Stellar Kinematics of z~2 Galaxies and the Inside-out Growth of Quiescent Galaxies

Sterrewacht Leiden

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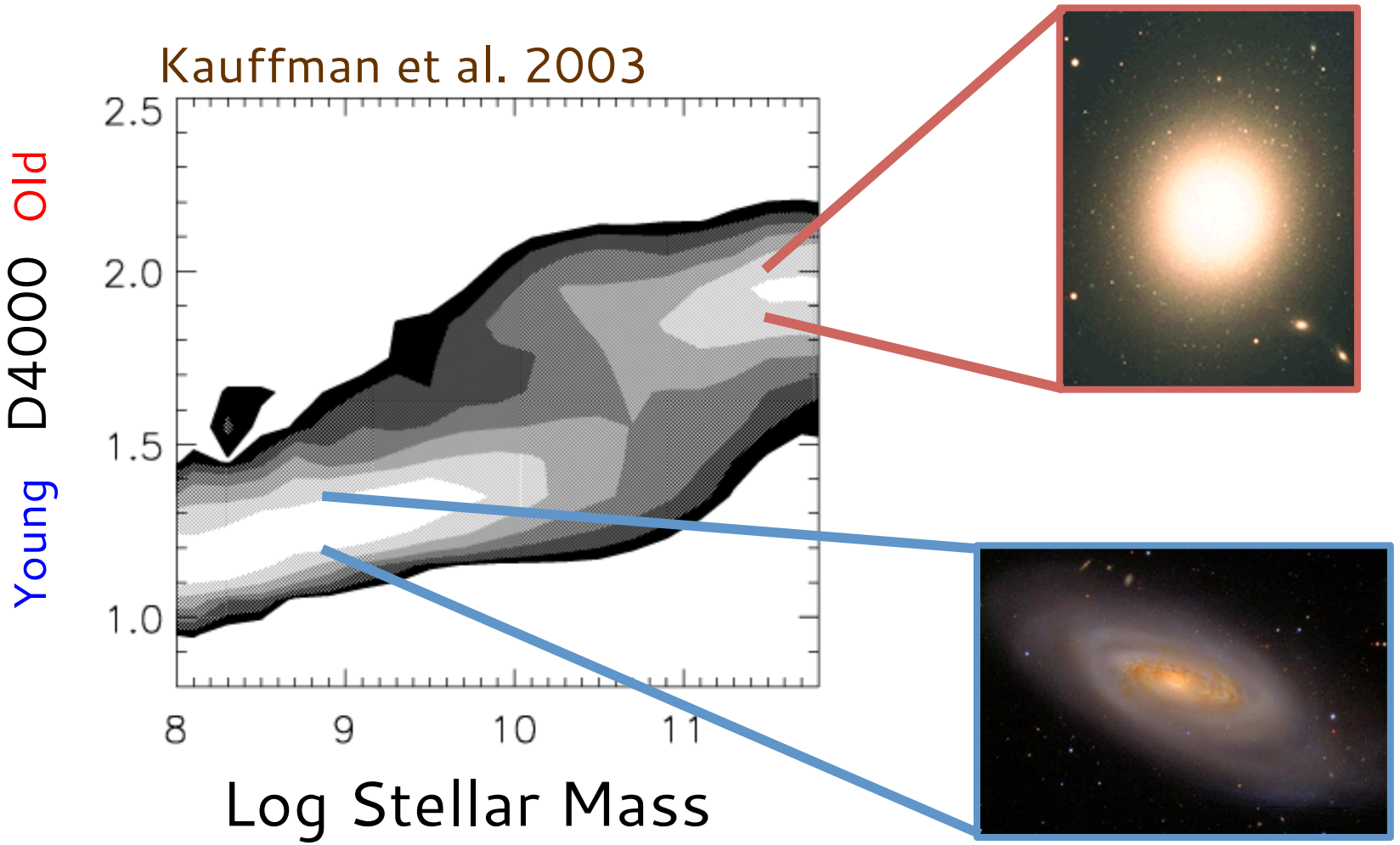
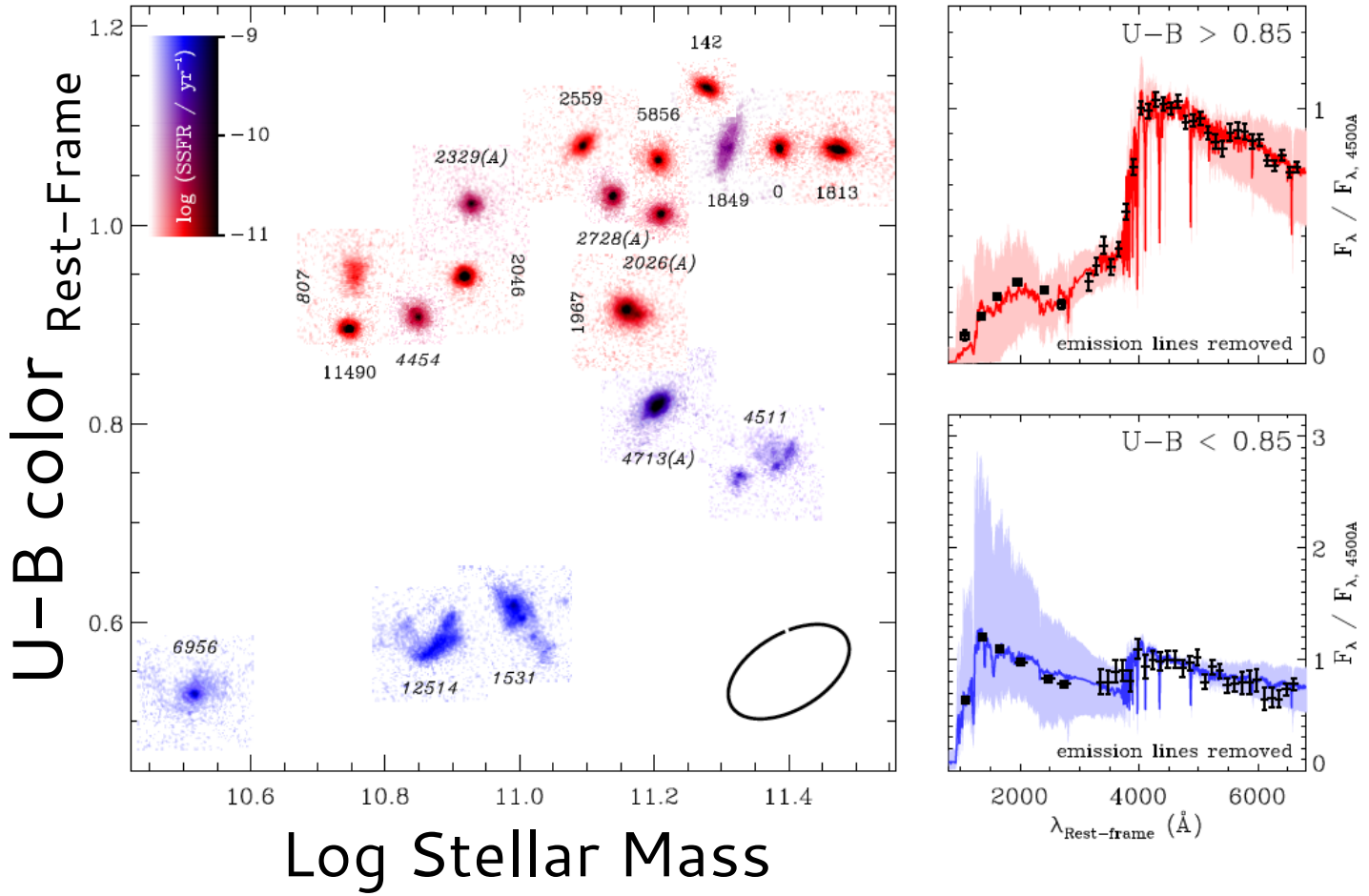
Galaxies from SDSS z~0.1



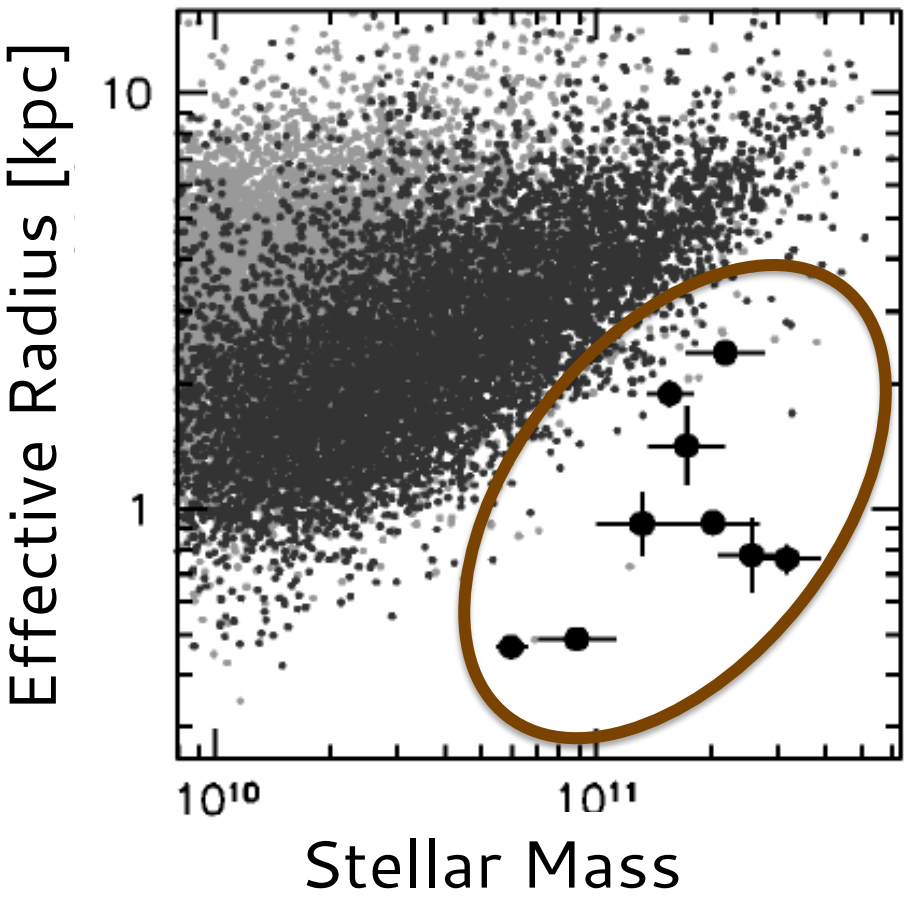
Red-and-Dead Galaxies at z~2

Kriek et al. 2009



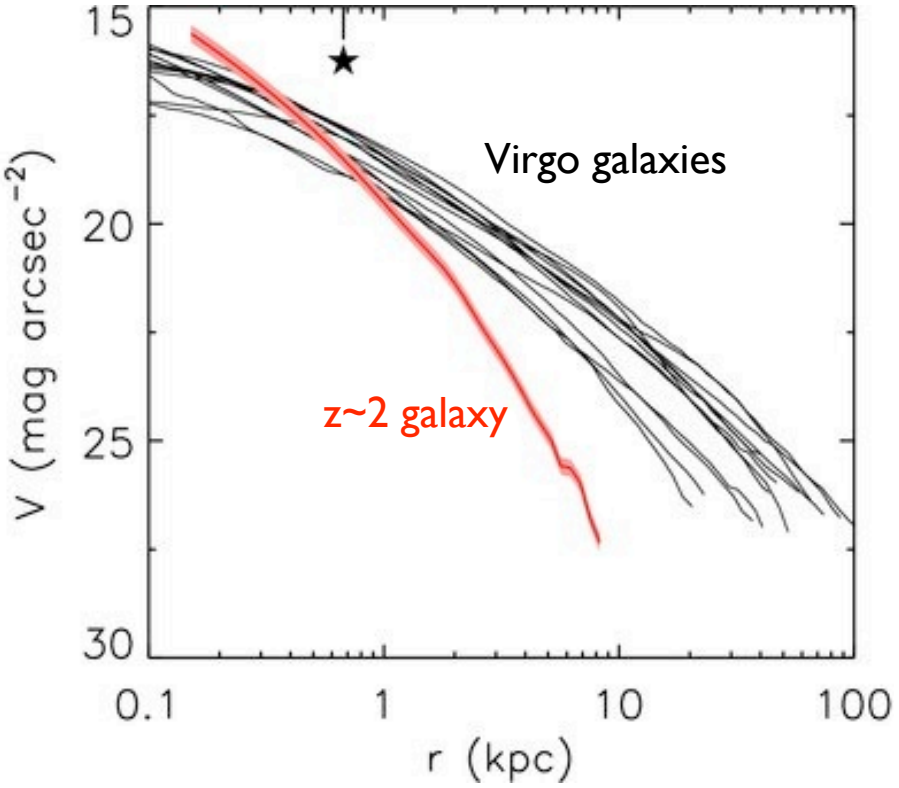
Early-type galaxies at z ≈ 2 were smaller and denser than low-z analogs

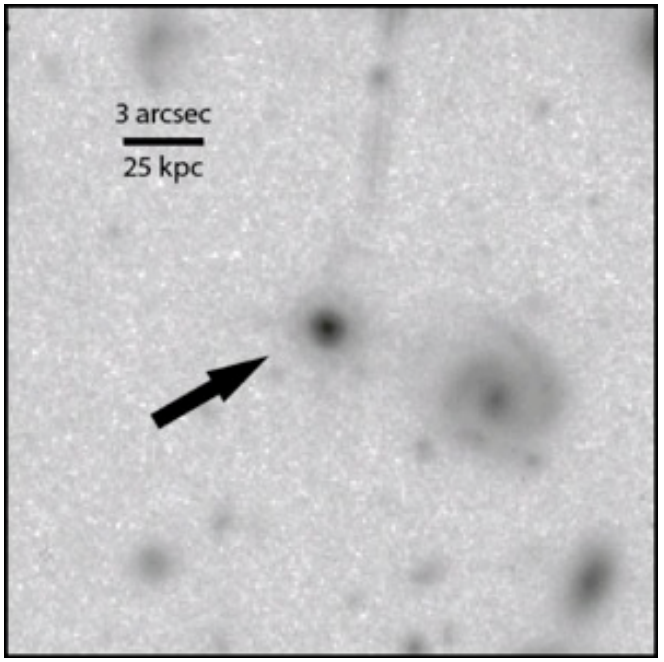
Van Dokkum et al. 2008



Confirmation of small sizes with HST-WFC3

Szomoru et al. 2010





Stellar Kinematics of z~2 Galaxies

Use dynamical mass instead:

$$M_{dyn} = K(n) \cdot r_e \cdot \sigma^2$$

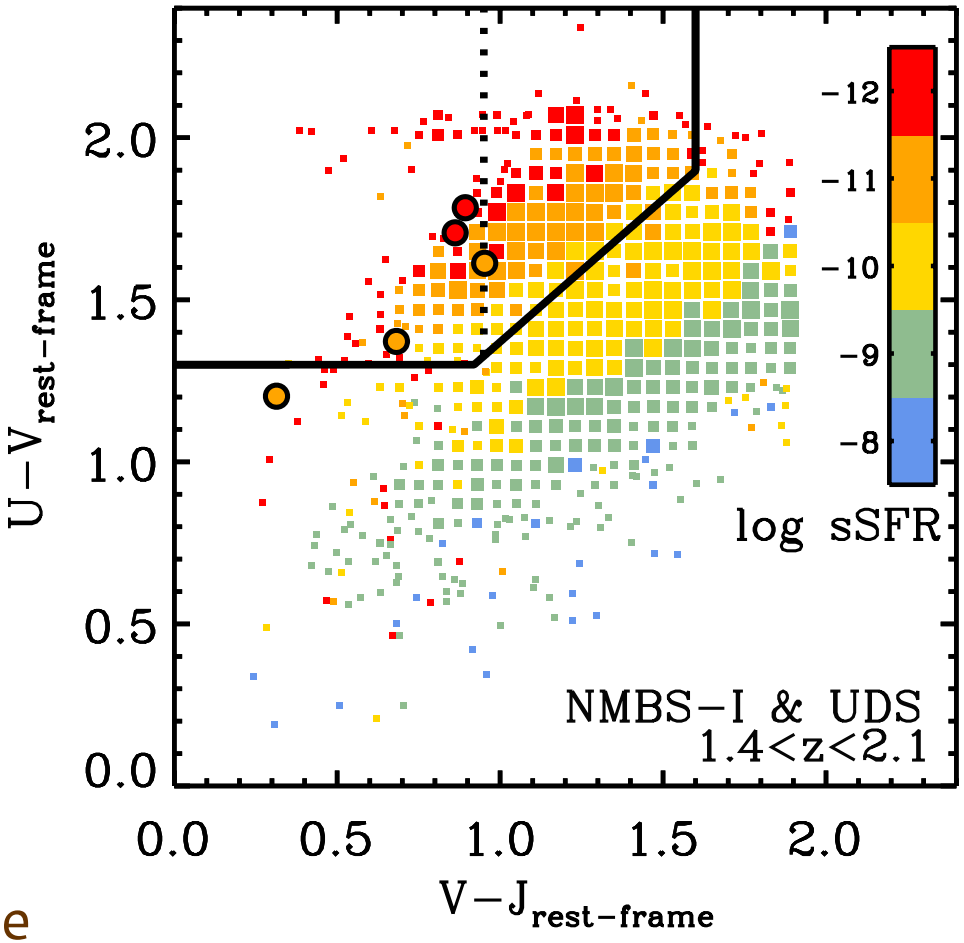
Requires deep Near Infrared spectroscopy for z >1.4

Confirming high stellar densities using stellar kinematics

VLT X-Shooter Observations:

- 5 Targets from NMBS-I (van Dokkum et al. 2009) and UDS (Williams et al 2009.)
- Selected to be bright, non-starforming galaxies at $1.4 < z < 2.1$
- 2 – 5 hours per source
- UV to NIR in single shot
- R = 5600 (~23 km/s)

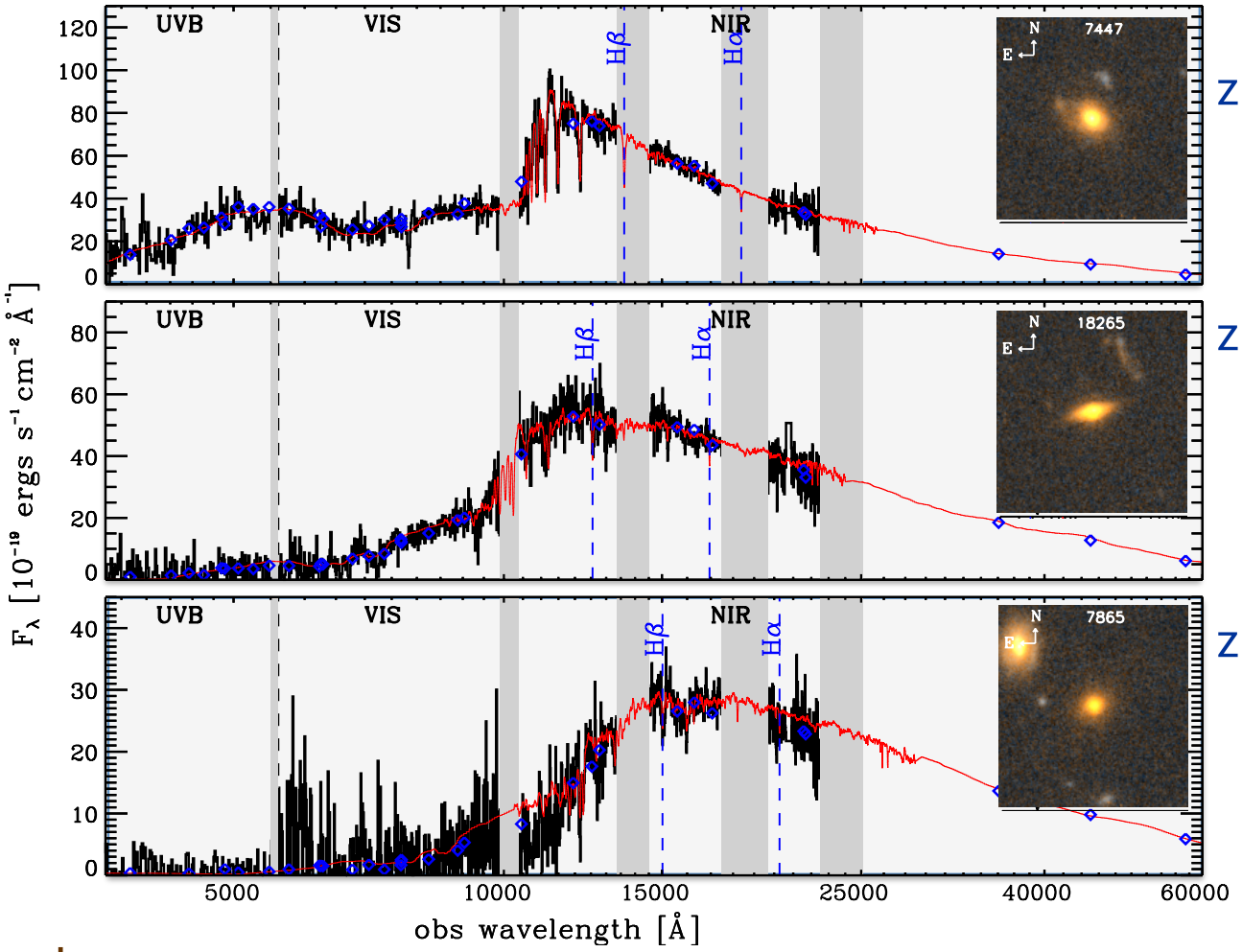
Selection Effects: young post-starburst like galaxies



van de Sande et al. 2013

X-Shooter spectroscopy

UV to NIR in one single shot



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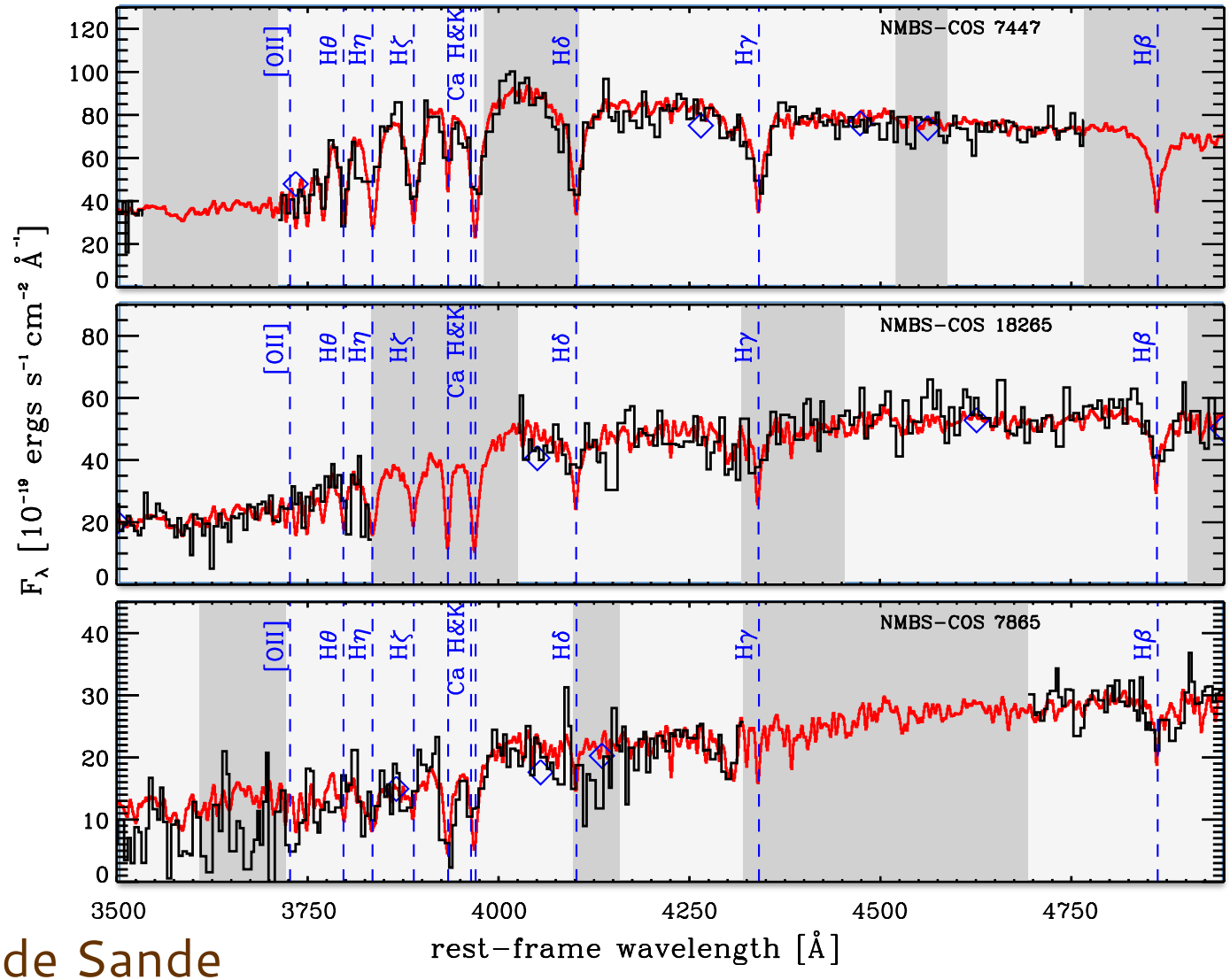
X-Shooter spectra zoom



z = 1.80

$\sigma_* = 281^{\pm 34}$ km/s

z = 1.58

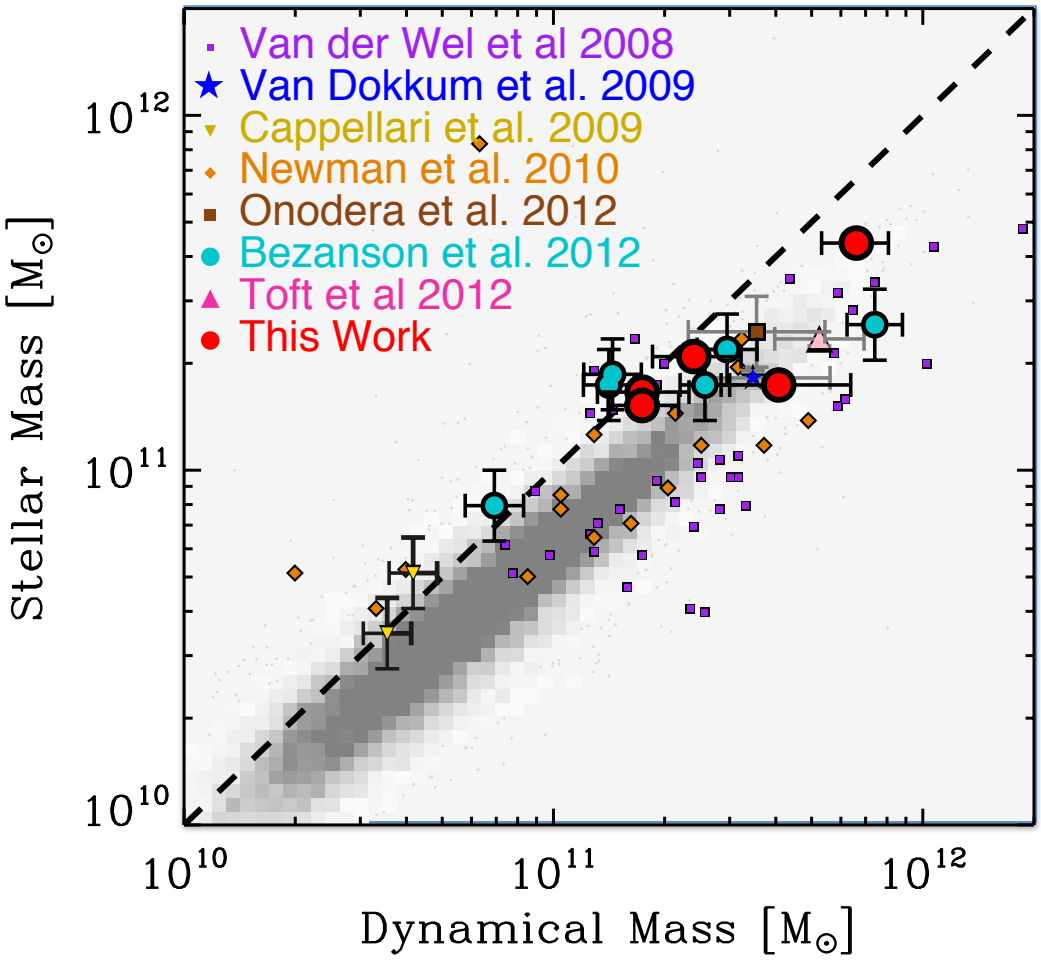
$\sigma_* = 378^{\pm 54}$ km/s

z = 2.09

$\sigma_* = 442^{\pm 51}$ km/s

van de Sande et al. 2013

Stellar and Dynamical Mass in good agreement



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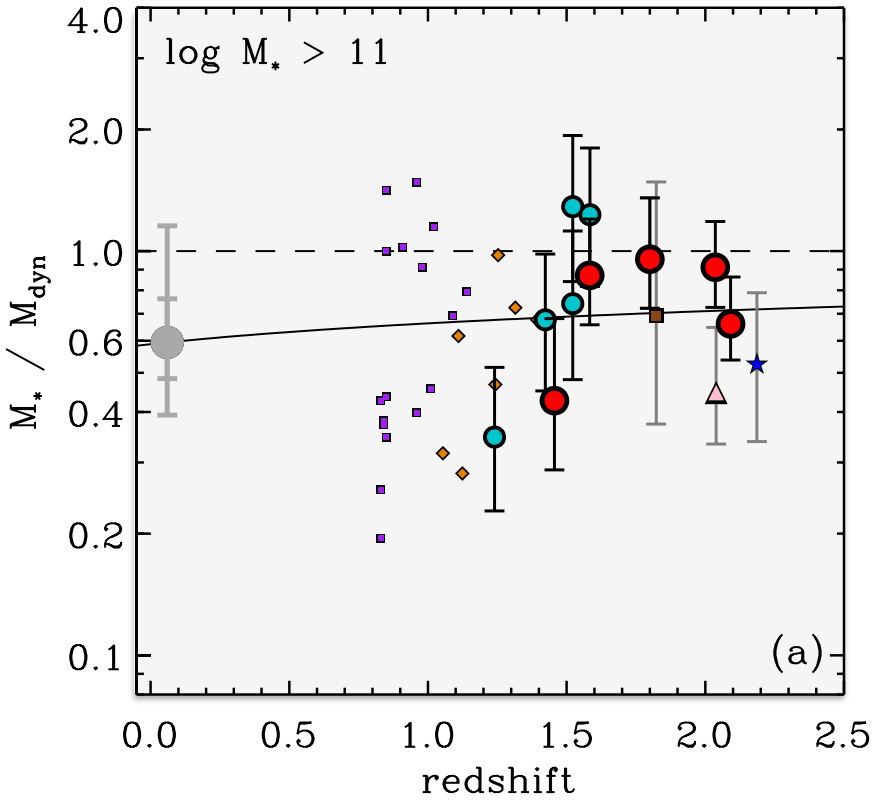
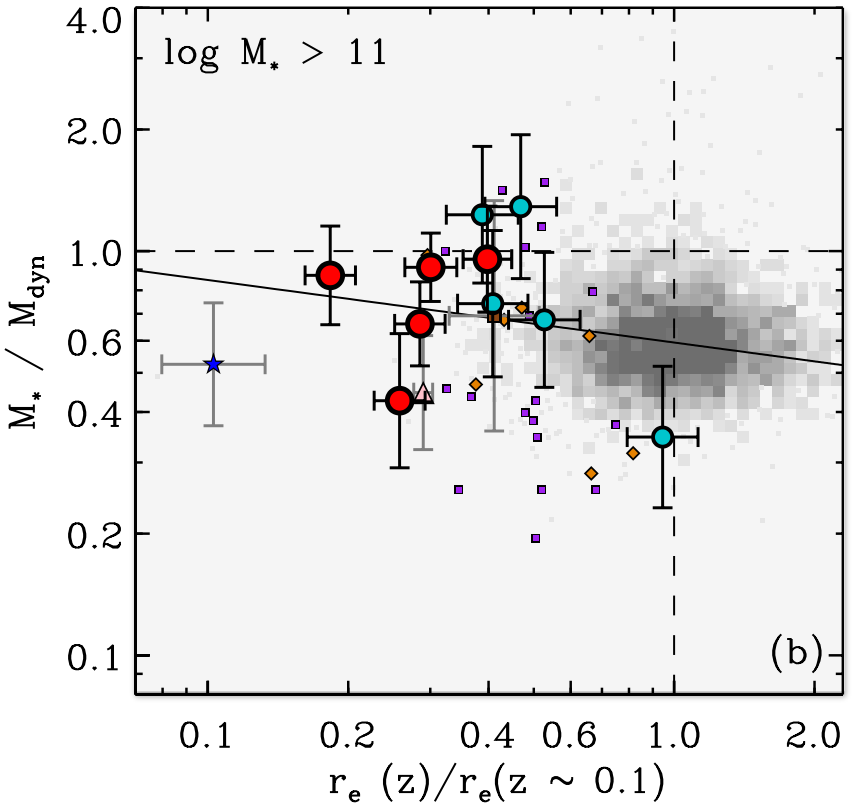
M^*/M_{dyn} may decrease over time: increase in dark matter fraction?





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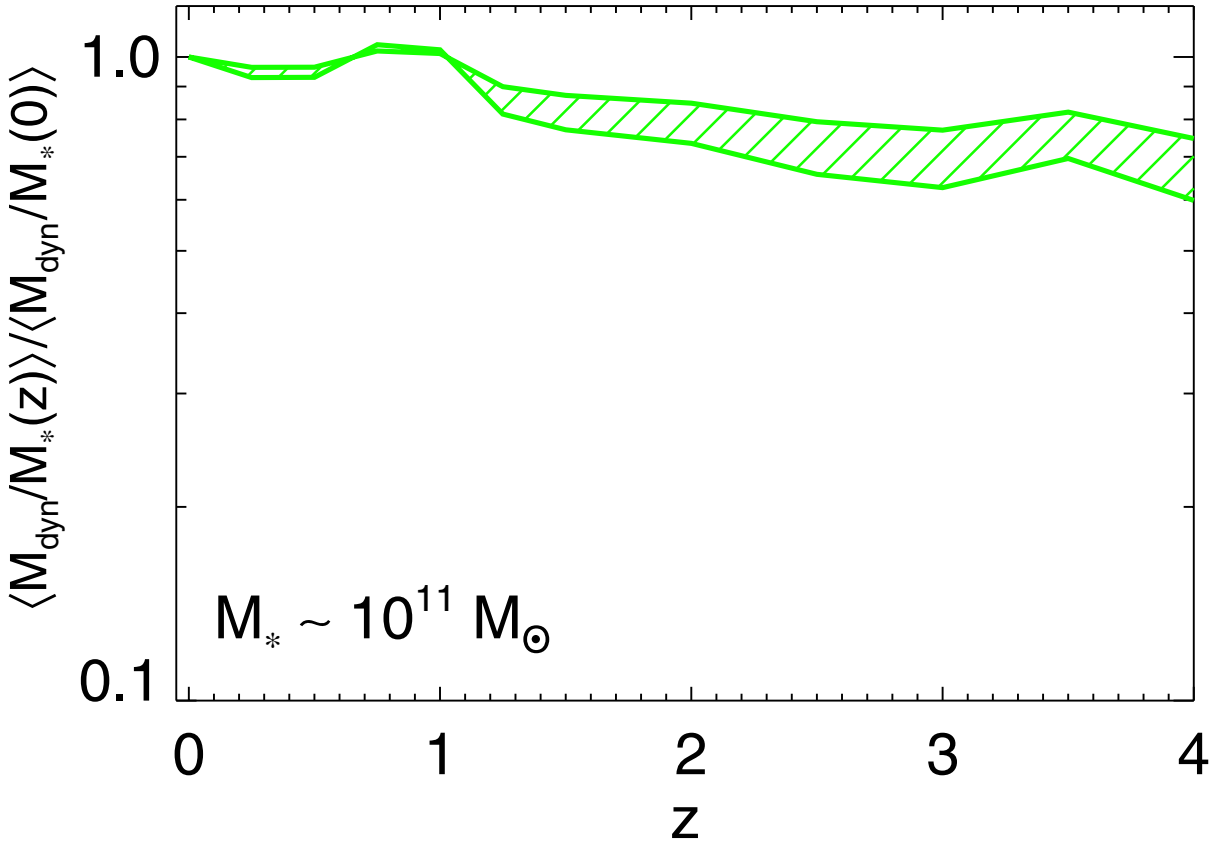
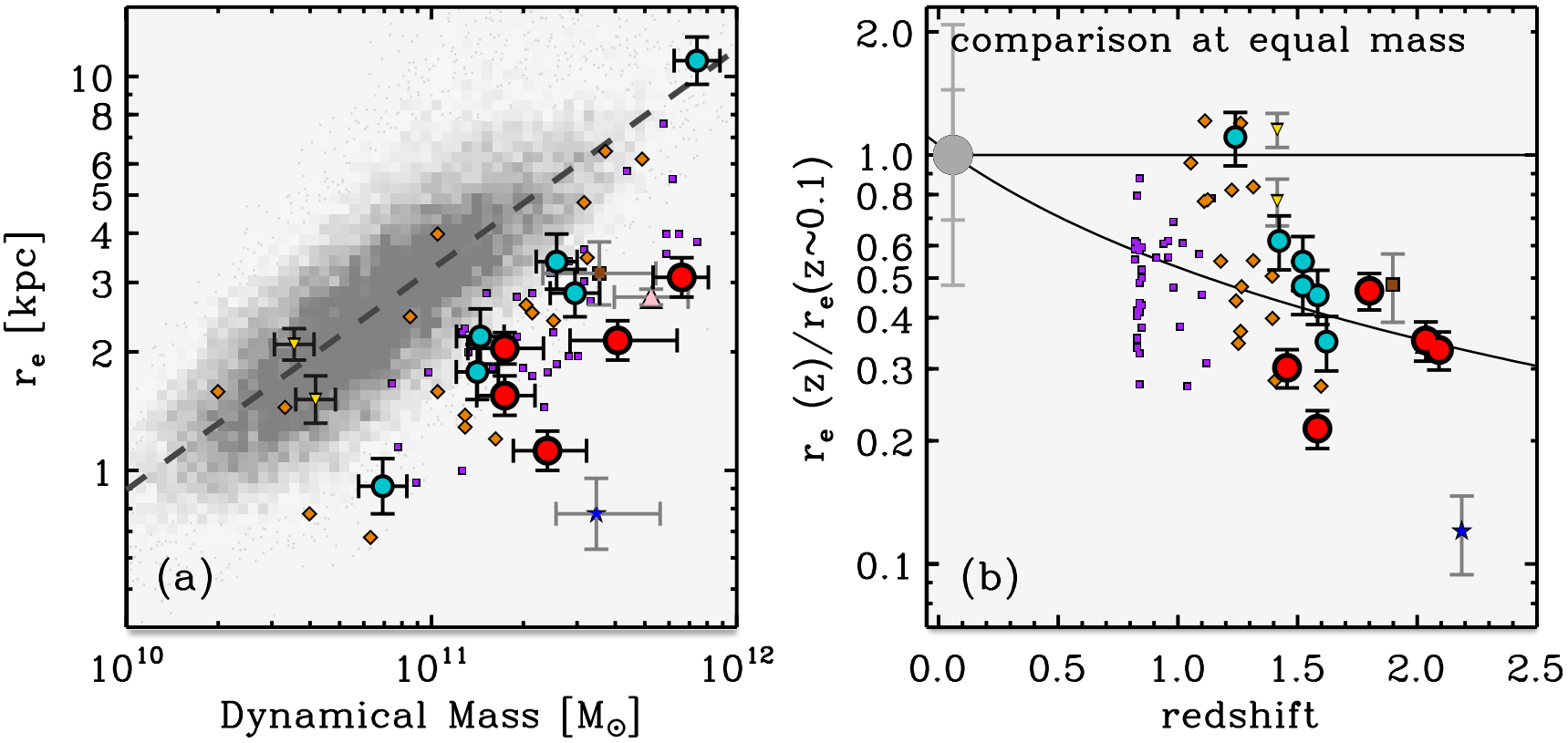
Evolution in M_* / M_{dyn} : prediction from simulations

Hopkins et al. 2009



Massive Quiescent galaxies are indeed smaller at earlier times



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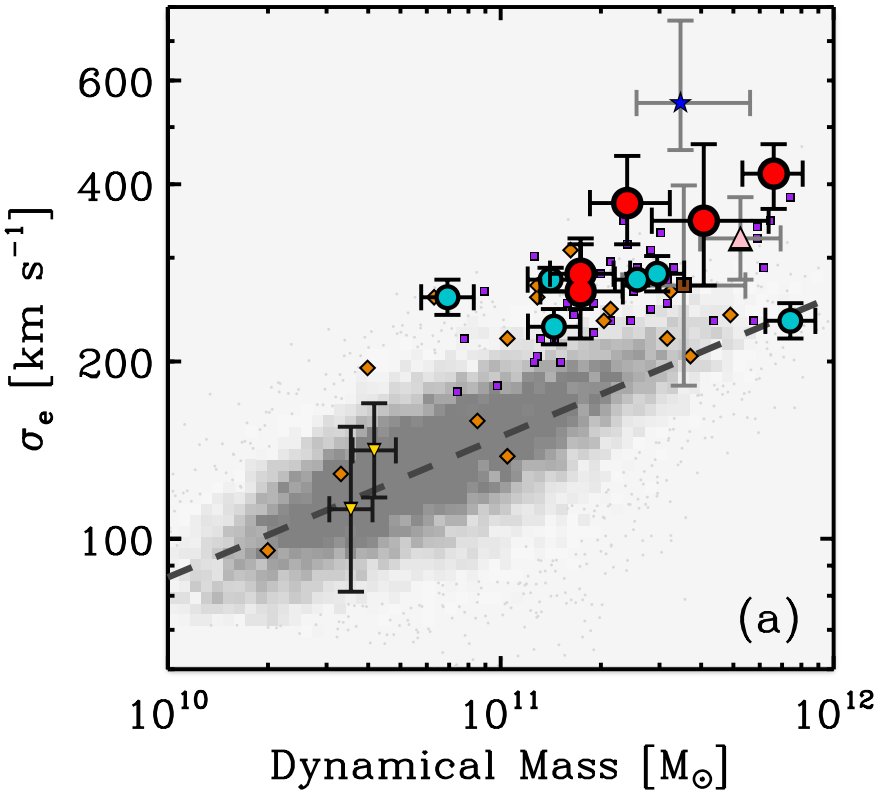
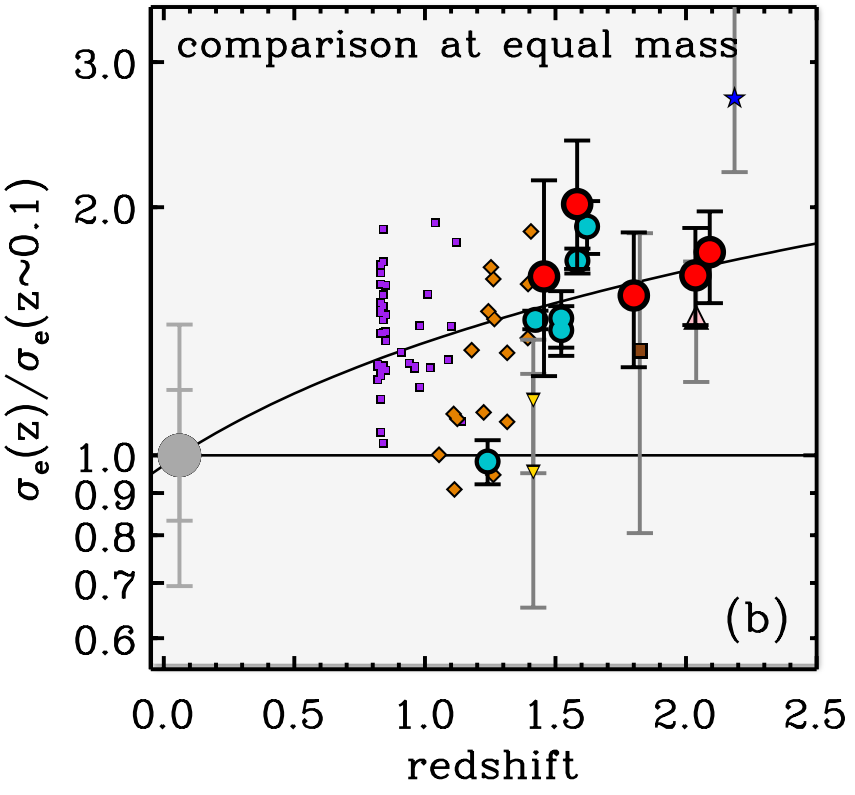
Massive Quiescent galaxies have higher velocity dispersions at earlier times





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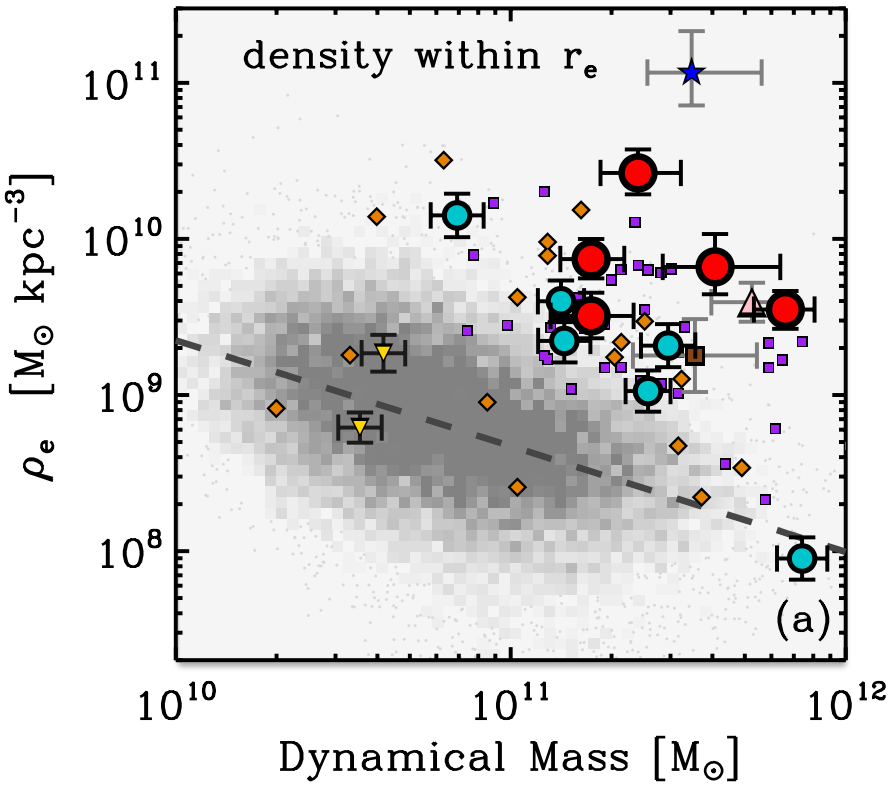
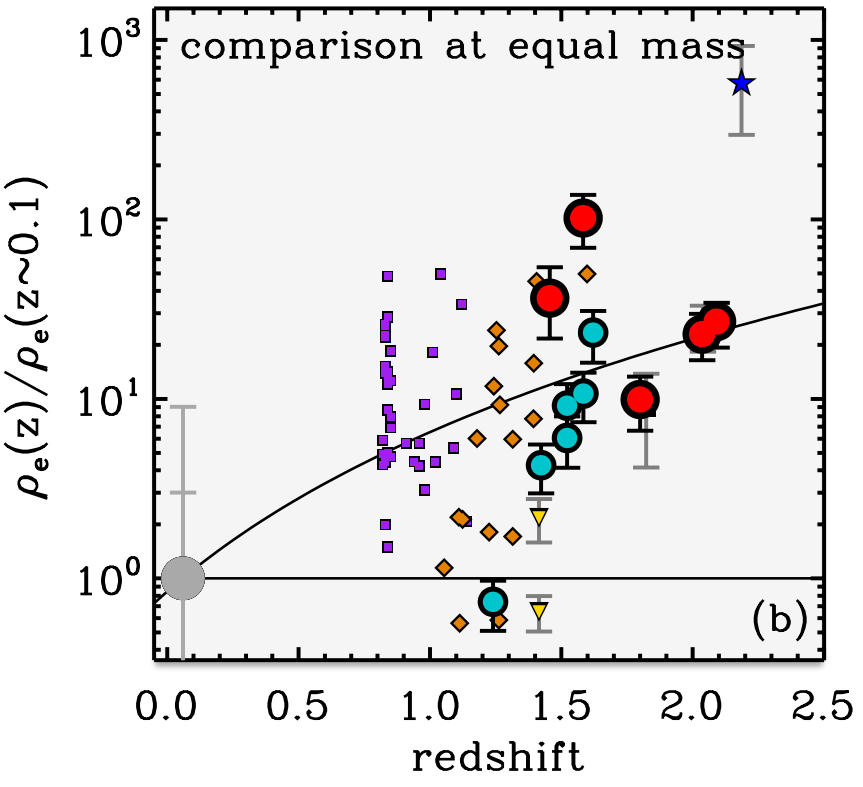
Stellar density within r_e is higher at z~2 and evolves rapidly with time





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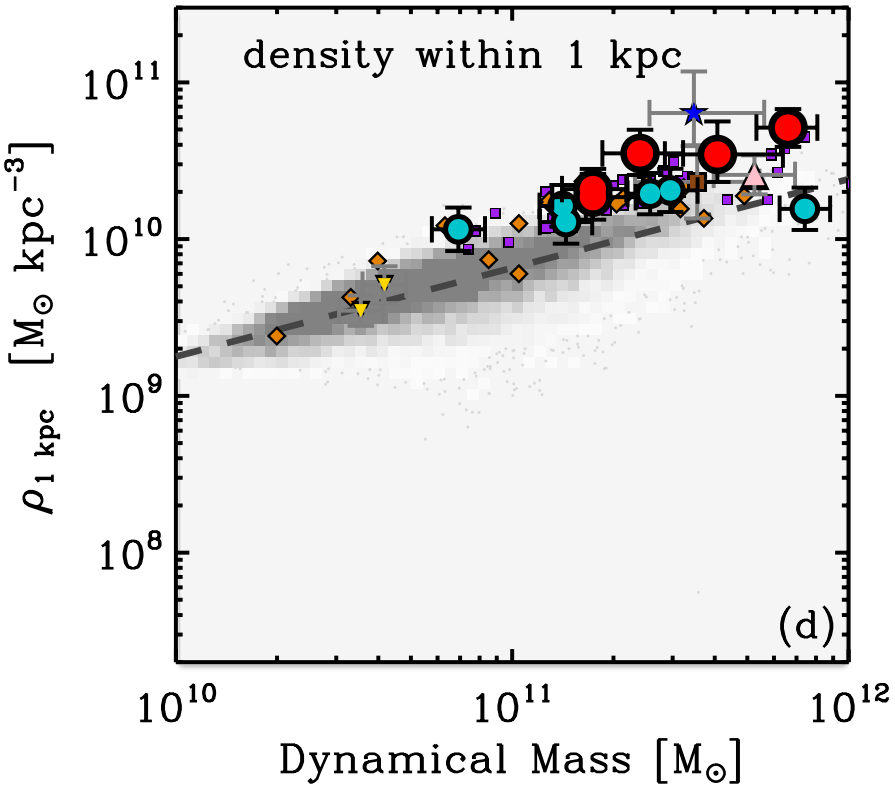
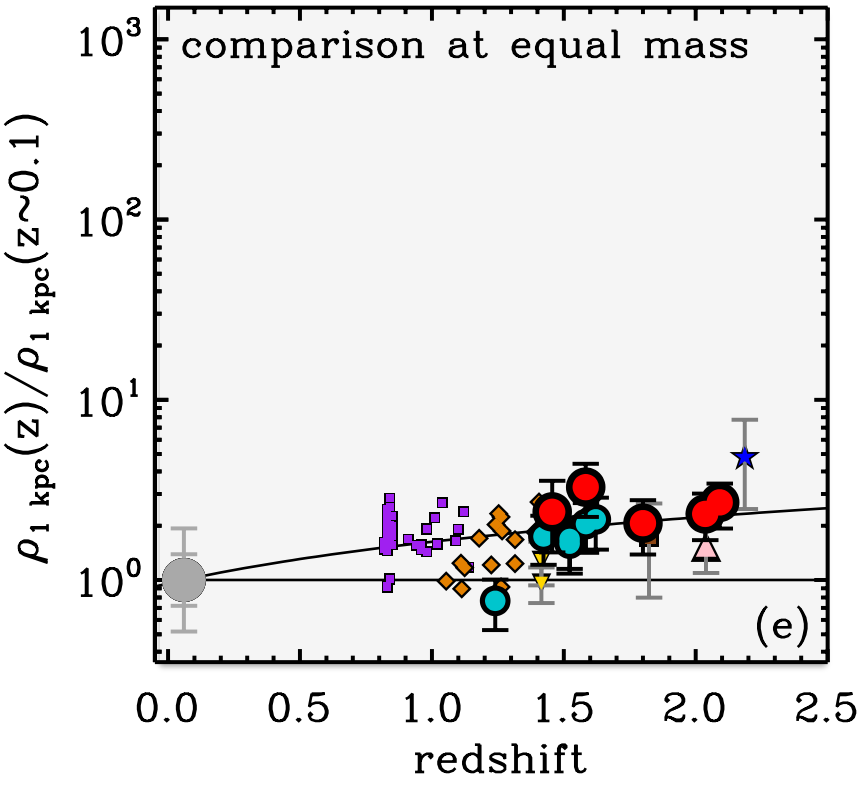
Stellar density within 1 kpc only slightly higher at earlier times

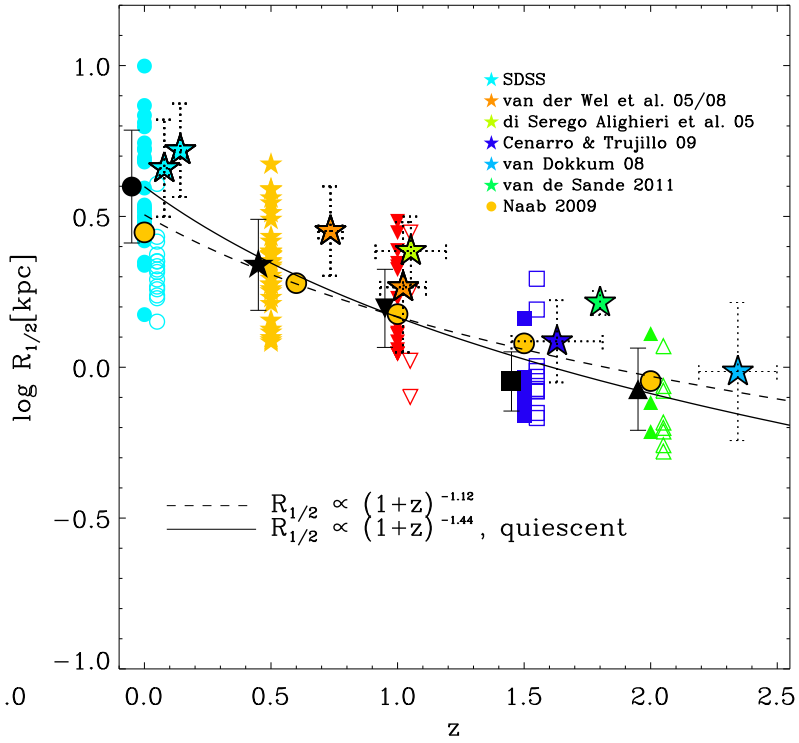


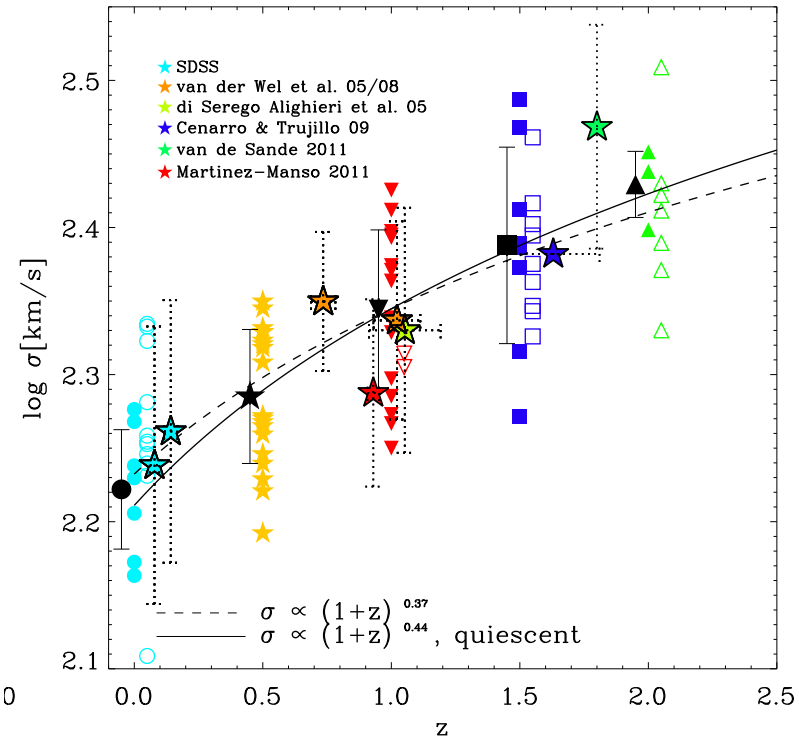


van de Sande et al. 2013

Hydro-simulation predict similar evolution in size and velocity dispersion

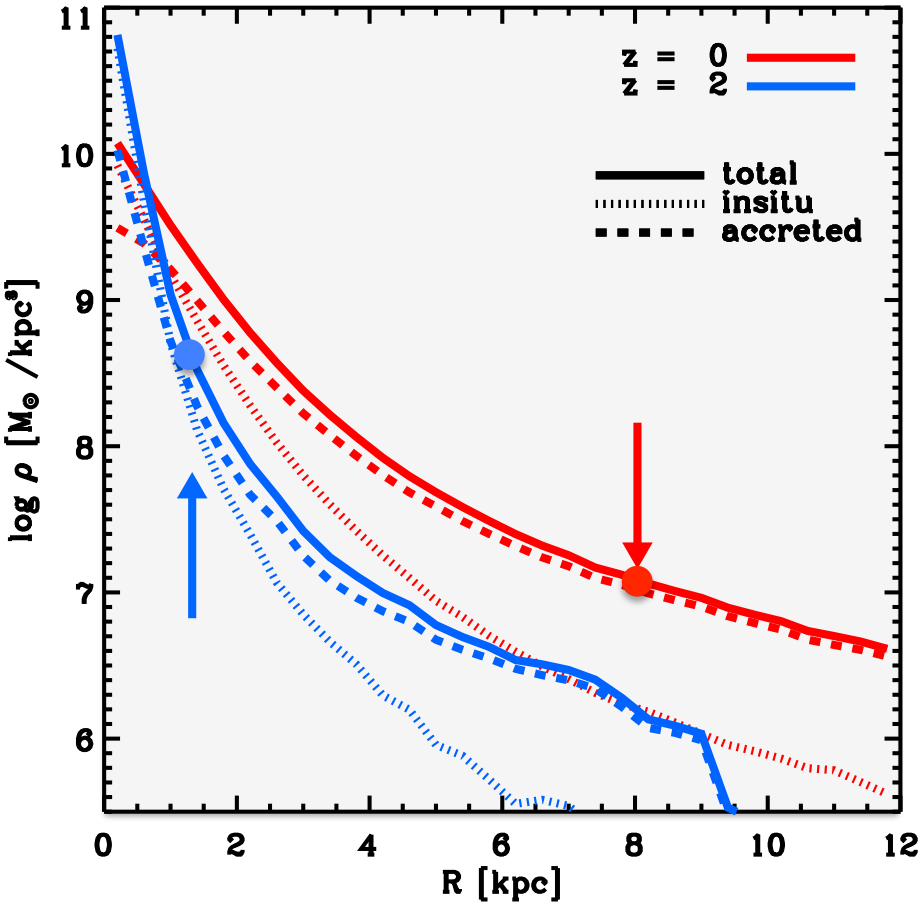
Oser et al. 2012





Strong evolution in effective density central density stays roughly the same

Oser et al. 2012



Take Home Message

Photometric and dynamical masses of distant compact massive galaxies are in **good agreement**

The **stellar density** within re **evolves rapidly**, while within **1 kpc** it is consistent with a **very mild or no evolution**

Distant **massive compact galaxies** are the **cores** of present-day **ellipticals** and **grow inside-out** by mostly **minor mergers**