Evolution of Dynamical Scaling Relations to z = 1

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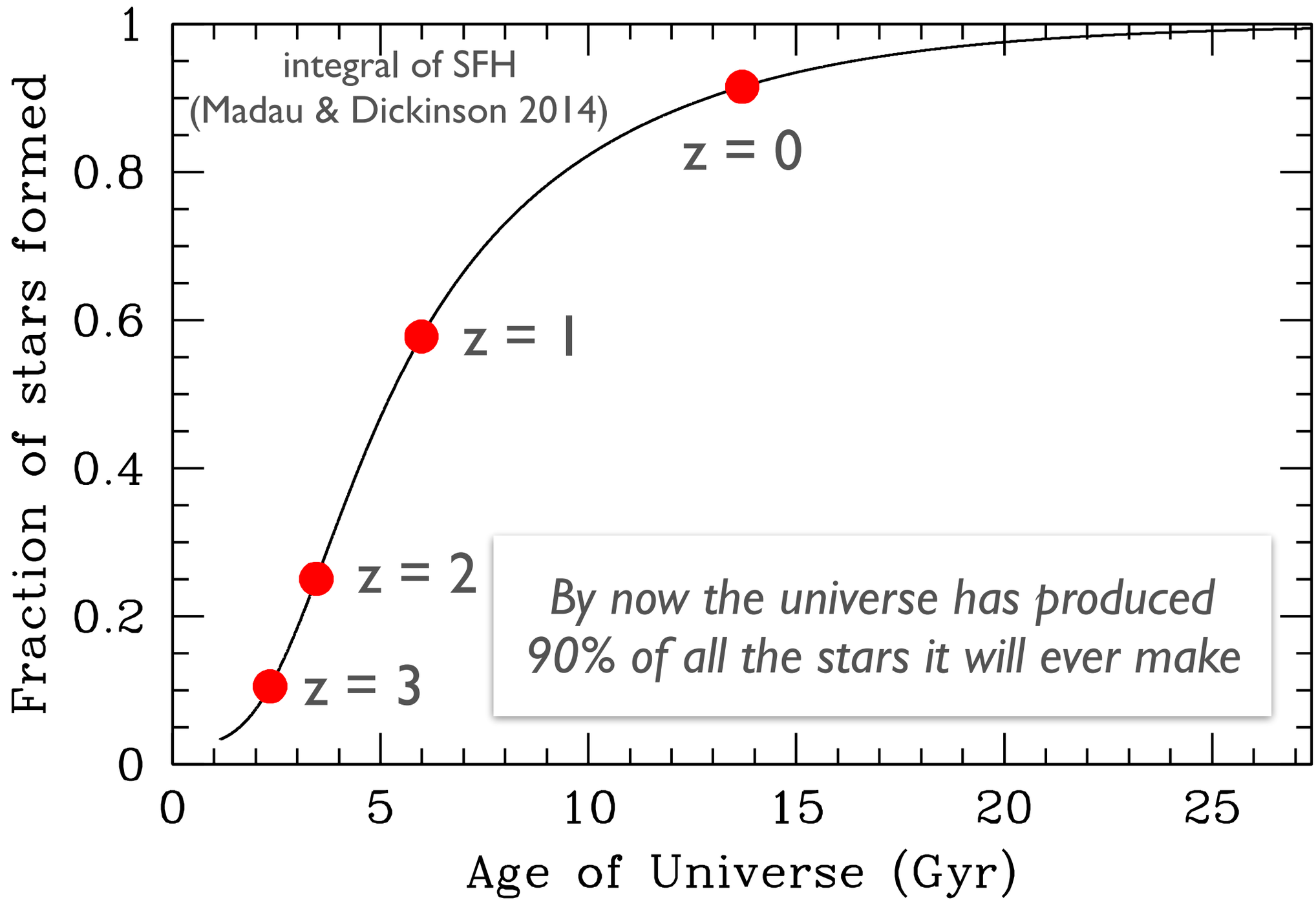
OUTLINE

- Evolution of the Size-Mass Photometric Scaling Relation
- The LEGA-C Survey
- The Faber-Jackson Relation and Fundamental Plane at z~1
- Spatially Resolved Stellar Dynamical Structure at z~1

How do galaxies evolve after they cease to form stars?

28 Gyr of Galaxy Evolution

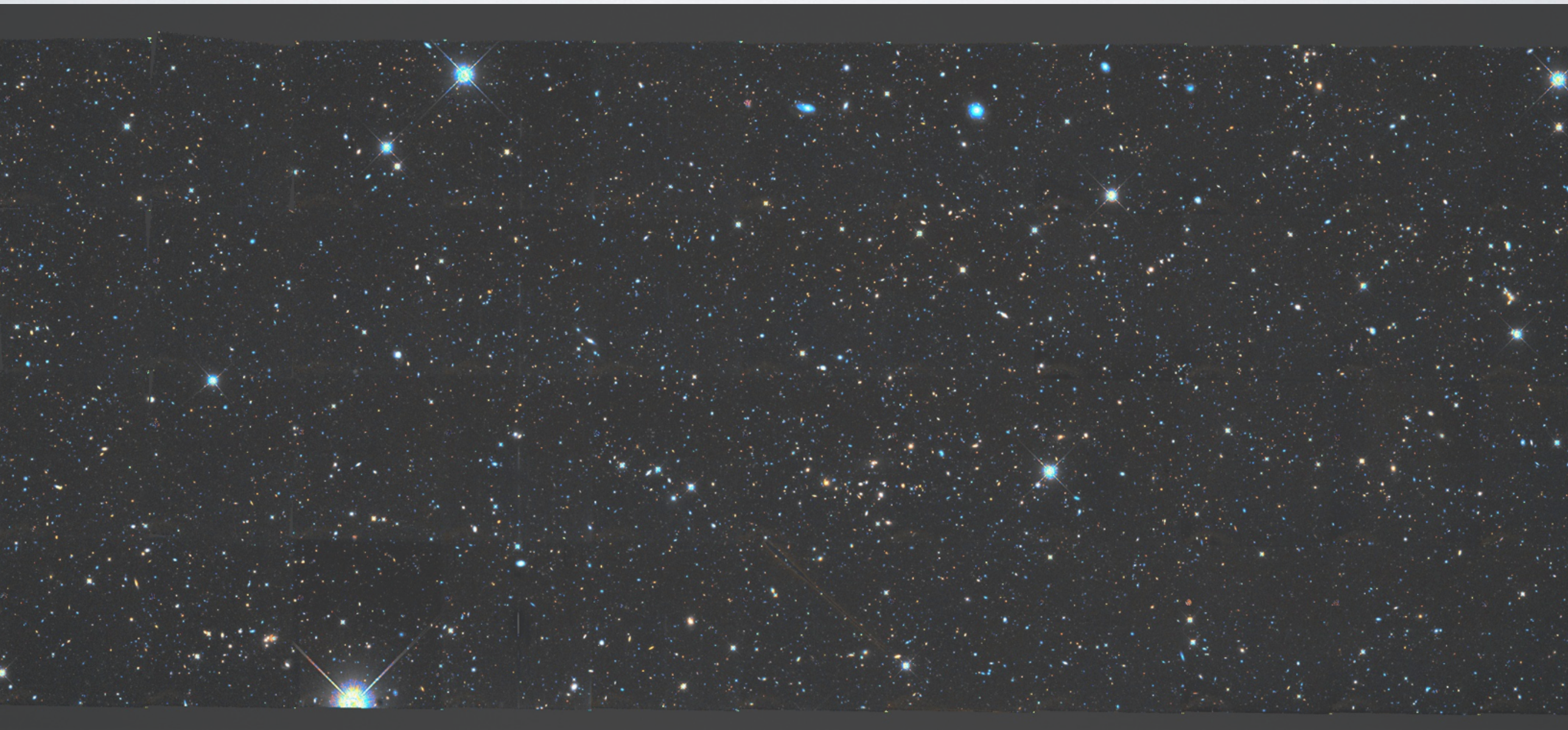


By now the universe has produced 90% of all the stars it will ever make

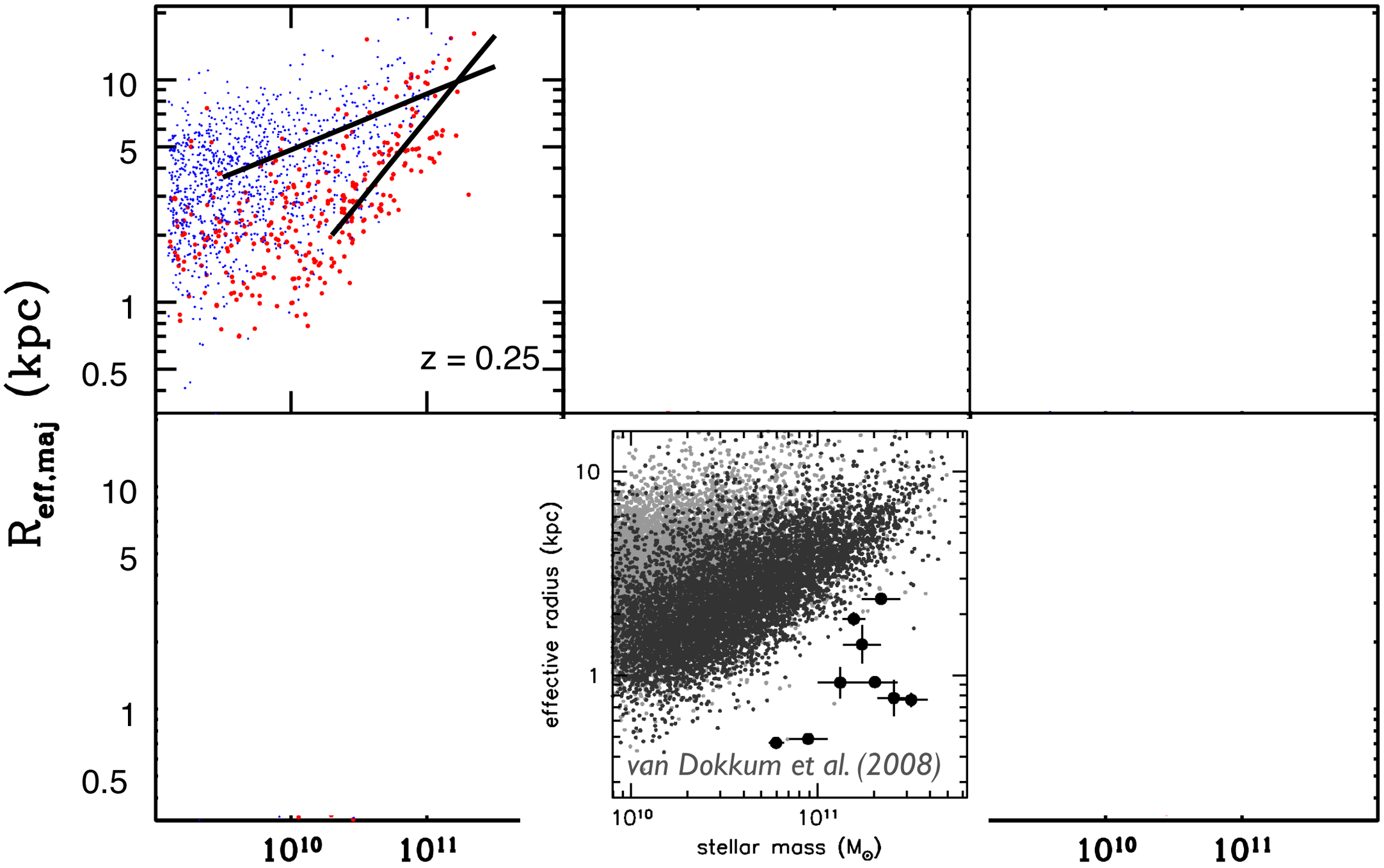
CANDELS (Grogin+11, Koekemoer+11)

The Cosmic Assembly Near-IR Deep Extragalactic Legacy Survey

- HST near-IR imaging at ~0.18” (distant galaxies are ~1” across)
- to depth H(AB)~27 (10^9 $M_\odot$ in stars at z~2)
- 800 sq. arcmin: sizes and shapes for several x10^5 galaxies



Evolution in the Stellar Mass — Size Plane



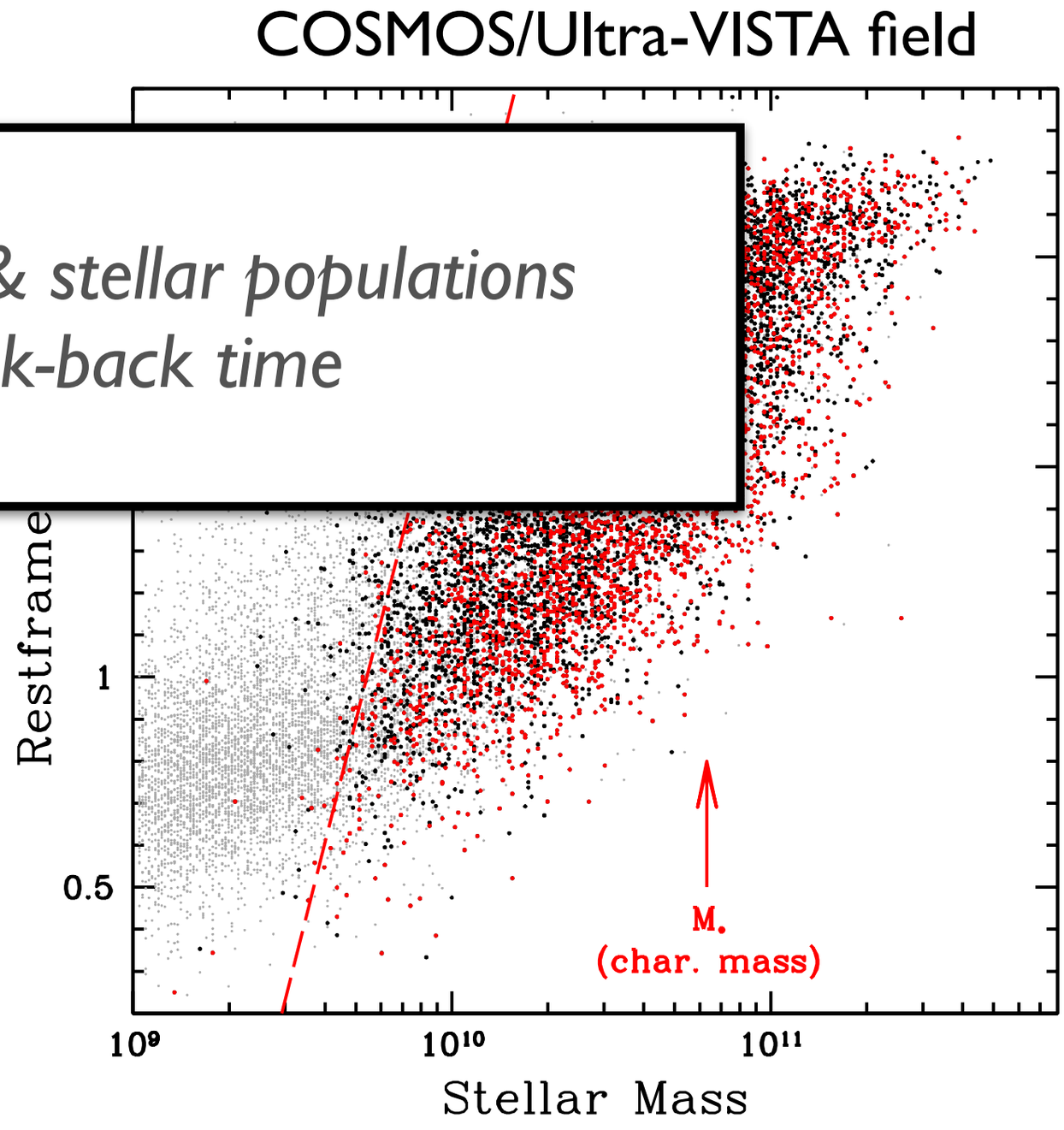
van der Wel et al. (2012, 2014)

LEGA-C: a VLT/VIMOS Public Survey

Large **E**arly **G**alaxy **A**strophysics **C**ensus (*van der Wel et al. 2016*)

- >1000hr allocation
- Decembe
- >3000 ga
- 20h integ
- DR2 in June 2018

Stellar kinematics & stellar populations at large look-back time



LEGA-C: a VLT/VIMOS Public Survey

The LEGA-C group
in Heidelberg/Ghent:

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Priscilla Chauke
Francesco d'Eugenio
Josha van Houdt
Caroline Straatman
Arjen van der Wel (PI)
Aaron Wilkinson
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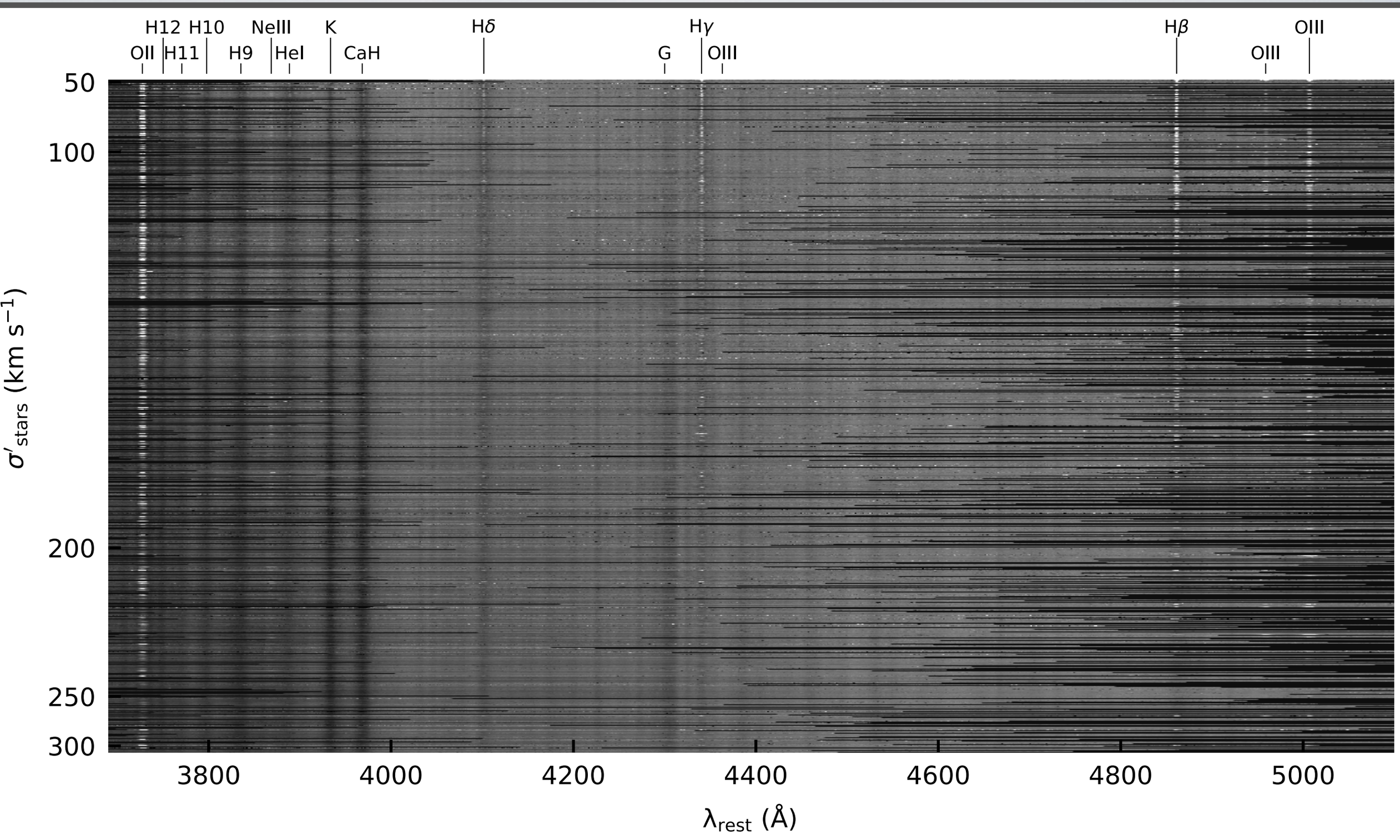
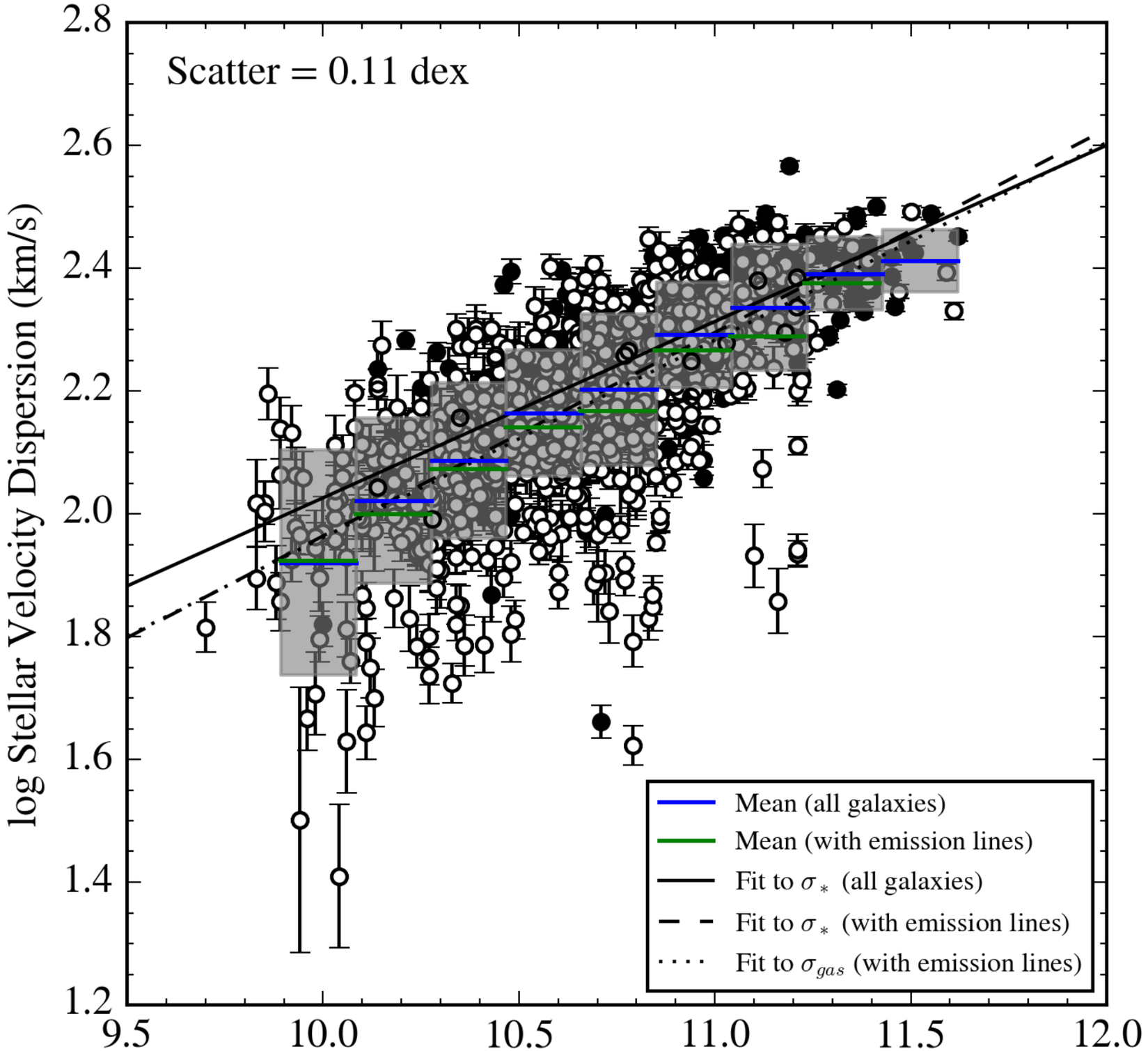
Marijn Franx (Leiden)
Anna Gallazzi (Arcetri)
Ivo Labbe (Leiden)
Michael Maseda (Leiden)
Juan Carlos Munoz (ESO)
Adam Muzzin (York)
Kai Noeske (Heilbronn planetarium)
Camilla Pacifici (STScI)
Hans-Walter Rix (MPIA)
David Sobral (Lancaster)
Jesse van de Sande (Sydney)
Ros Skelton (Capetown)
Justin Spilker (Arizona)
Pieter van Dokkum (Yale)
Vivienne Wild (St. Andrews)
Christian Wolf (ASU)

1442 spectra of z~0.8 galaxies



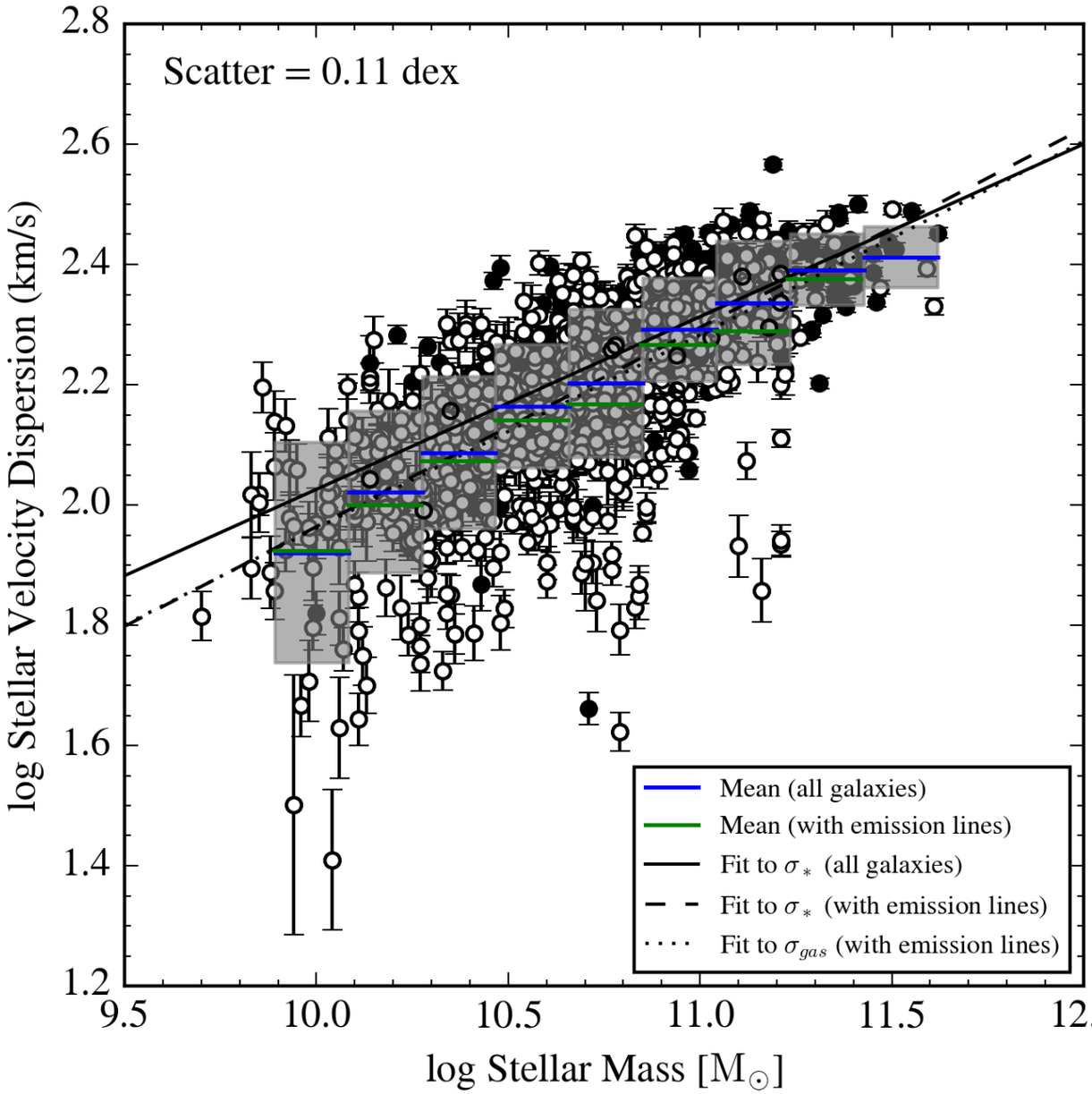
Data Release 2 (Straatman, vdW+, subm.)

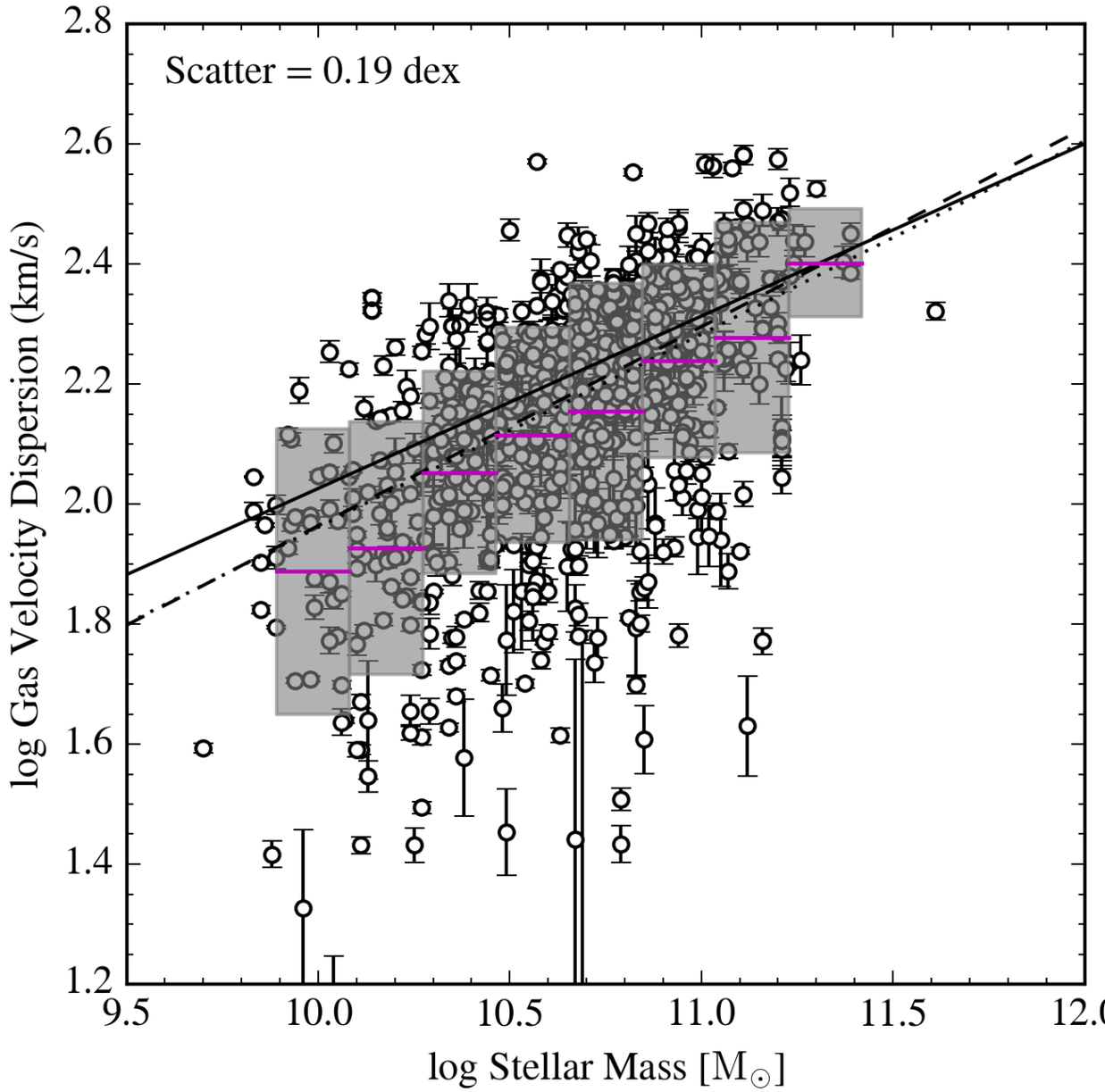
The Faber-Jackson relation



Bezanson, vdW+ subm.

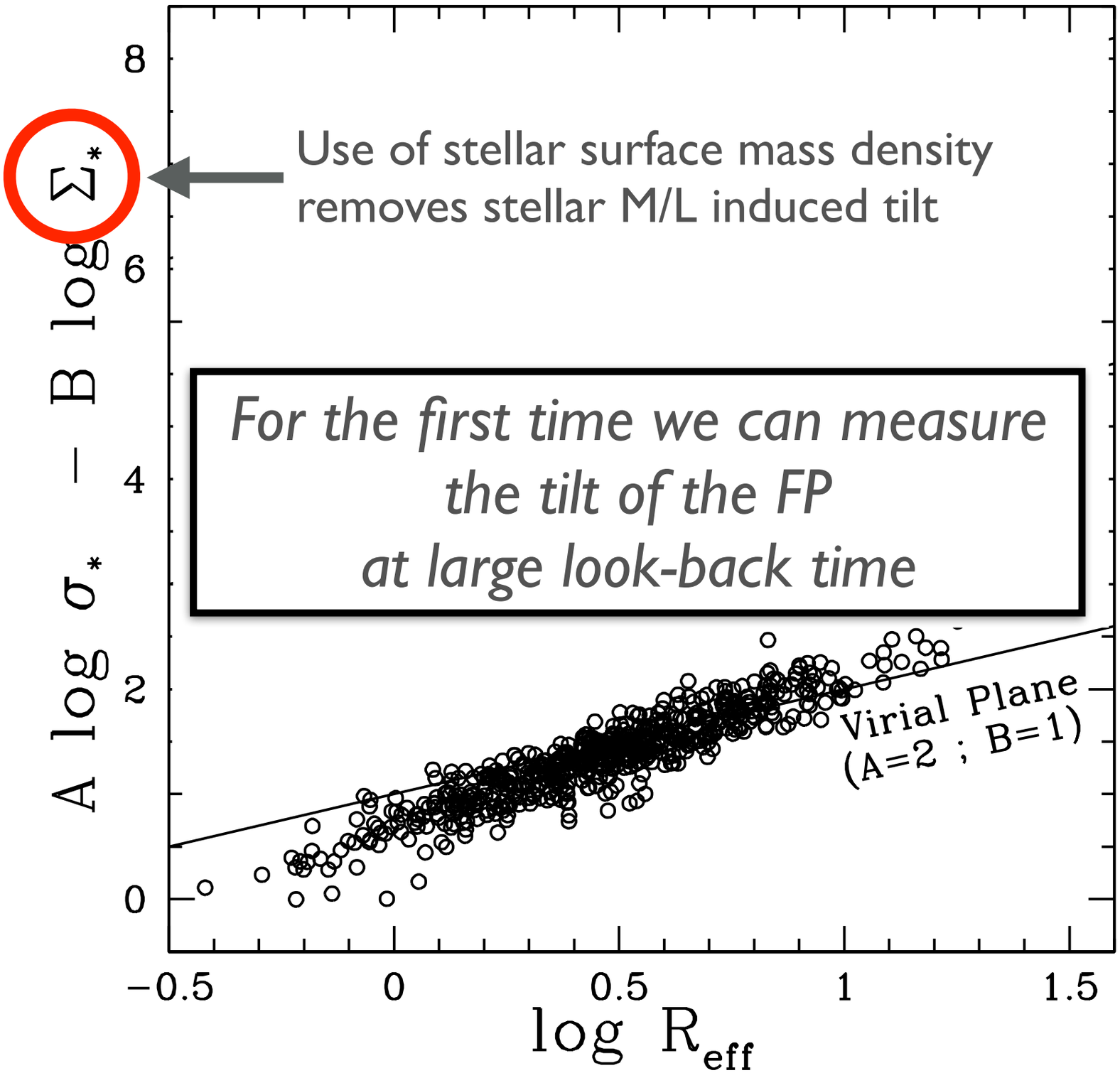
The Faber-Jackson relation





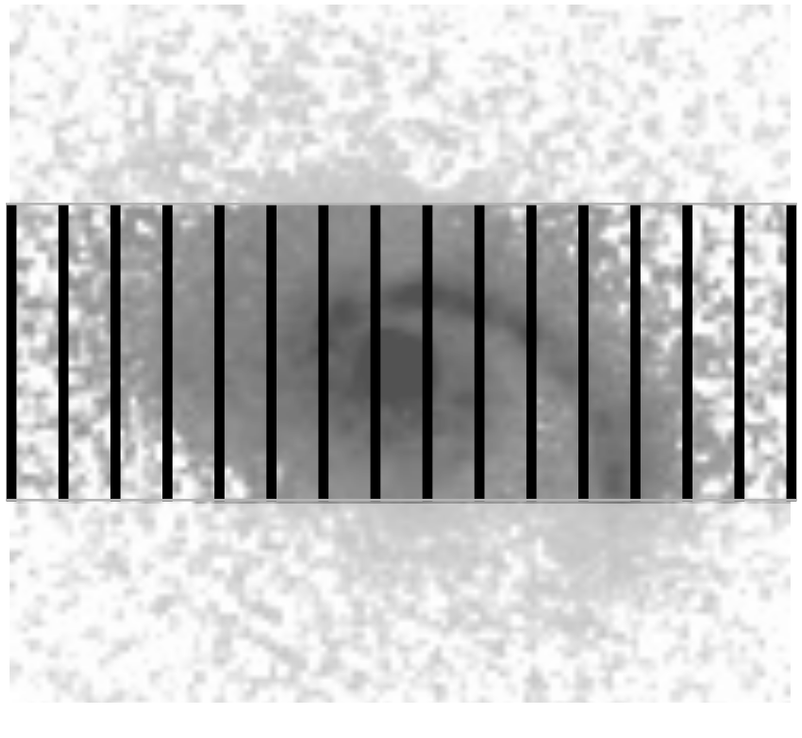
Bezanson, vdW+ subm.

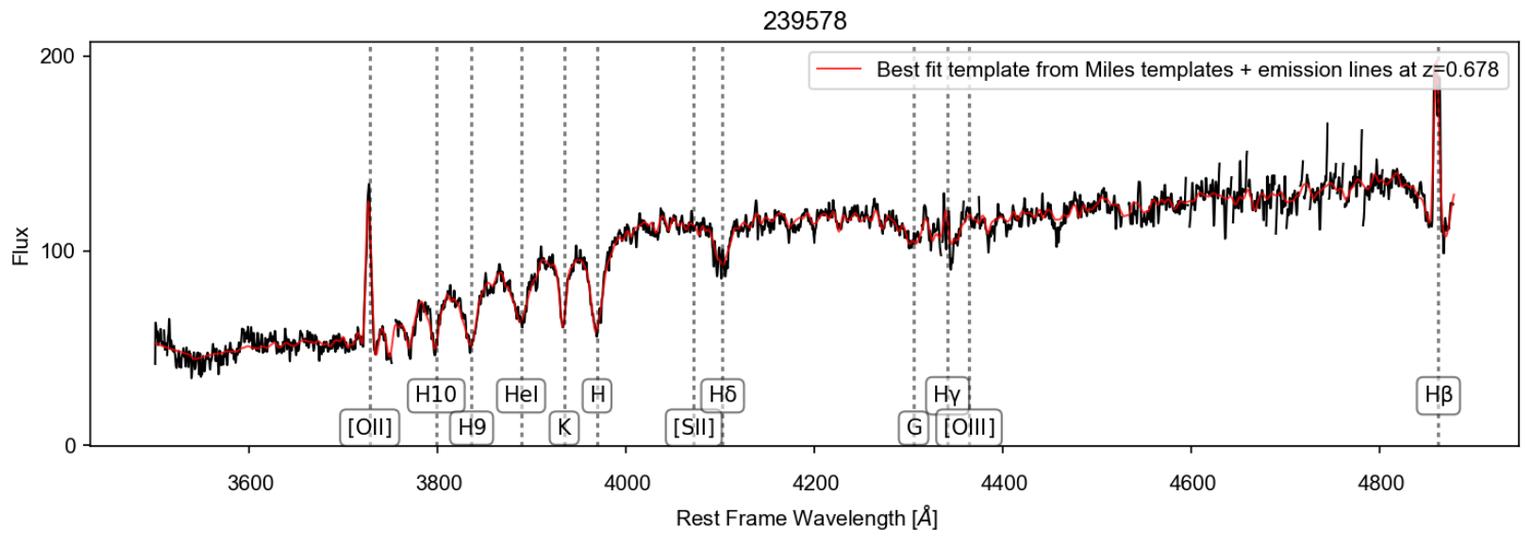
The Fundamental Plane for 600 z~0.8 galaxies



Previous works: van der Wel+05, Treu+05, Holden+12, Jorgensen&Chiboucas13, Bezanson+15

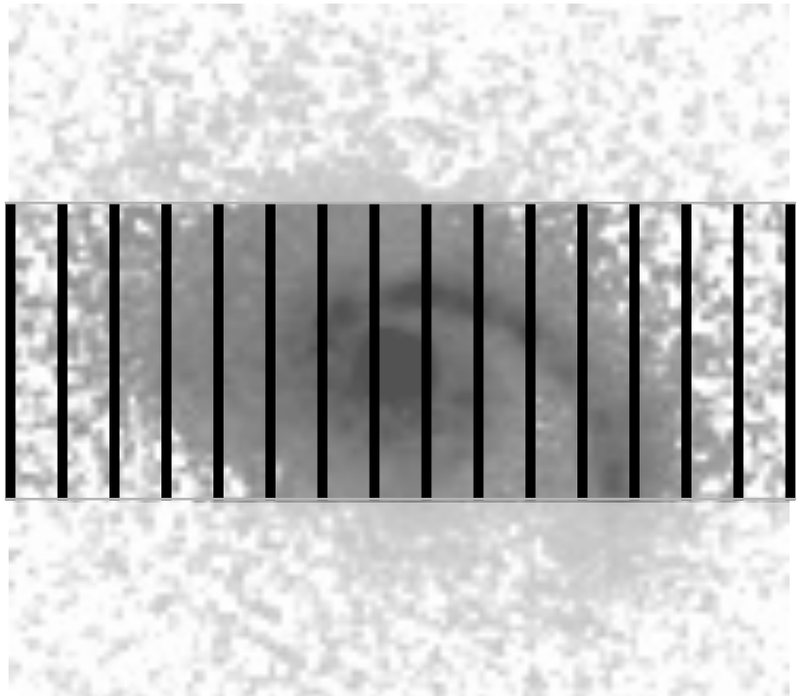
Spatially Resolved Kinematics





z = 0.68
Mstar = 4 x 10^{10} Msol
SFR = 28 Msol/yr

Spatially Resolved Kinematics



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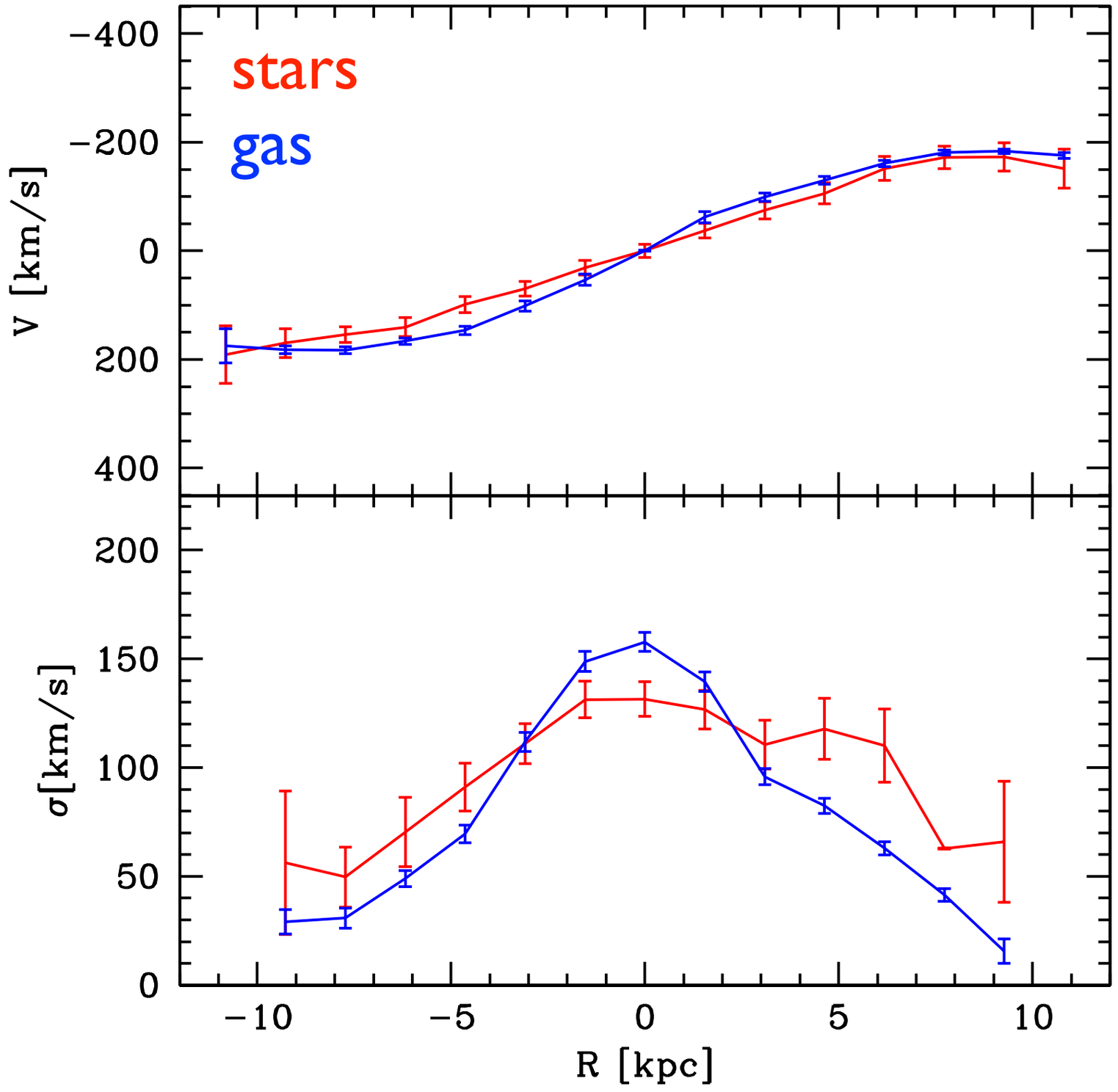
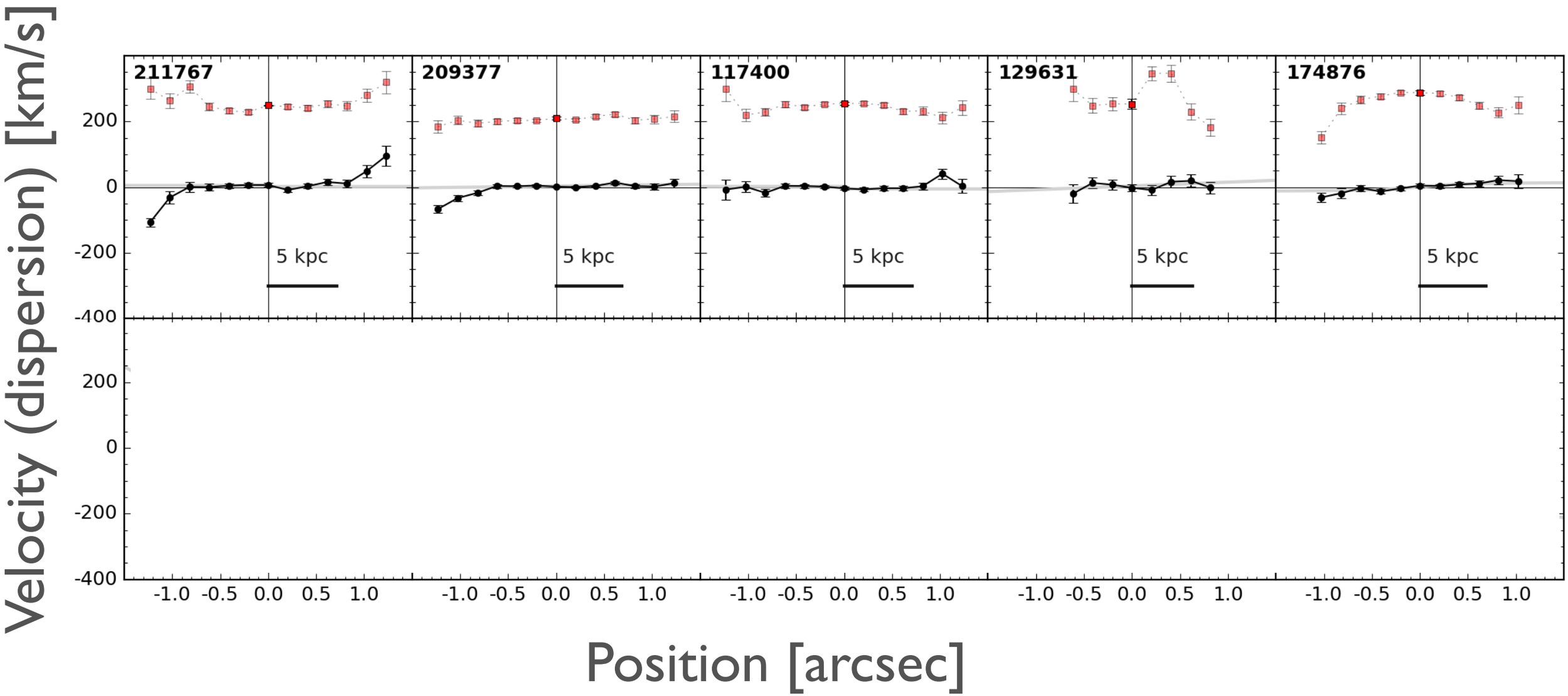
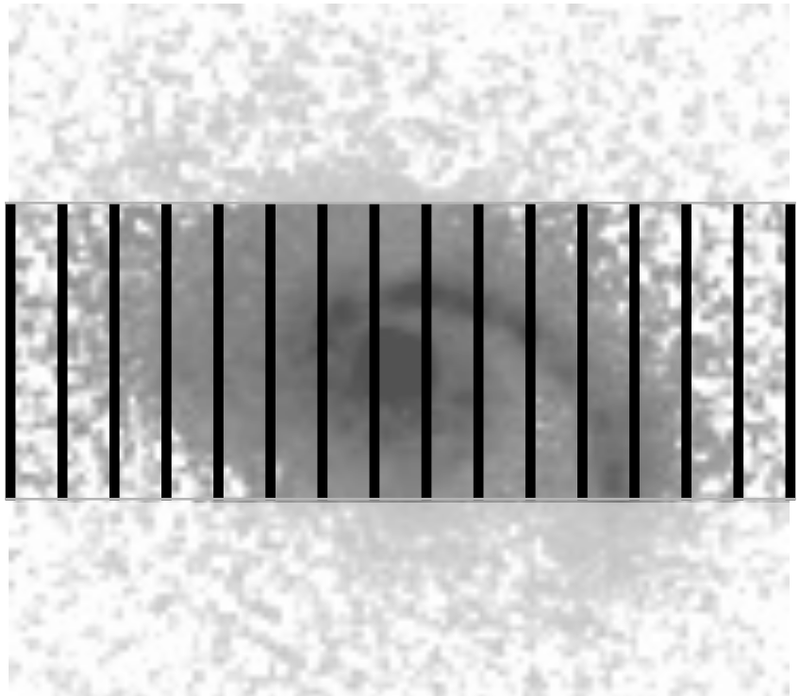


Stellar rotation in massive, passive galaxies



Bezanson, van der Wel et al. (2018)

Spatially Resolved Kinematics



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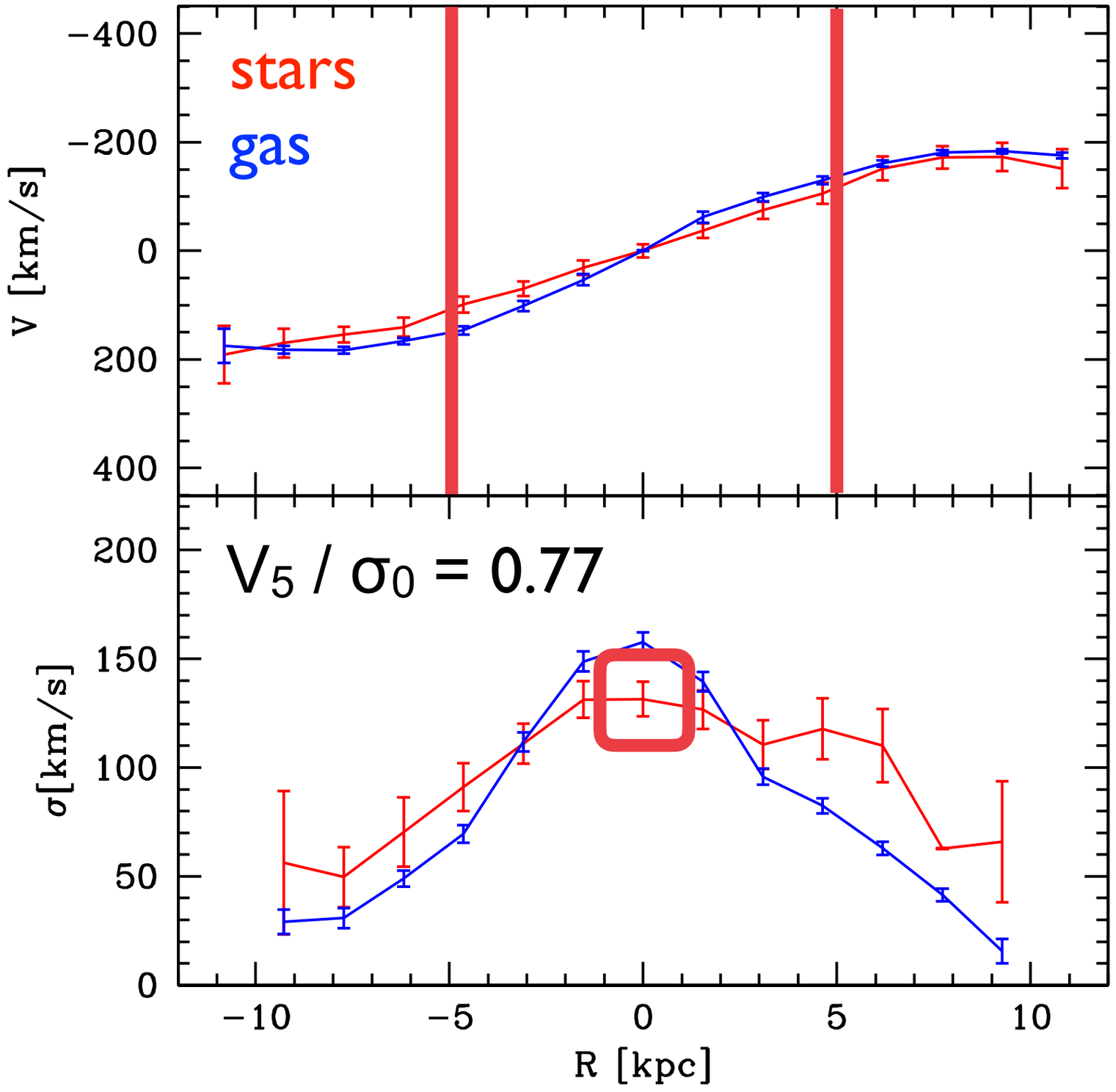
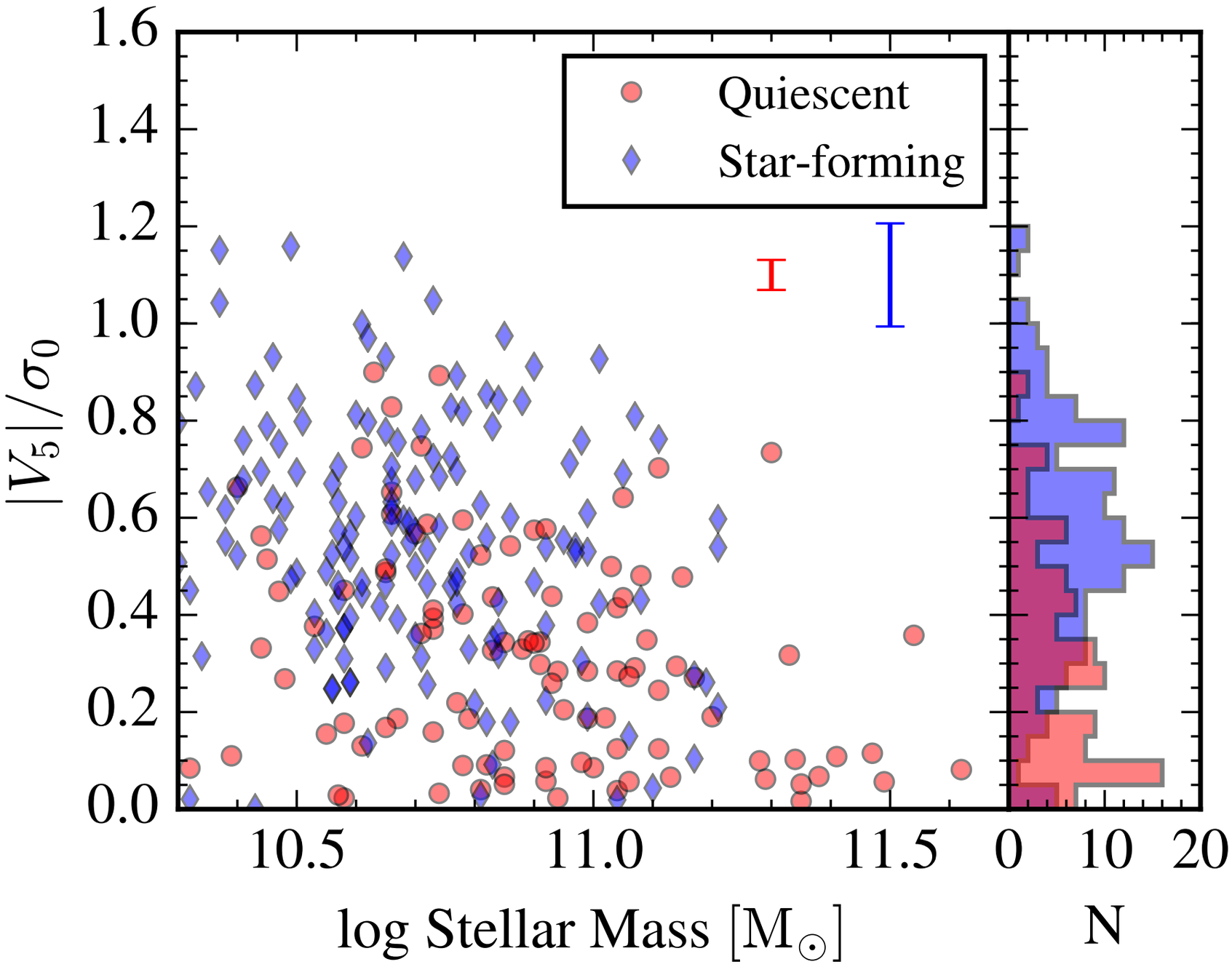
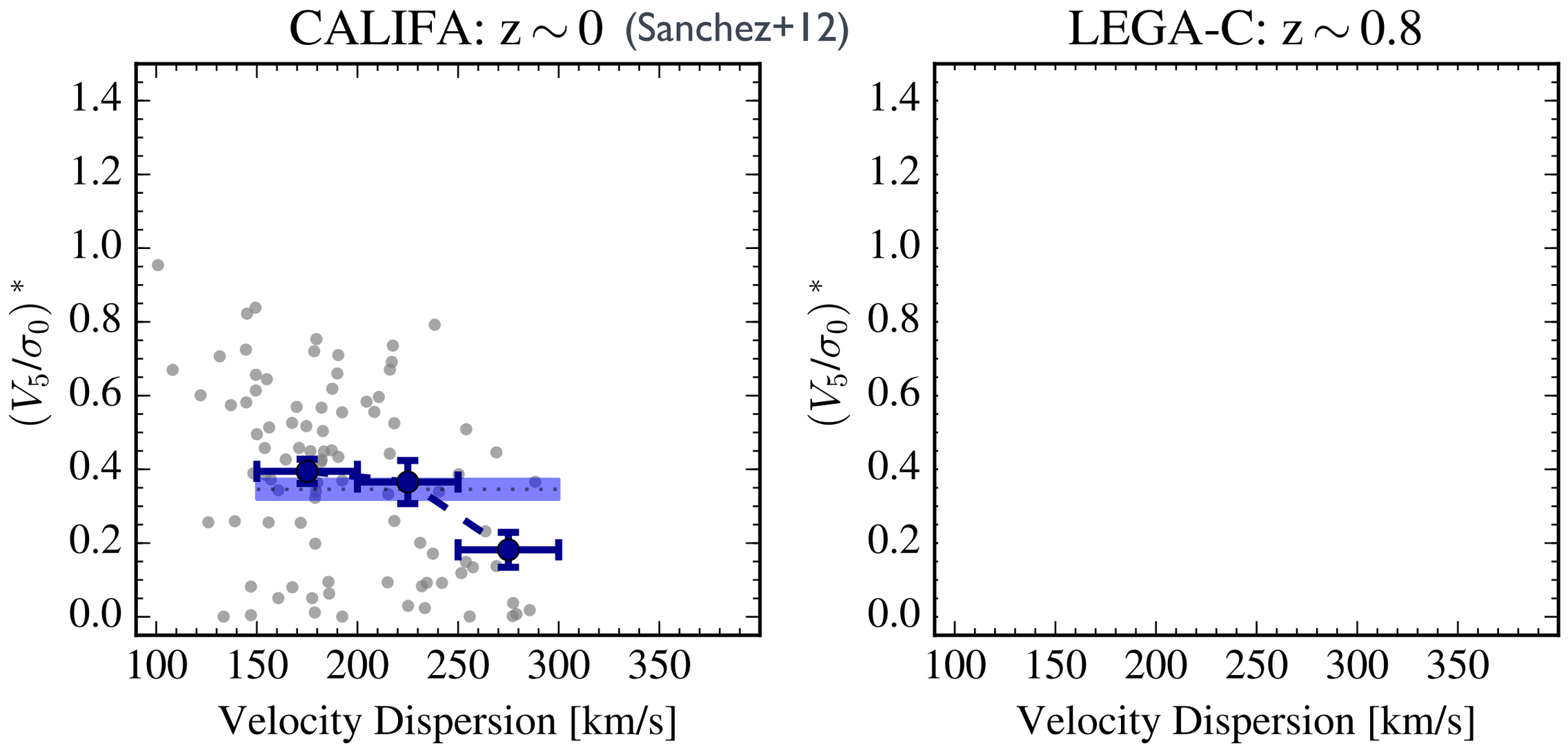


Stellar rotation distribution



Bezanson, van der Wel et al. (2018)

Stellar rotation in passive galaxies



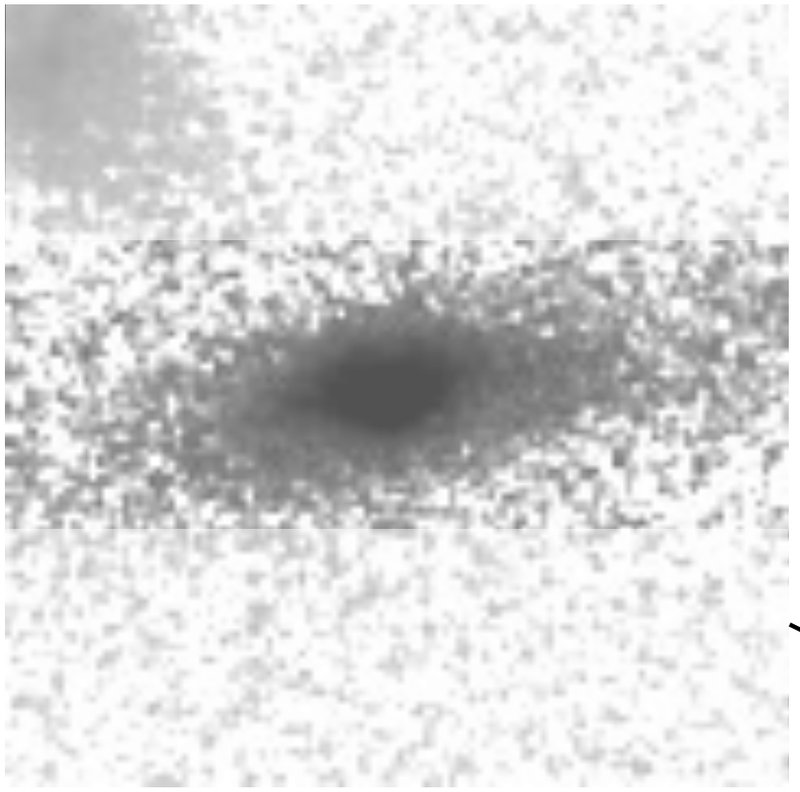
The decrease in rotational support implies significant merging activity

Previous work:
25 z~1 ellipticals (van der Wel+08)
2 z~2 lensed galaxies (Newman+15; Toft+17)

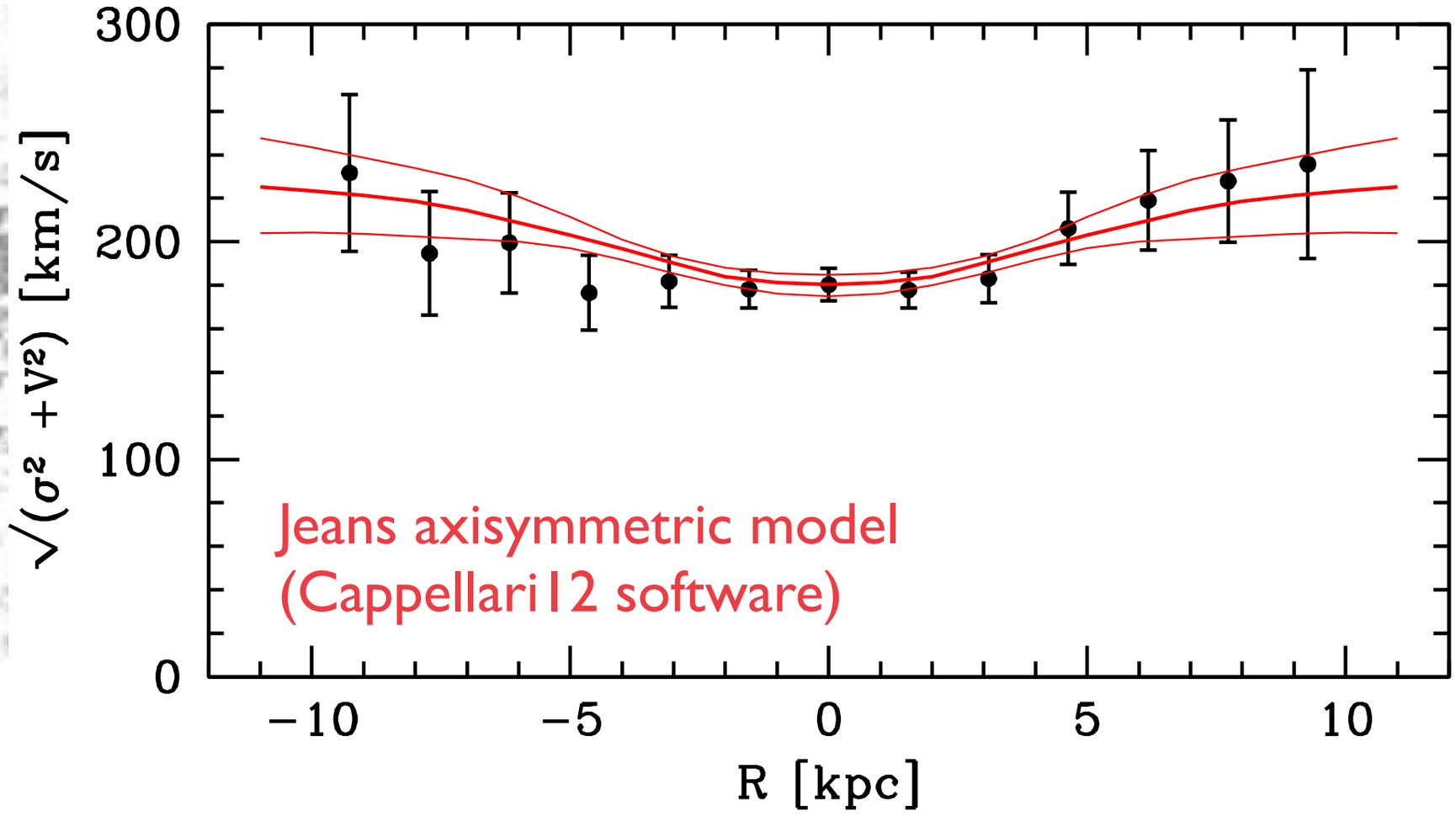
Bezanson, van der Wel et al. (2018)

Jeans dynamical modeling

$\sqrt{(\sigma^2 + V^2)} \equiv V_{rms} \sim \sigma_e$ (cf. Cappellari's talk)



z = 0.75
Mstar = 9 x 10^{10} Msol
SFR = 6 Msol/yr



van Houdt, van der Wel et al. (in prep.)

Jeans dynamical modeling

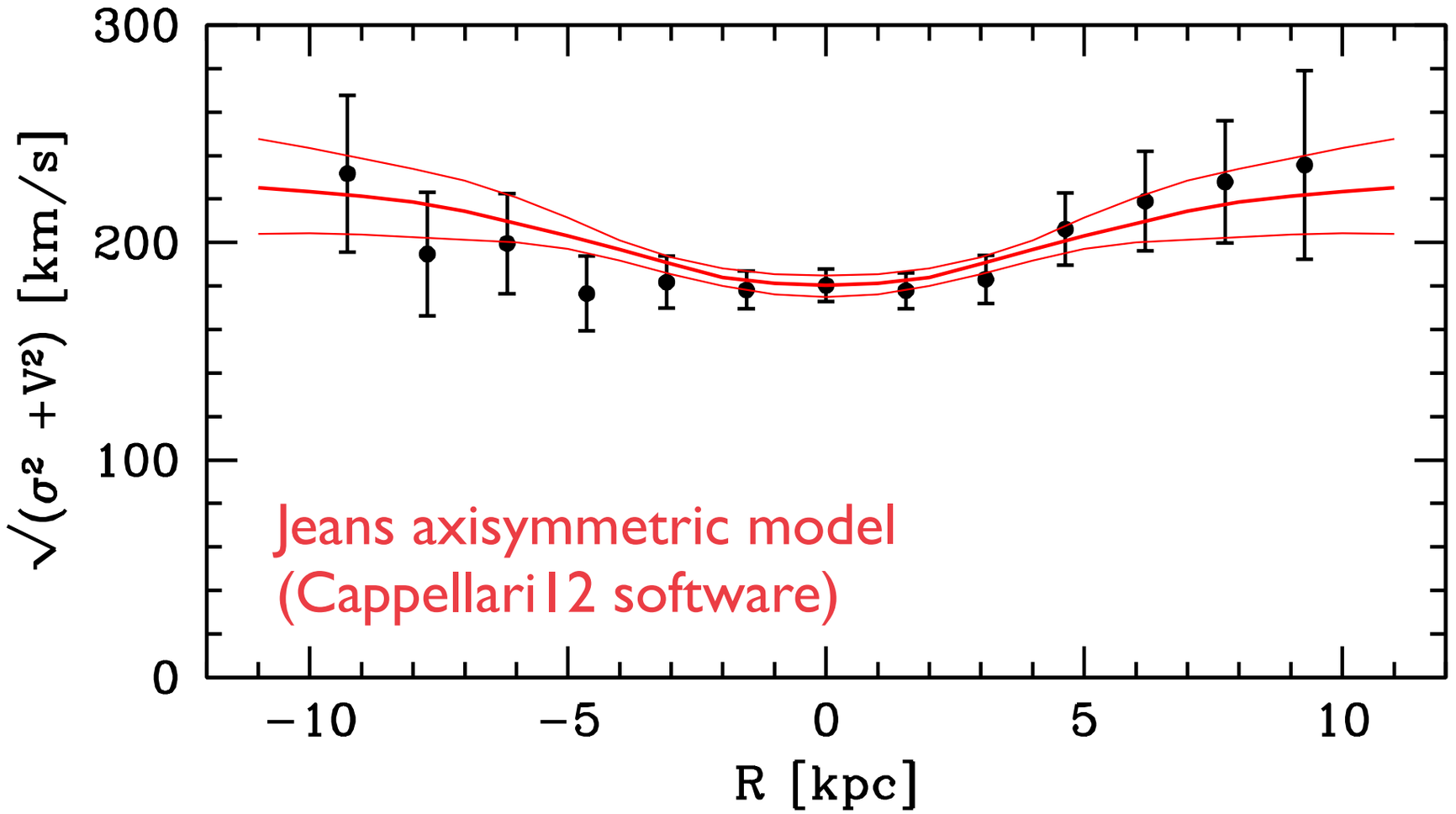
$\sqrt{(\sigma^2 + V^2)} \equiv V_{rms} \sim \sigma_e$ (cf. Cappellari's talk)

Free parameters:

- stellar M/L
- NFW halo
- Inclination
- Anisotropy

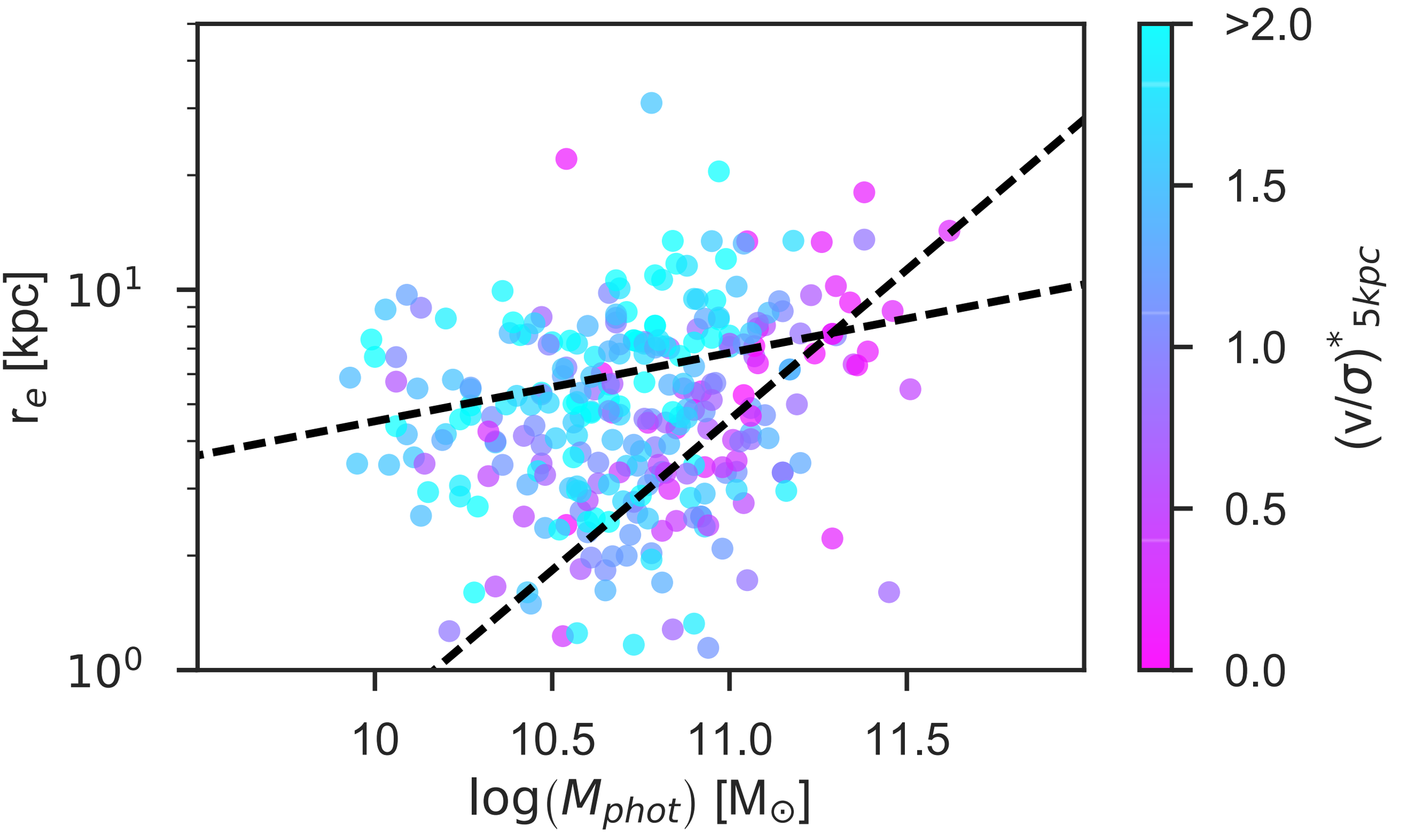
$M = 2.7 \times 10^{11}$ Msol

$(V_5 / \sigma_0)_{intr} = 1.3$



van Houdt, van der Wel et al. (in prep.)

Dynamical Structure of z~0.8 galaxies



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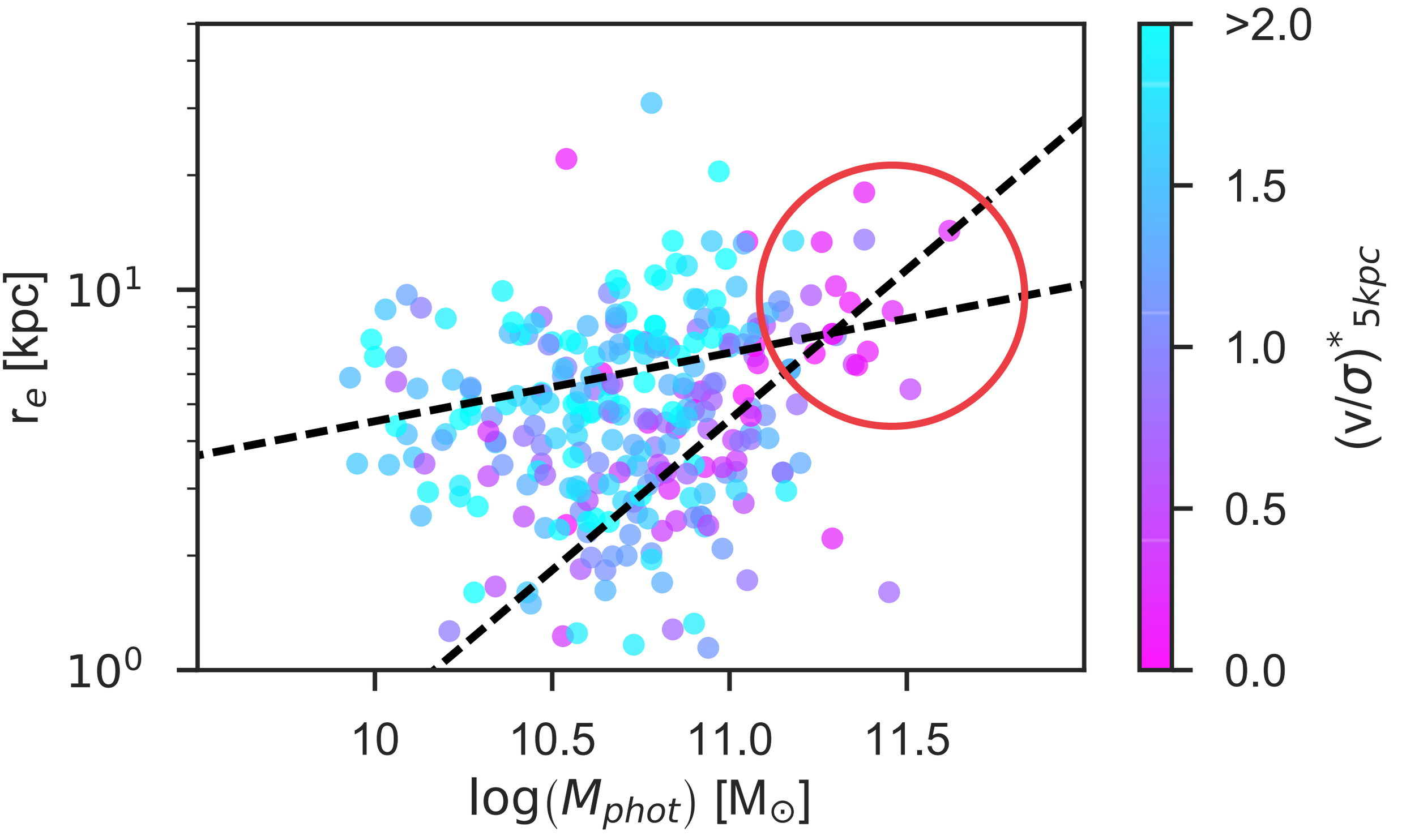

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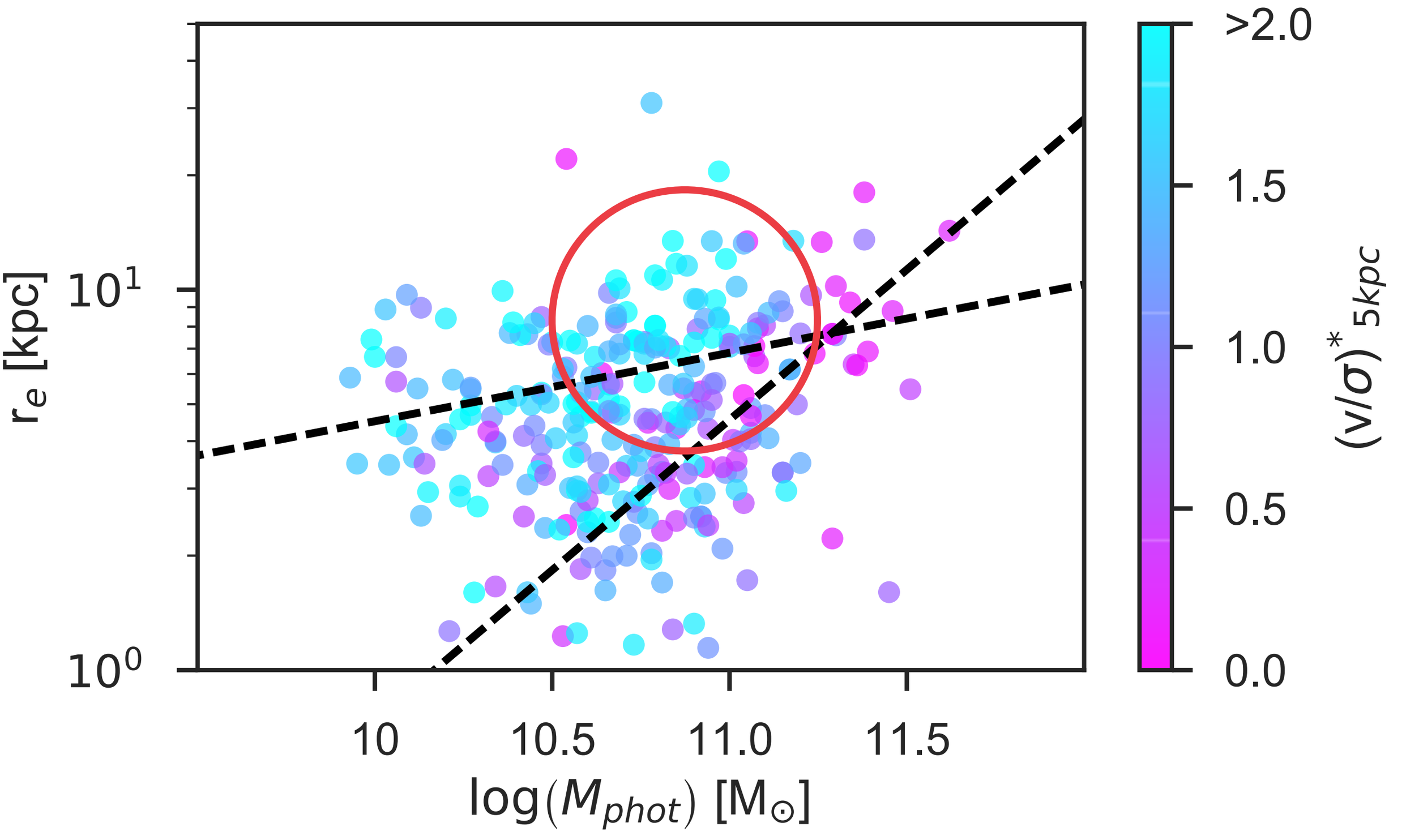

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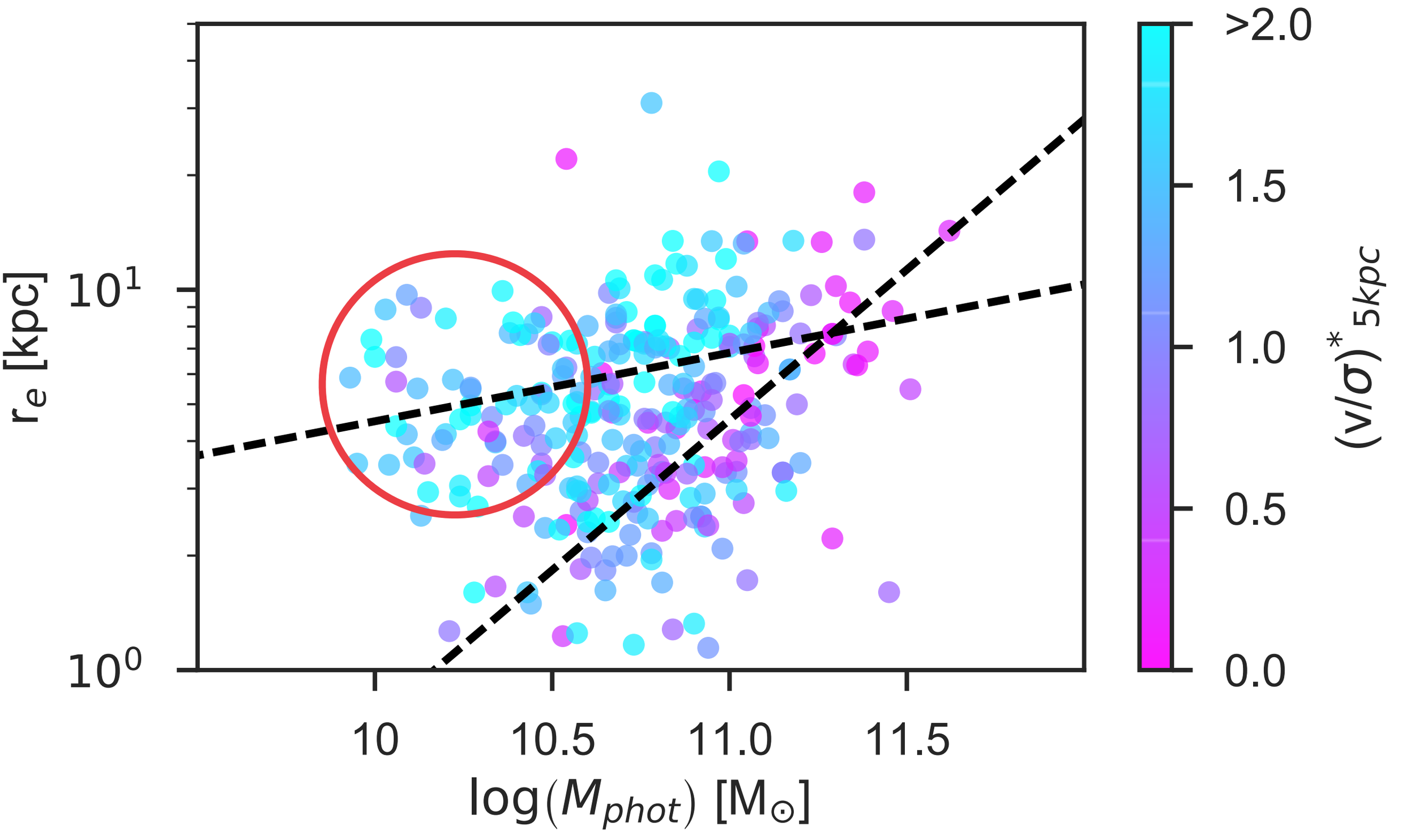

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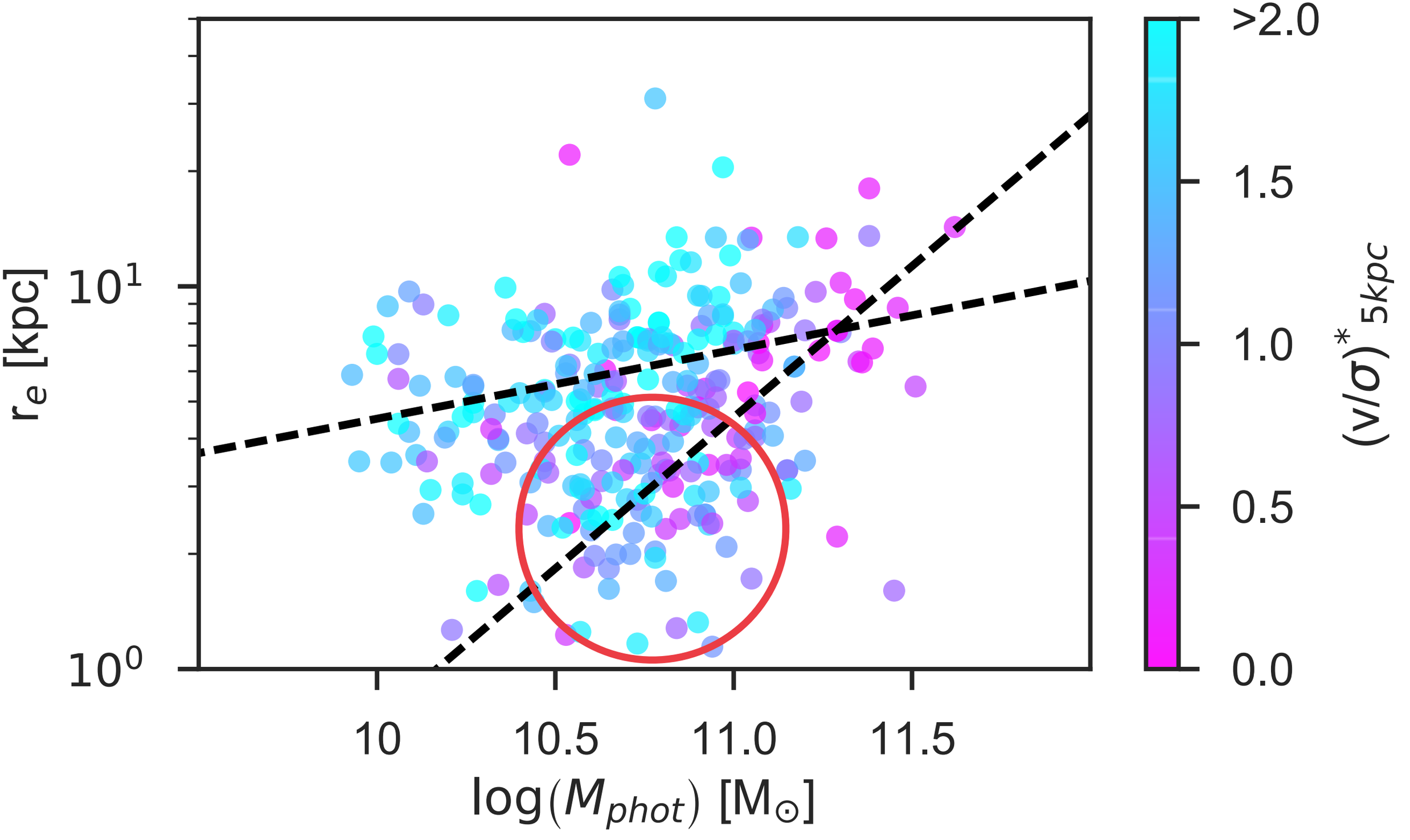
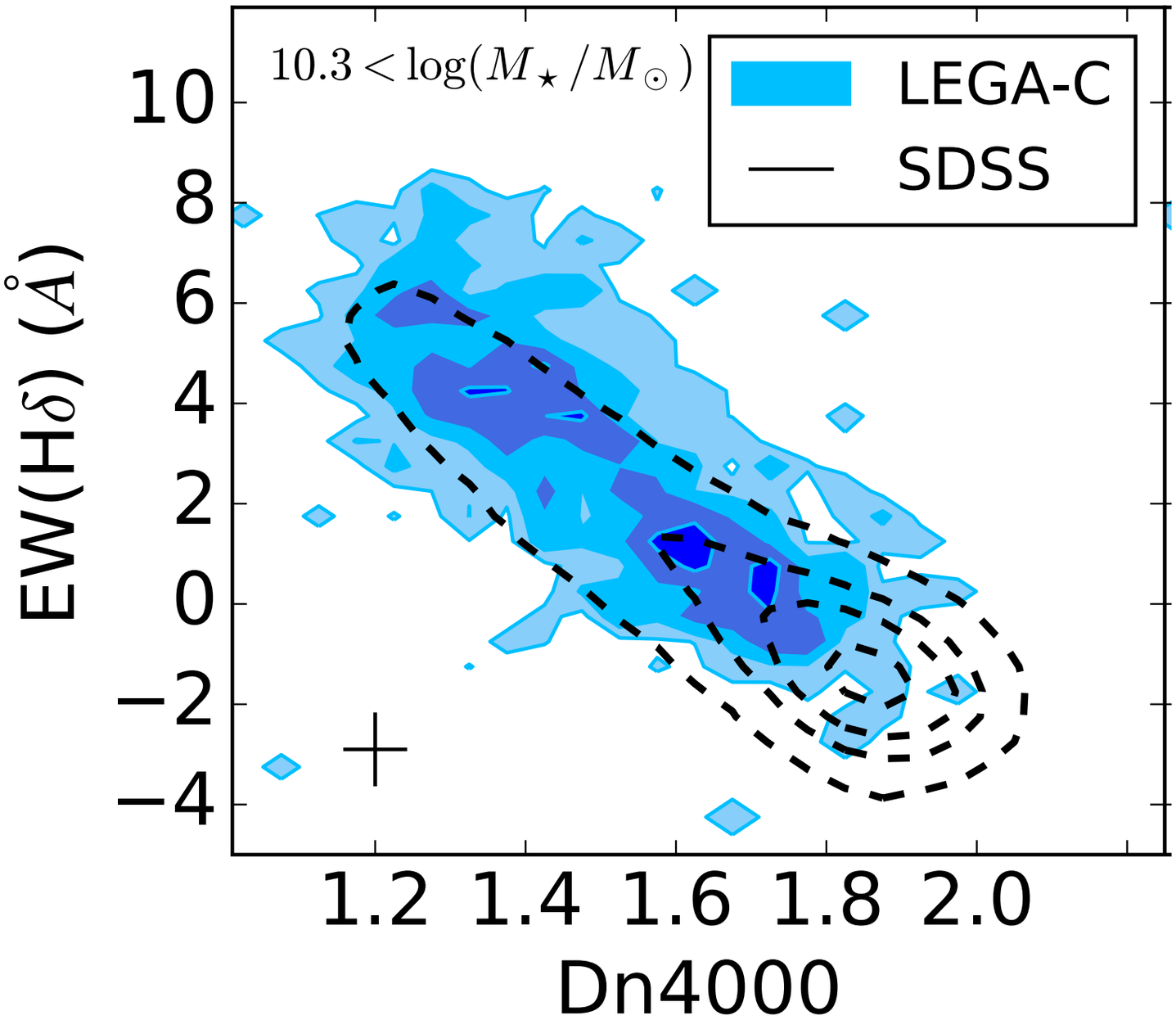


van Houdt, van der Wel et al. (in prep.)

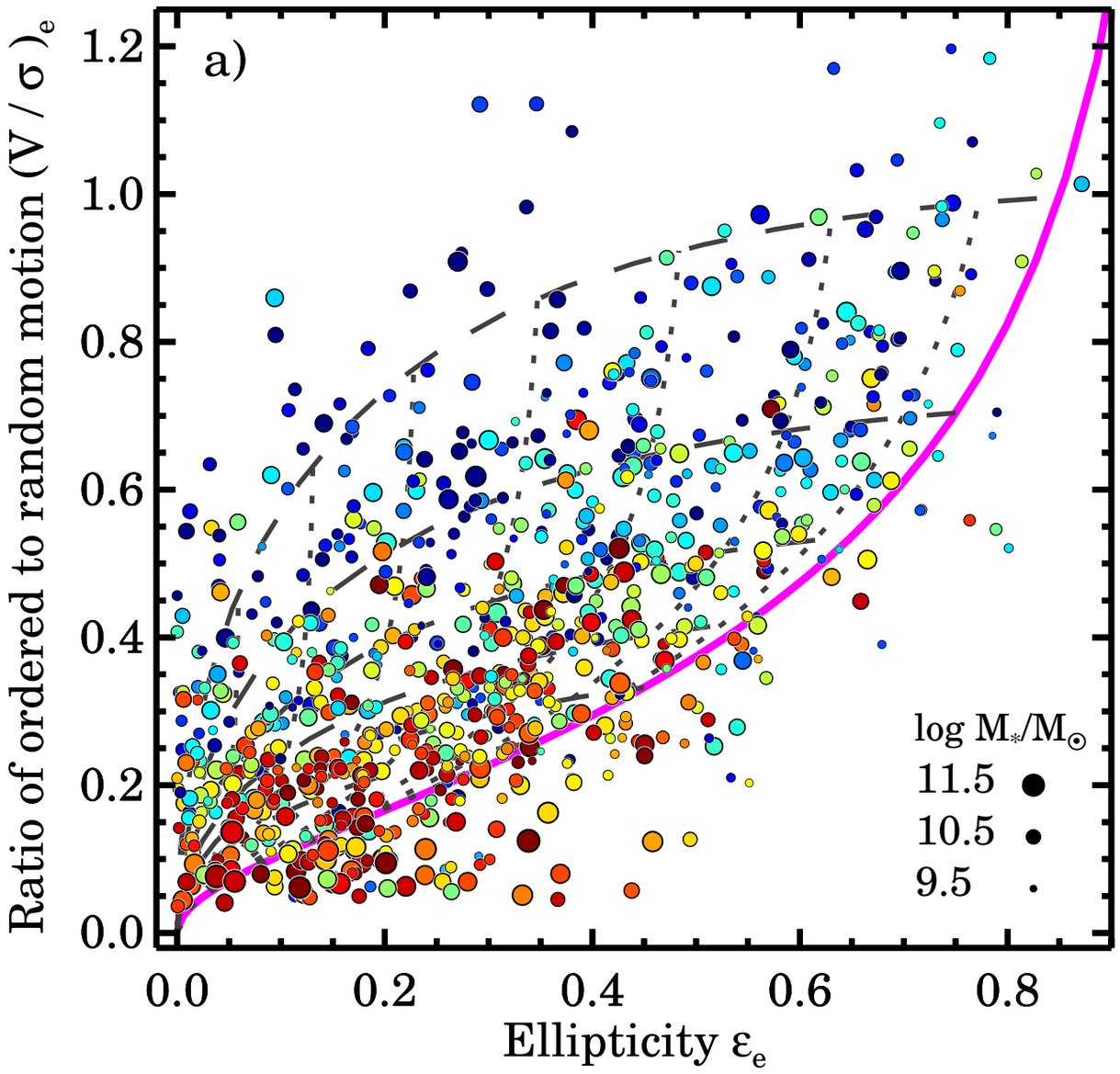
Stellar Populations



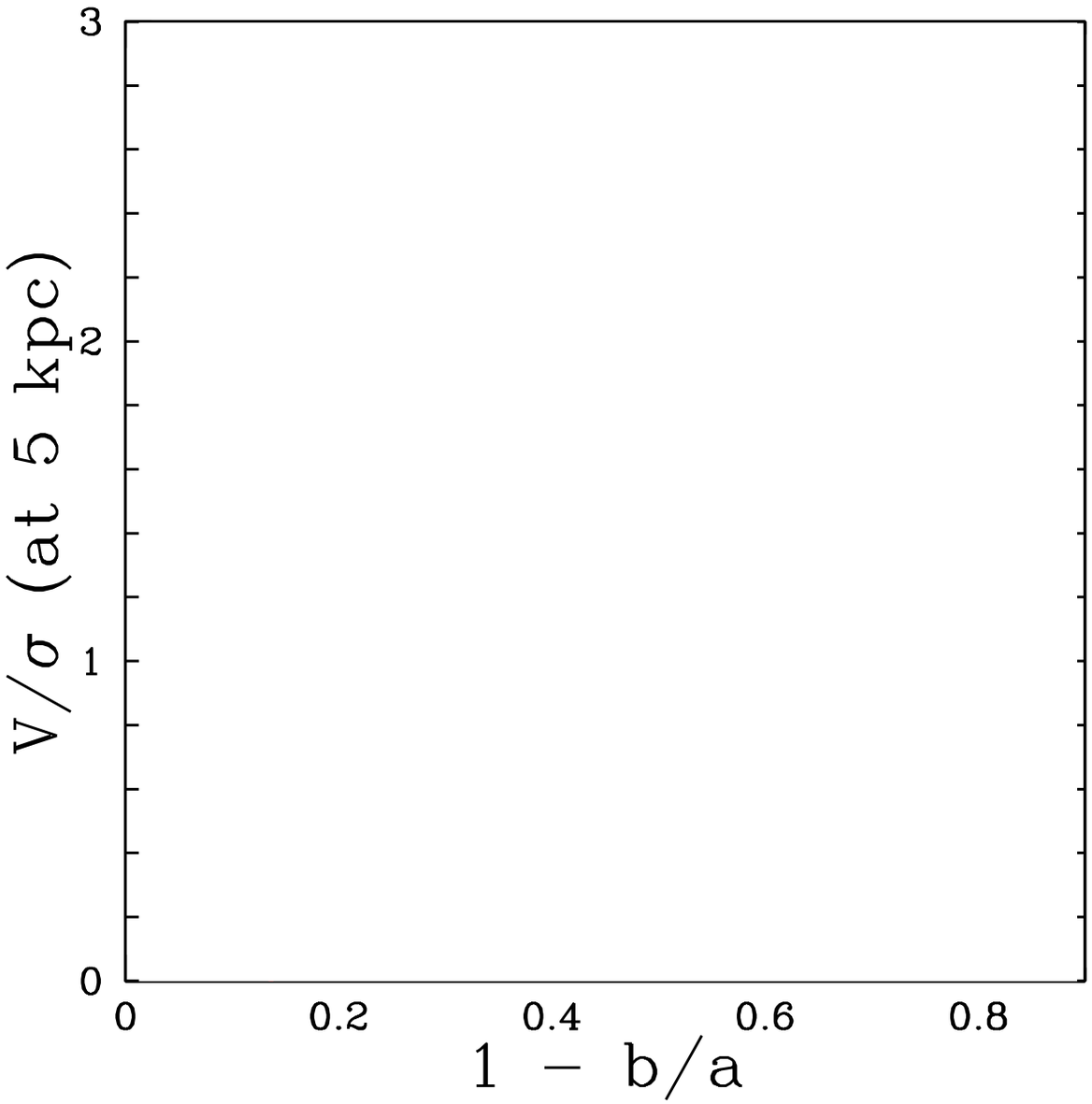
Wu, van der Wel et al. (2018)

Dynamical Structure vs. Stellar Populations

z=0 (SAMI; van de Sande et al. 2018)



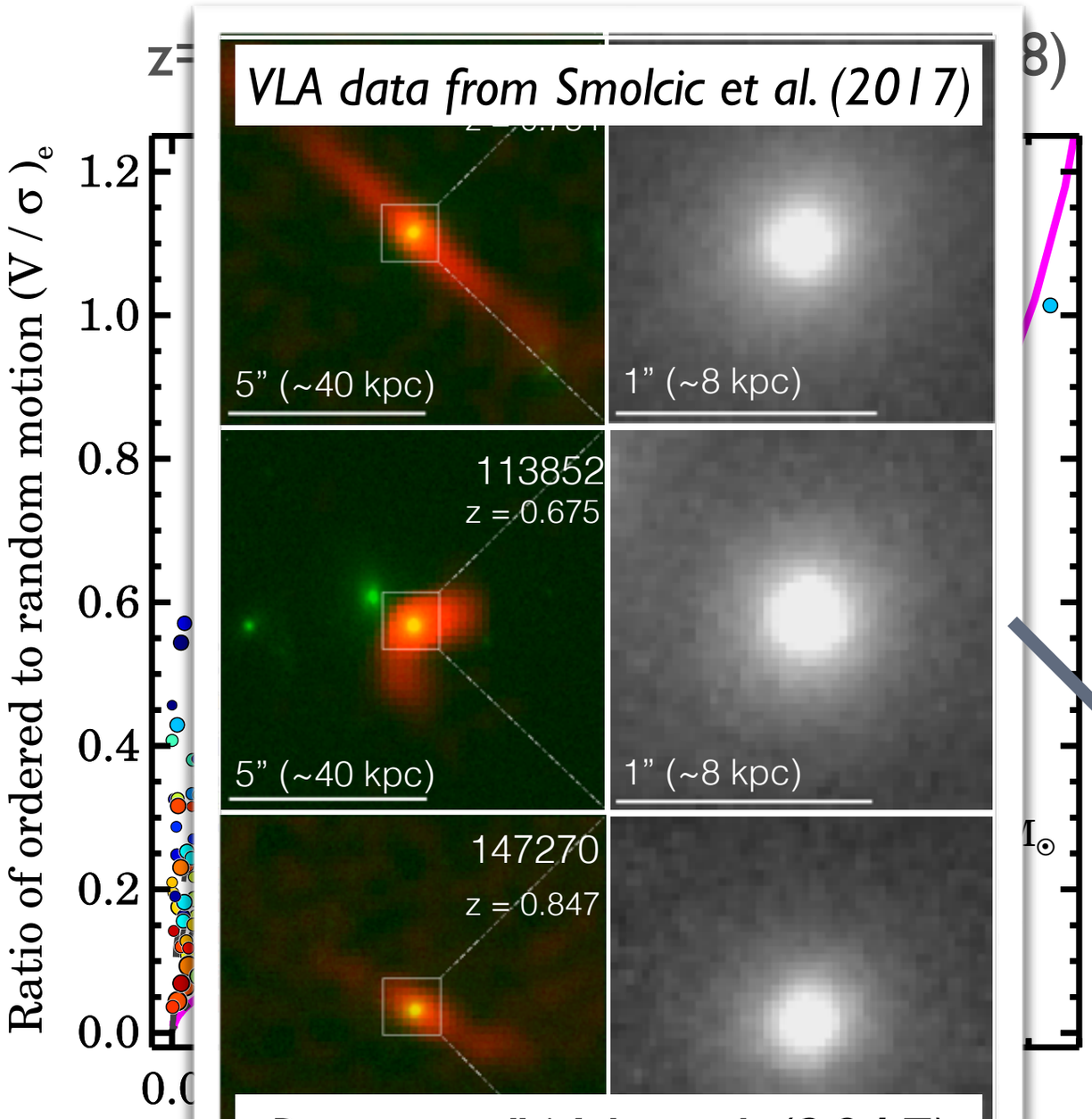
z=0.8 (LEGA-C; van Houdt et al. in prep.)



Symbol size: stellar mass

Color: Stellar population age

Dynamical Structure vs. Stellar Populations



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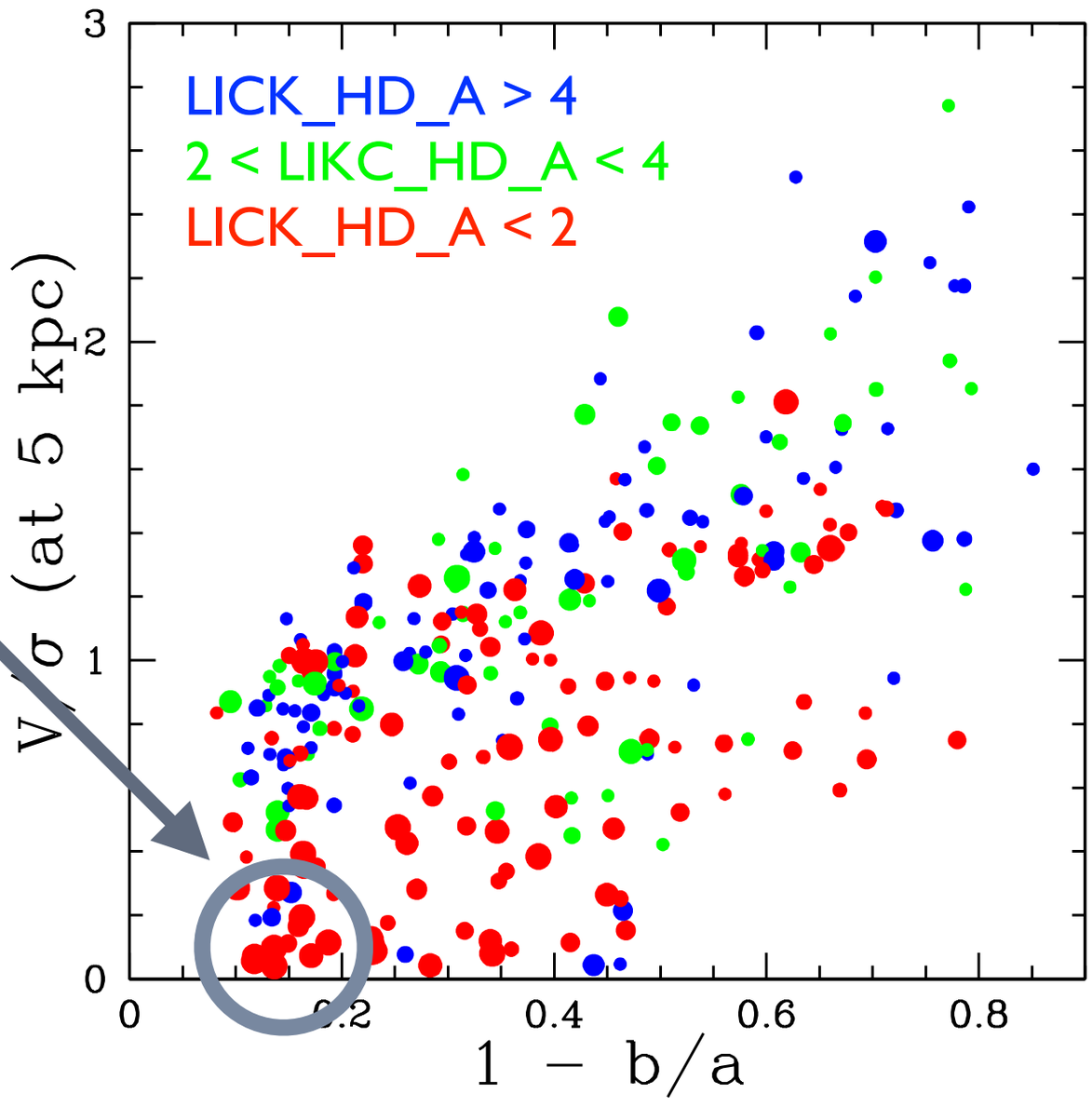

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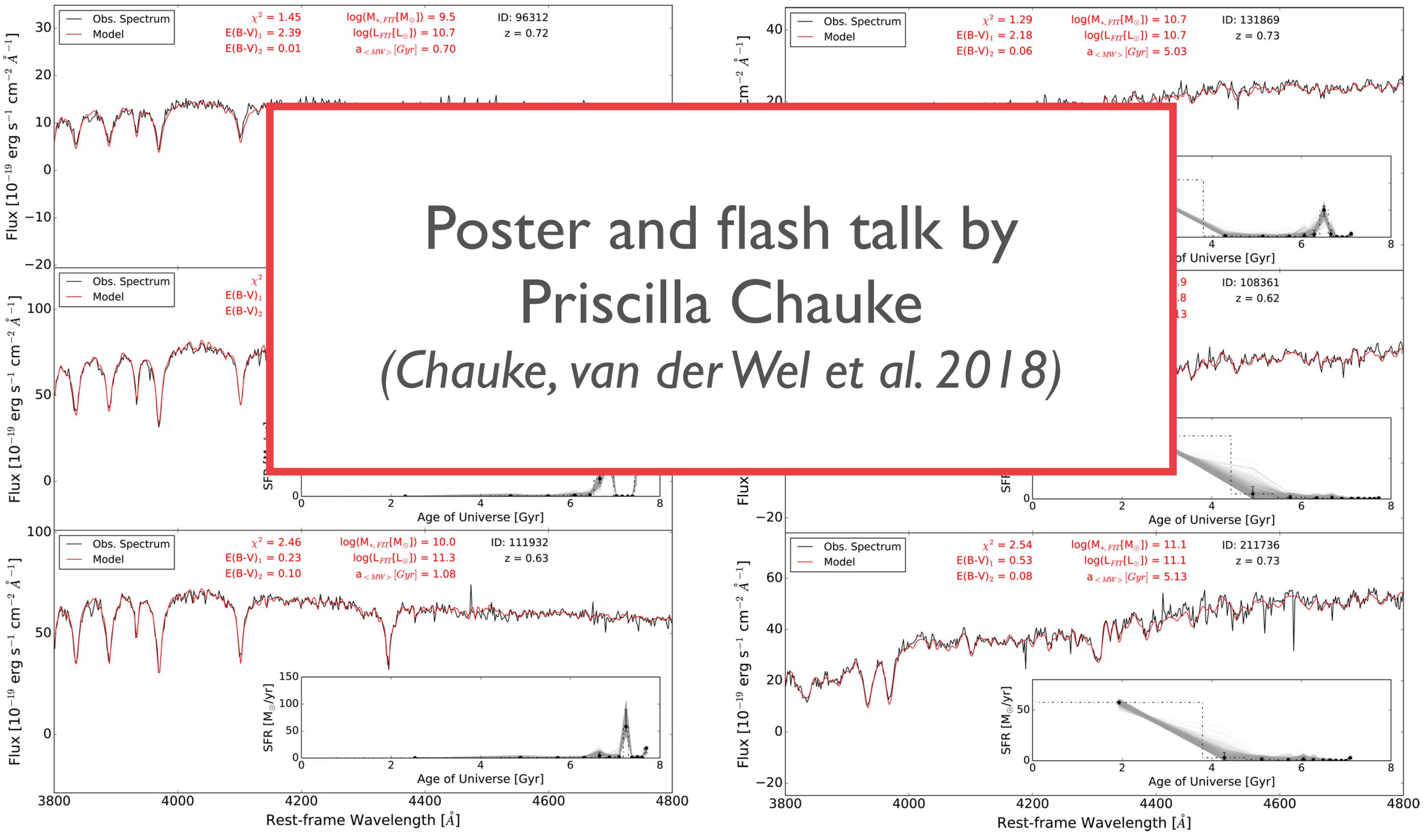
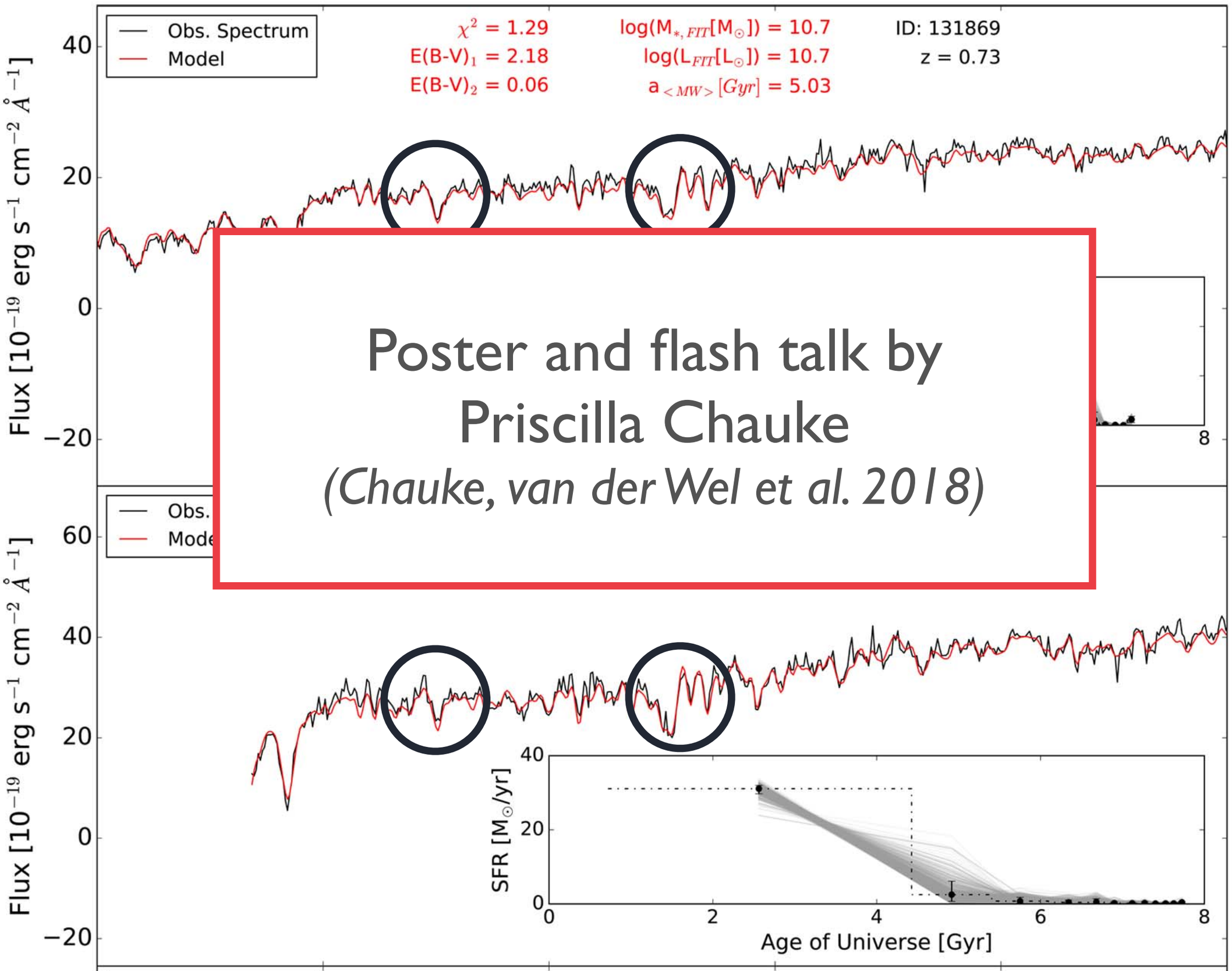
Reconstruction of Star Formation Histories



Poster and flash talk by Priscilla Chauke

(Chauke, van der Wel et al. 2018)

Reconstruction of Star Formation Histories



Poster and flash talk by Priscilla Chauke

(Chauke, van der Wel et al. 2018)

Summary & Conclusions

- LE
- Ev
- Sig
- Dy

How do galaxies evolve after they cease to form stars?

Answer:
Substantially, loosing 30-50% of their rotational support between z~0.8 and the present

This is direct evidence for the `dry' merging scenario invoked to explain size evolution