The Gemini CLuster Astrophysics Spectroscopic Survey (GCLASS)

Adam Muzzin, York University

Gillian Wilson, Howard Yee, Remco van der Burg, Jasleen Matharu, Michael Balogh, Andrea Biviano, David Gilbank, Henk Hoekstra, Ricardo Demarco, Chris Lidman, Sean McGee, Allison Noble, Tracy Webb, Ryan Foltz

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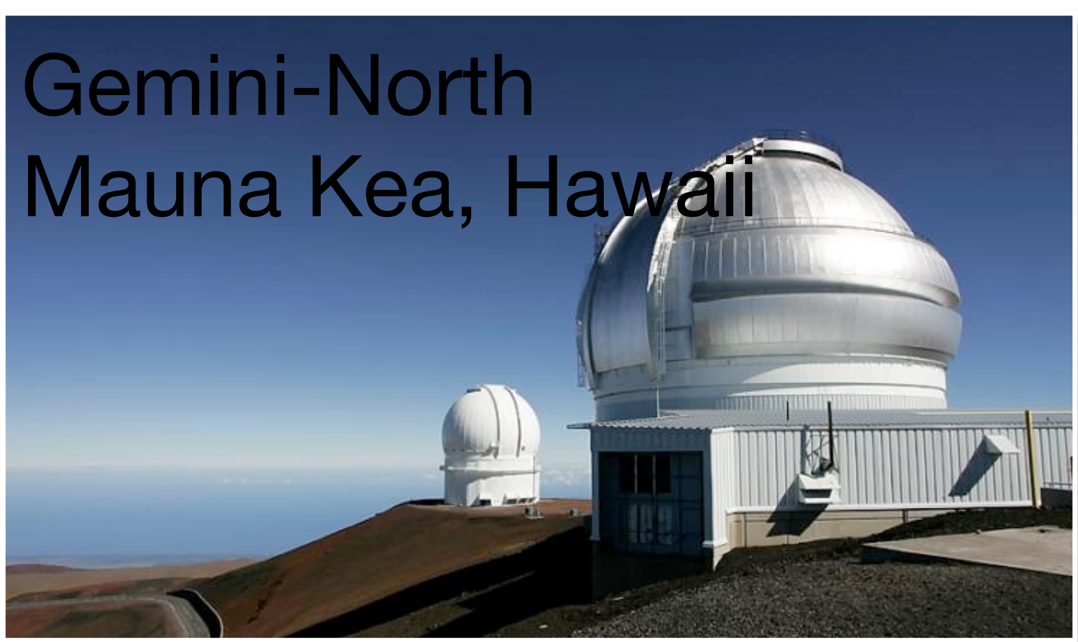

Spectroscopic survey of 10 rich, IR-selected clusters at $0.86 < z < 1.34$ with Gemini/GMOS

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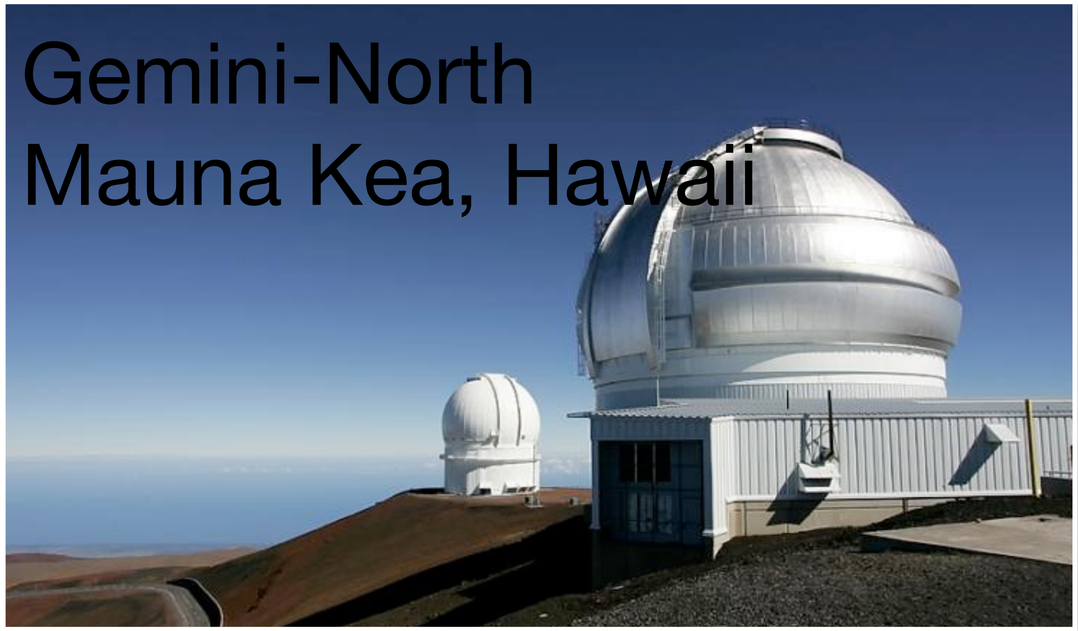

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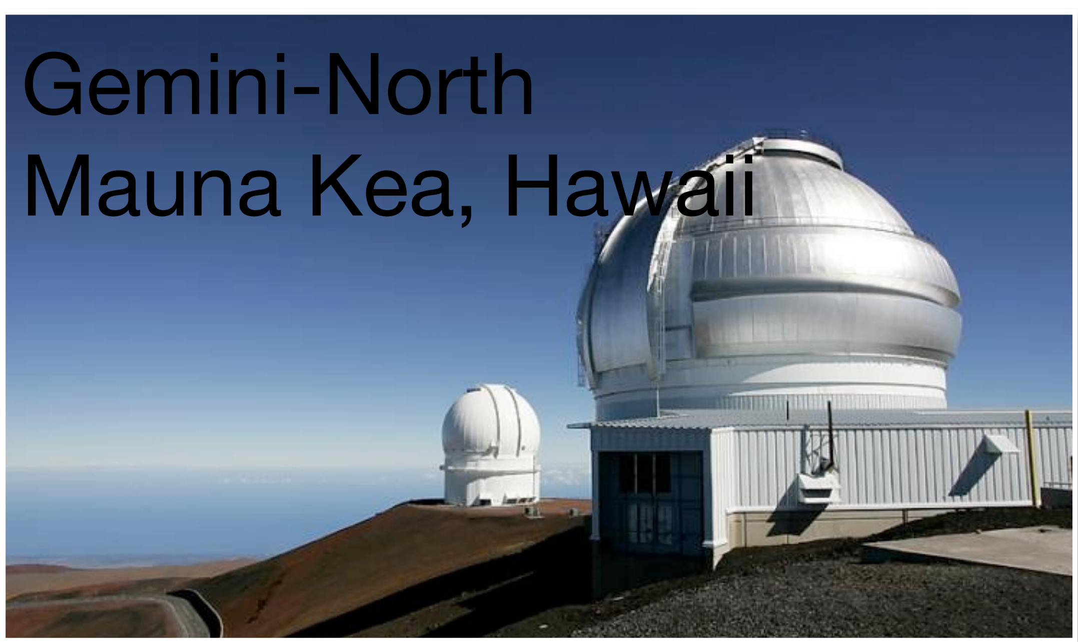

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High spectroscopic completeness, ~500 members across 10 clusters

222-hour project from 2009-2012 with Gemini/GMOS (8 allocations)

GCLASS Cluster Sample

Name	Redshift	Velocity-Disp	Photometry	Members
SpARCS J003442-430753	0.867	610 km s^{-1}	ugriz,JK,IRAC	45
SpARCS J003645-441050	0.869	910 km s^{-1}	ugriz,JK,IRAC	48
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Field Galaxies	$0.85 < z < 1.20$	N/A		294

Muzzin+2009, Wilson+2009, Demarco+2010

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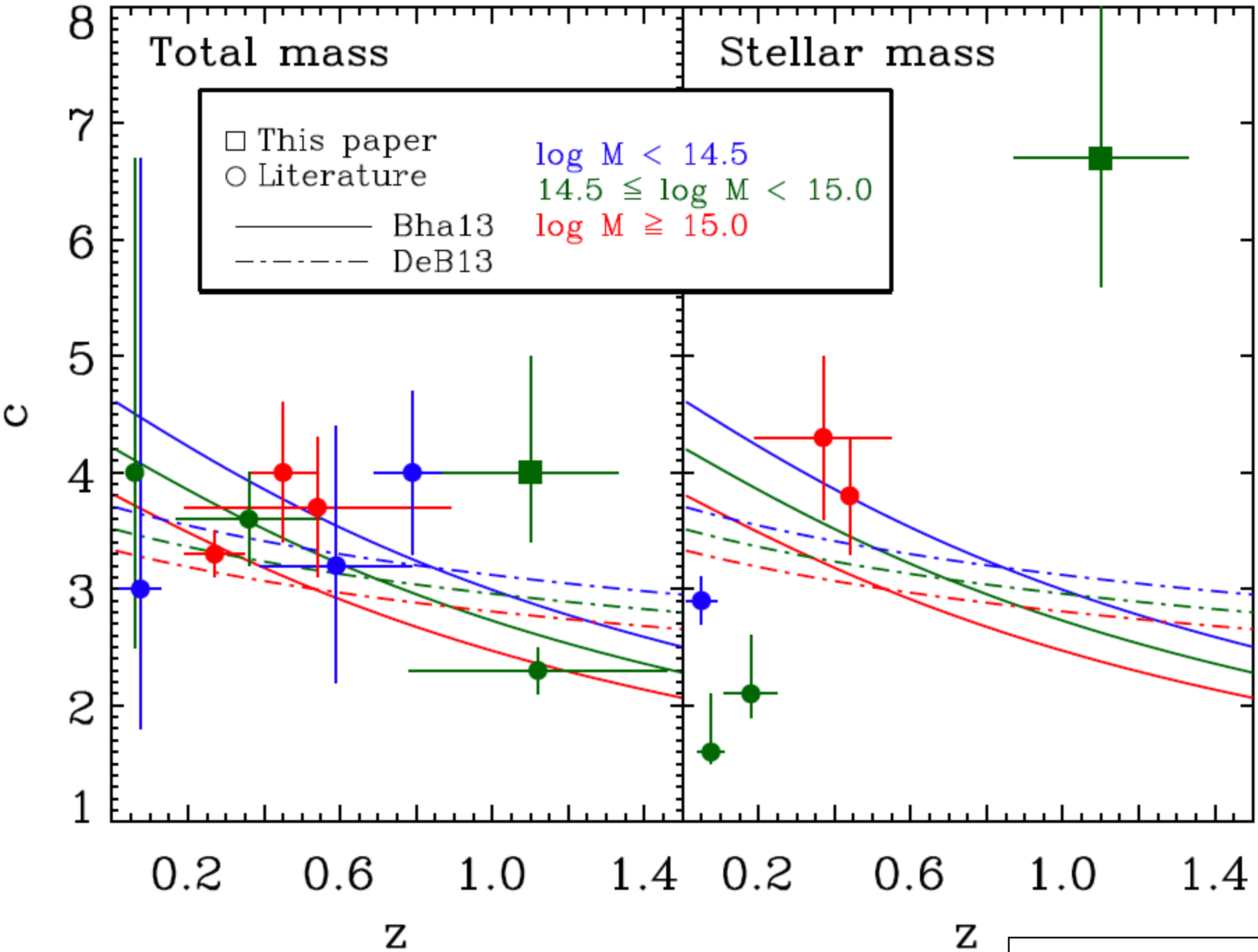
GCLASS Papers (14 published, 1 in prep)

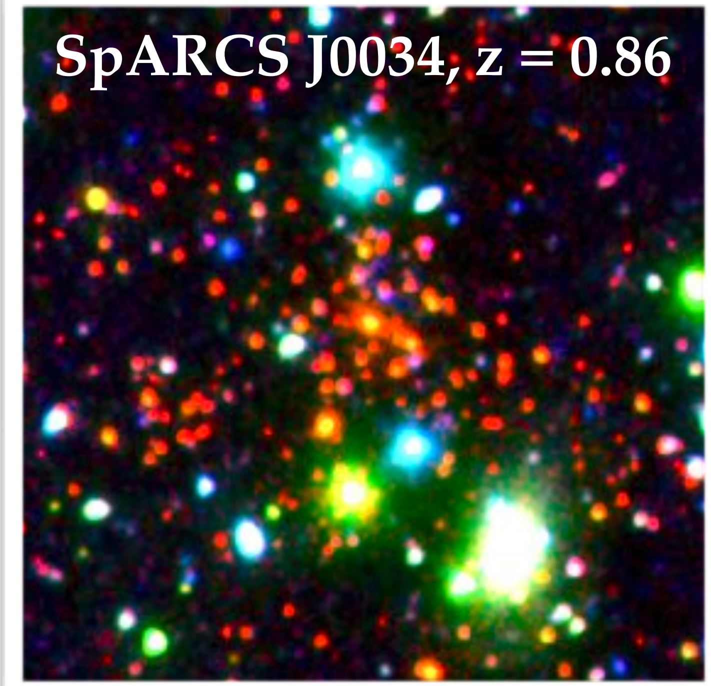
- The effect of environment on galaxy evolution at z ~ 1 **(Muzzin+2012, Balogh+2016, Matharu+in prep)**
- Mass growth of brightest cluster galaxies since z ~ 1 **(Lidman+2012, Lidman+2013)**
- Dynamics of cluster galaxies and implications for quenching **(Noble+2013, Muzzin+2014, Noble+2016)**
- Stellar mass function of cluster galaxies at z ~ 1 **(van der Burg+2013)**
- The mass-size relation of cluster and field galaxies at z ~ 1 **(Matharu+2019, Matharu+2020)**
- Total stellar baryon content and cluster assembly since z ~ 1 **(van der Burg+2014, van der Burg+2015)**
- Growth of the red-sequence in clusters since z ~ 1 **(Foltz+2015)**
- Cluster scaling relations and dark matter profiles at z ~ 1 **(Biviano+2016)**

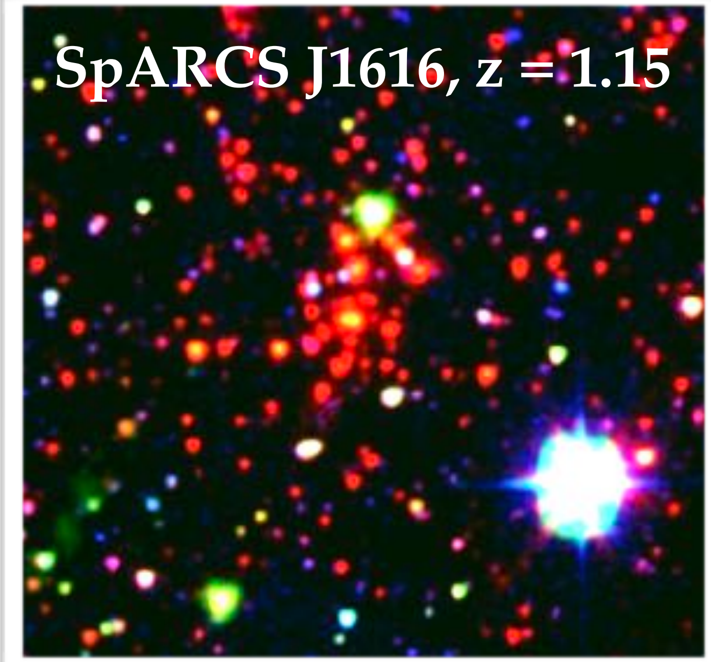
GCLASS: Key Results

- Clusters are compact and dense at $z = 1$ and grow in stellar mass inside out

1. Clusters Grow in Stellar Mass Inside Out







van der Burg+2015, Biviano+2016

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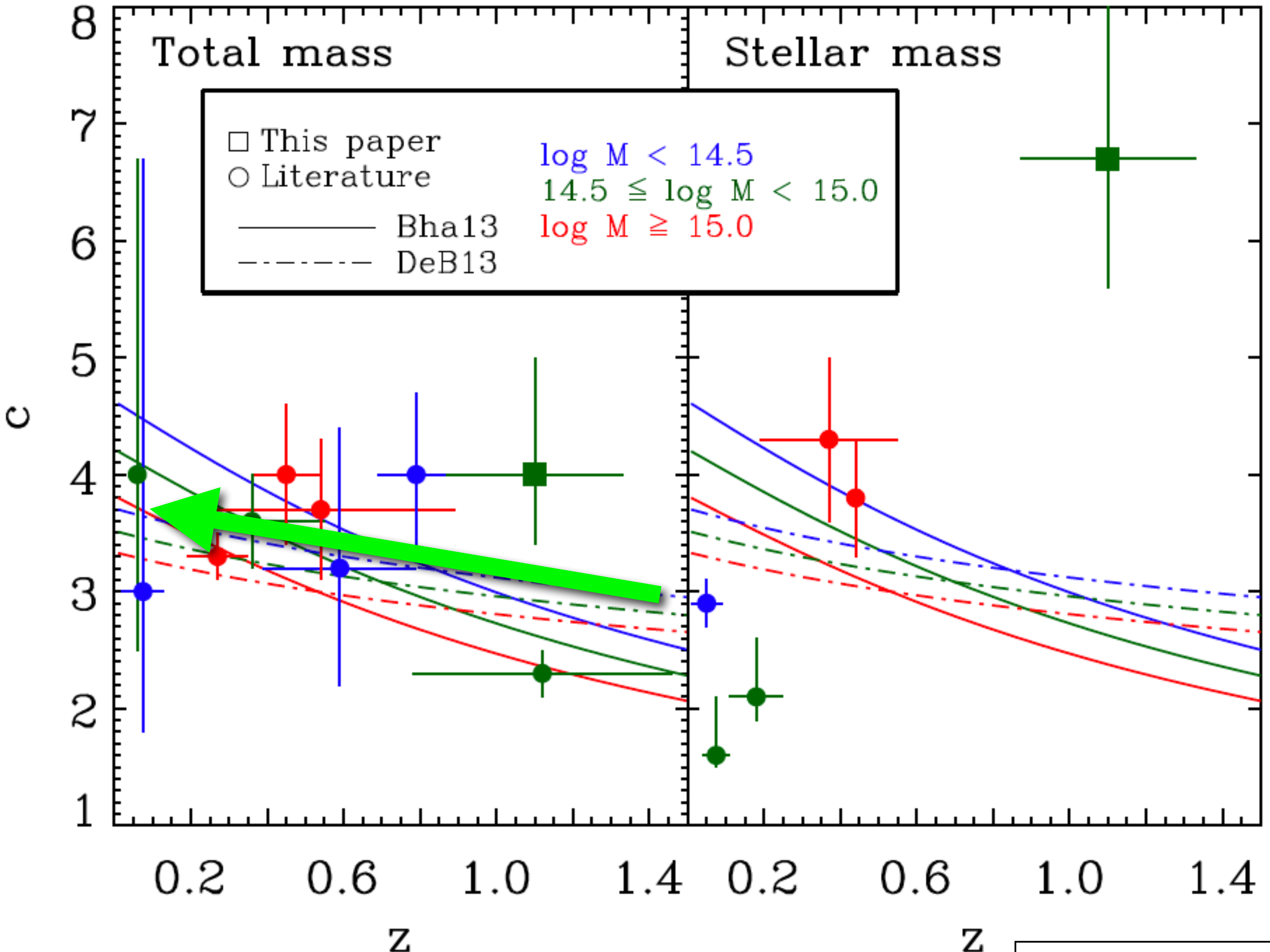

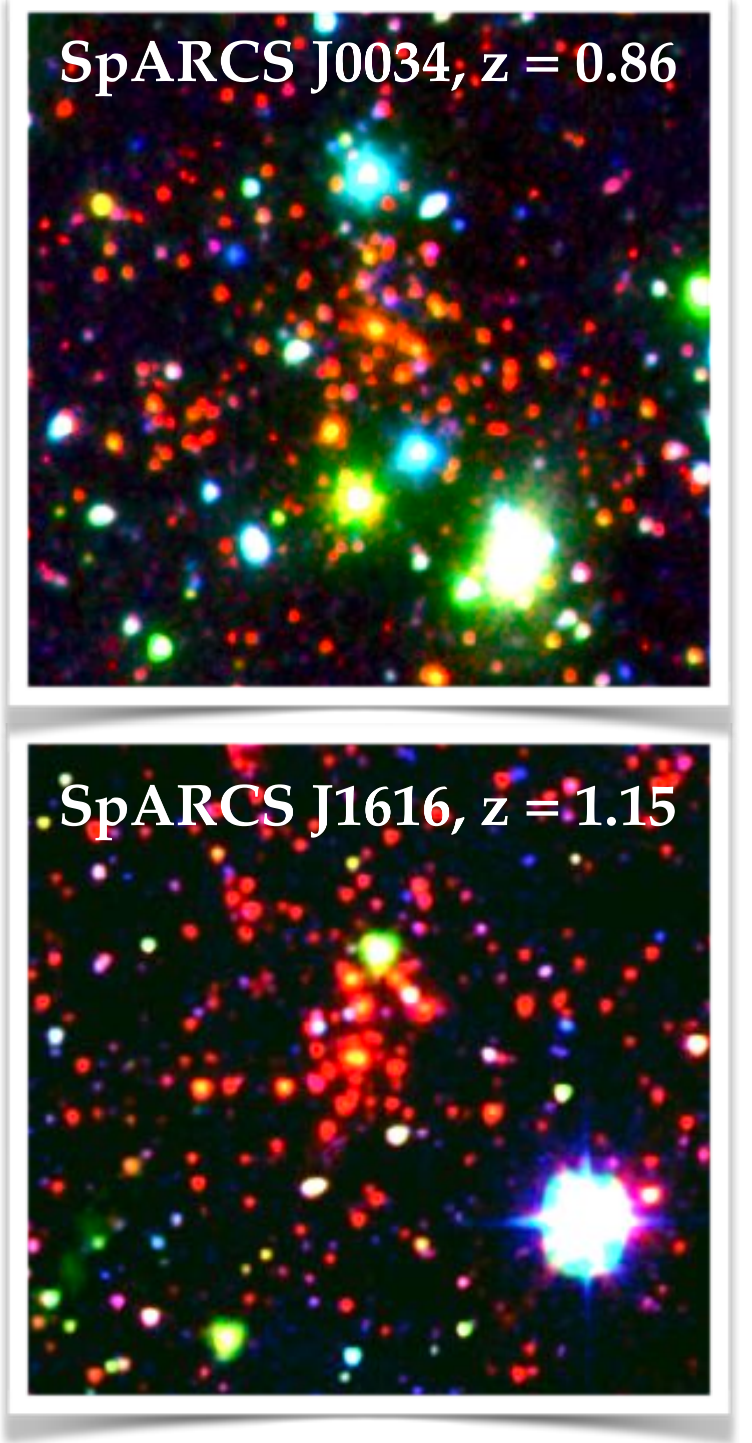

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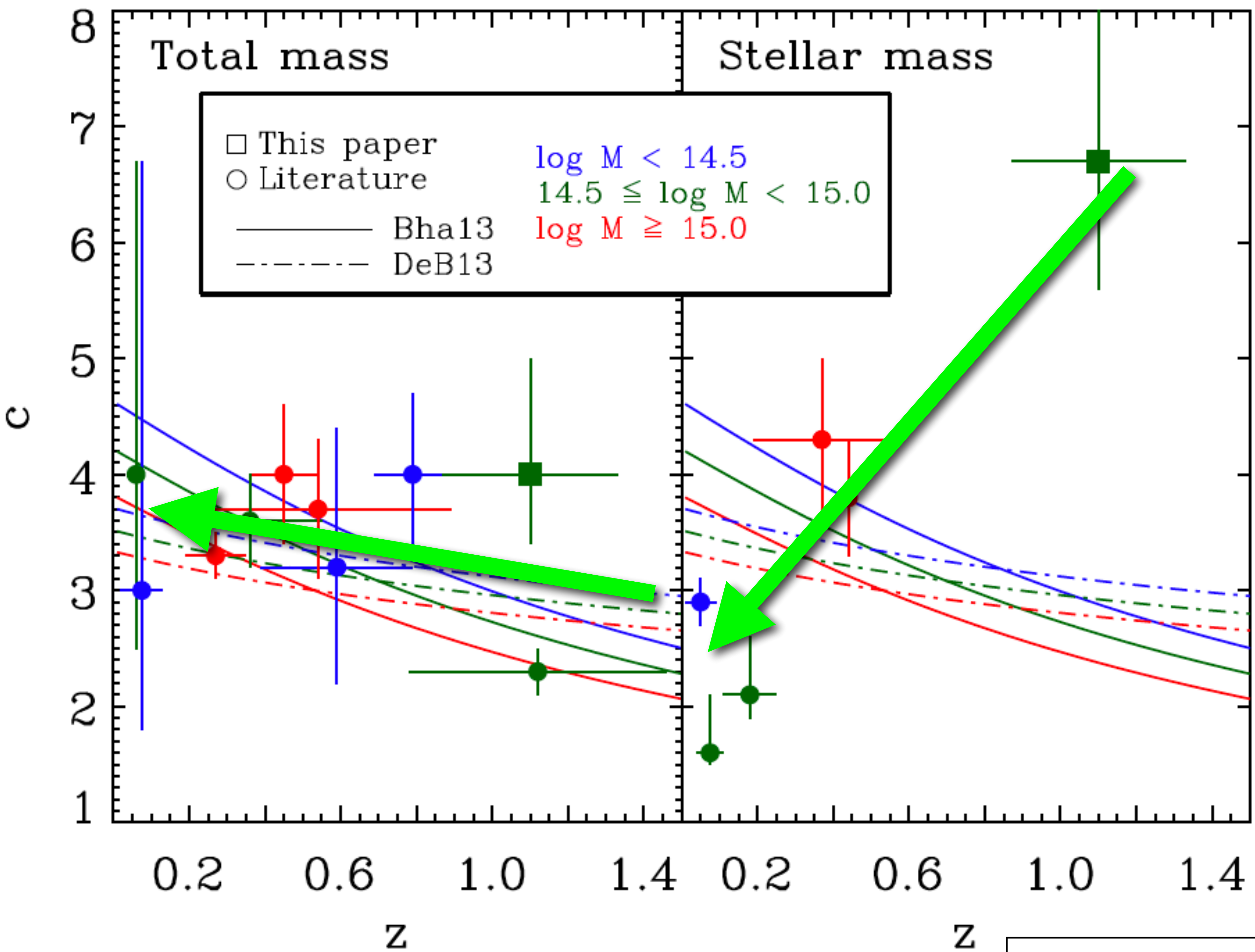

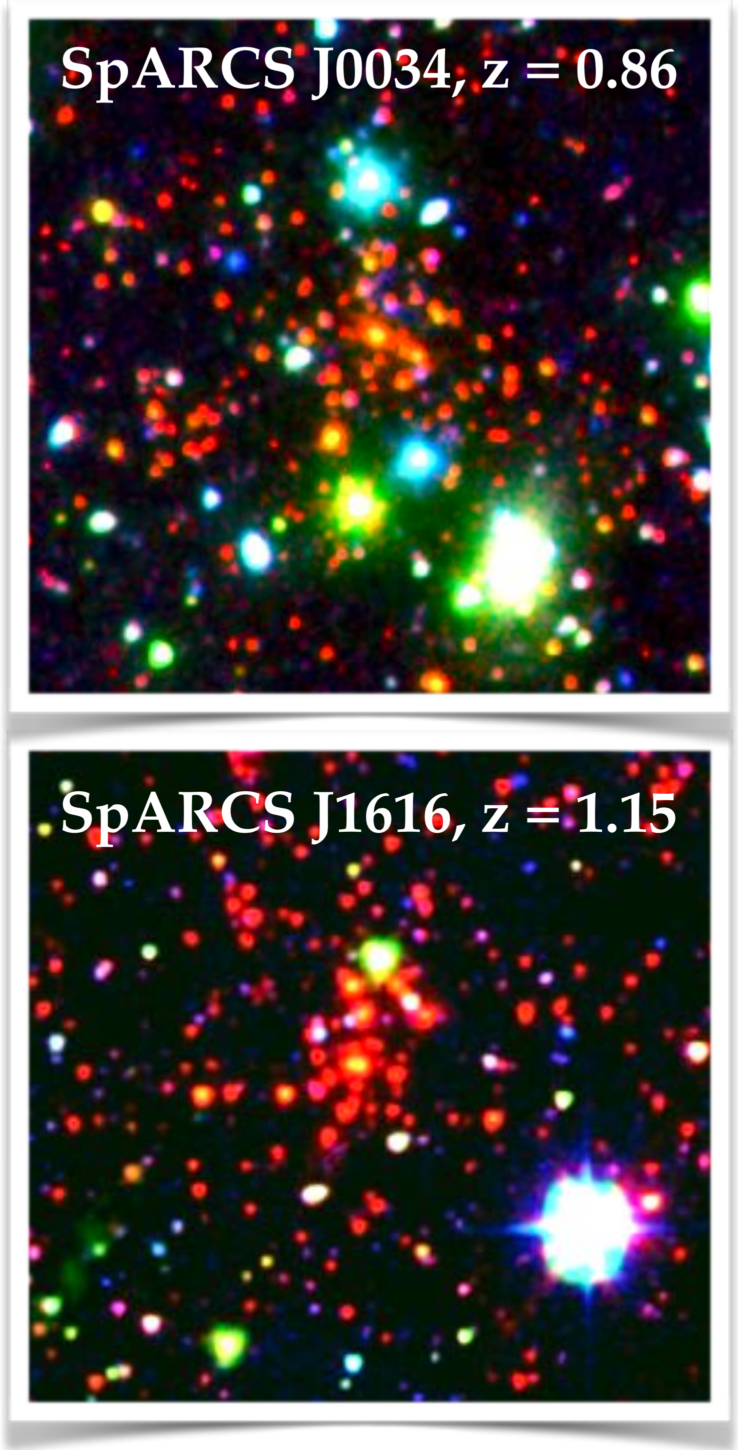

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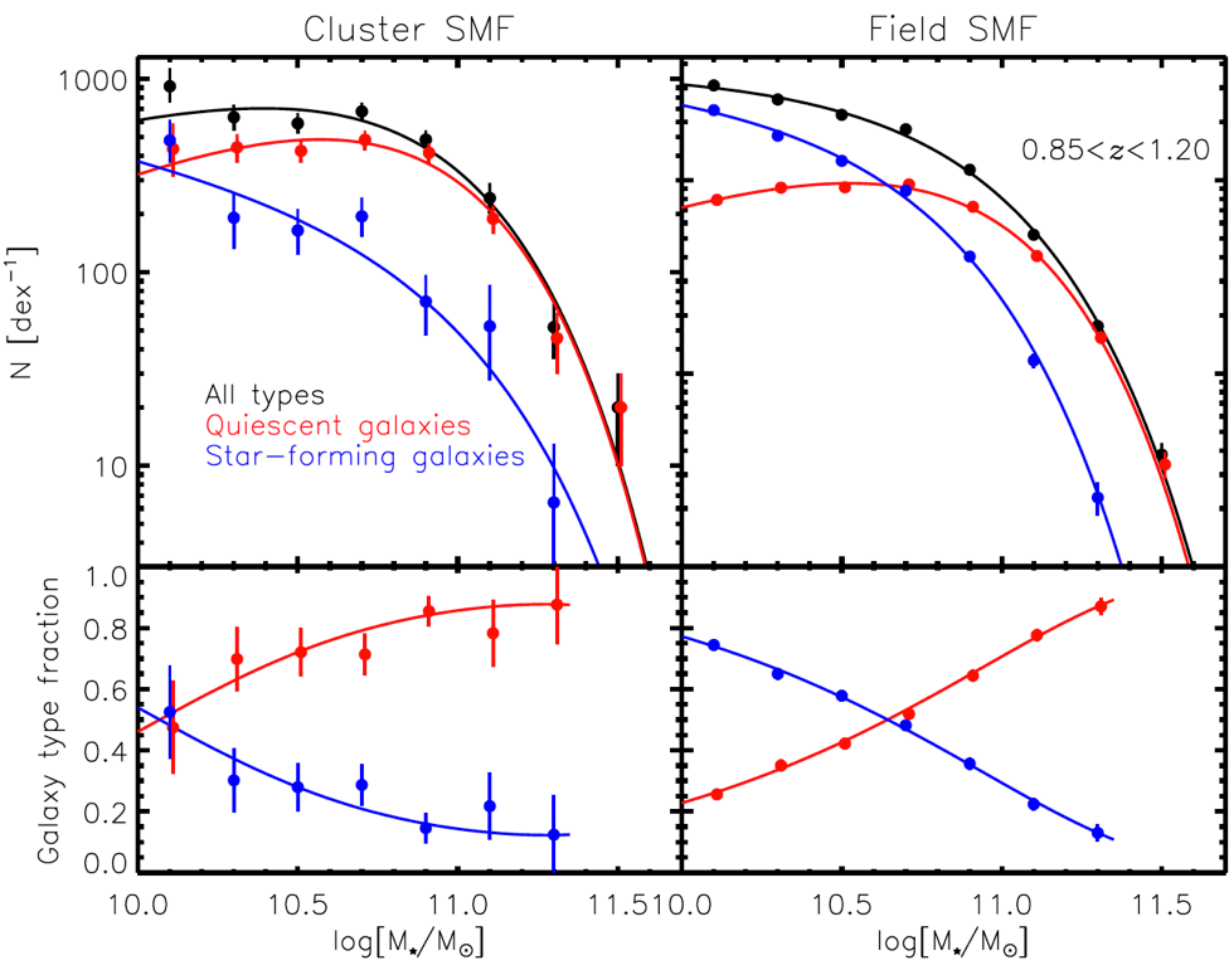
2. Environment Determines the Galaxy Quenched Fraction



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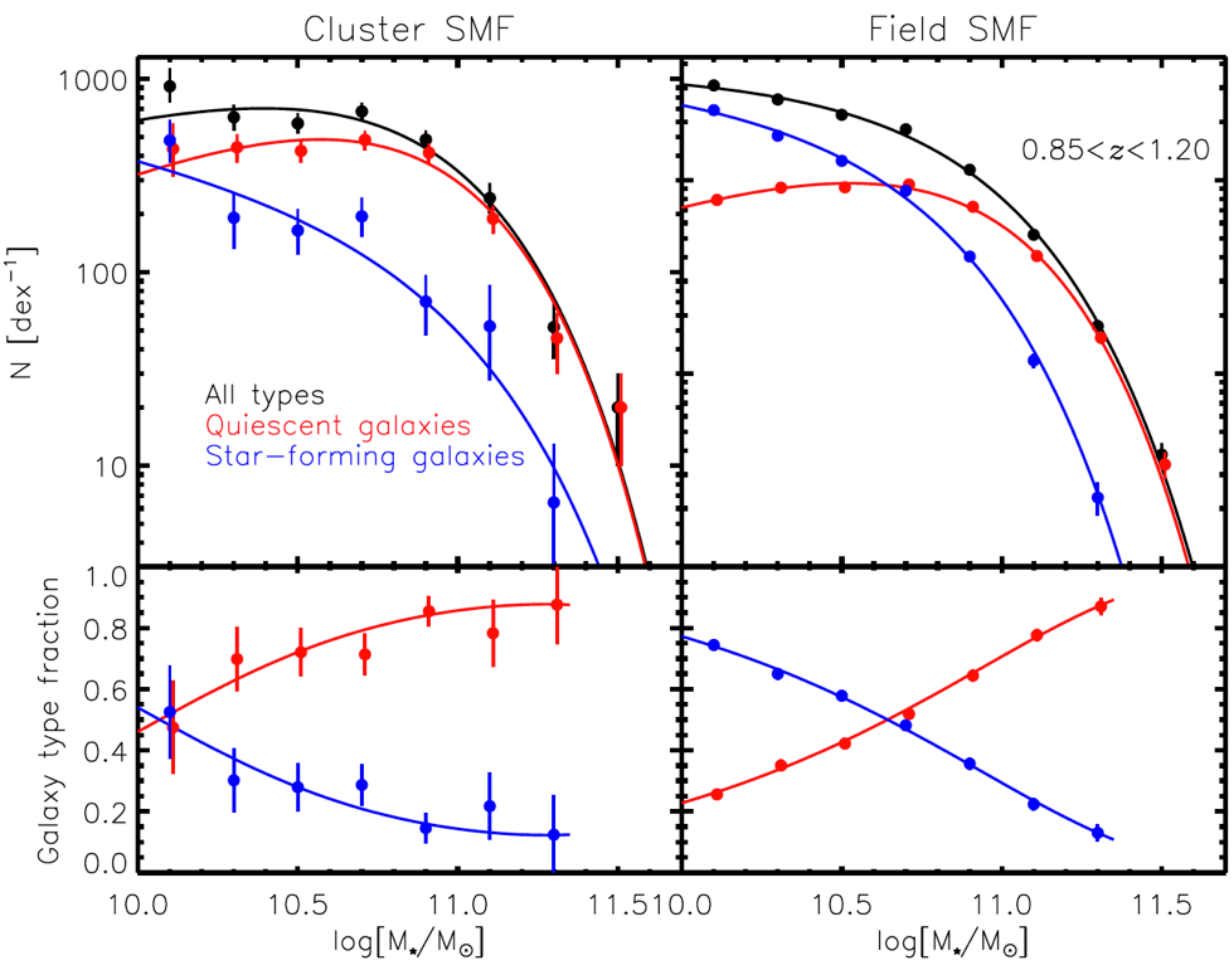

Significant population of quenched galaxies in z = 1 clusters

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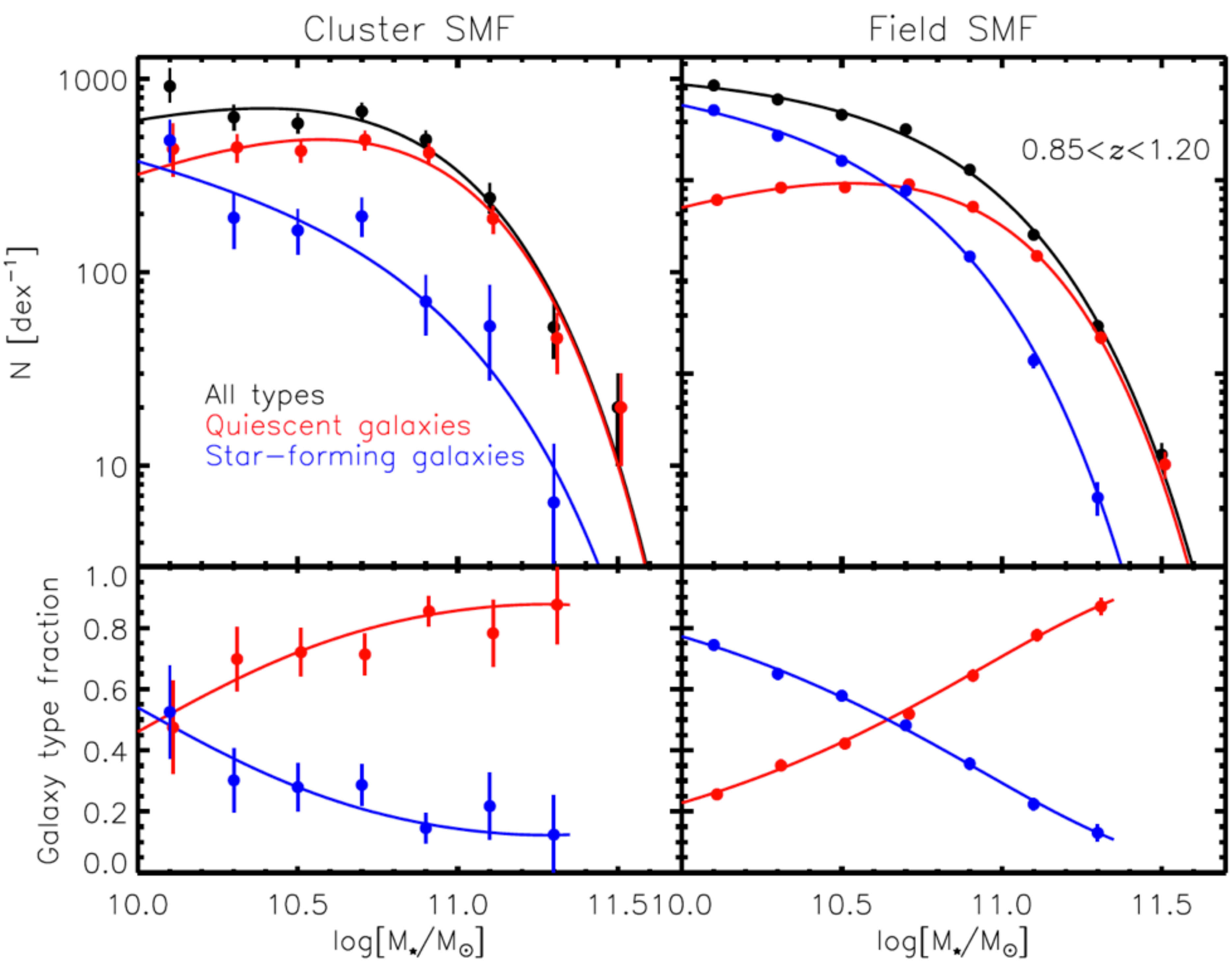

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GOGREEN results in talk by van der Burg

van der Burg+2013

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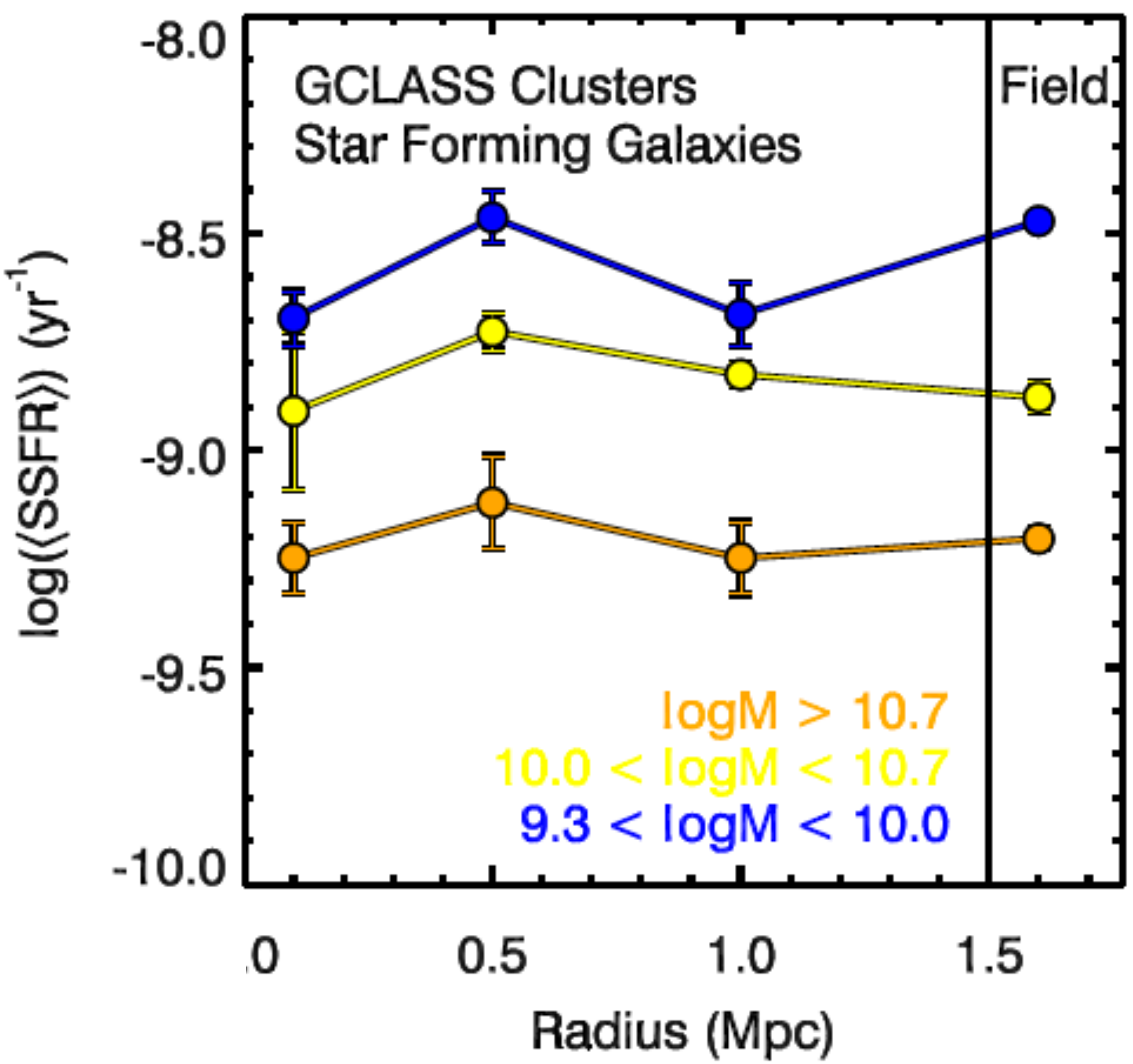

Muzzin+2012

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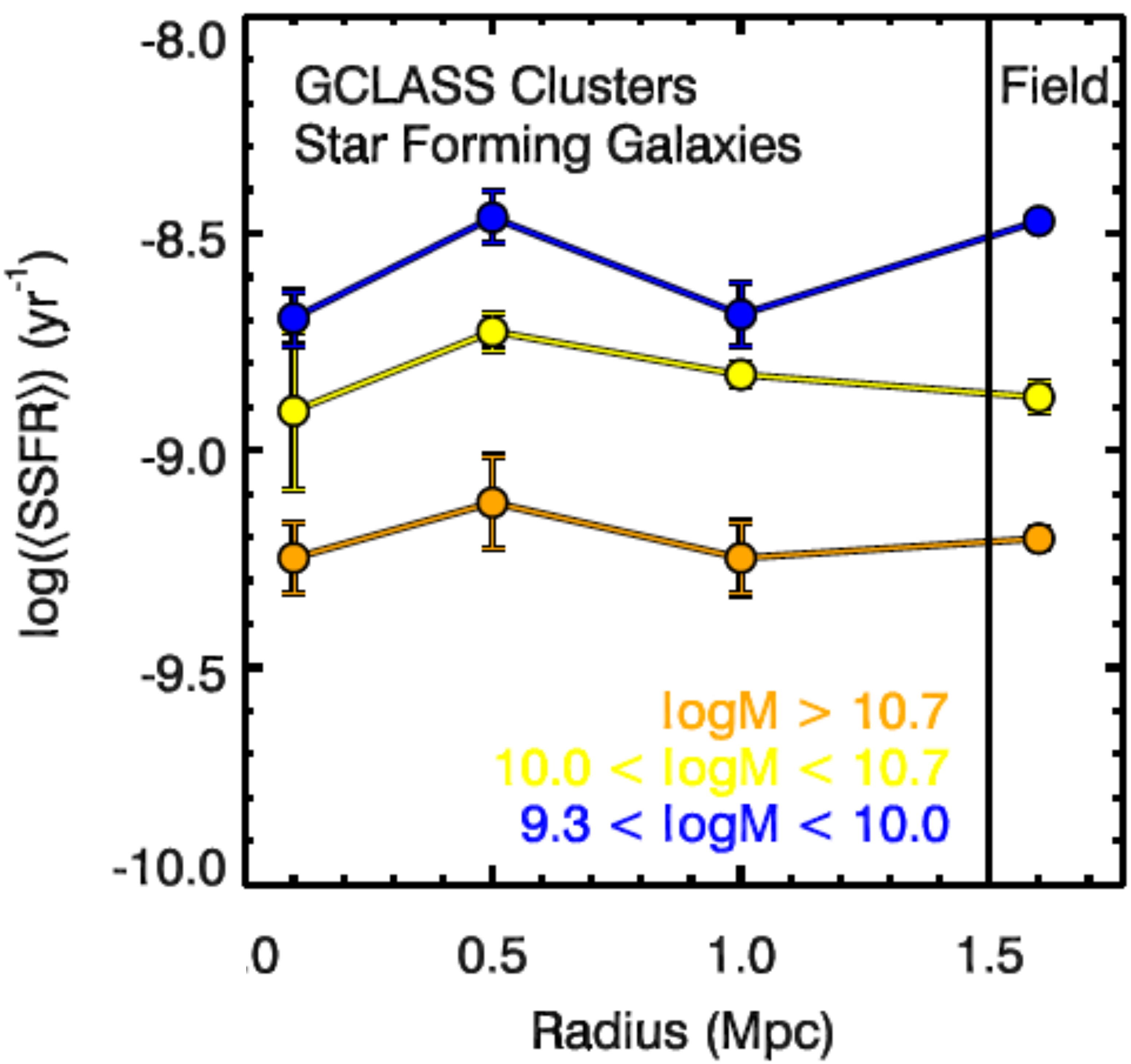

Specific star formation rate of star-forming galaxies correlates with stellar mass, **not** environment

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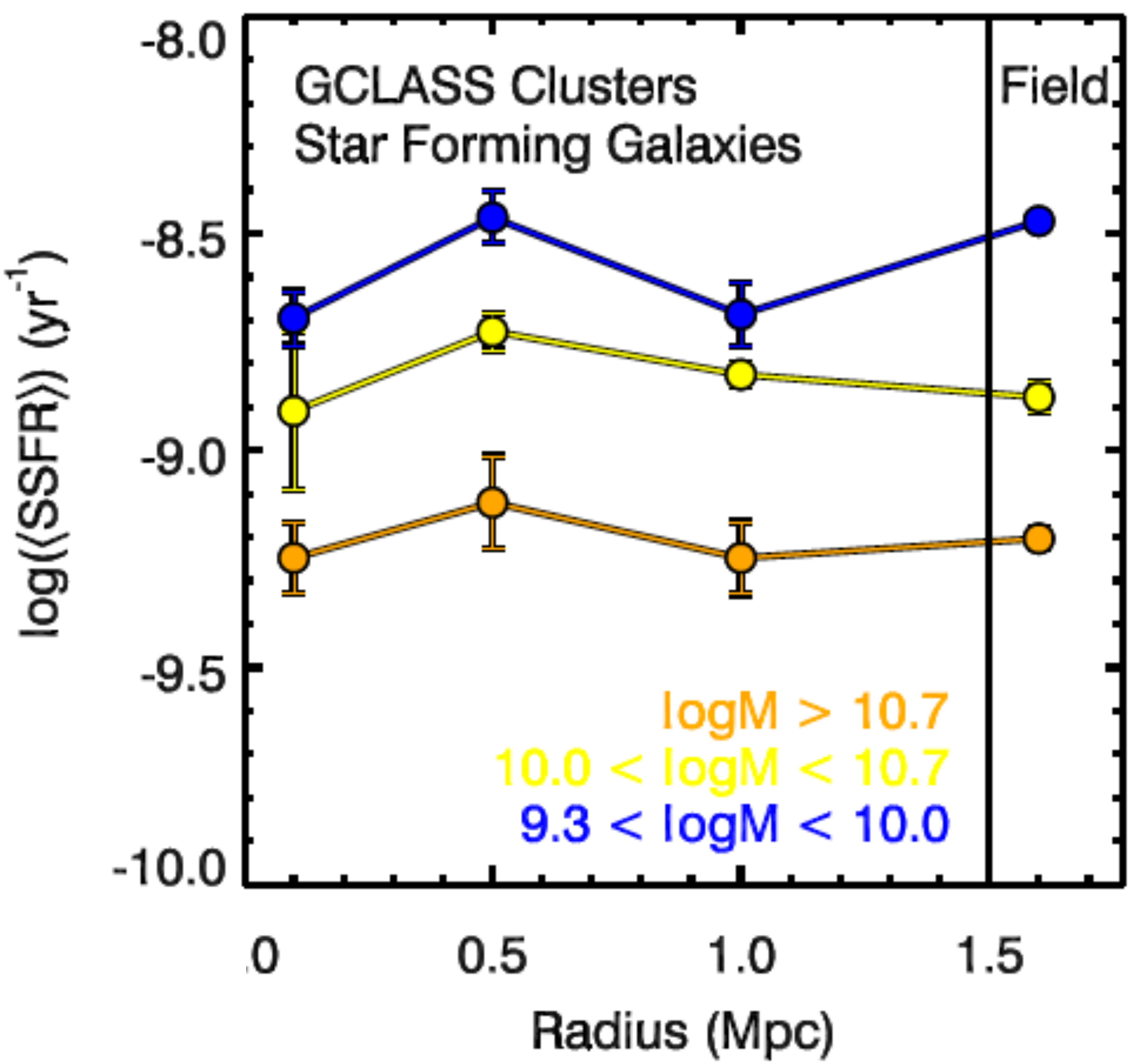

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GOGREEN results in talk by L. Old

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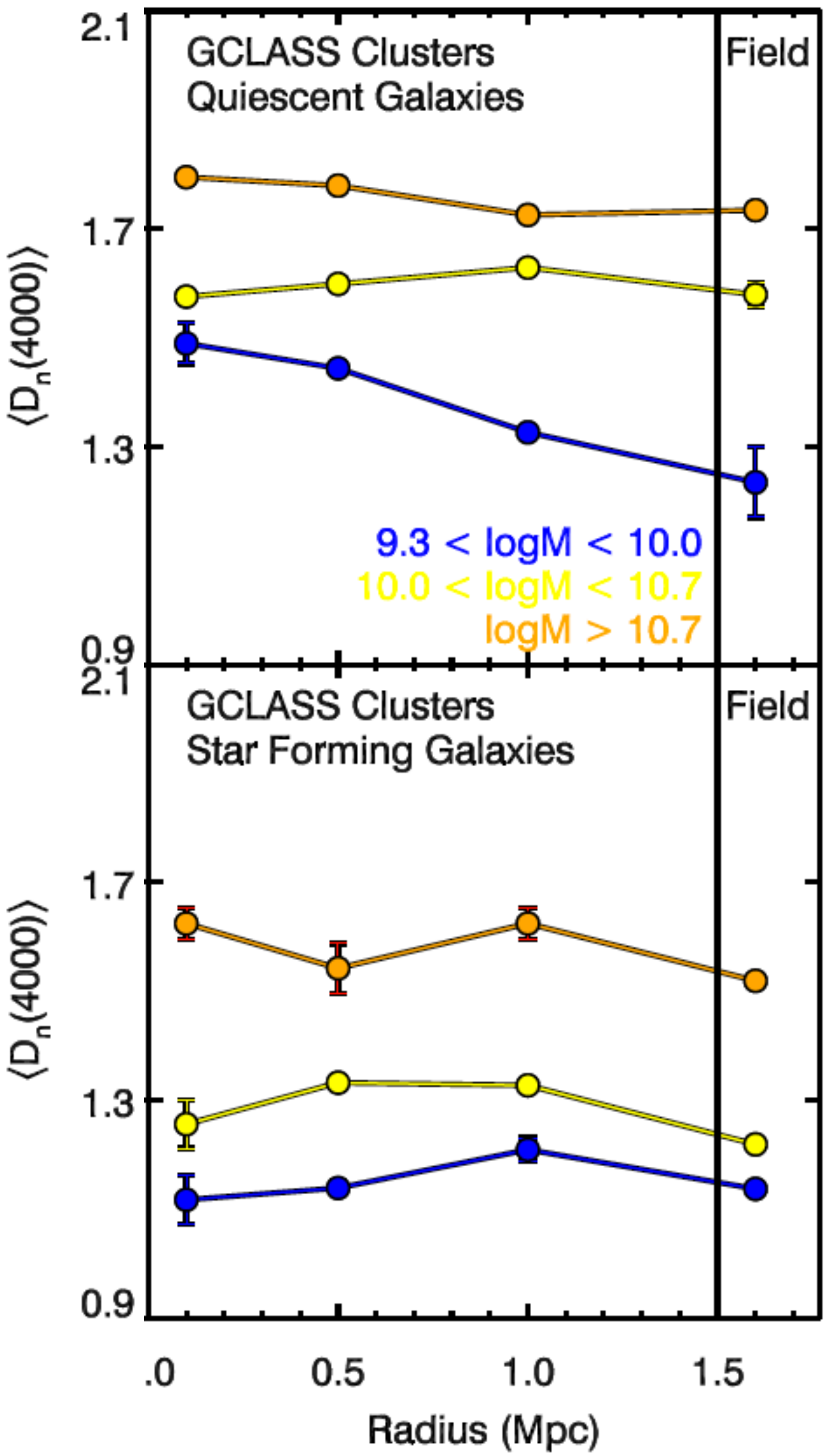

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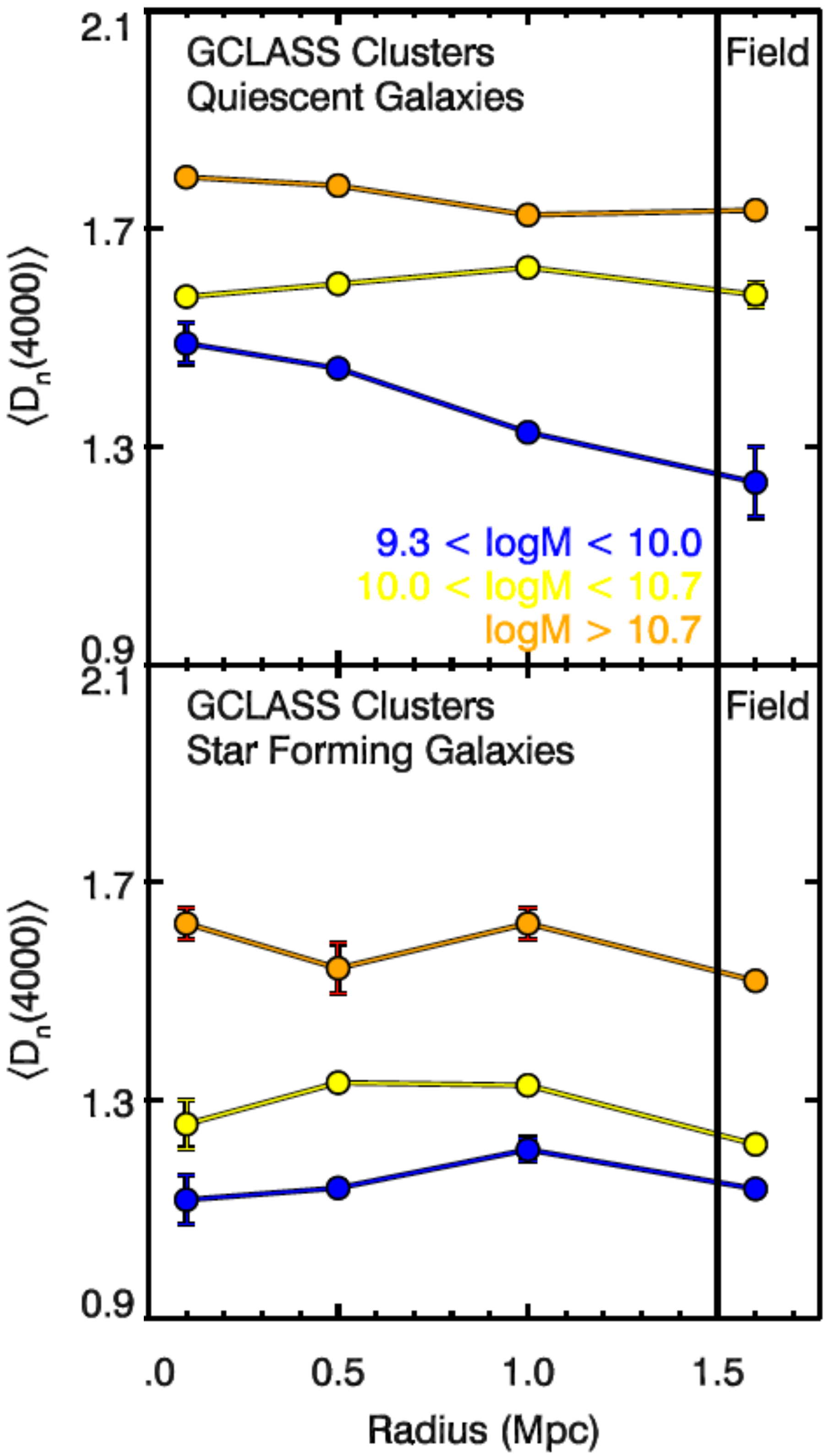

Dn(4000) of star-forming galaxies and quiescent galaxies correlates with stellar mass, **not** environment

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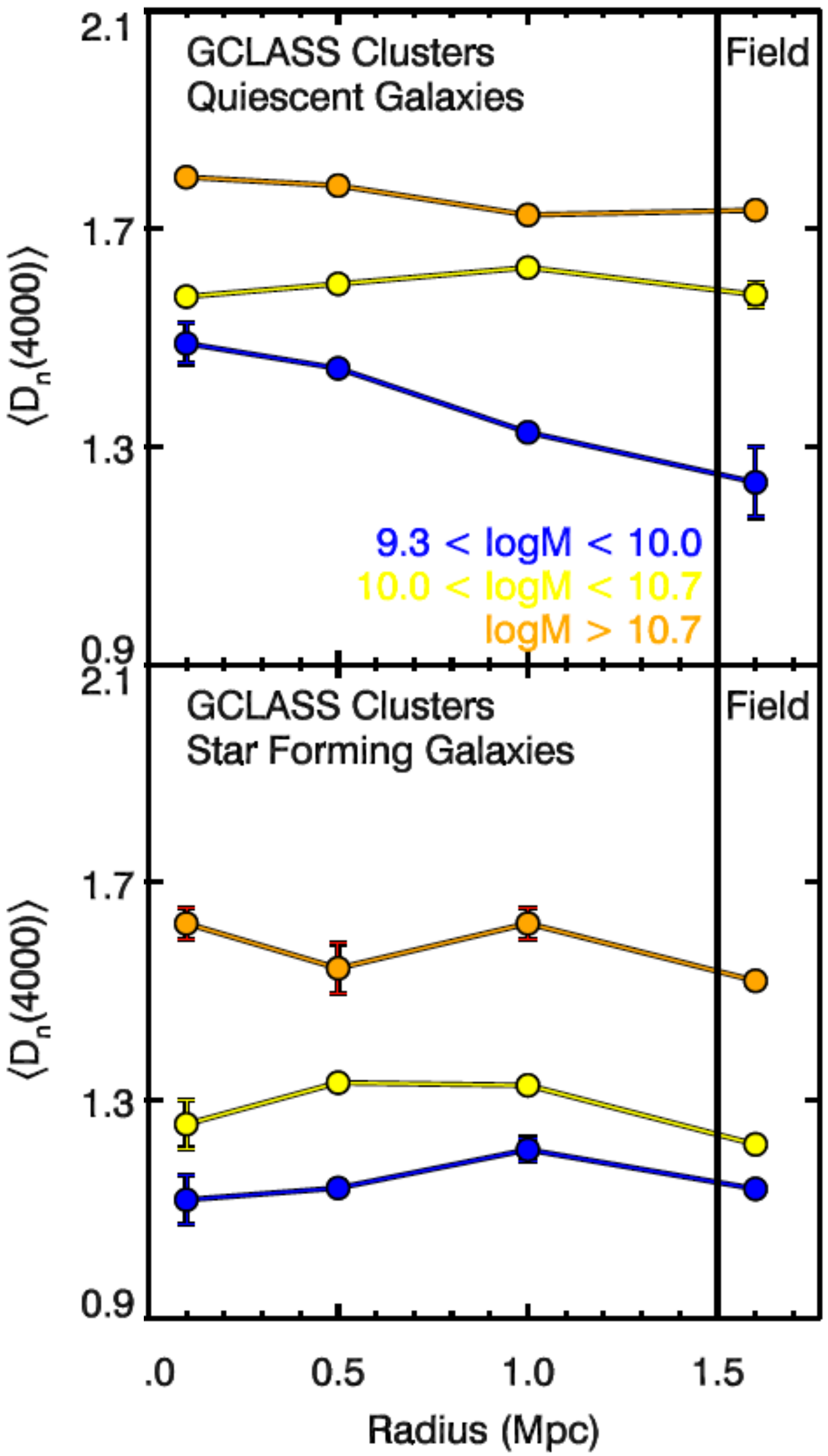

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GOGREEN results in talk by K. Webb

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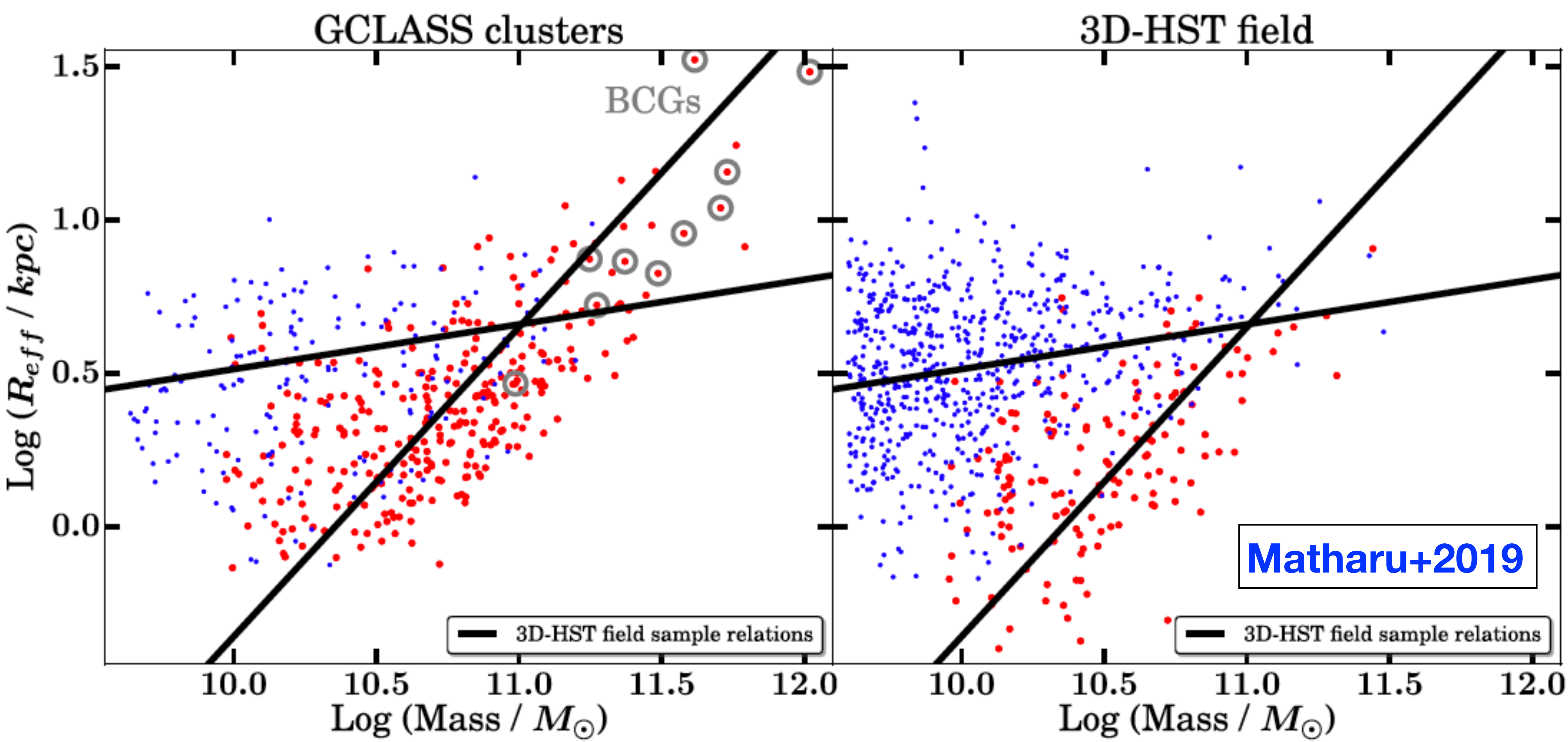

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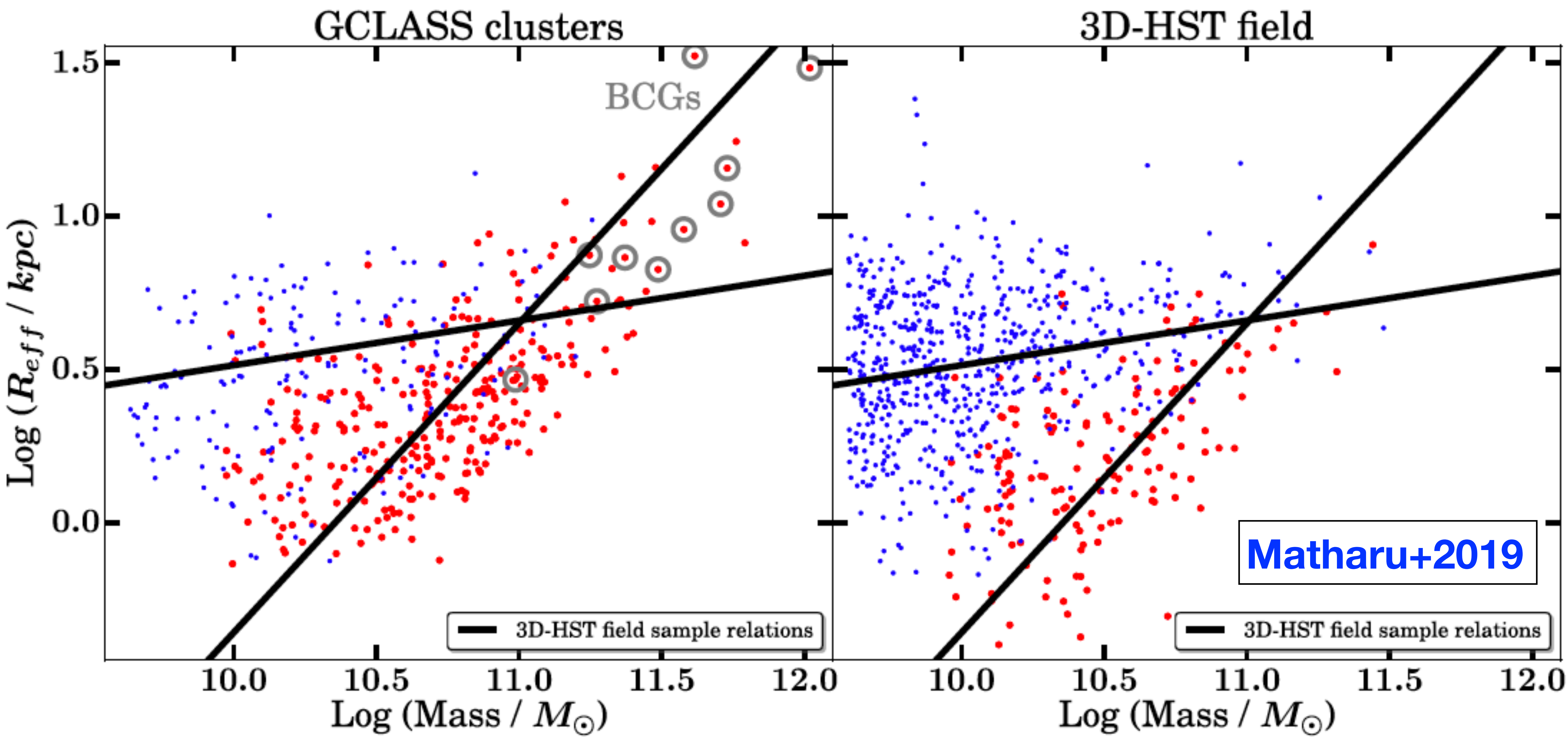

Mass-Size Relation (almost) identical between cluster and field

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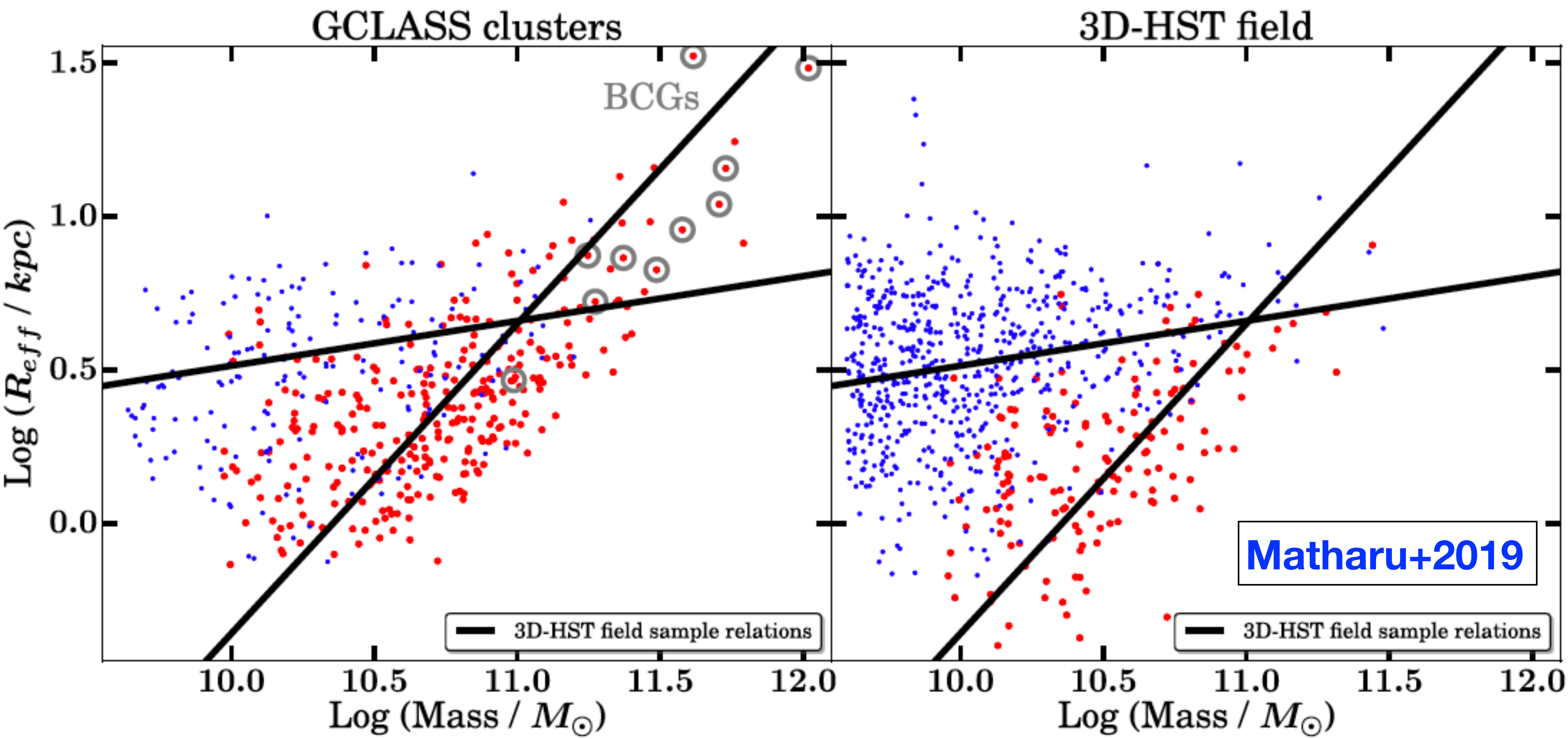

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GOGREEN results in talk by J. Chan

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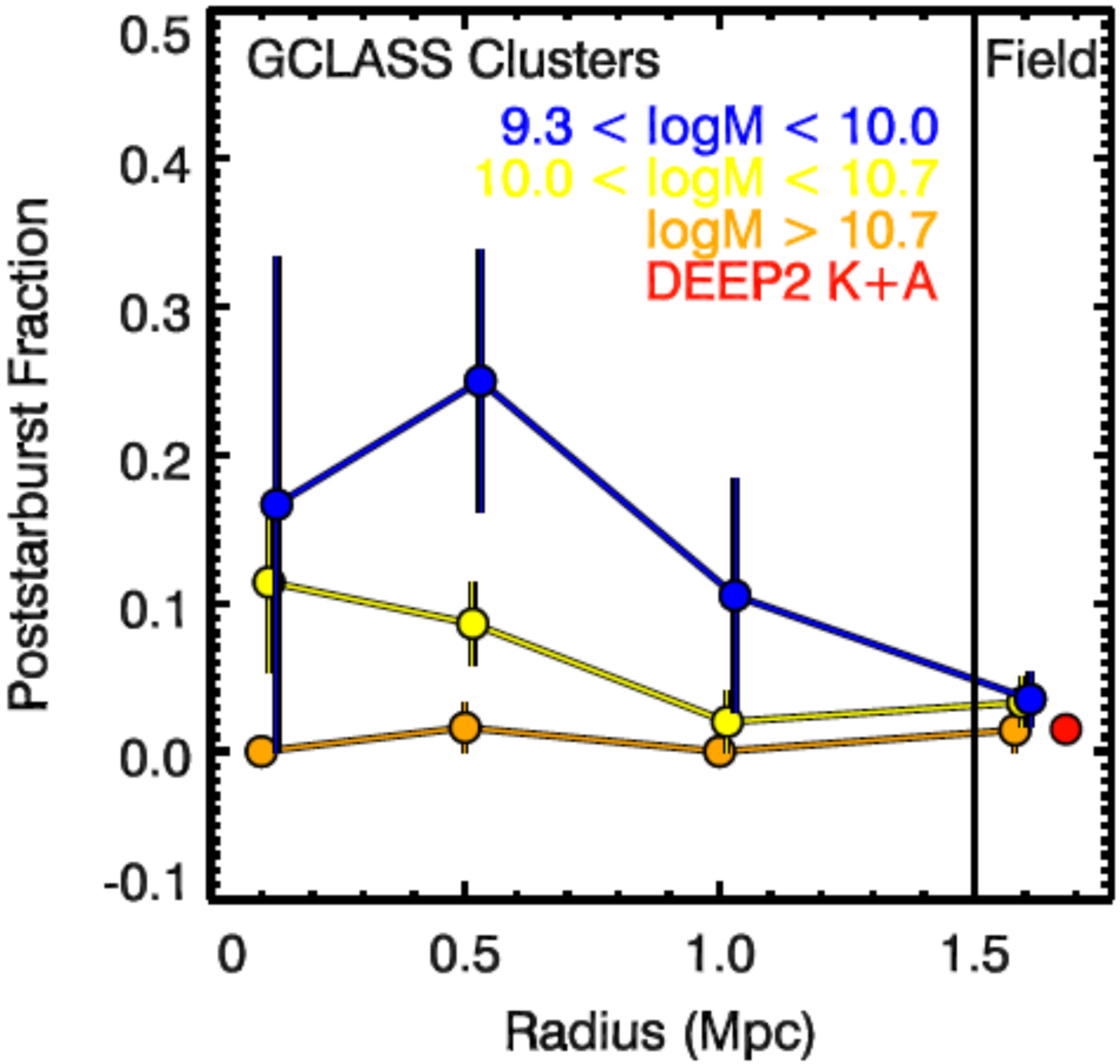
3. Poststarburst Galaxies are Common in Clusters at z = 1



Clusters contain 3.1 +/- 1.1 times more poststarbursts than the field

Muzzin+2012

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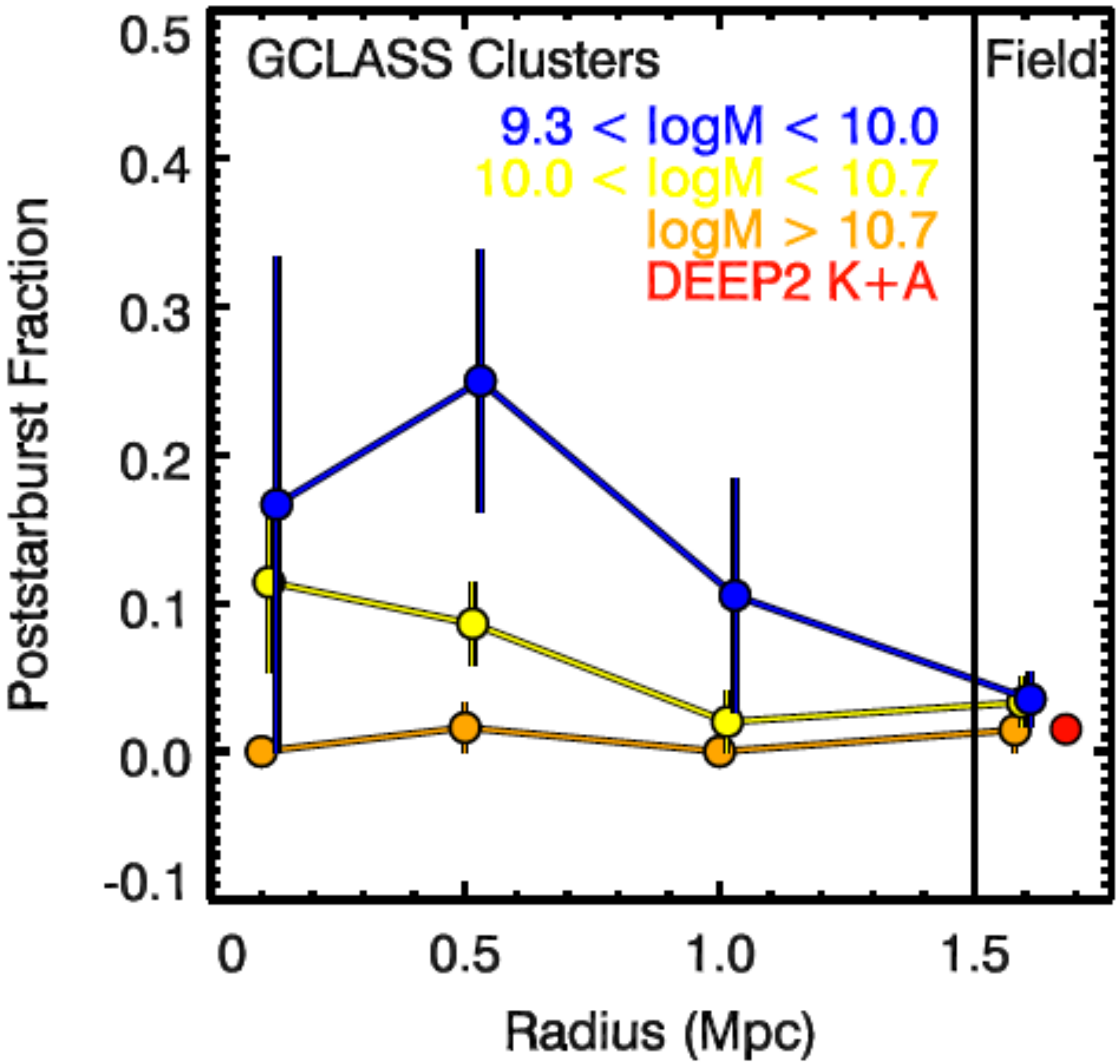

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GOGREEN results in talk by K. McNab

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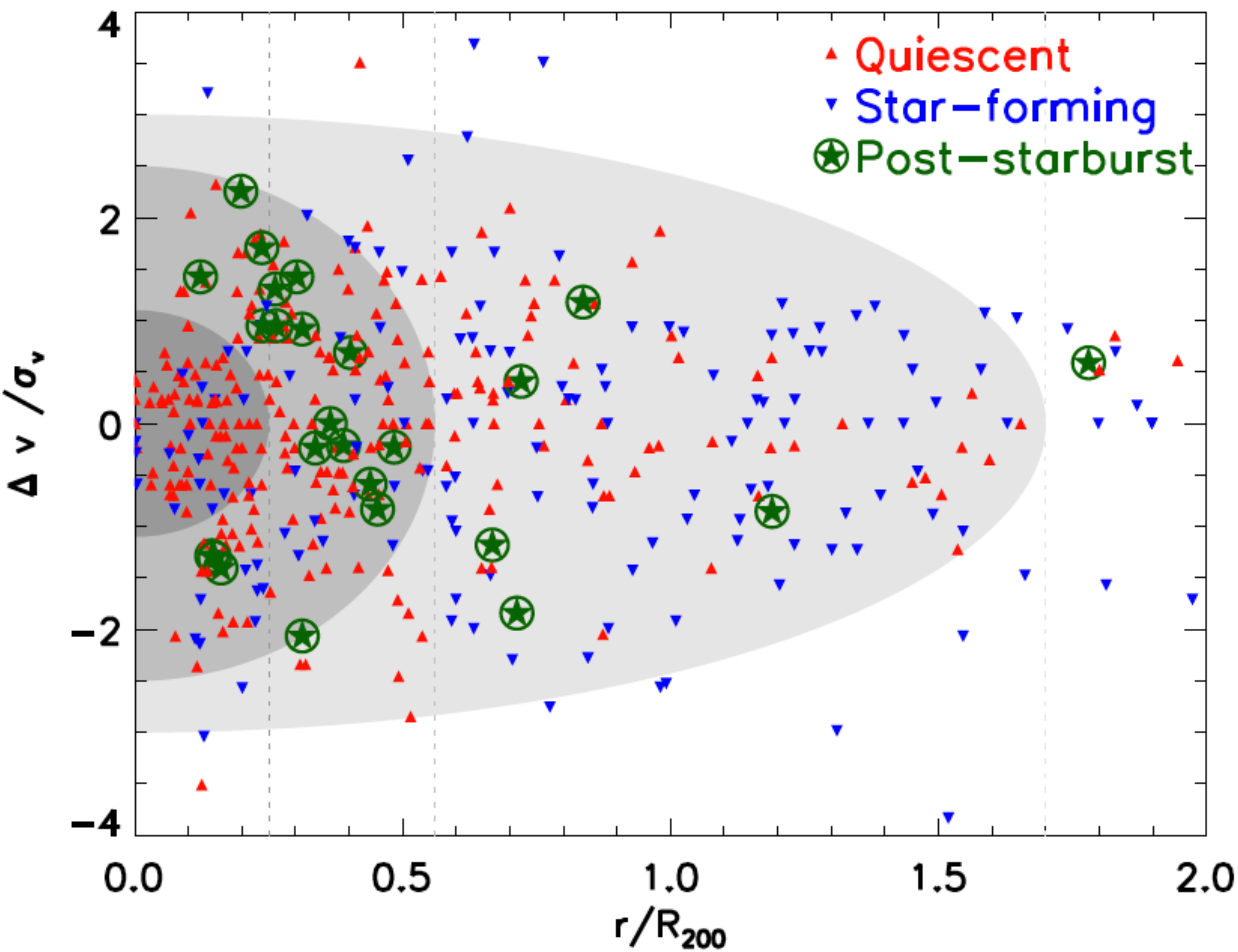

Poststarbursts are found at small radii, but high velocities

Muzzin+2014

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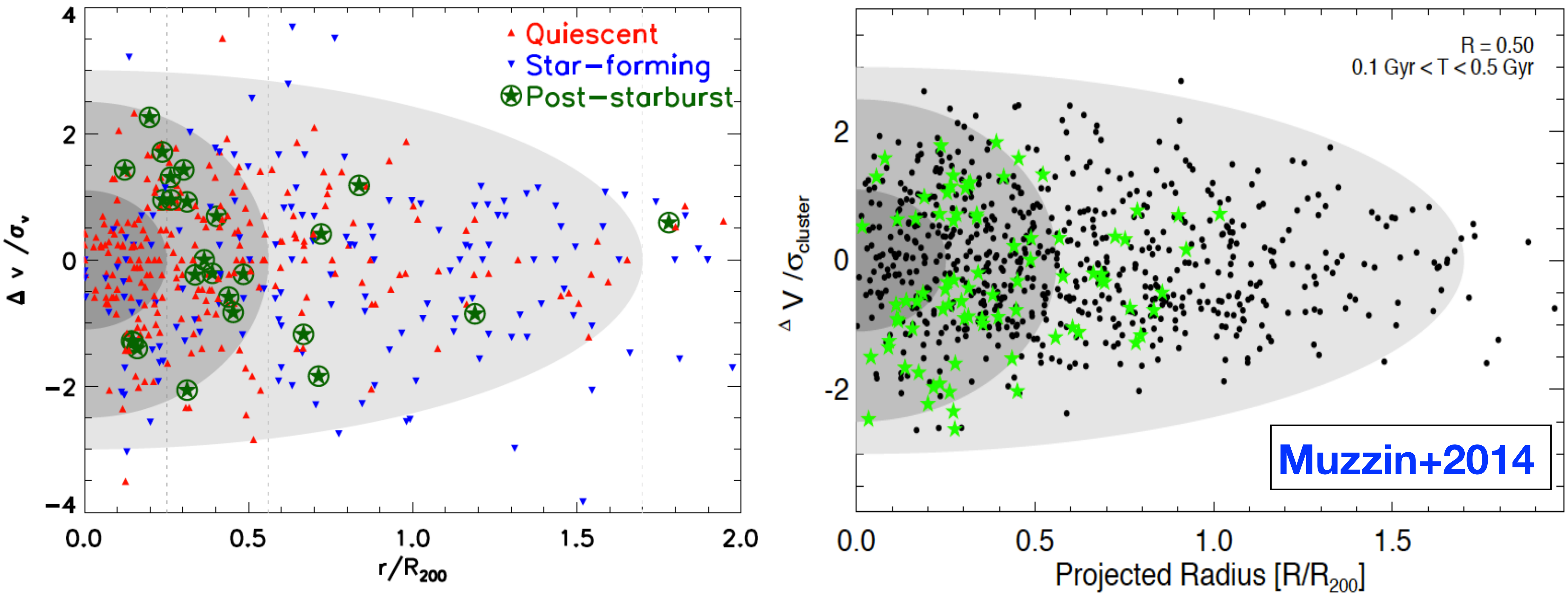
Quenching @0.5R_{200} with 0.1 Gyr < T < 0.5 Gyr



A reasonable match to phase space, avoids key regions

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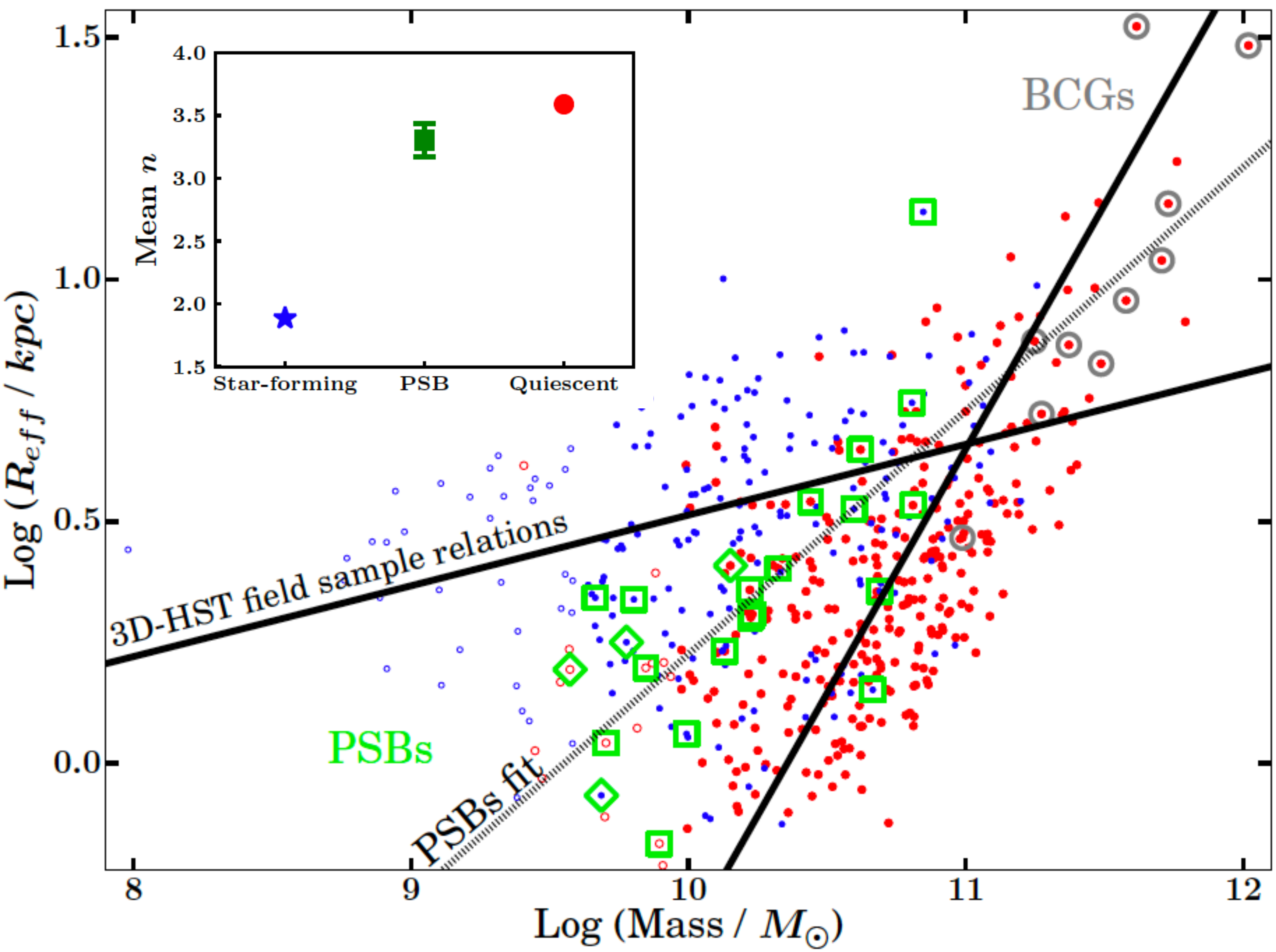

Poststarbursts are intermediate in size and morphology between SF and Q galaxies

Matharu+2020

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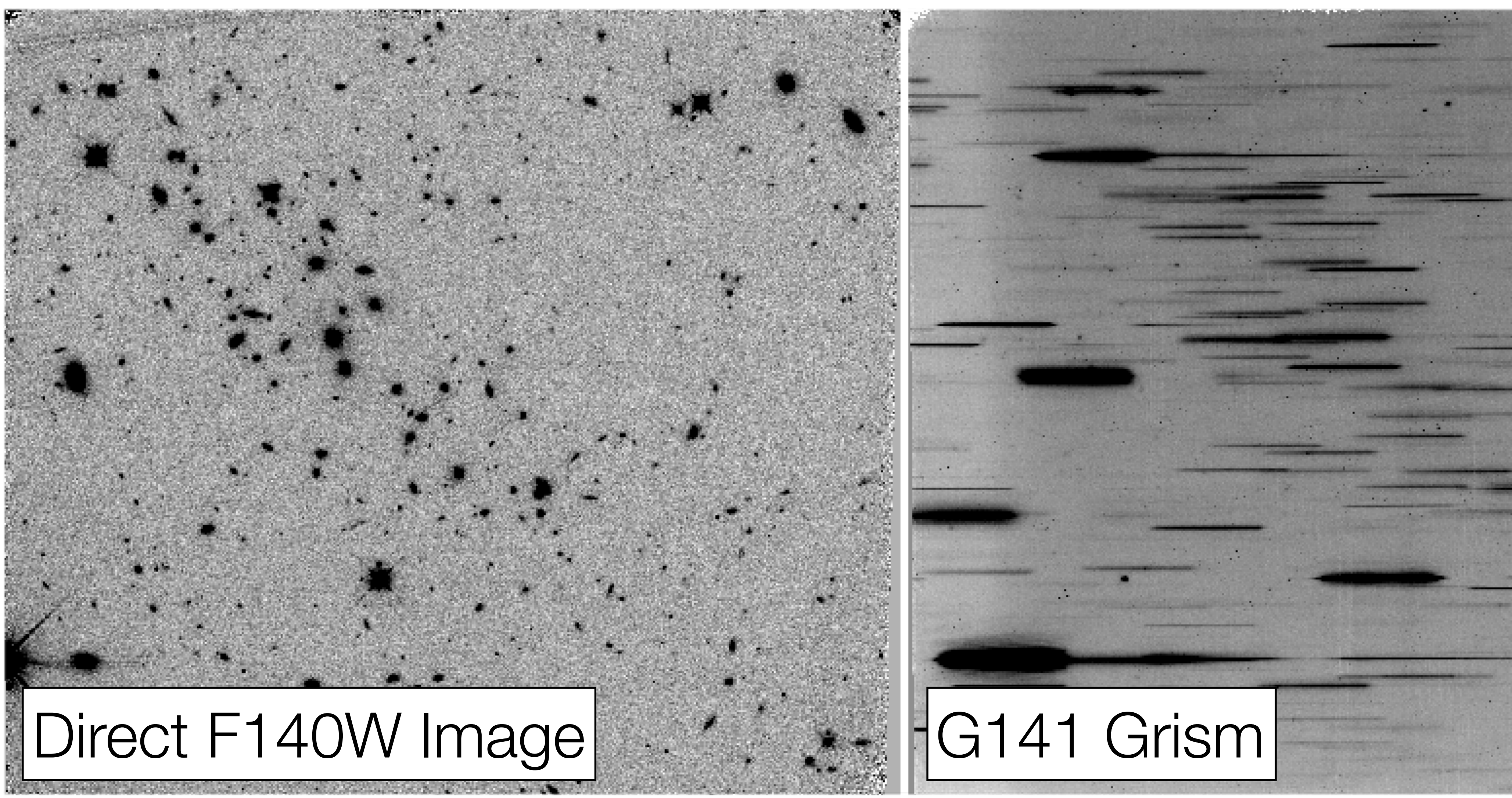
- Ram pressure stripping likely affects low-mass galaxies in clusters at $z=1$

GCLASS WFC3 Grism Program

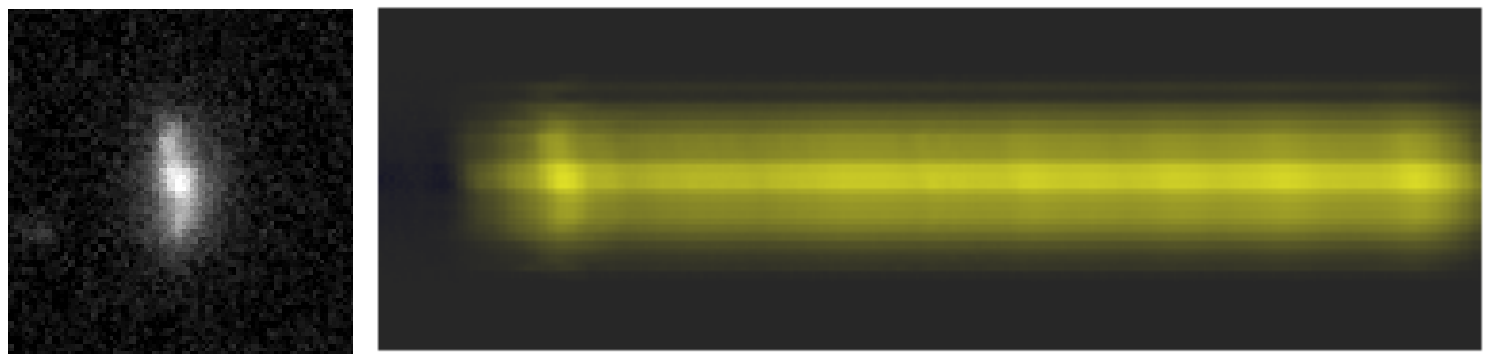
A 38-orbit G141 grism program to get resolved H-alpha maps of cluster galaxies

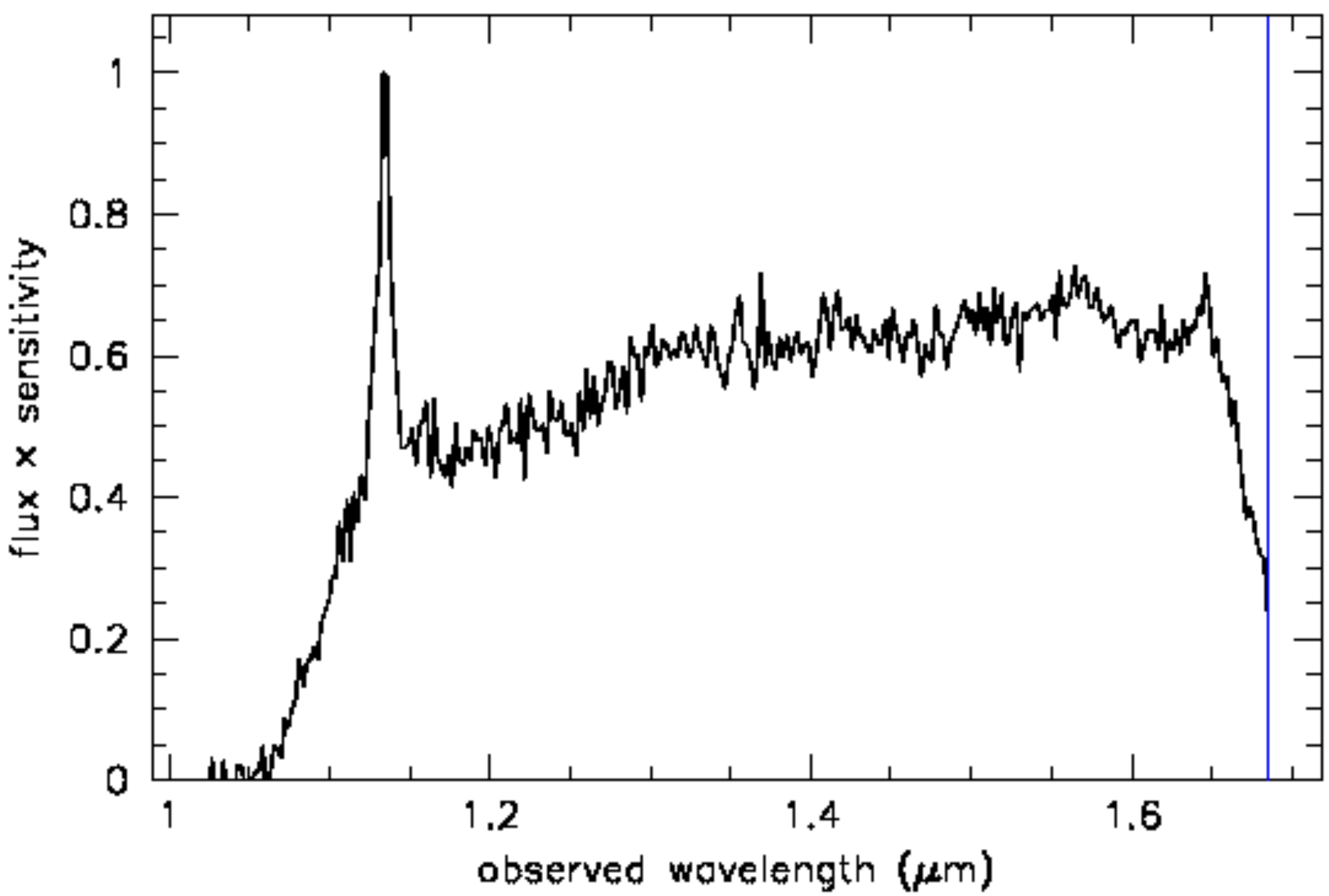


SpARCS J1638+4038, z = 1.179

Jasleen Matharu
(Texas A&M)

Demo of how WFC3 slitless spectroscopy works





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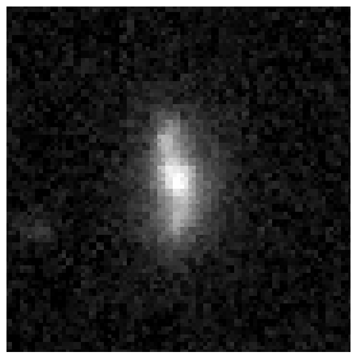
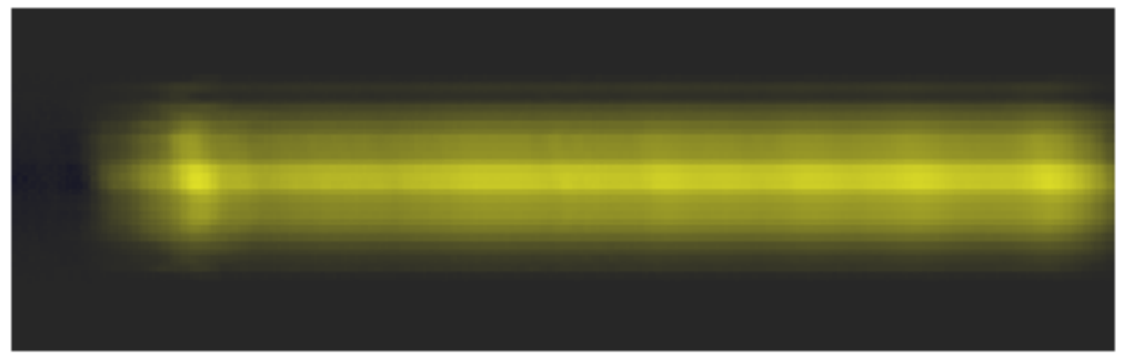
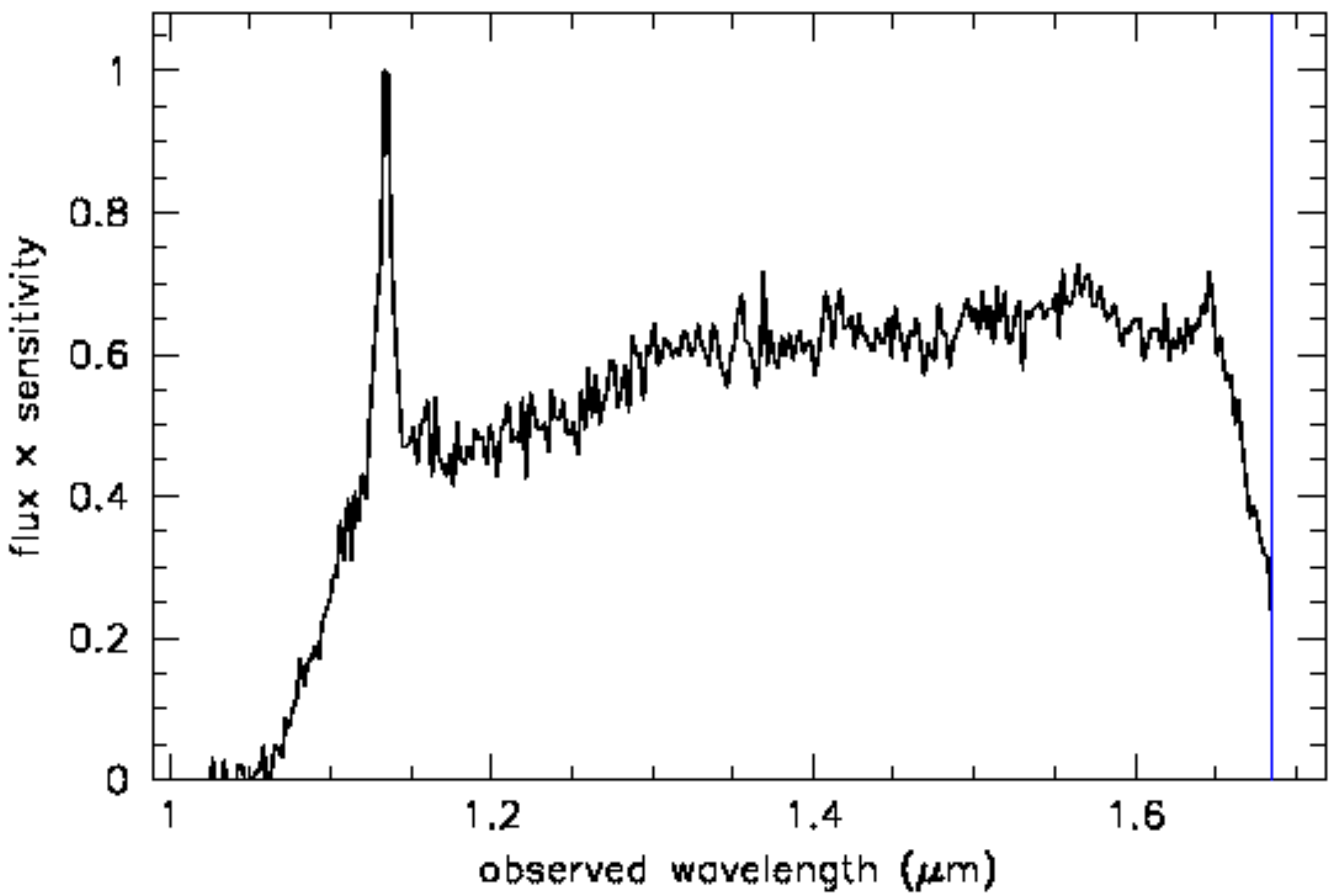
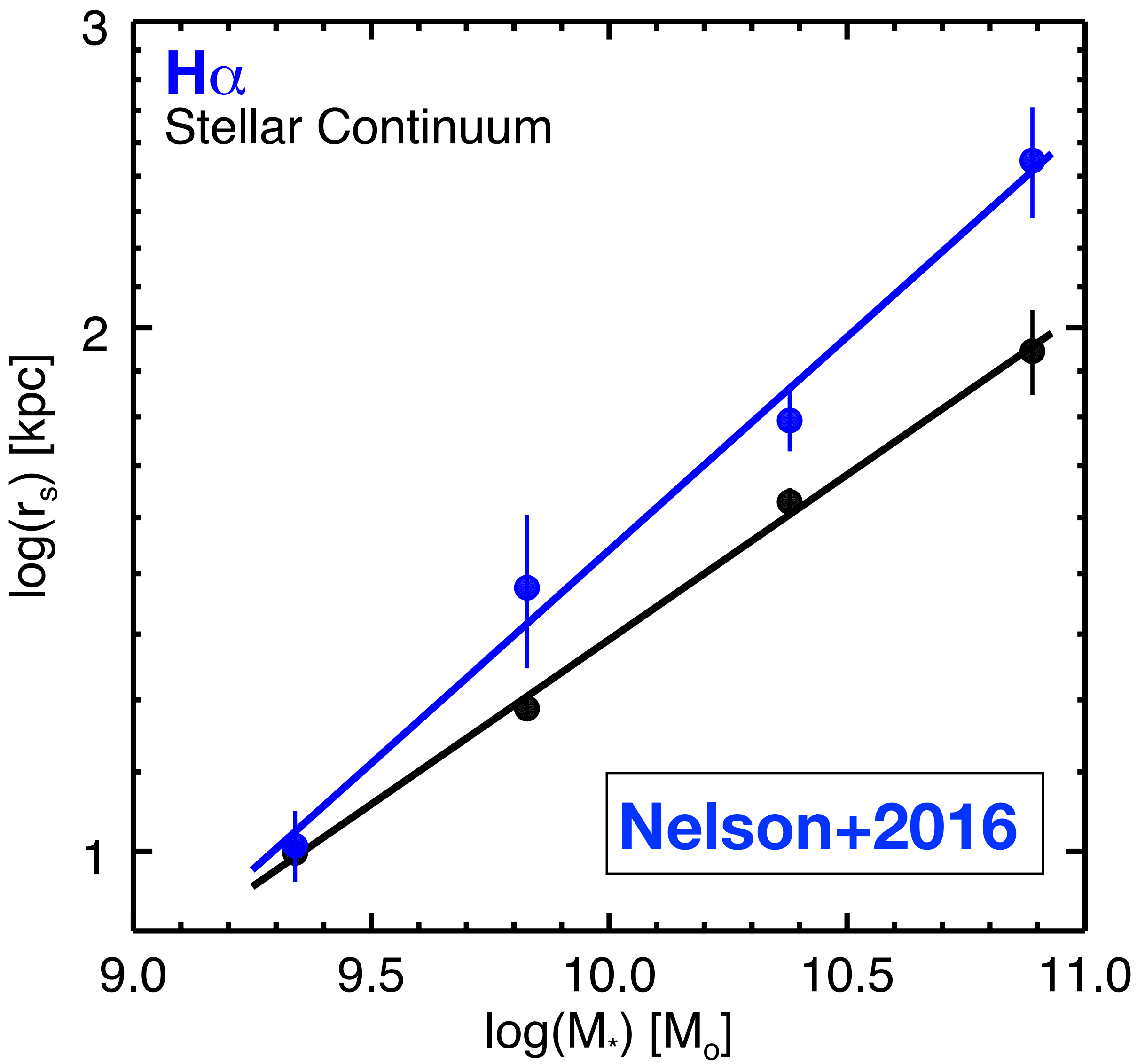




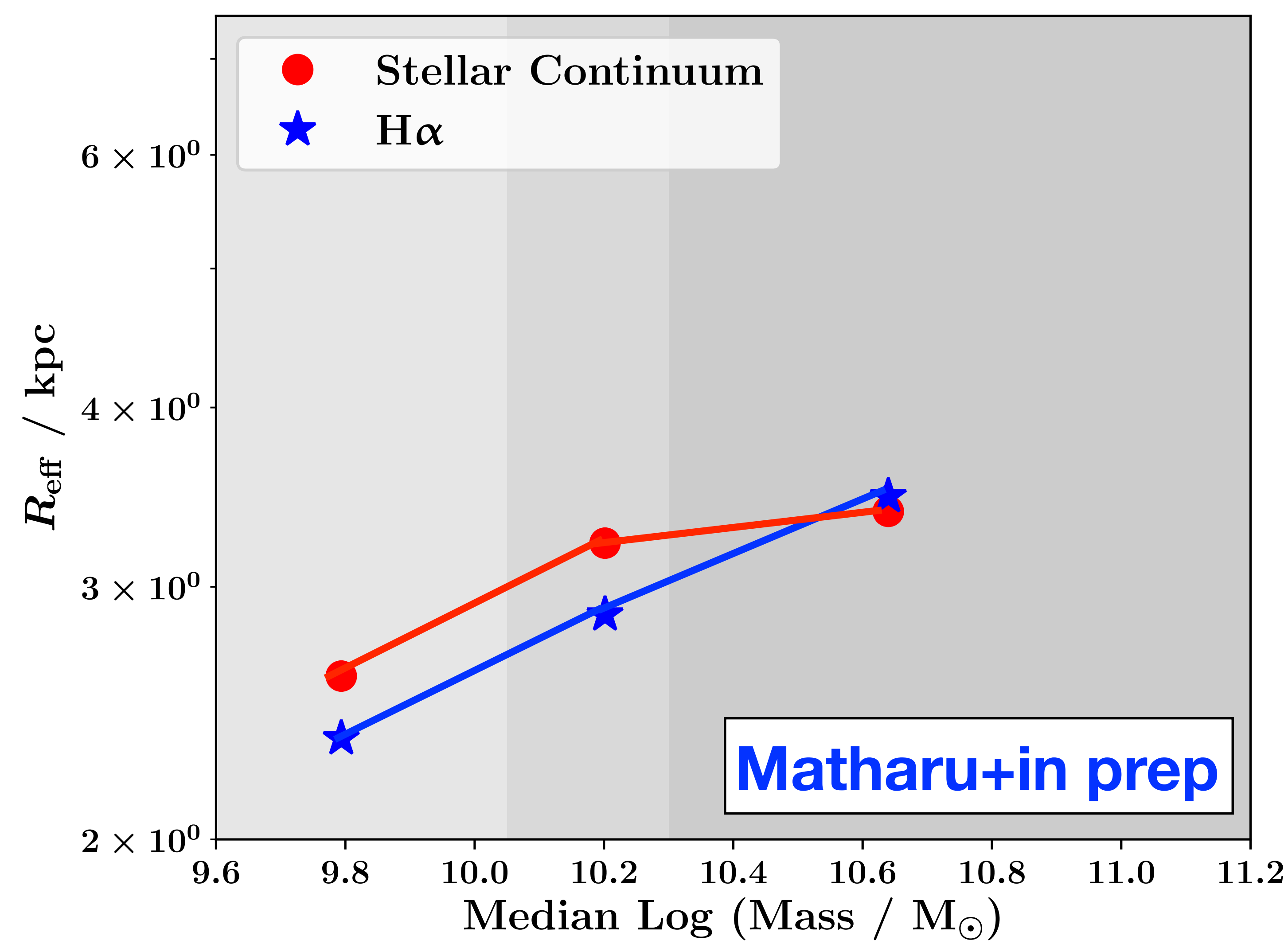


4. First Evidence for Ram Pressure Stripping in Clusters at z = 1

Field, z = 1



Clusters, z = 1



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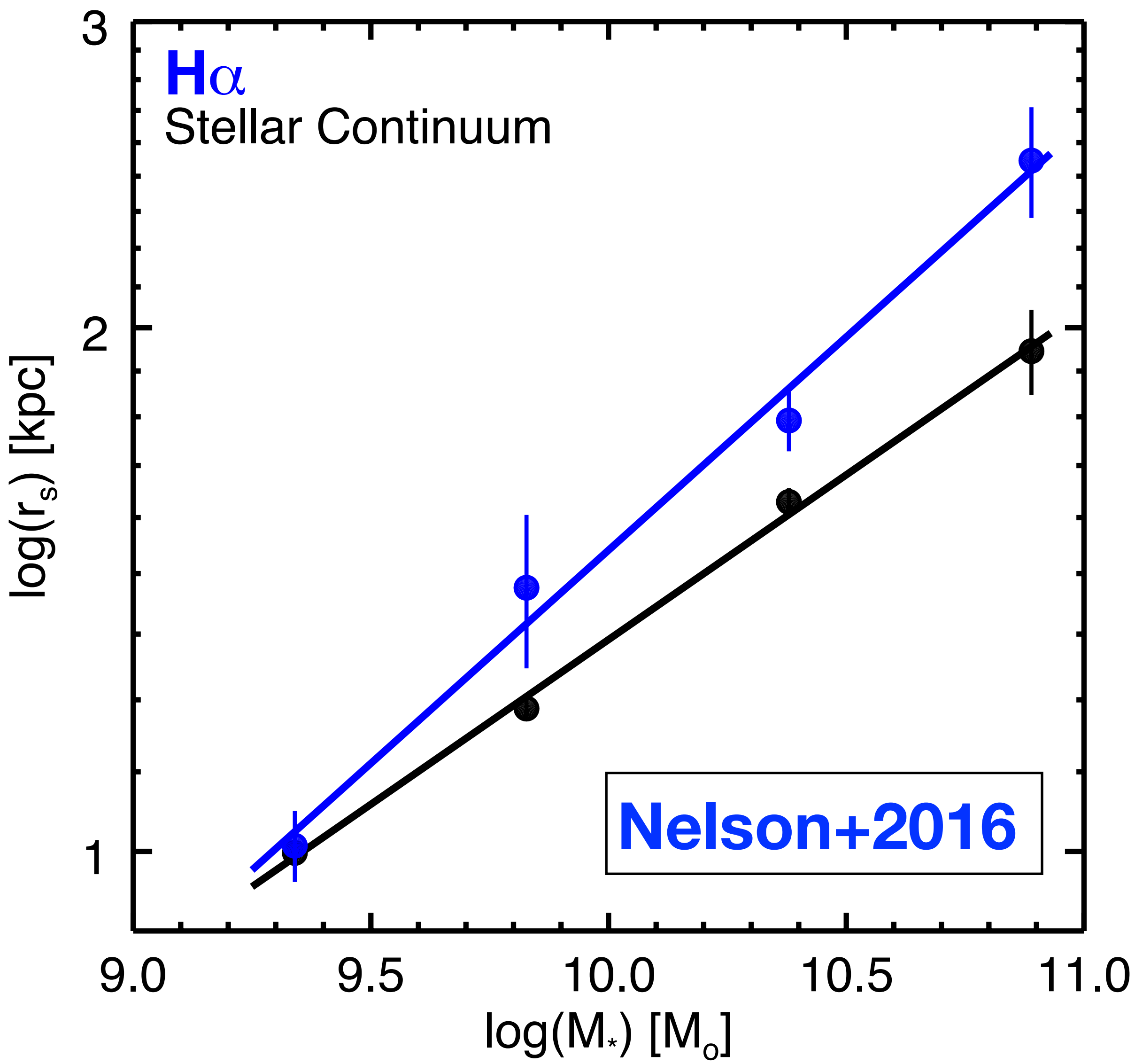

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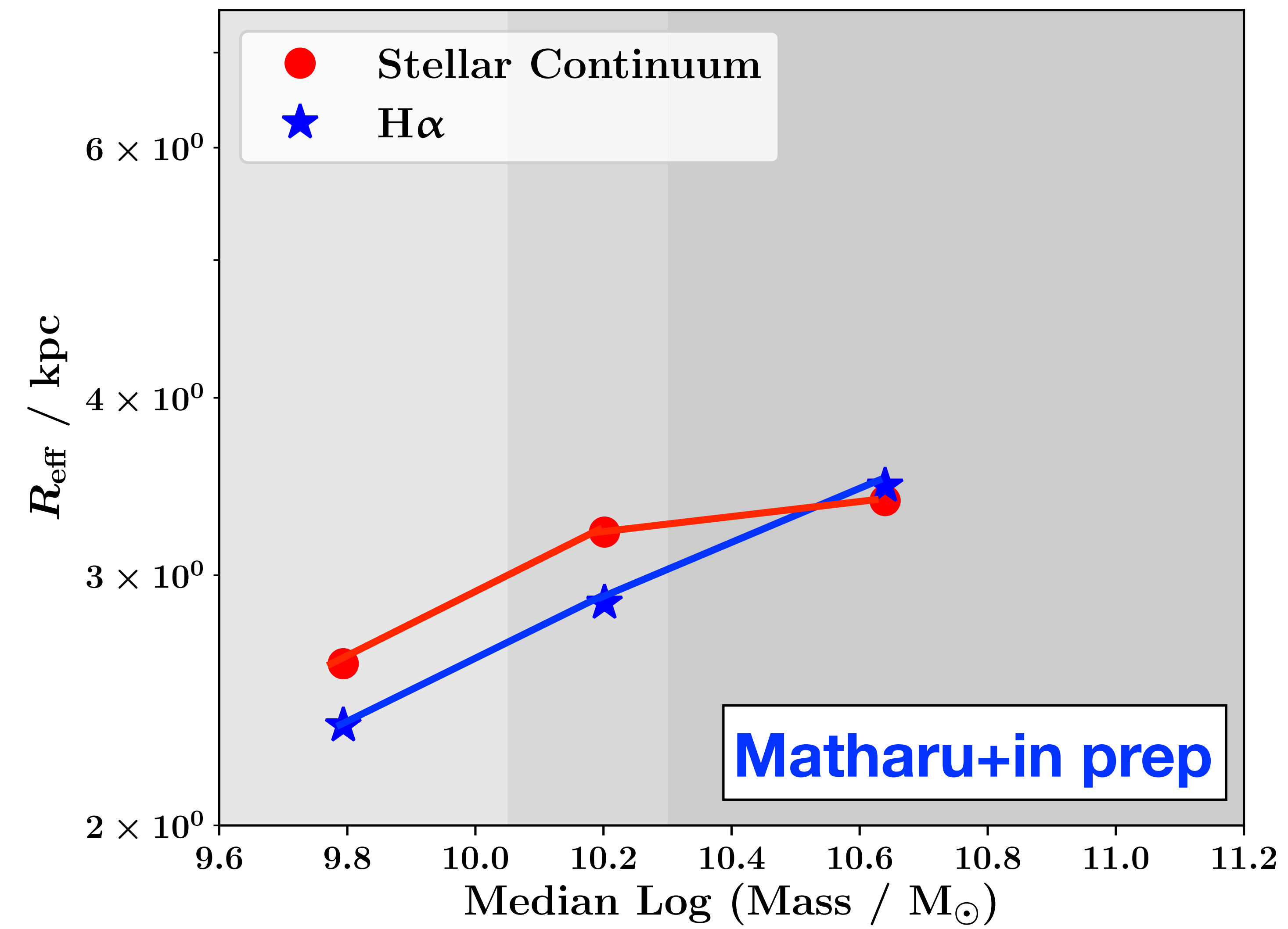

Clusters have smaller sizes in Ha vs. Continuum

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