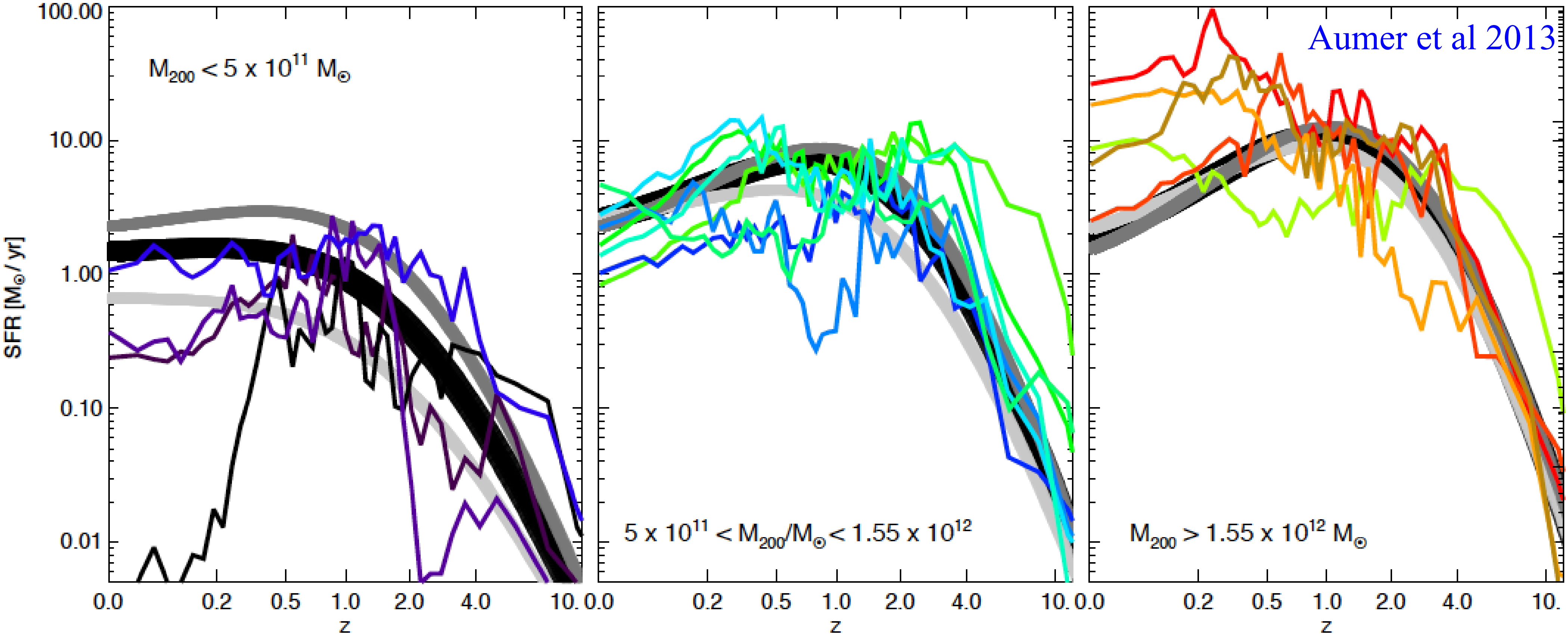
The simplest model suppresses SF at all times

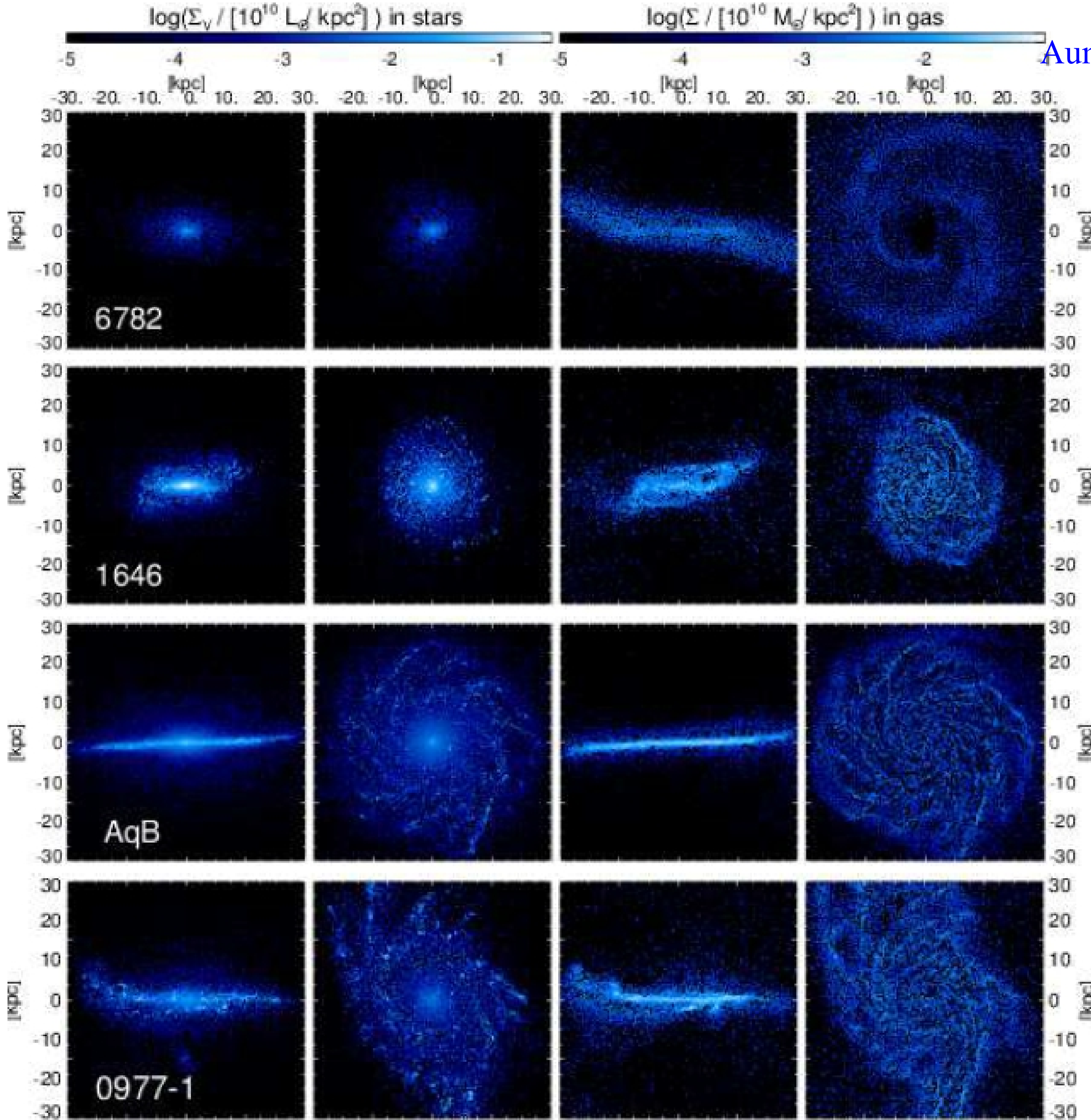
In most successful model, the FB strength increases with ρ, σ and Z

Old/new models vs abundance-matching expectations



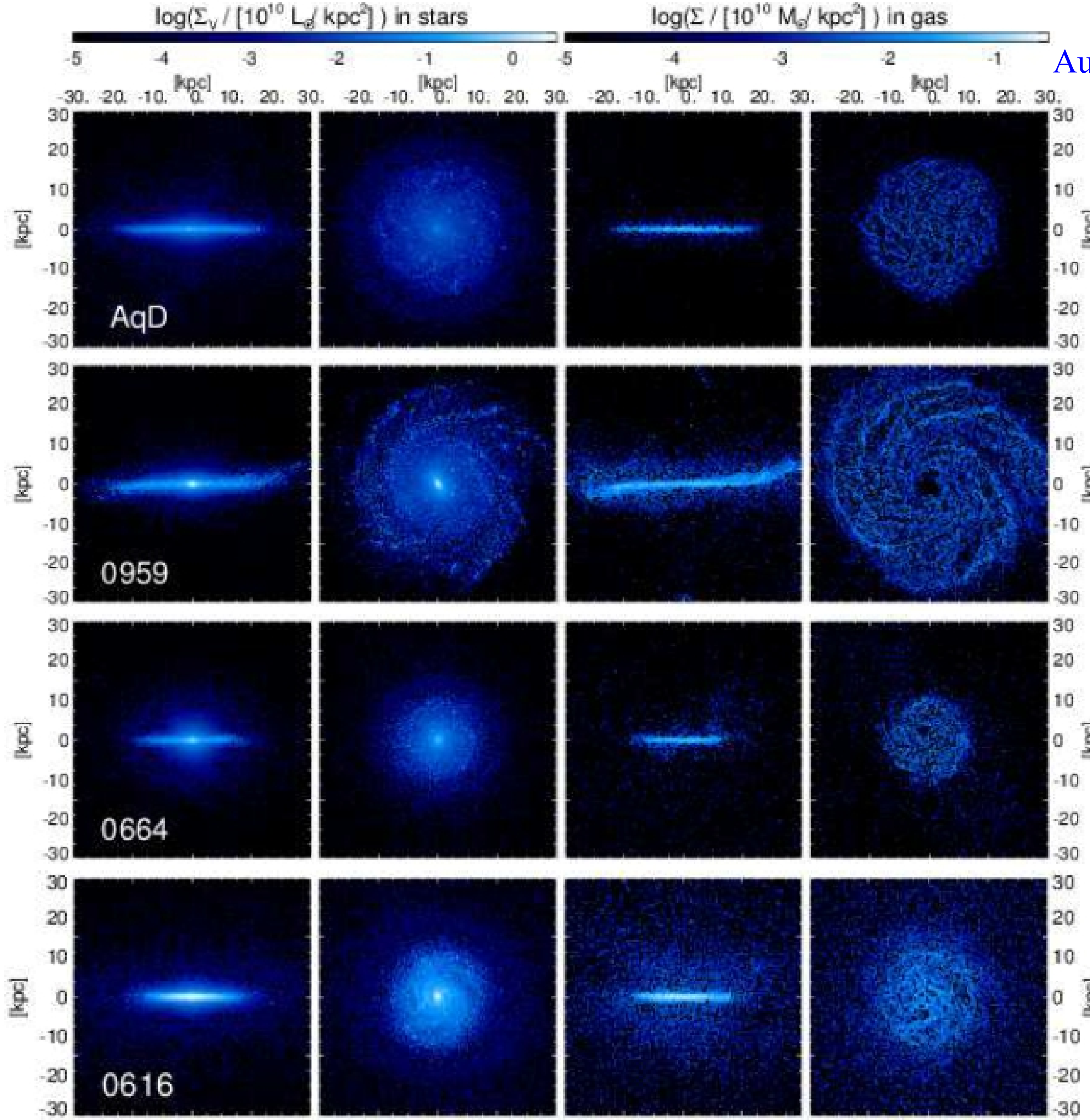
Old/new models vs abundance-matching expectations



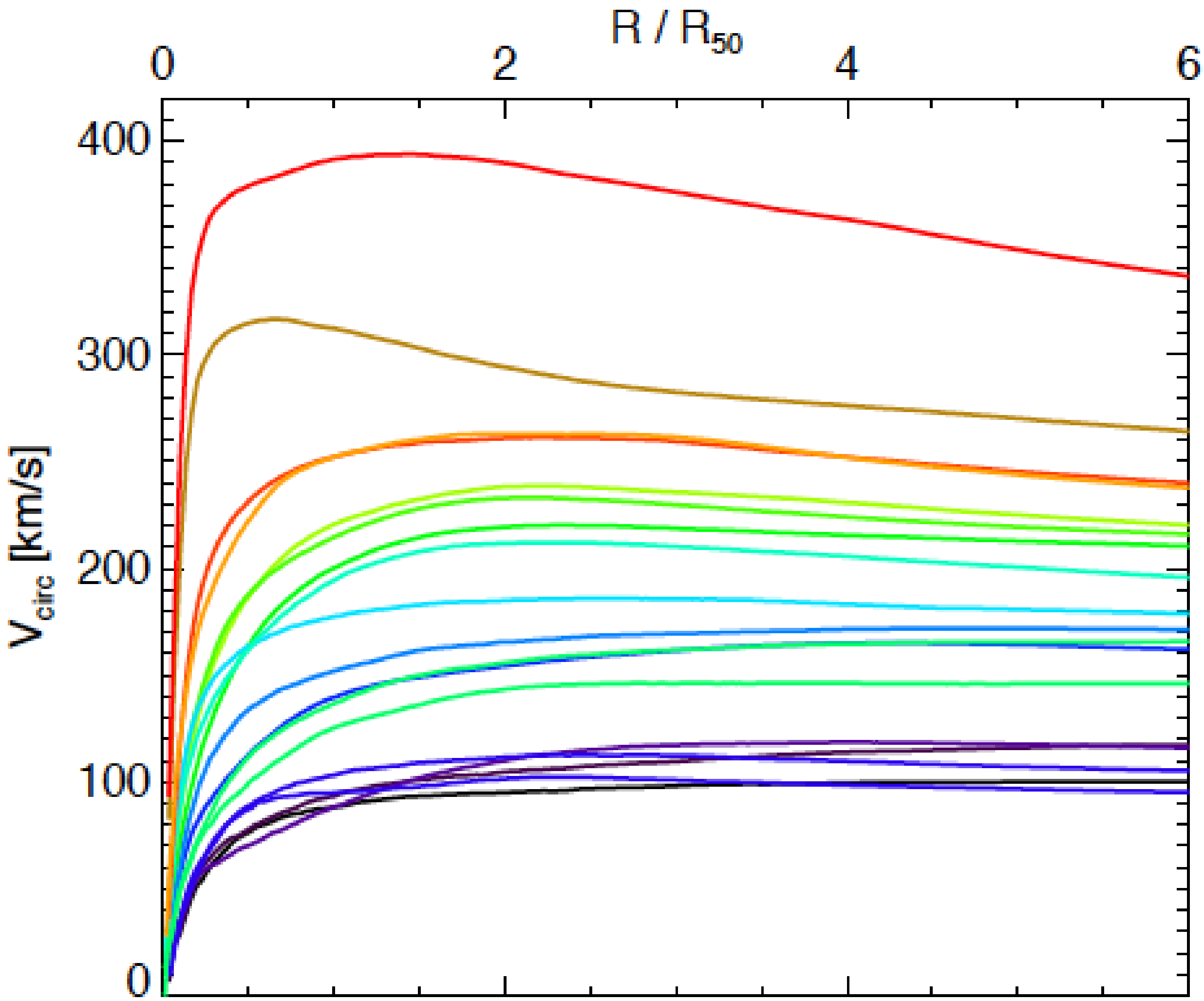


Aumer et al 2013

Aumer et al 2013

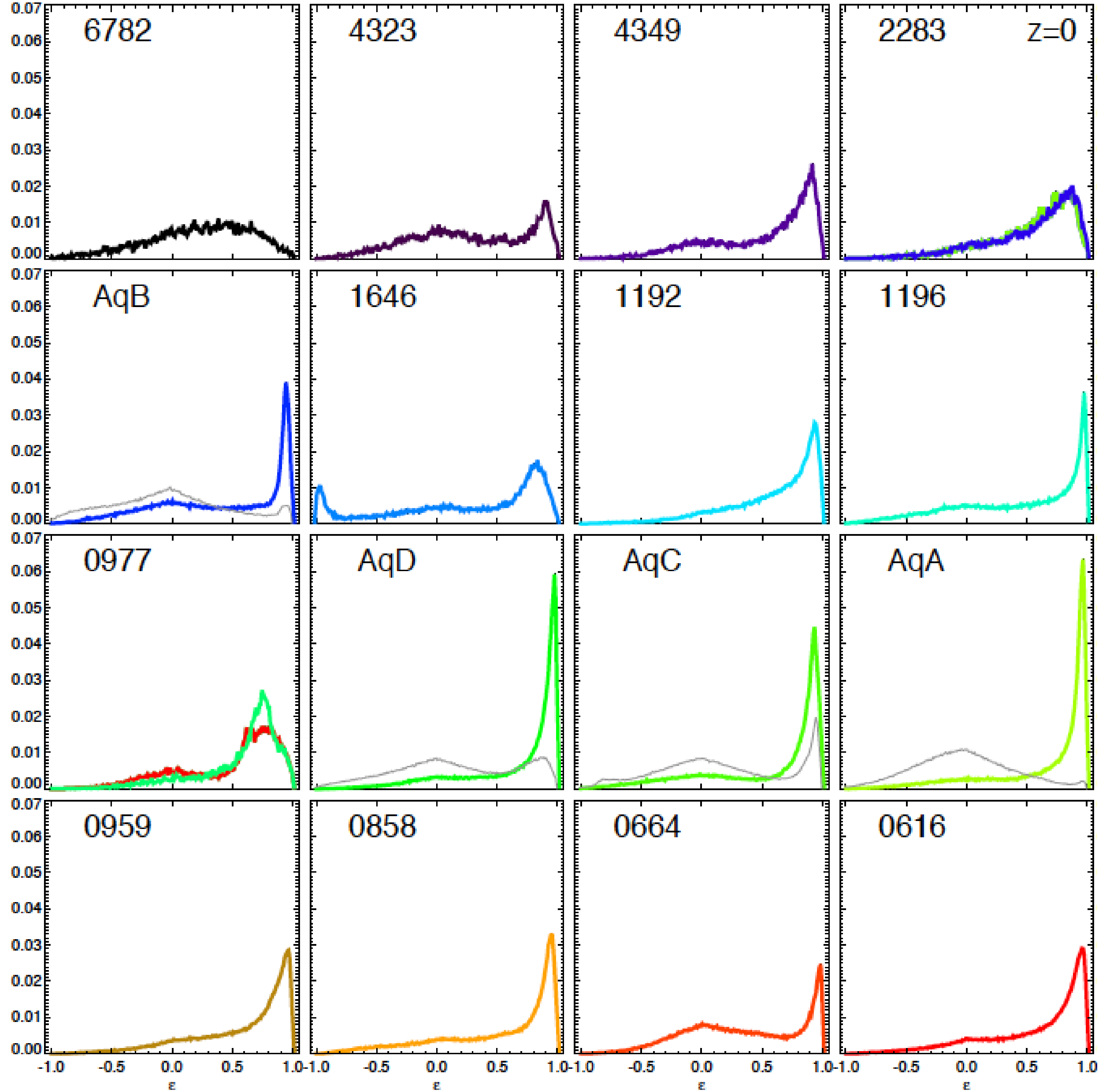


Circular velocity curves at z = 0



Aumer et al 2013

Circularity distributions



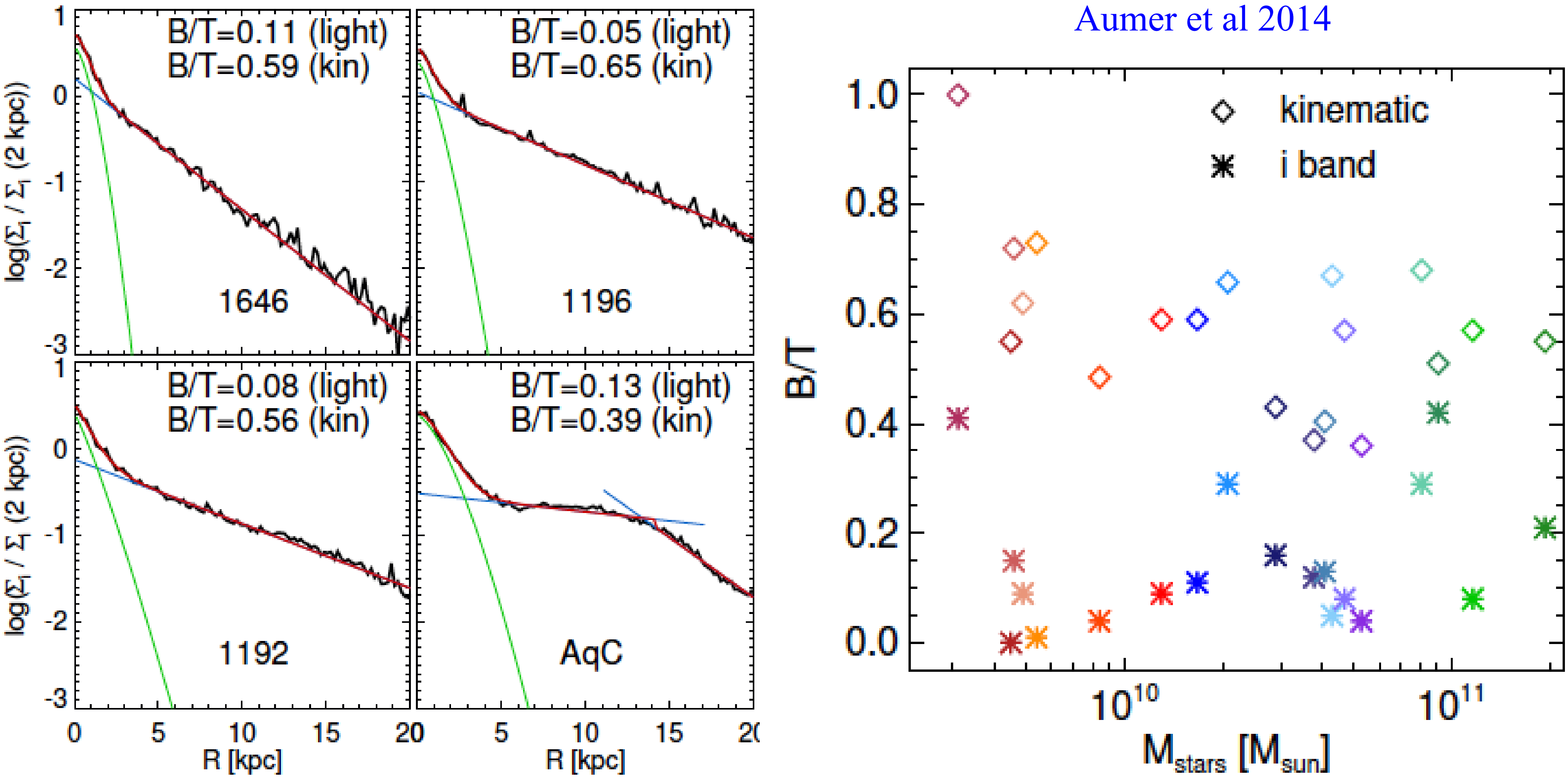
Prominent disks are found in most galaxies

Much stronger disks than in Scannapieco et al 2009 (in grey)

One halo produced counter-rotating disks!

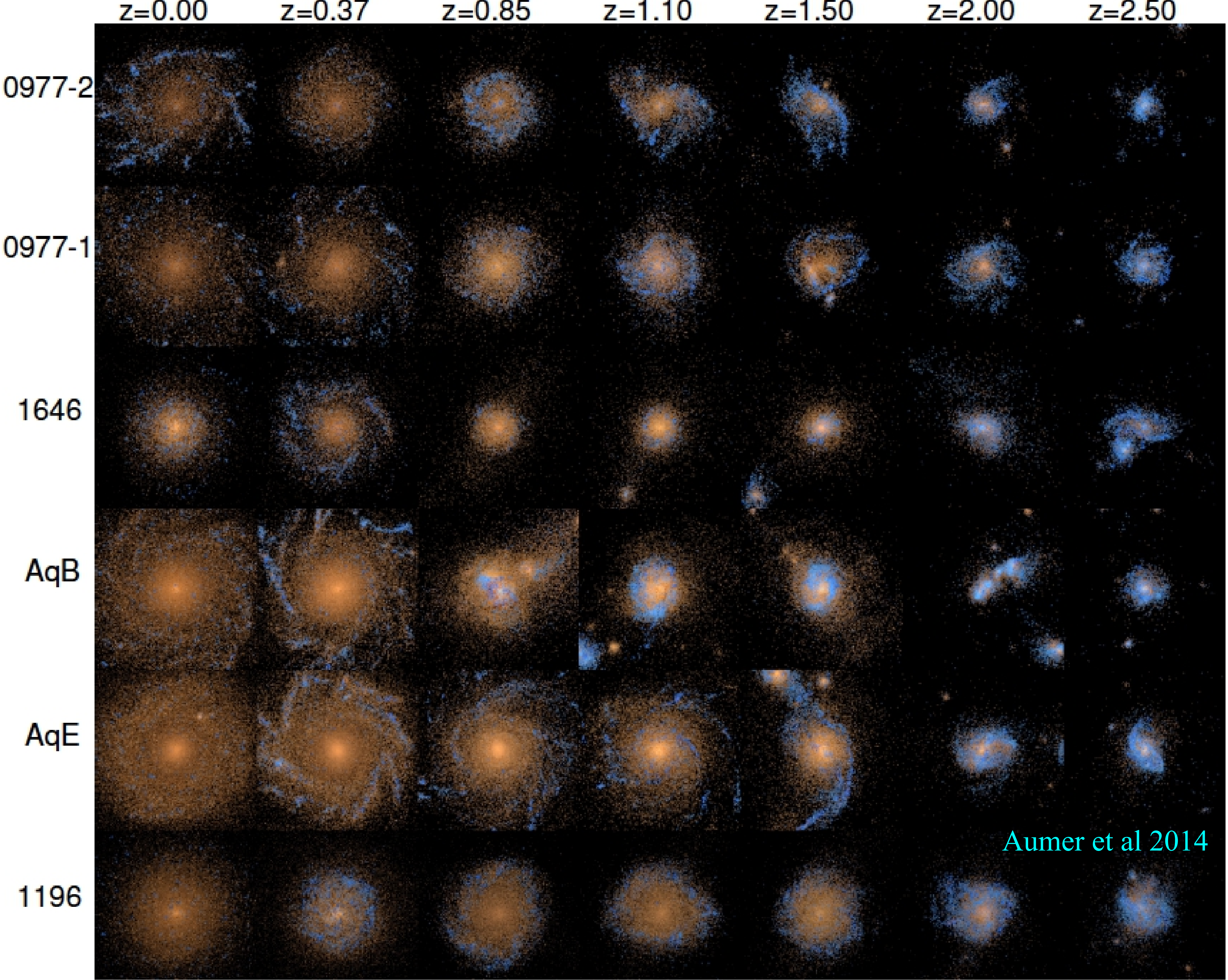
Aumer et al 2013

Aumer et al 2014



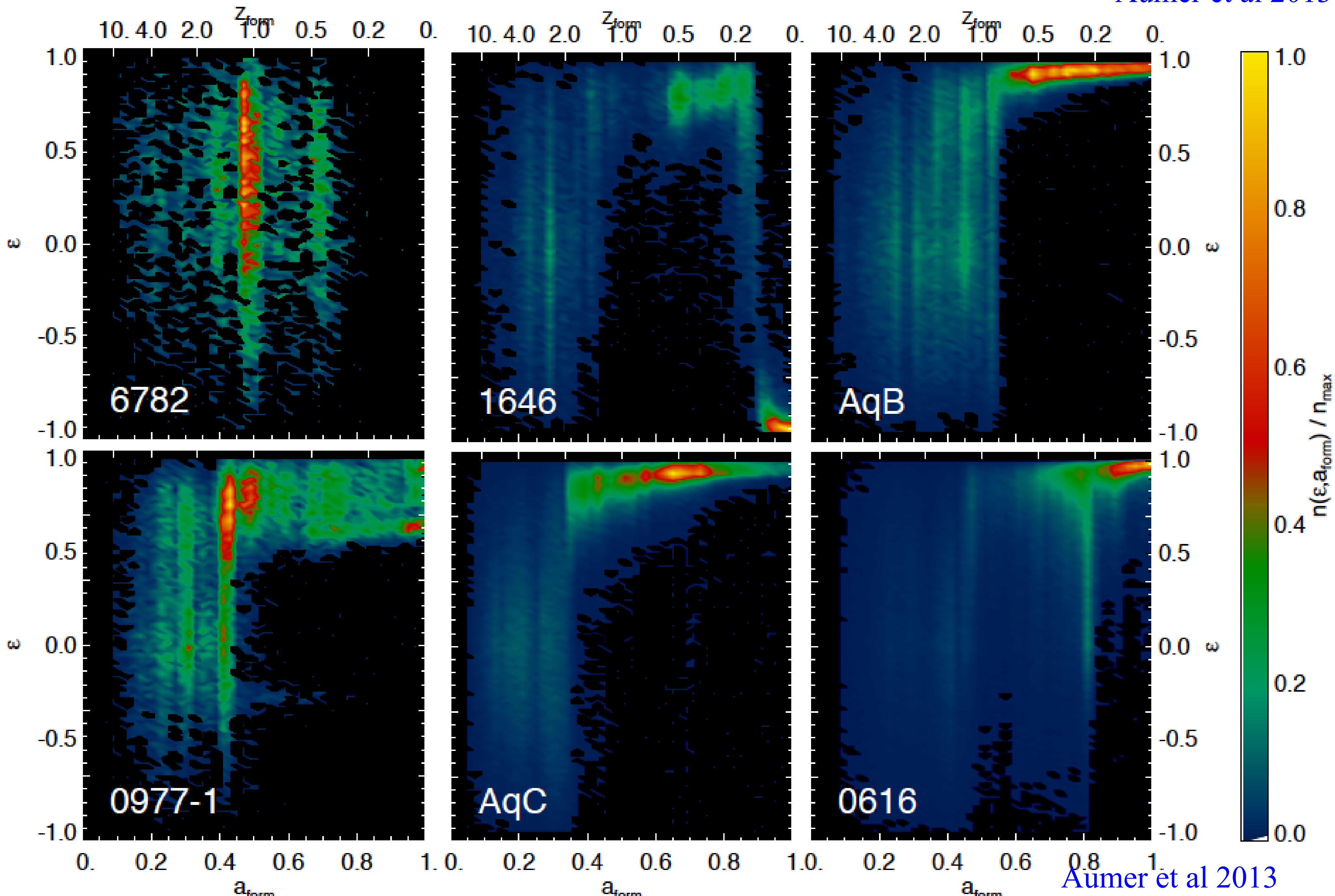
Photometric decompositions mostly a good fit to exp.disk+deV.bulge

Photometric B/T are typically << kinematic B/T: Most are < 0.1

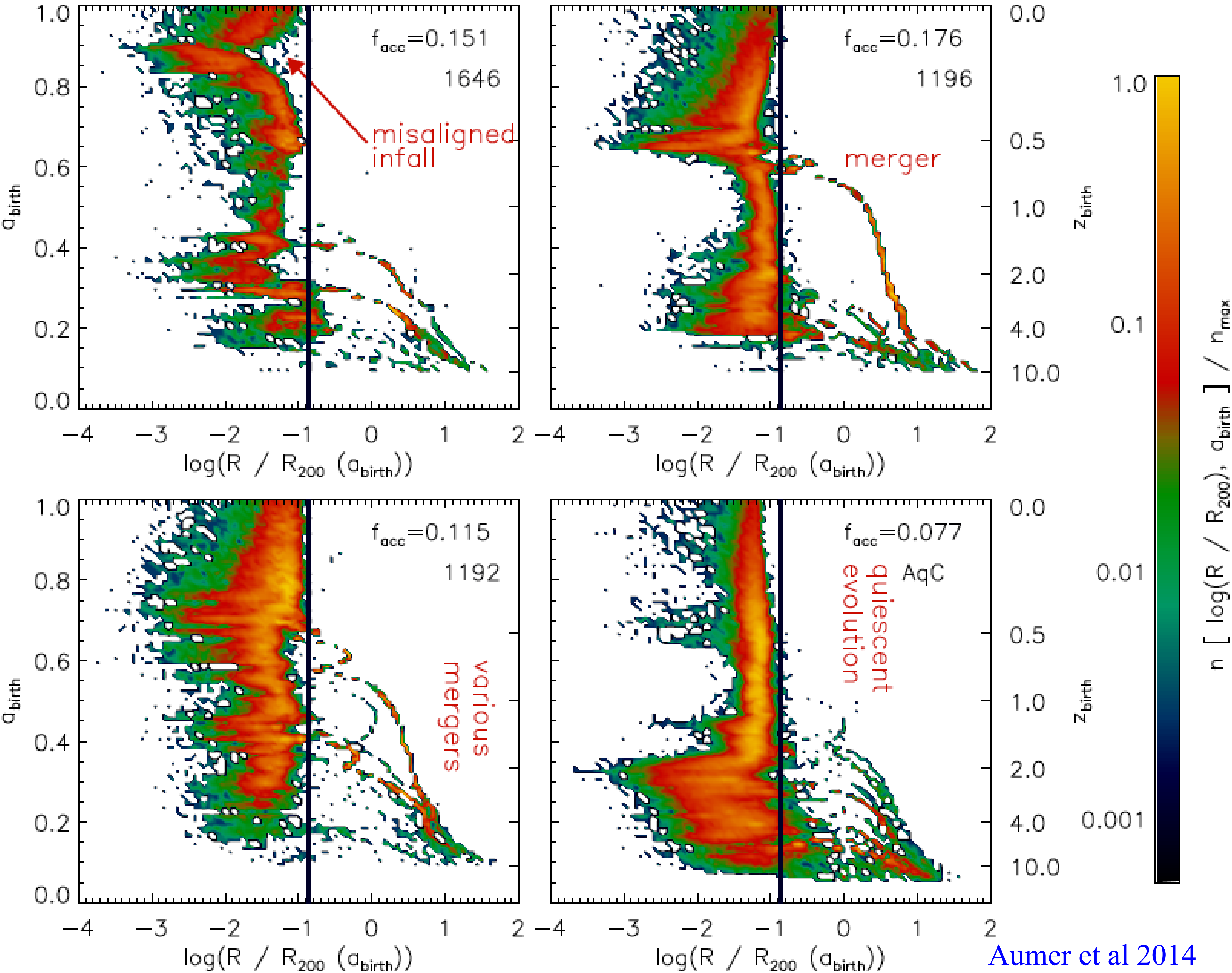

z=0.00
z=0.37
z=0.85
z=1.10
z=1.50
z=2.00
z=2.50
0977-2
0977-1
1646
AqB
AqE
1196
Aumer et al 2014

Disk formation occurs at late times

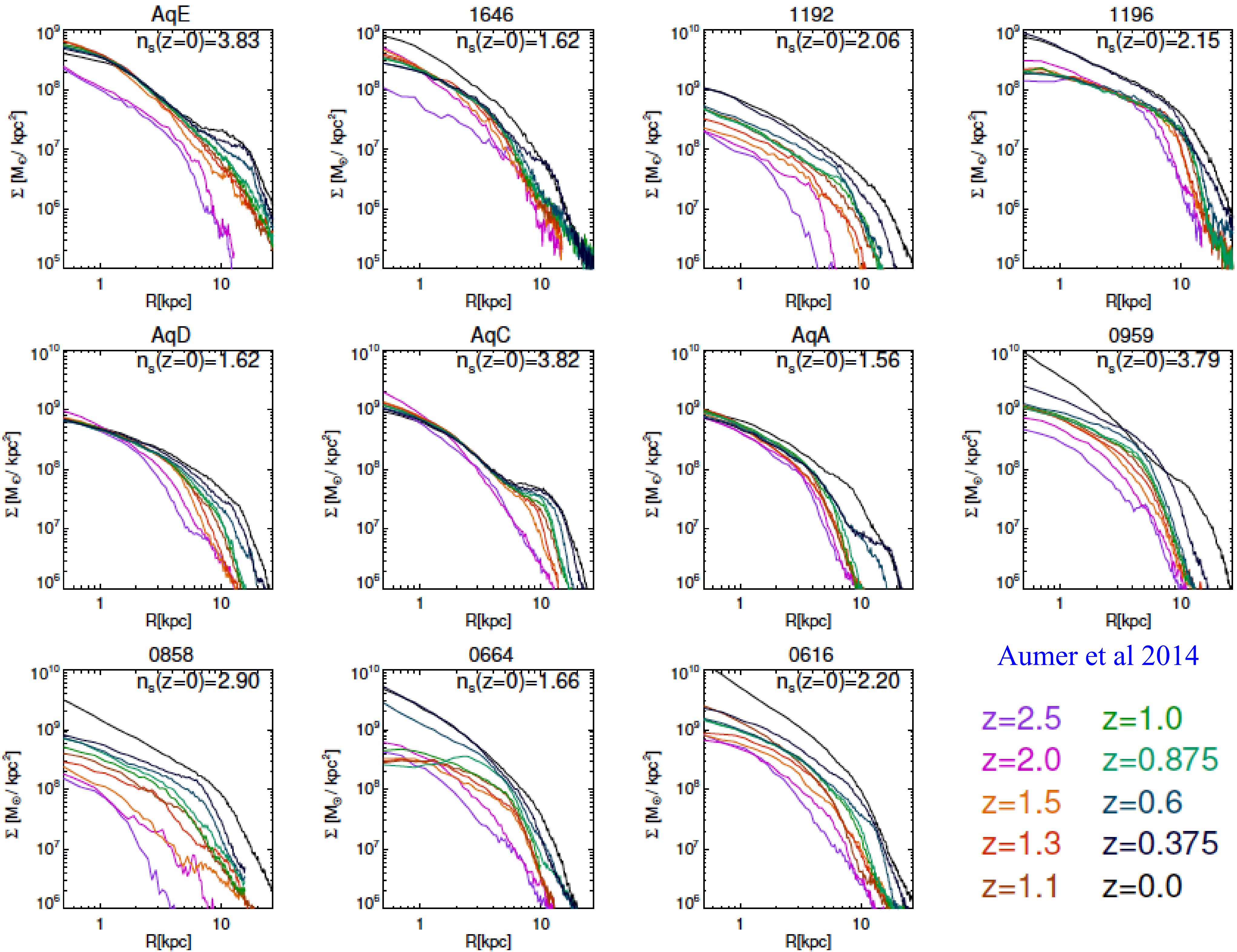
Aumer et al 2013



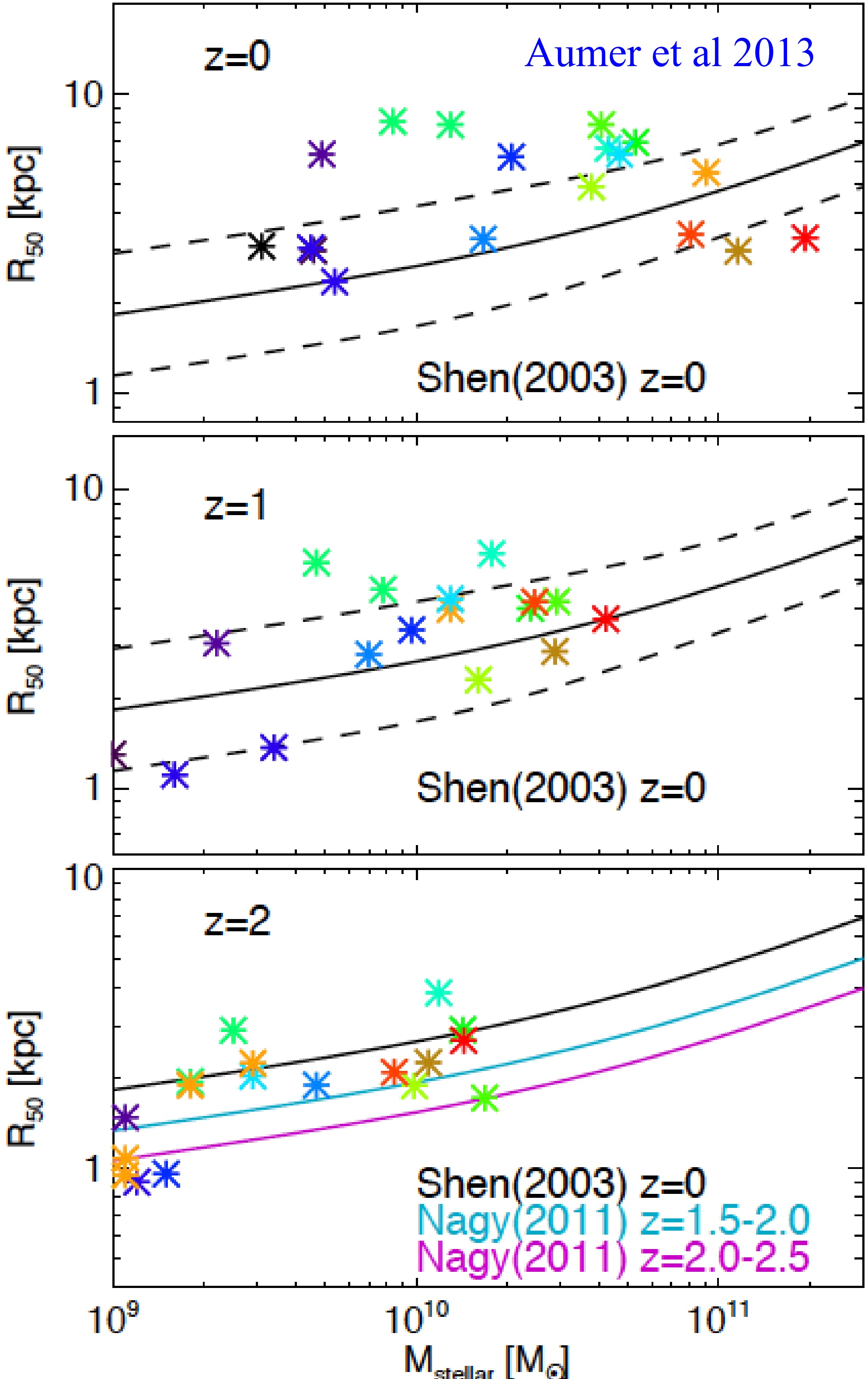
Aumer et al 2013



Aumer et al 2014



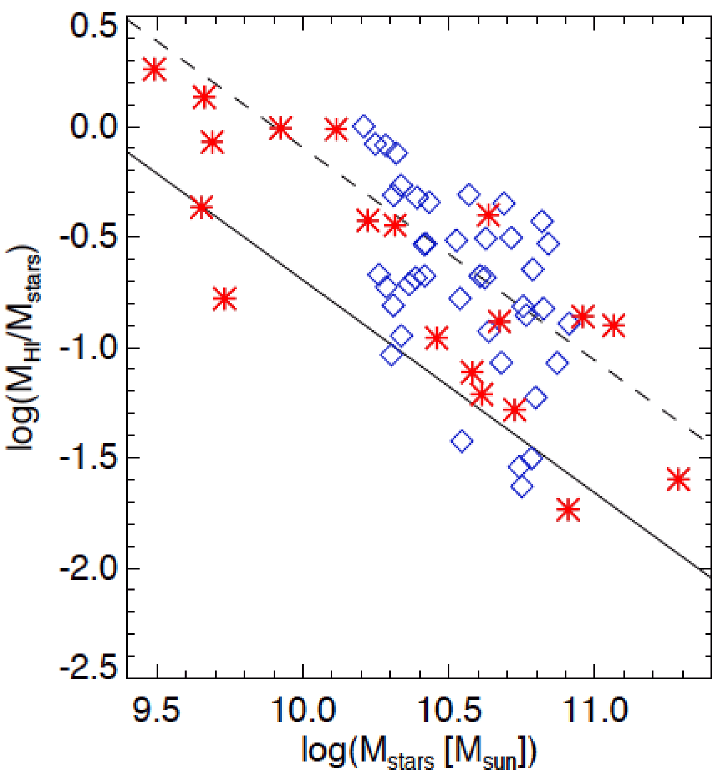
Aumer et al 2014

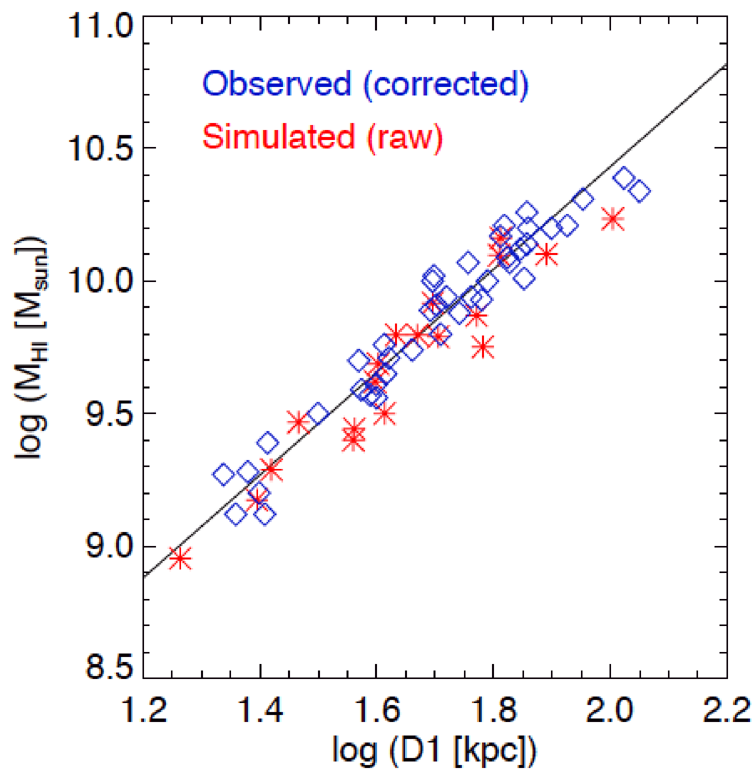


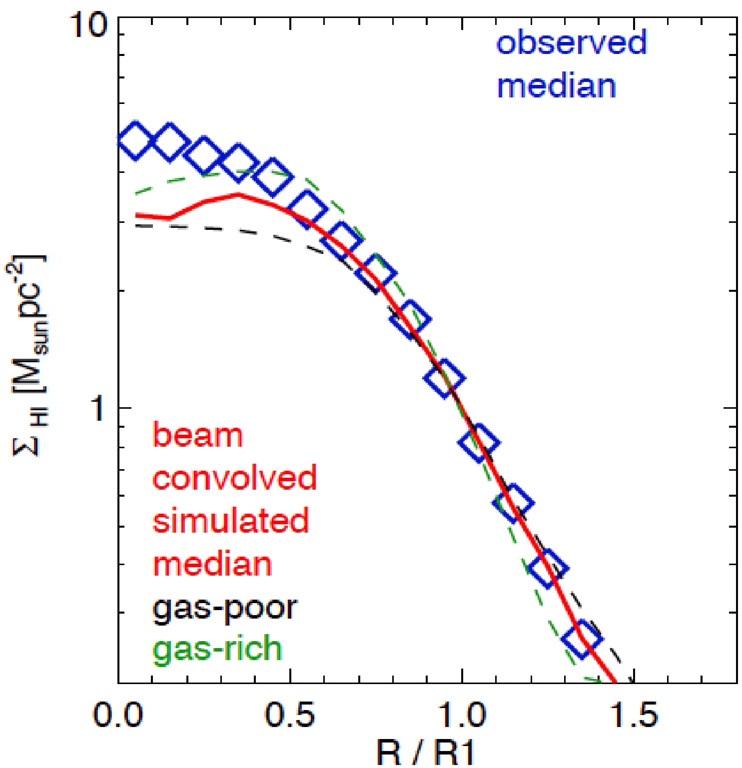
Stellar disk sizes

increase slowly with mass and time.

They agree well with observation at high redshift, but appear somewhat too large at z = 0



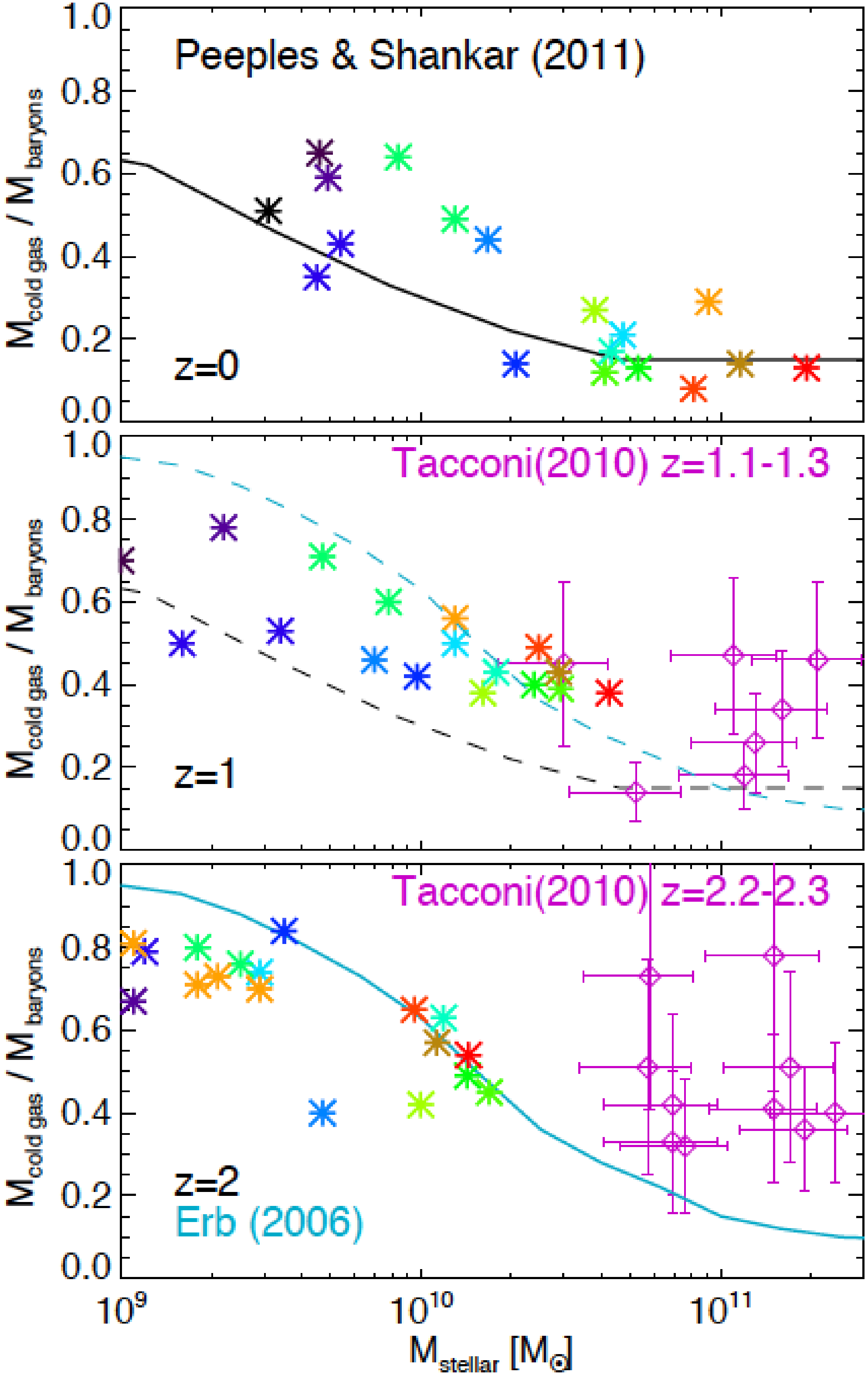




Wang et al 2014

HI masses and sizes

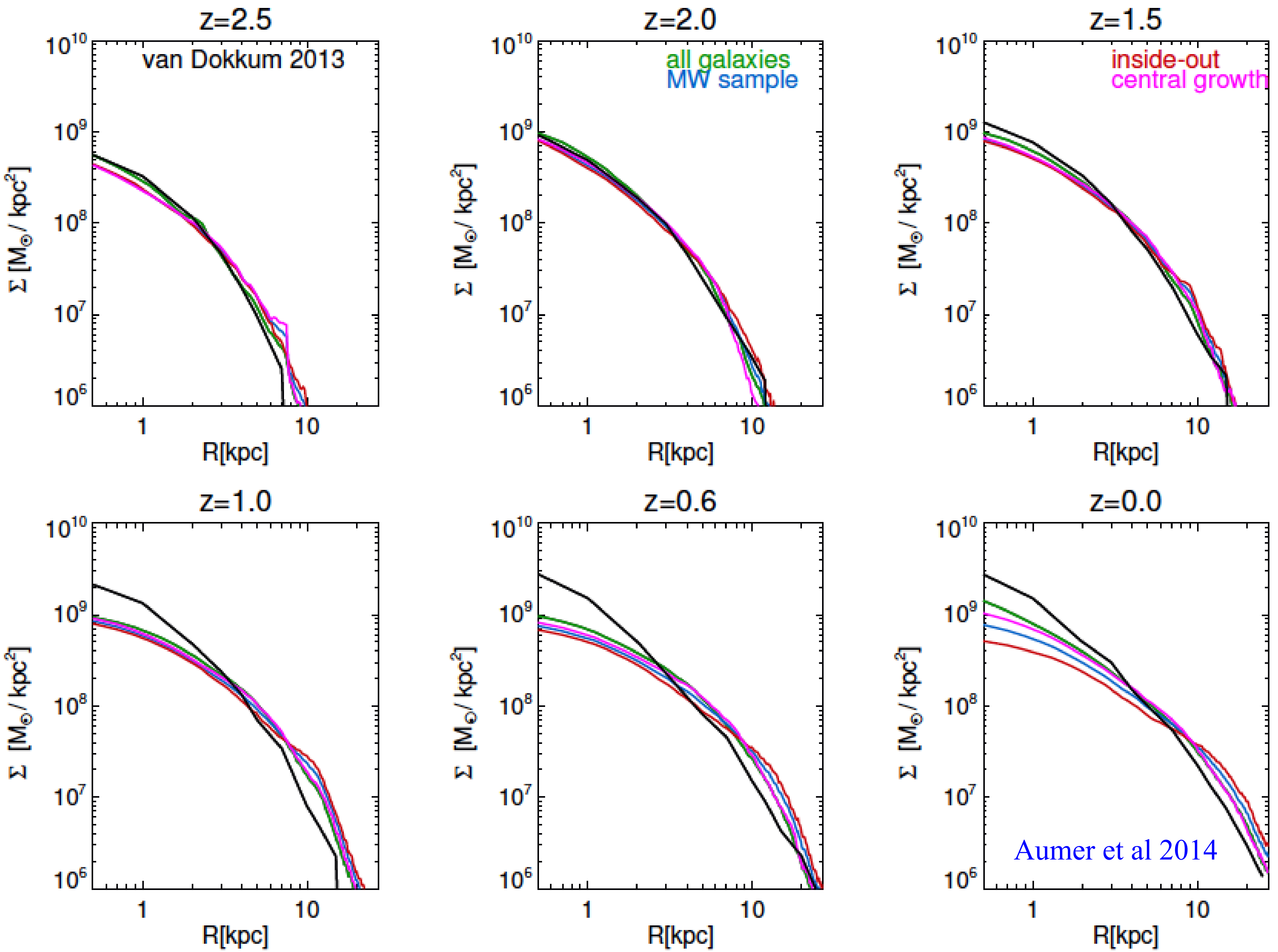
are, however, in good agreement with observation at low redshift



Gas Fractions

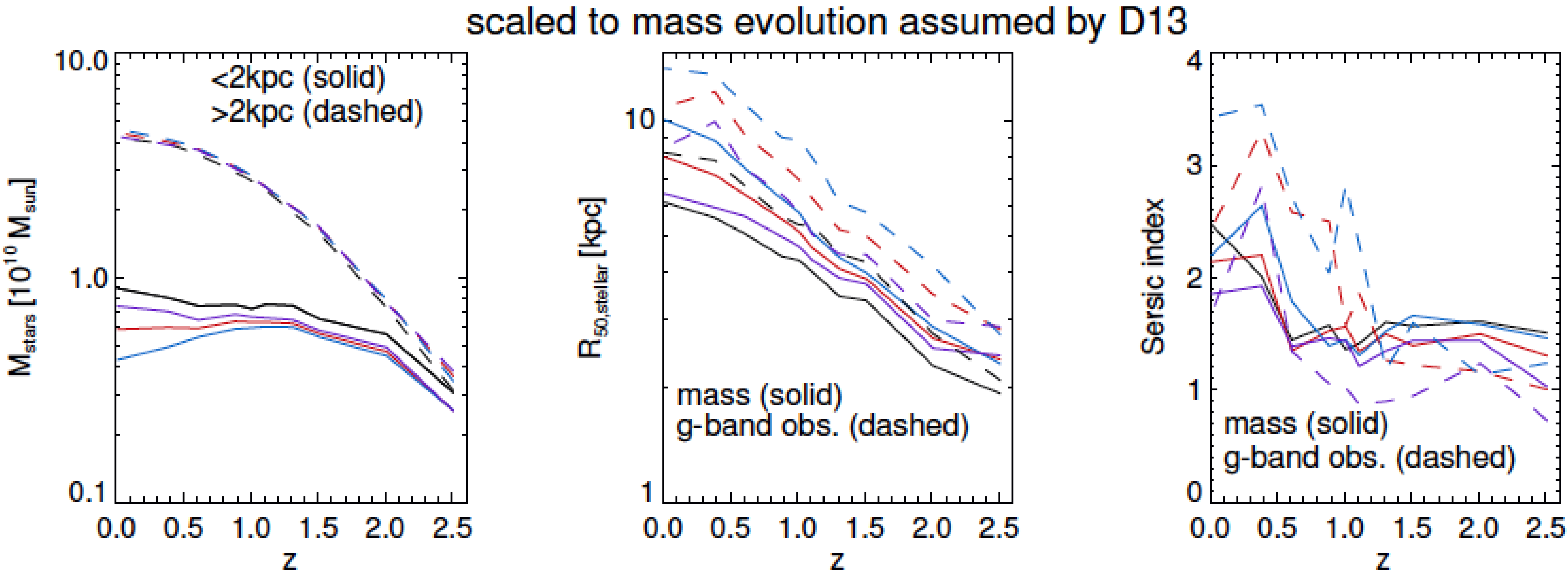
Are larger and lower mass and at higher redshift, in qualitative agreement with observation

Aumer et al 2013



z=2.5
van Dokkum 2013
z=2.0
all galaxies
MW sample
z=1.5
inside-out
central growth
z=1.0
z=0.6
z=0.0
Aumer et al 2014
Σ [$M_\odot$ / kpc^2]
R[kpc]

Stellar mass growth is inside-out



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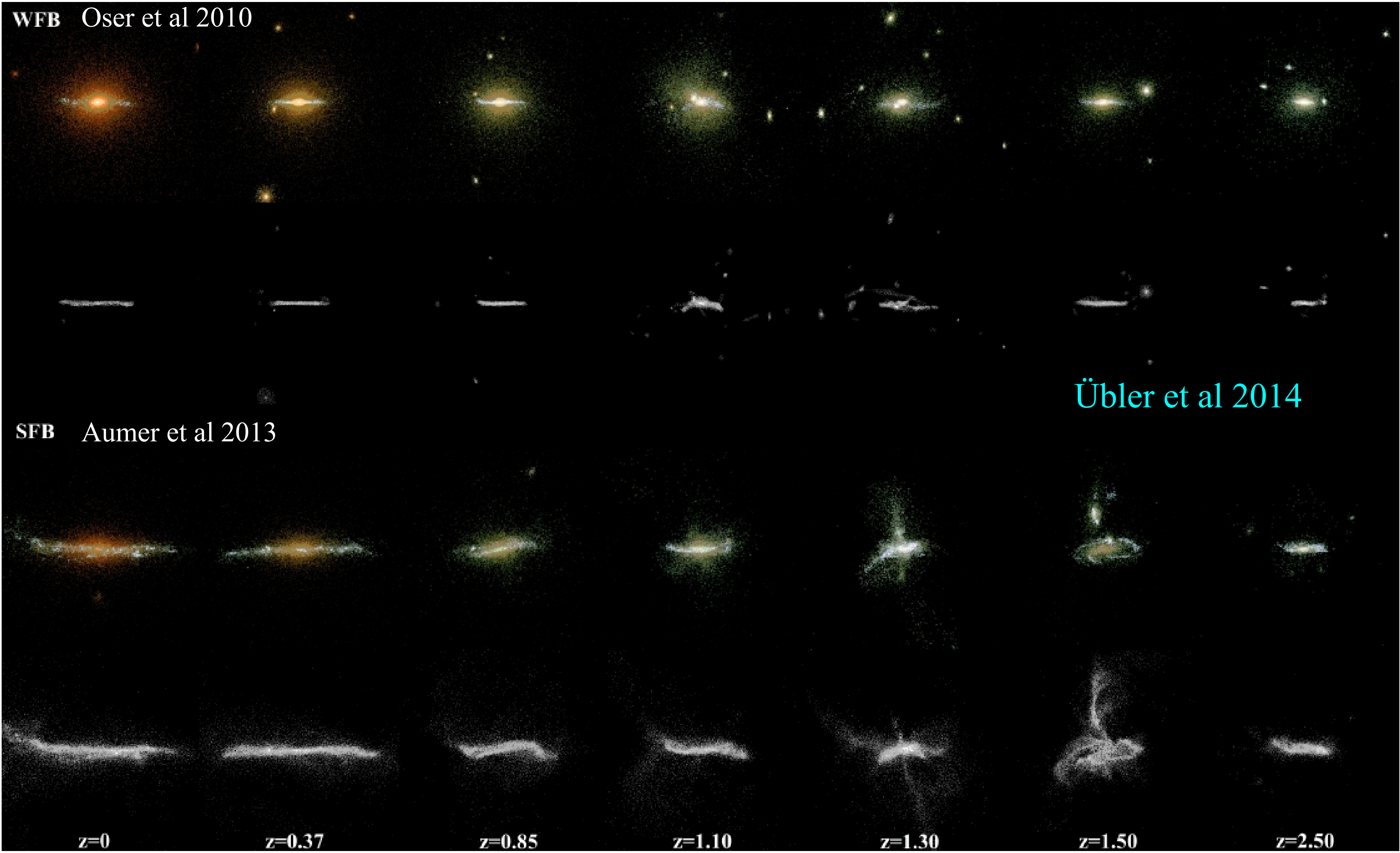
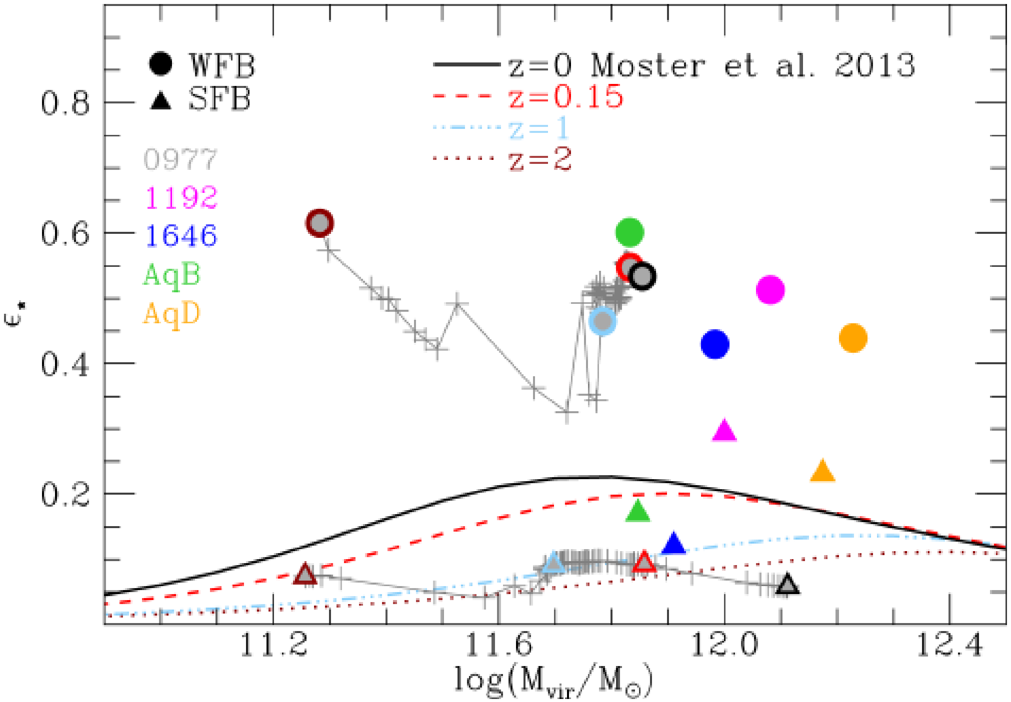
Comparing strong and weak FB from the same IC's

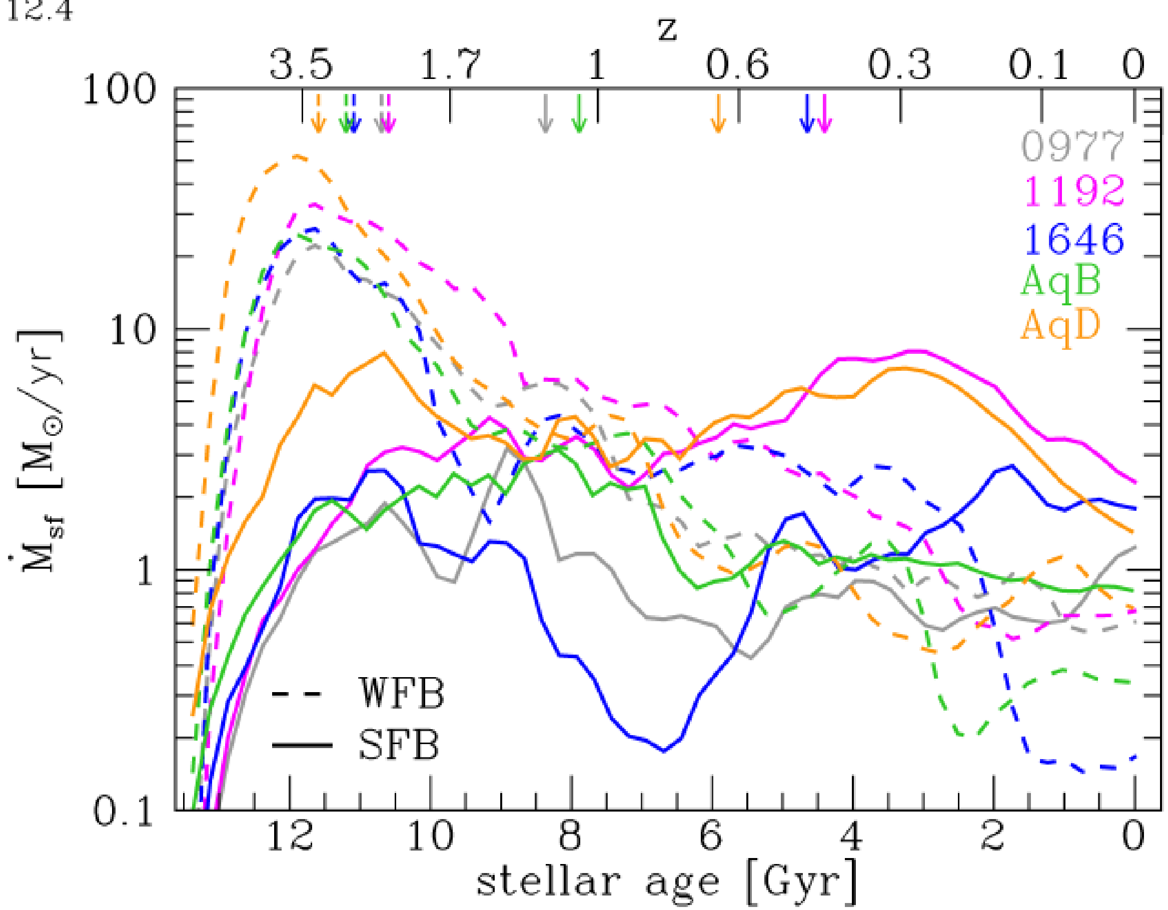


FB effects on the SFH

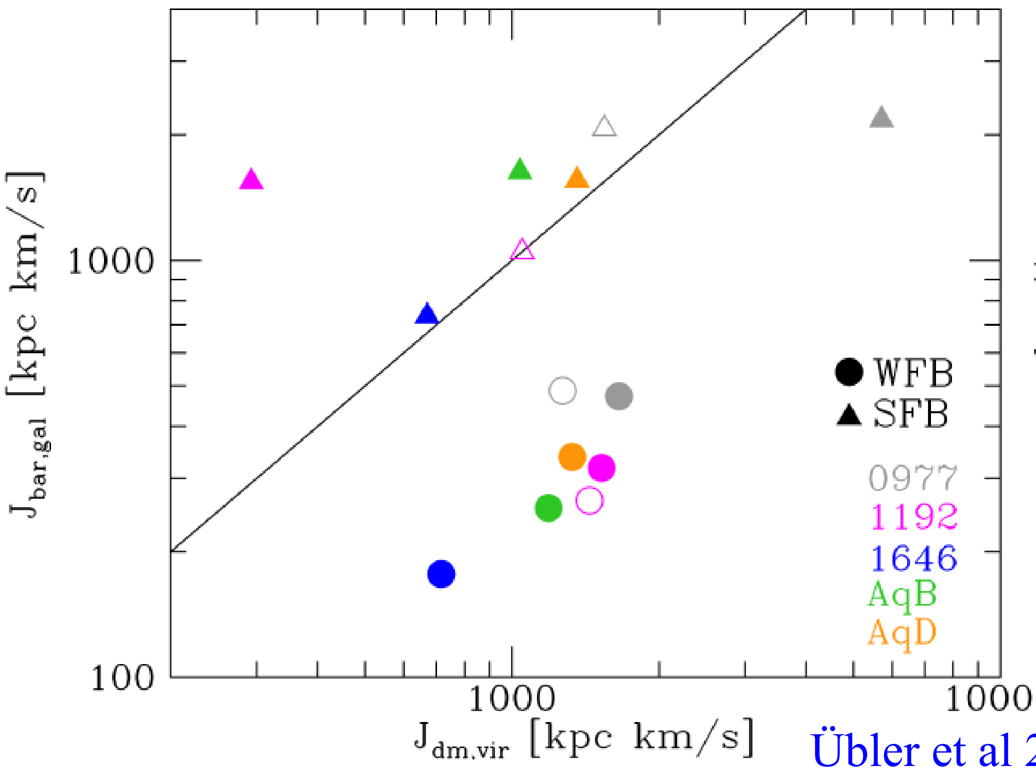


The total stellar mass is reduced at z=0 for strong FB

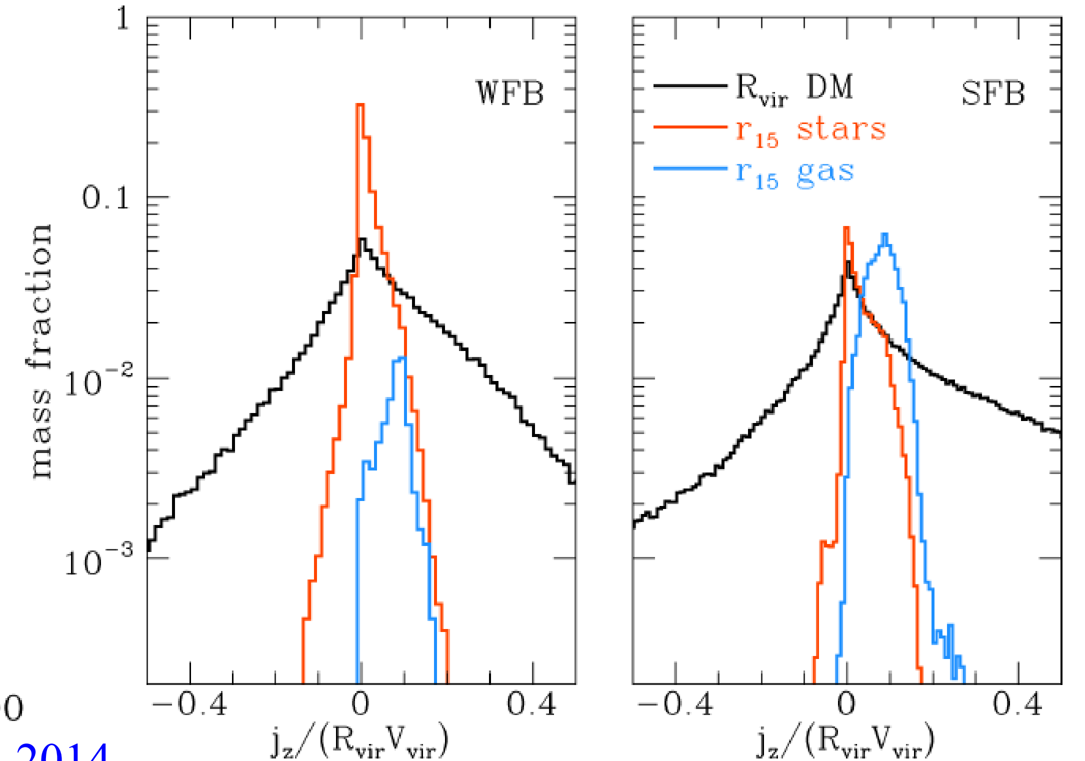
Übler et al 2014

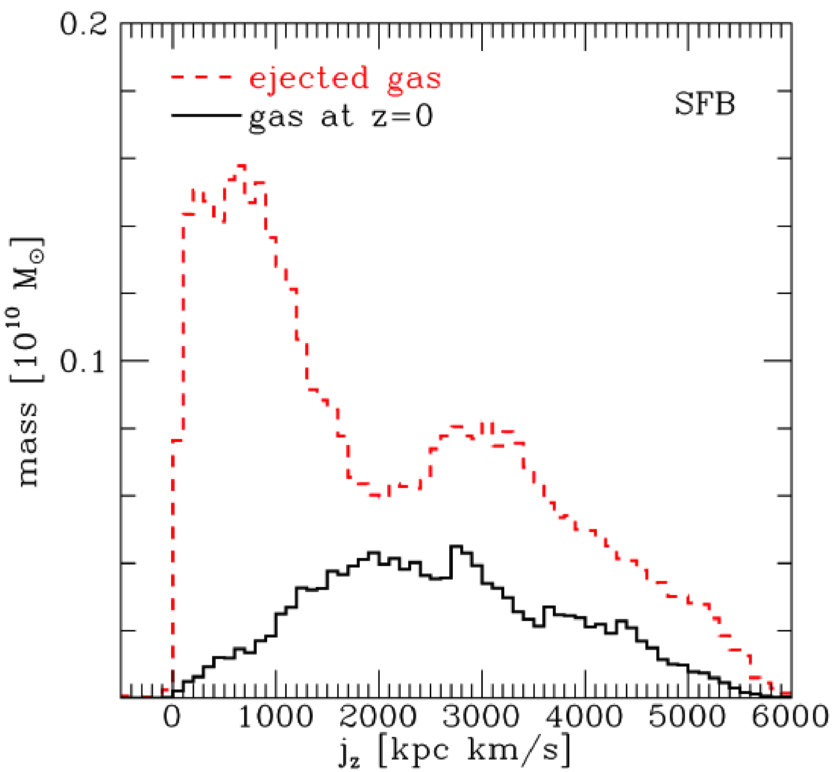


The reduction is primarily at early times



Übler et al 2014





FB effects on disk ang.mom.

Strong FB results in an increase of specific angular momentum by about x10

This is a result of ejection of low *J* gas at early times and preferential formation of stars from high *J* gas accreted late.

Why does strong early FB promote disk formation

1) The SFR is strongly suppressed at early times

2) Low J gas is preferentially ejected

3) Many stars form from recycled gas which has gained J

4) Disk is predominantly formed from late-time, high J accretion

5) Much gas is ejected altogether $\longrightarrow$ less compact galaxies