

Connecting dusty starburst galaxies and proto galaxy clusters - A case study at $z=2.1$

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Themiya Nayakkara, Kim-Vy Tran, COSMOS team



Abell 1689 (HST/ACS)
NASA, JHU

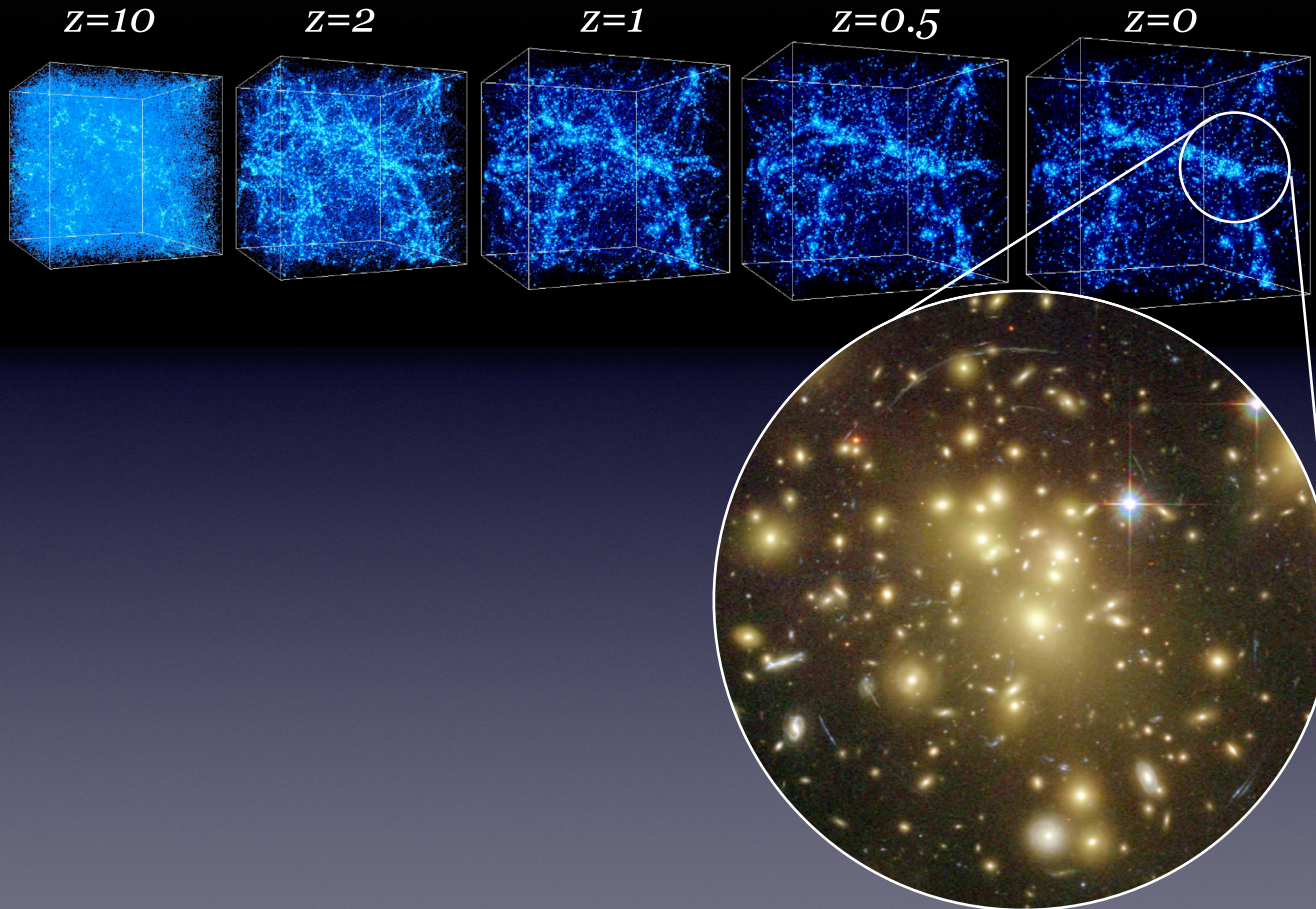


Image credit: NASA, JHU; Center for Cosmological Physics

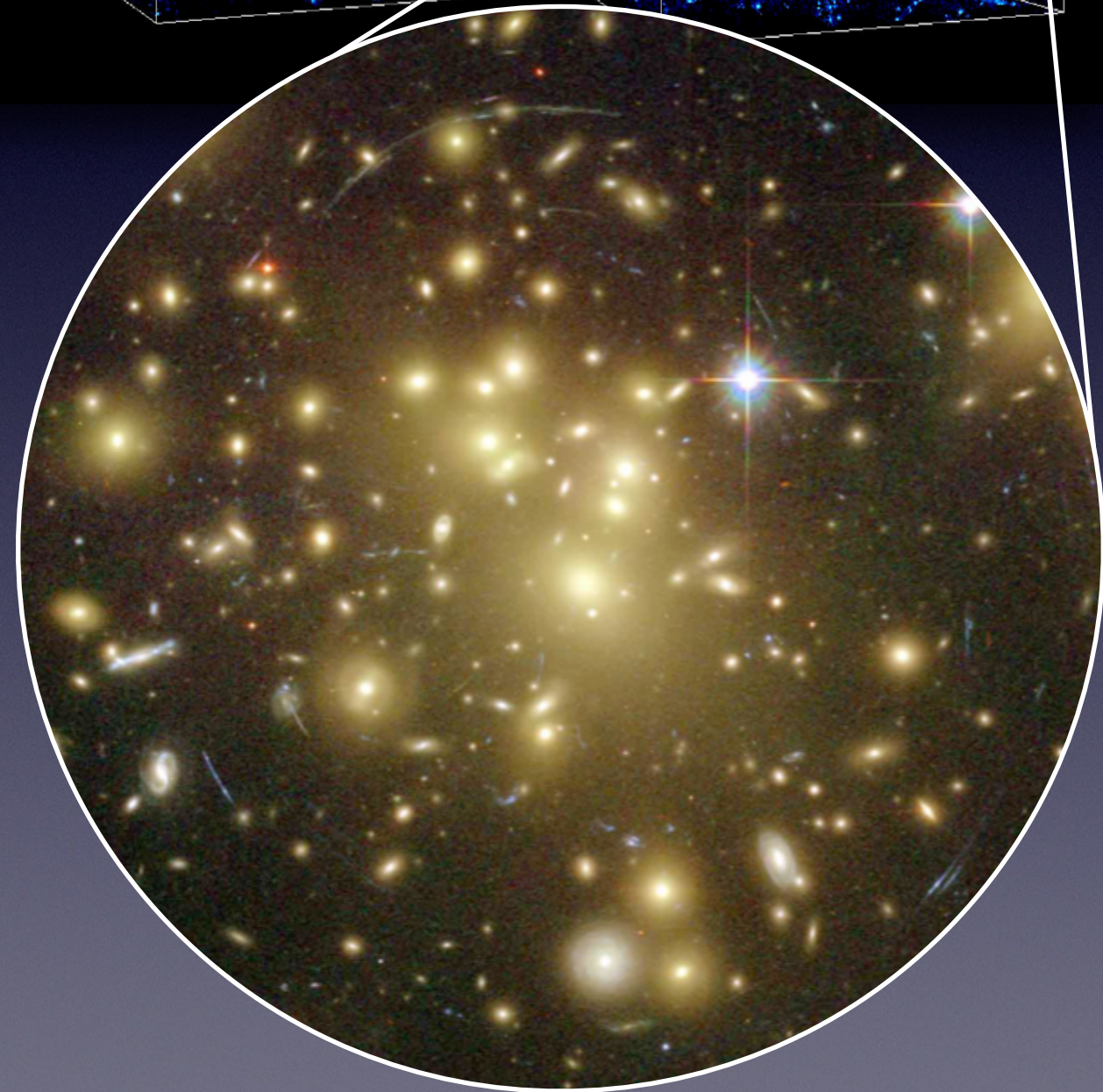
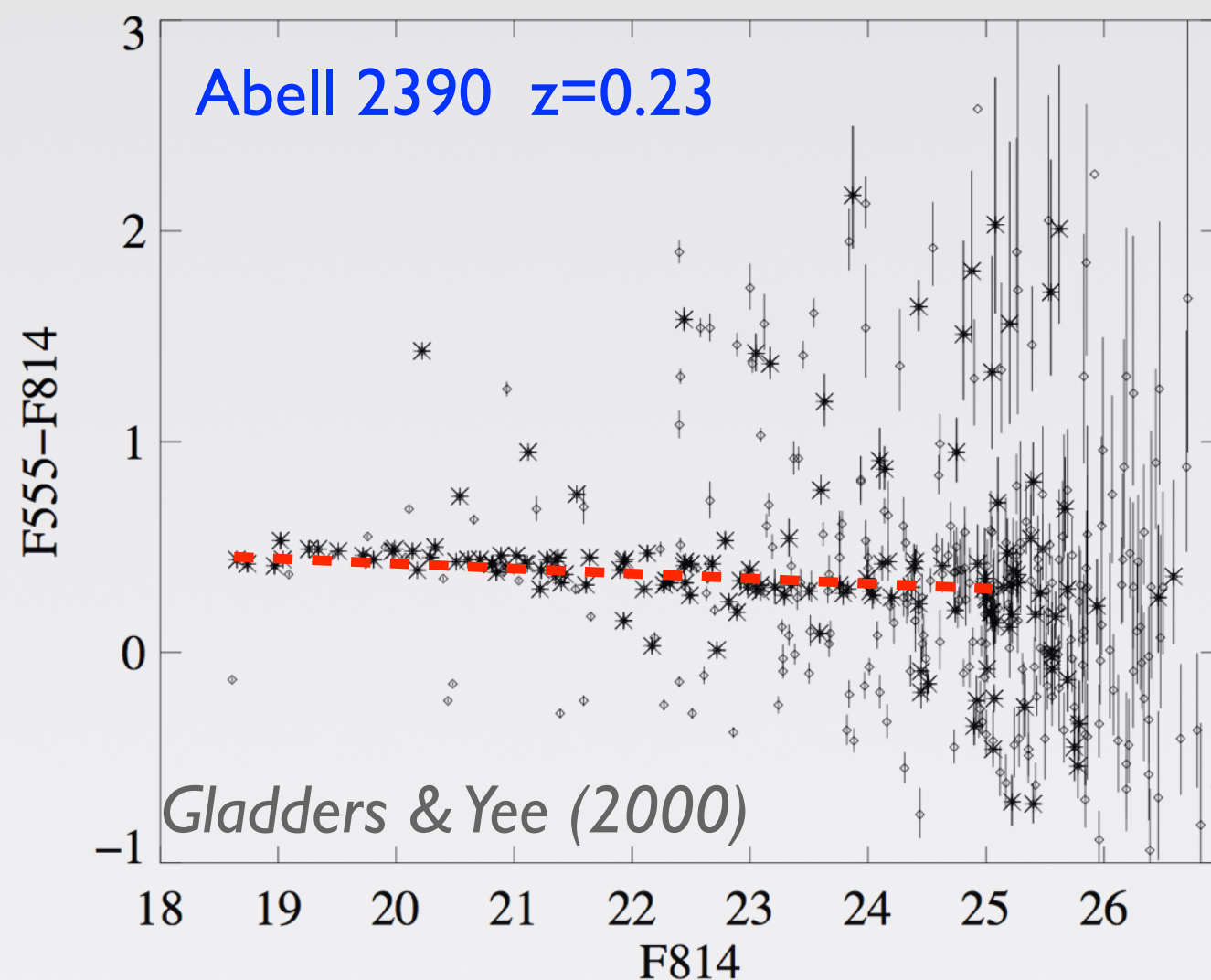
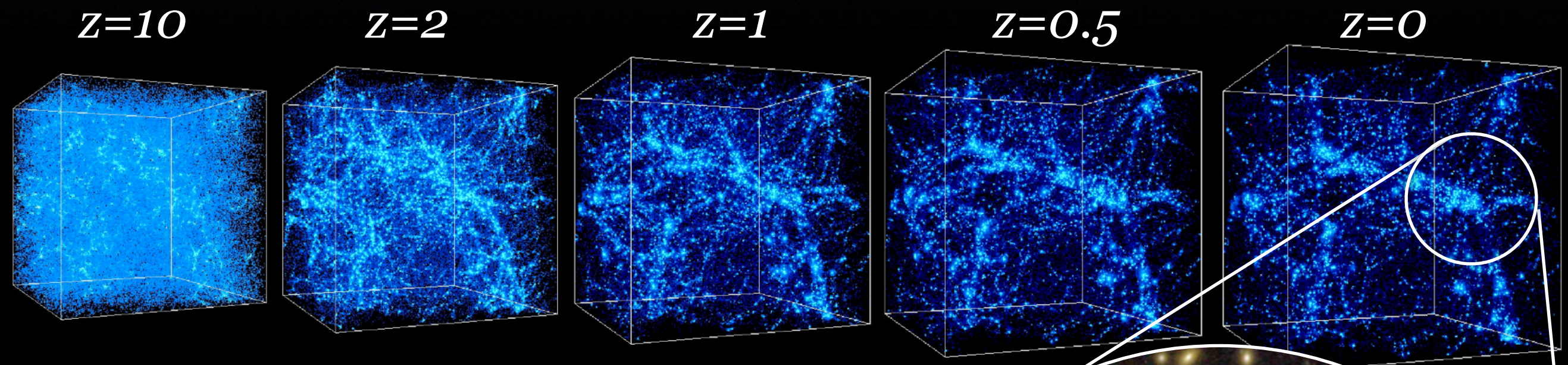
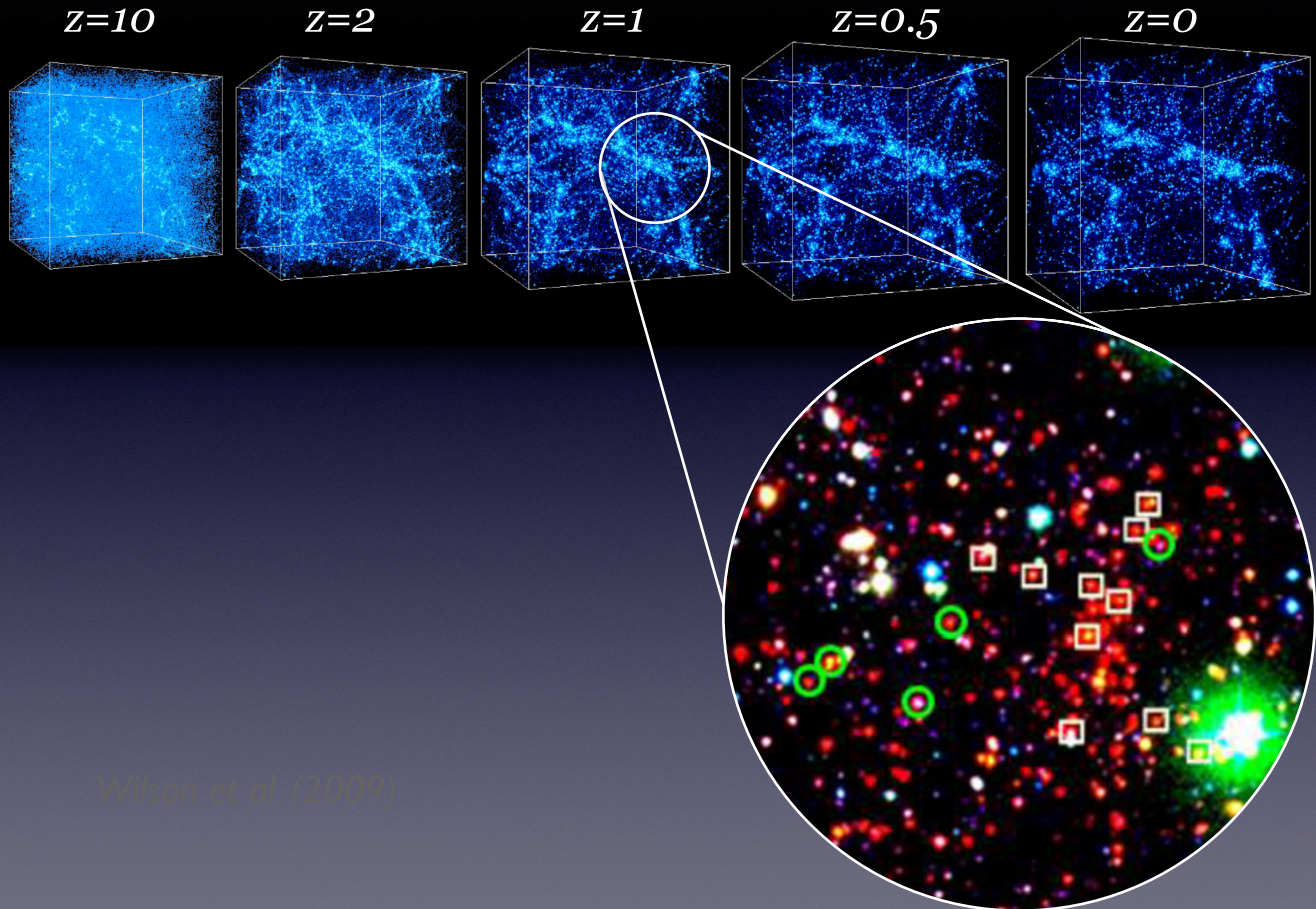


Image credit: NASA, JHU; Center for Cosmological Physics



Wilson et al. (2009)

Image credit: Center for Cosmological Physics; Wilson et al. (2009)

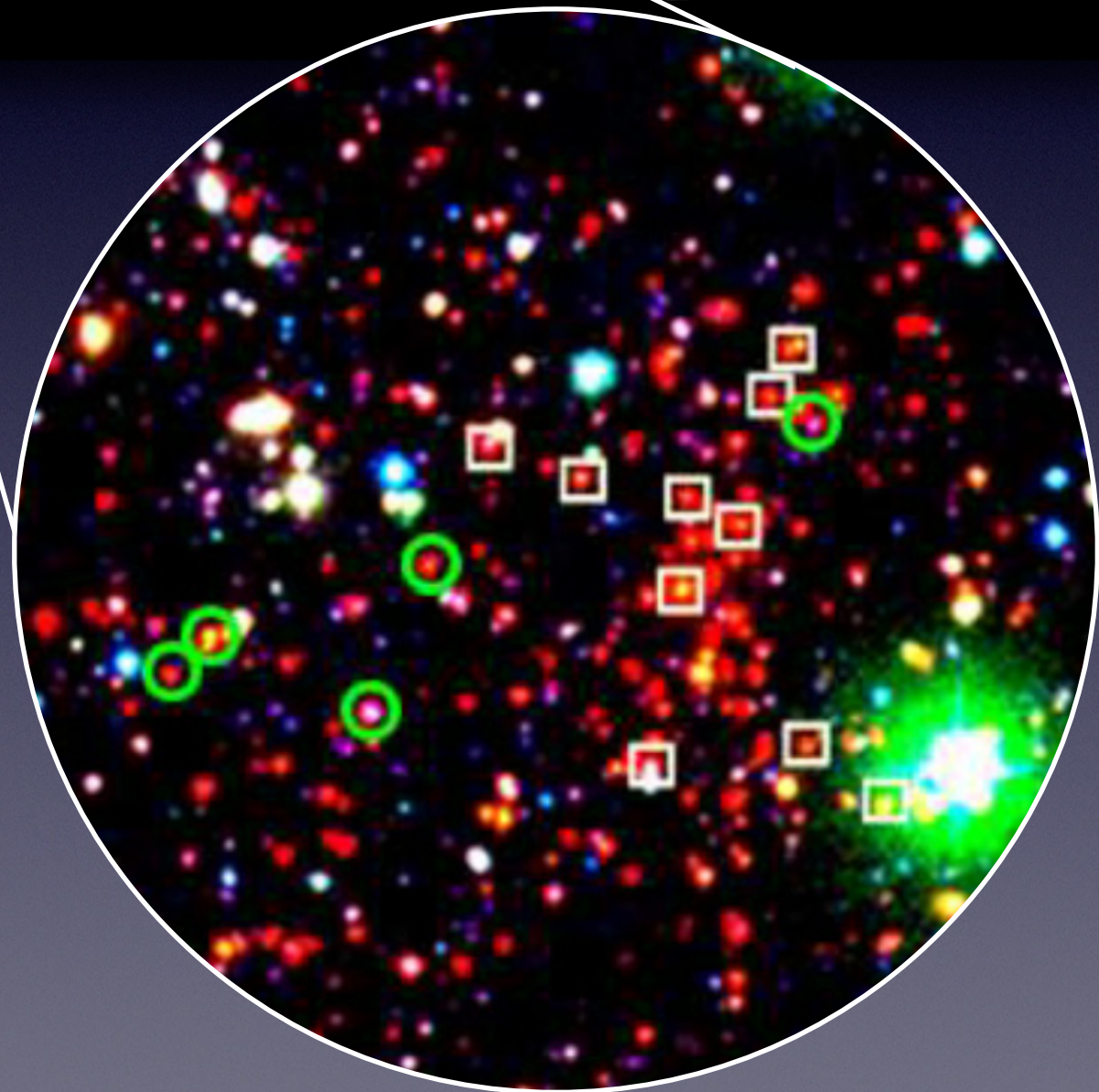
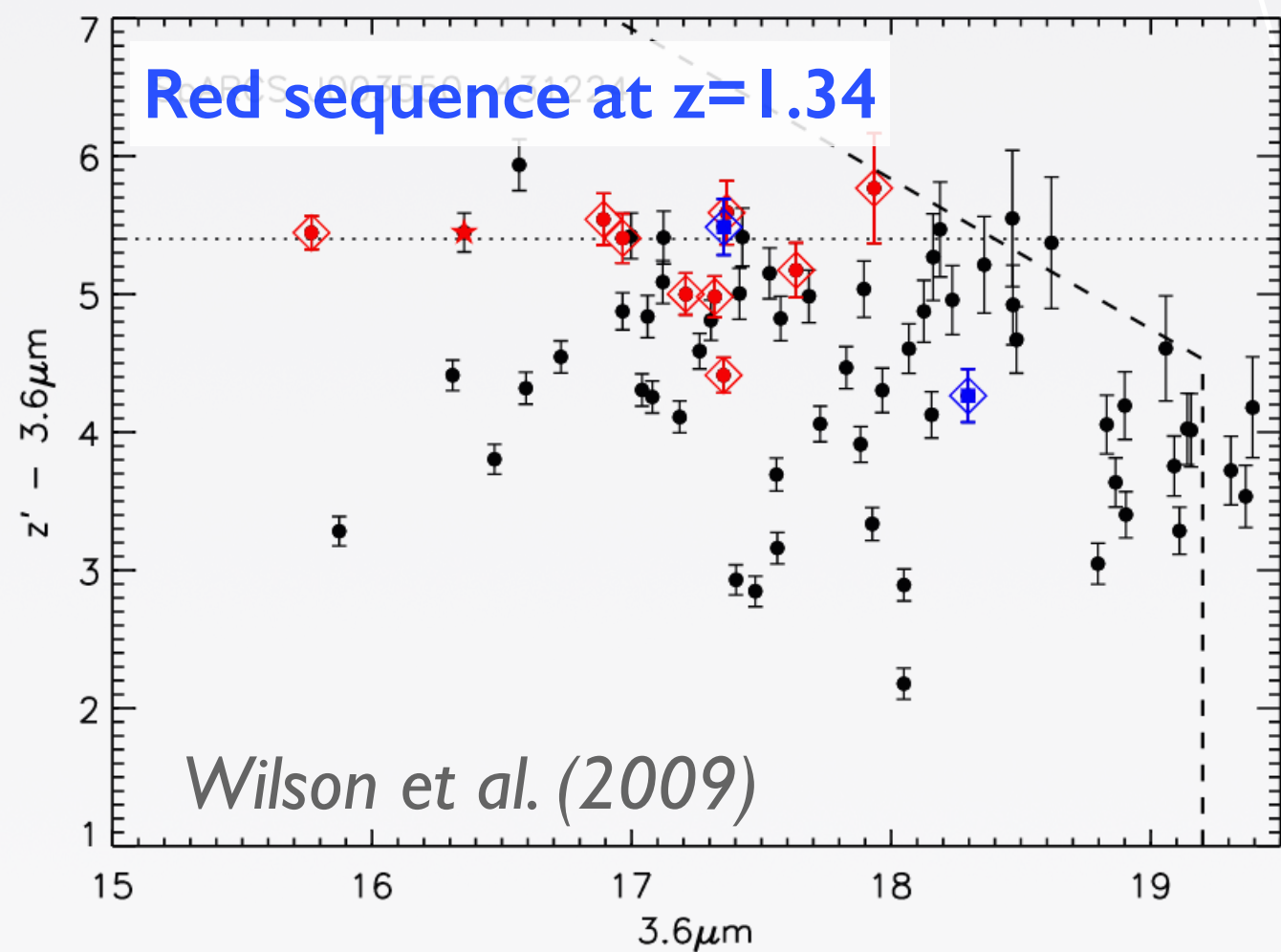
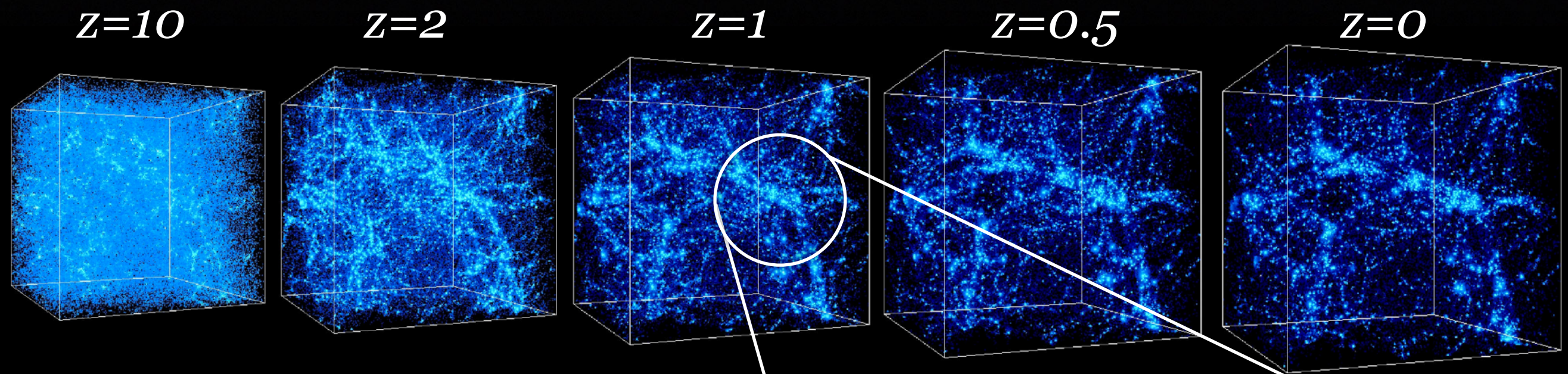
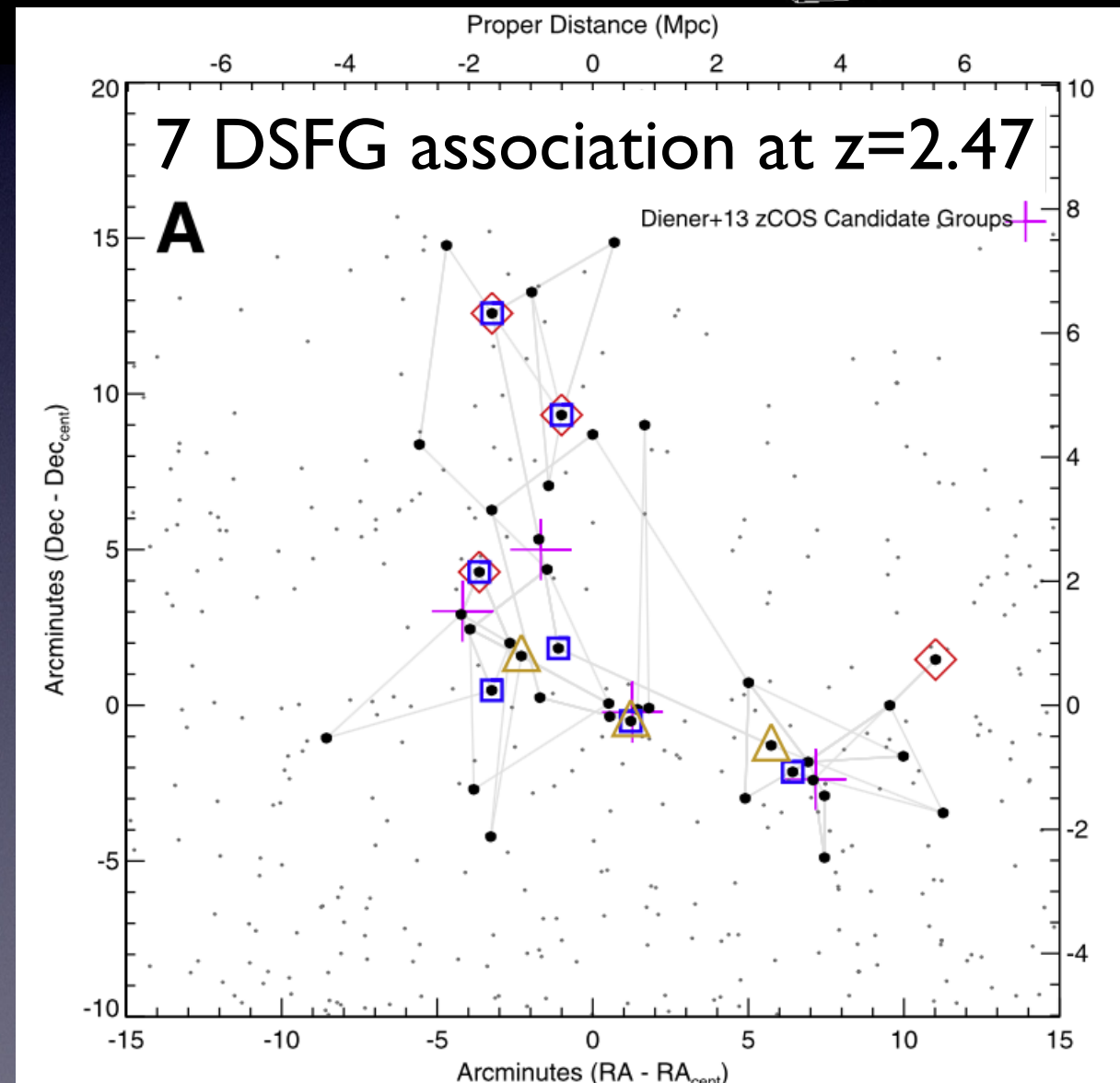
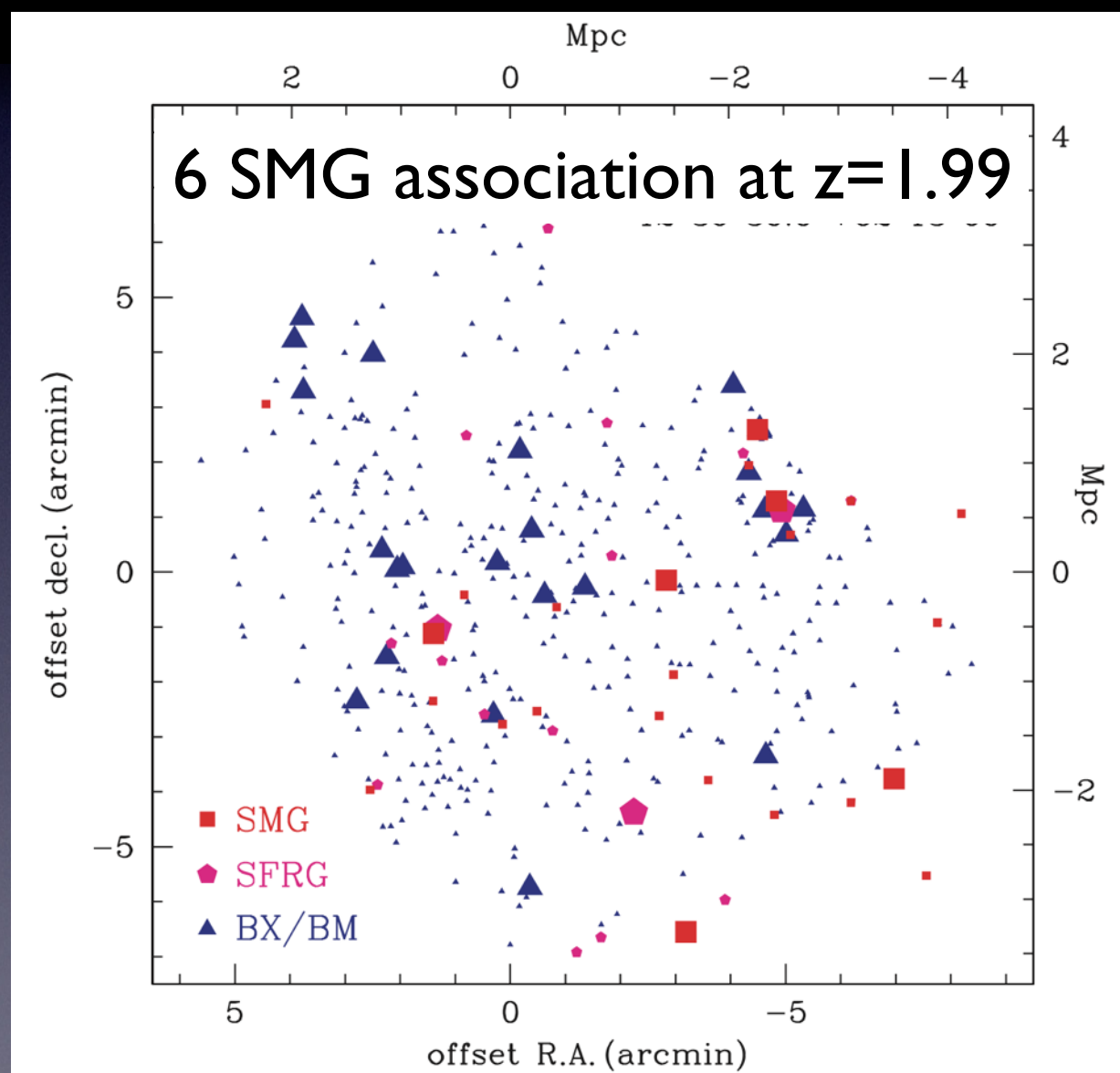
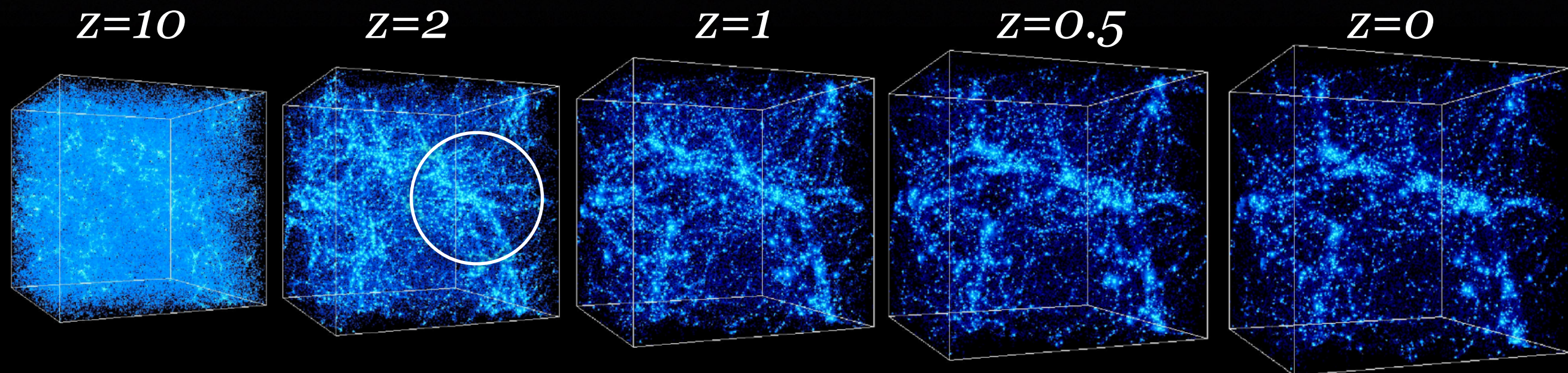
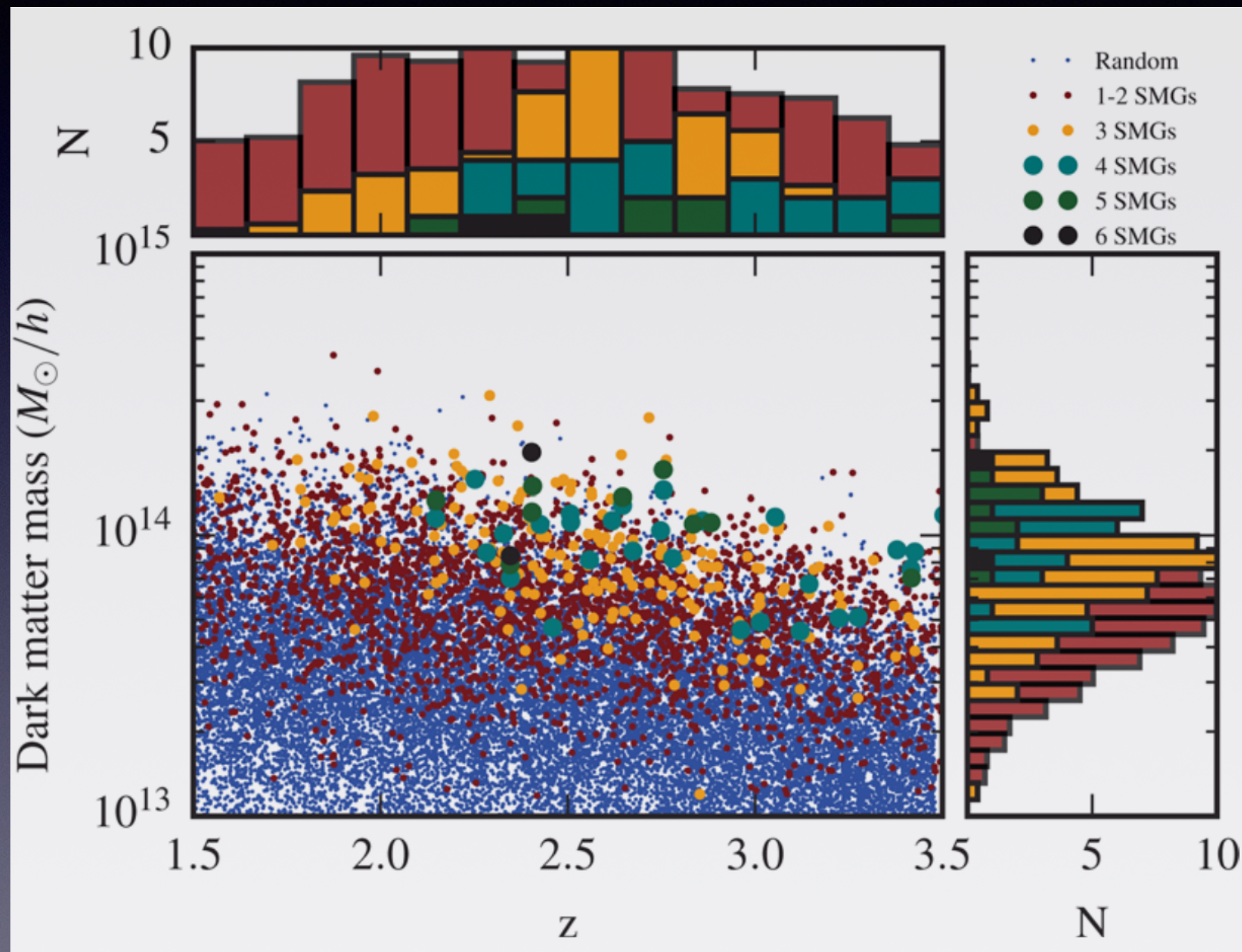


Image credit: Center for Cosmological Physics; Wilson et al. (2009)



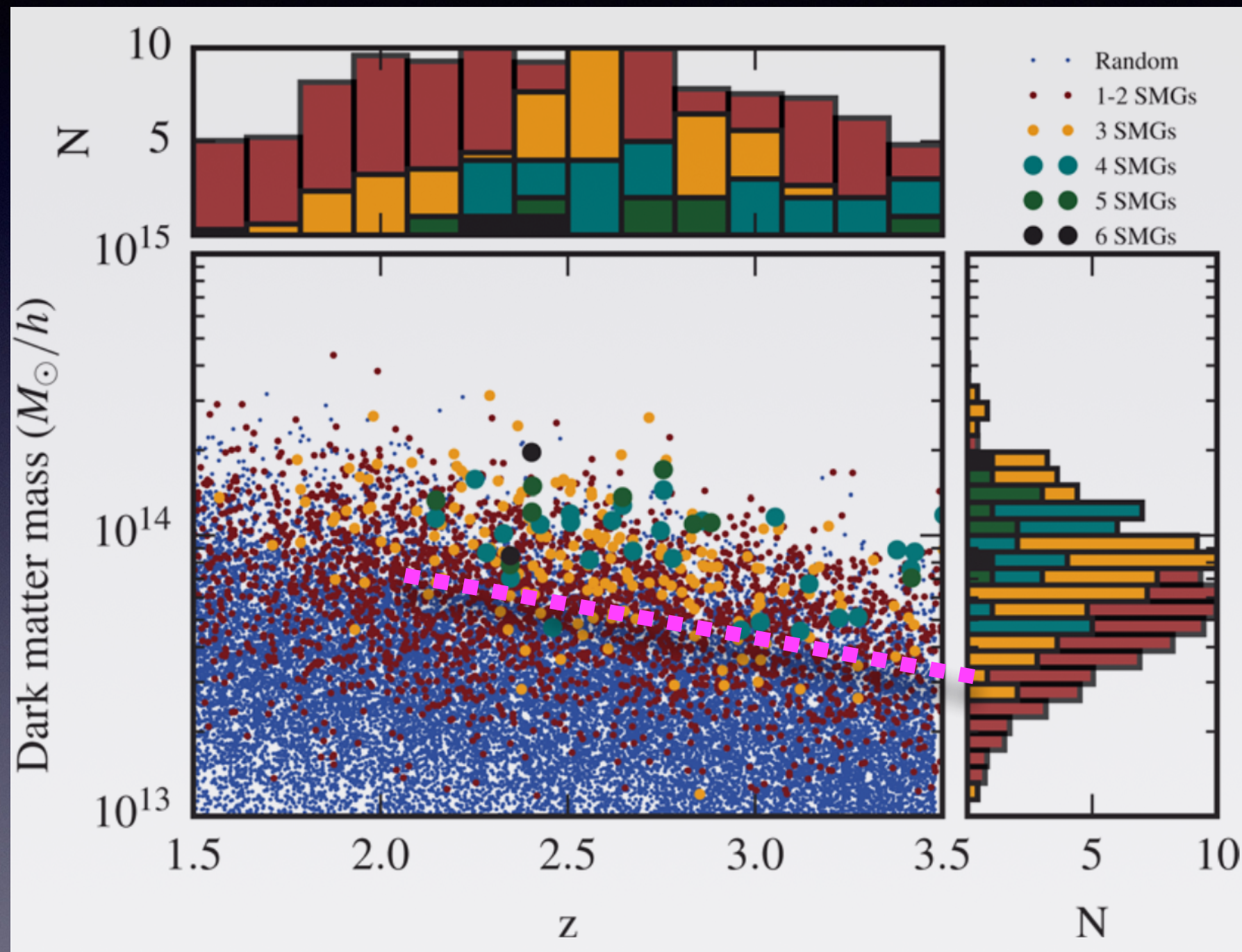
Chapman et al. (2009); Blain et al. (2004); Casey et al. (2015); also see Casey (2016)

Do SMGs/DSFGs trace overdensity of mass?



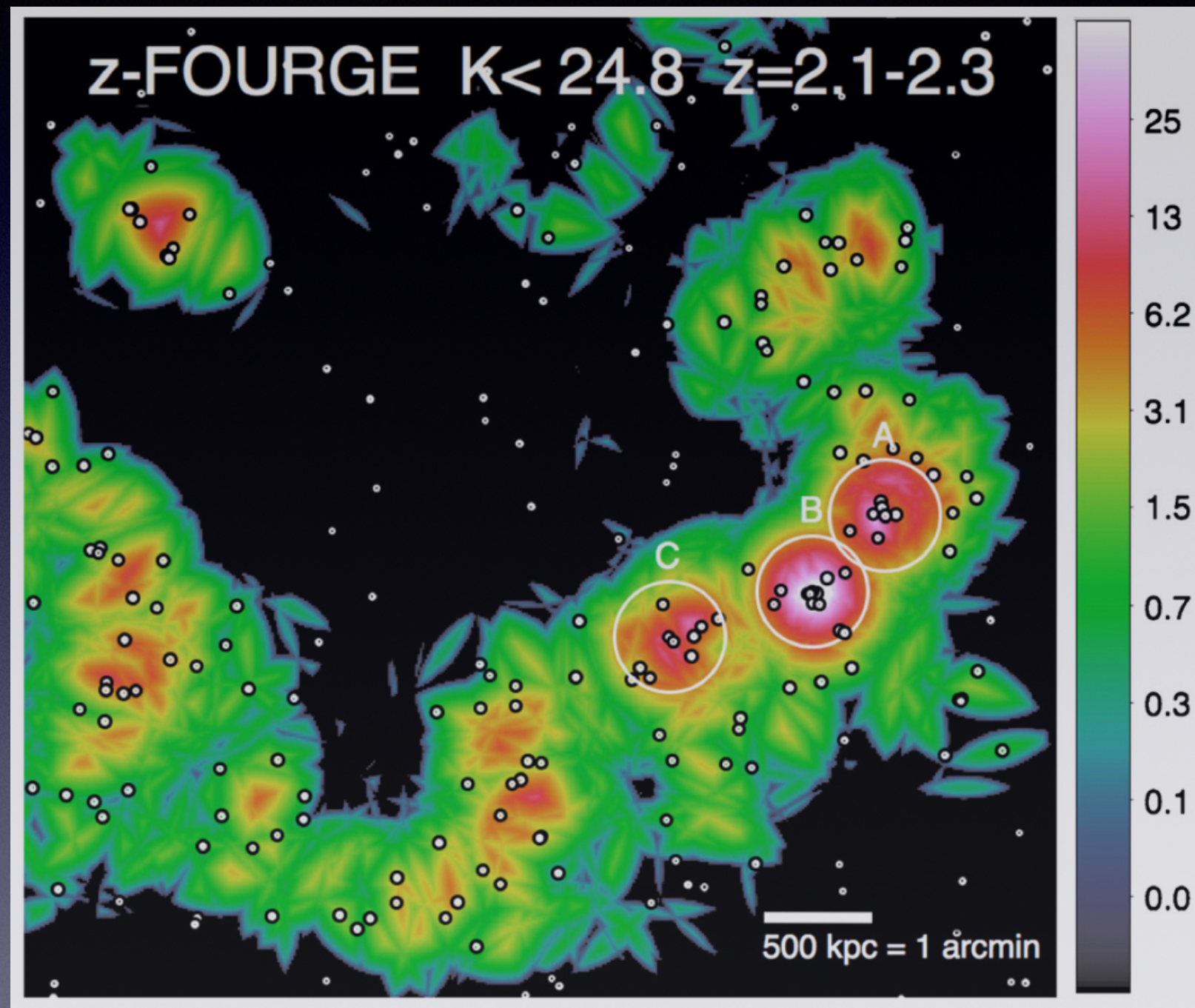
Miller et al. (2015)

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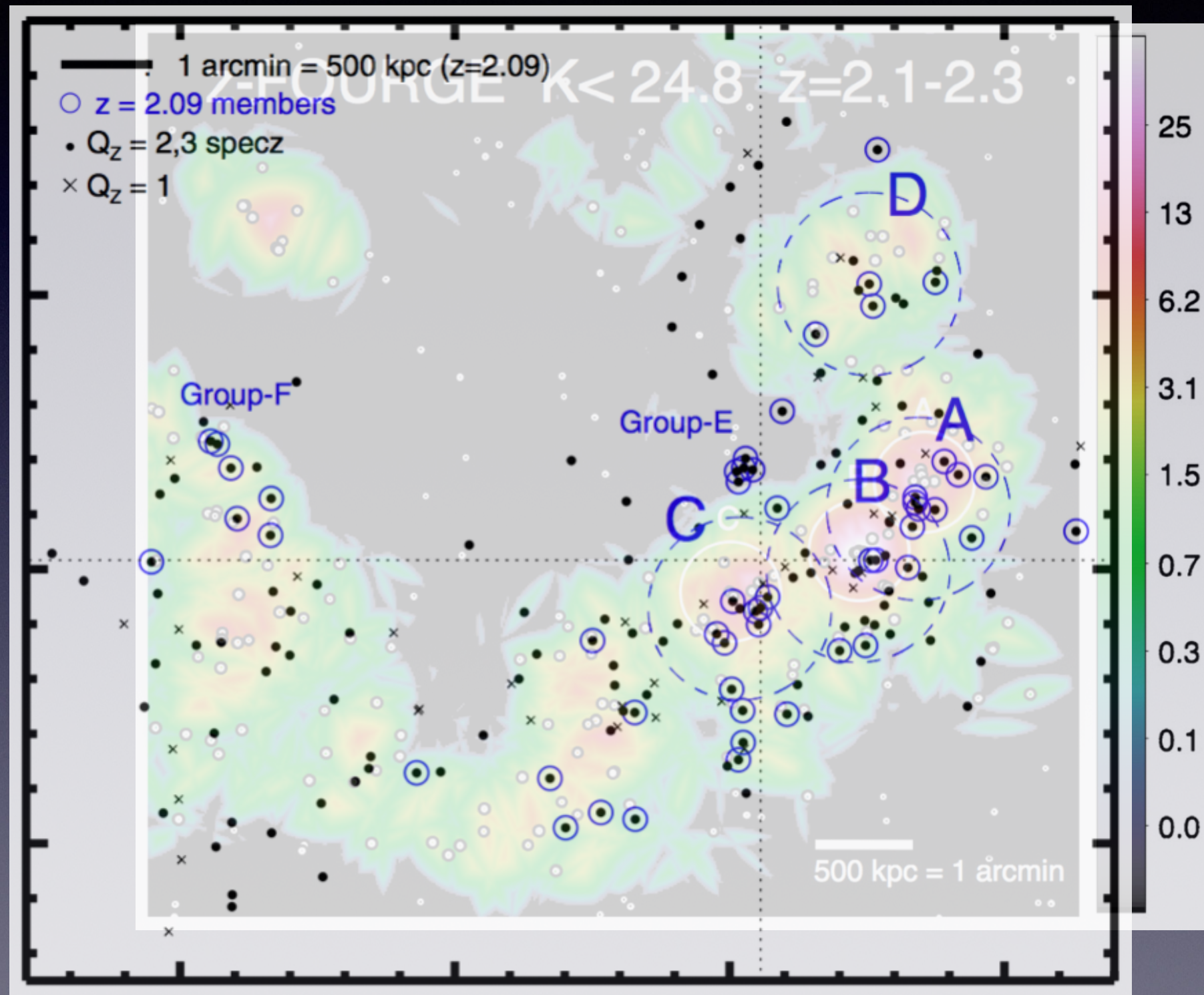
Miller et al. (2015)

A spectroscopically confirmed cluster at $z=2.1$



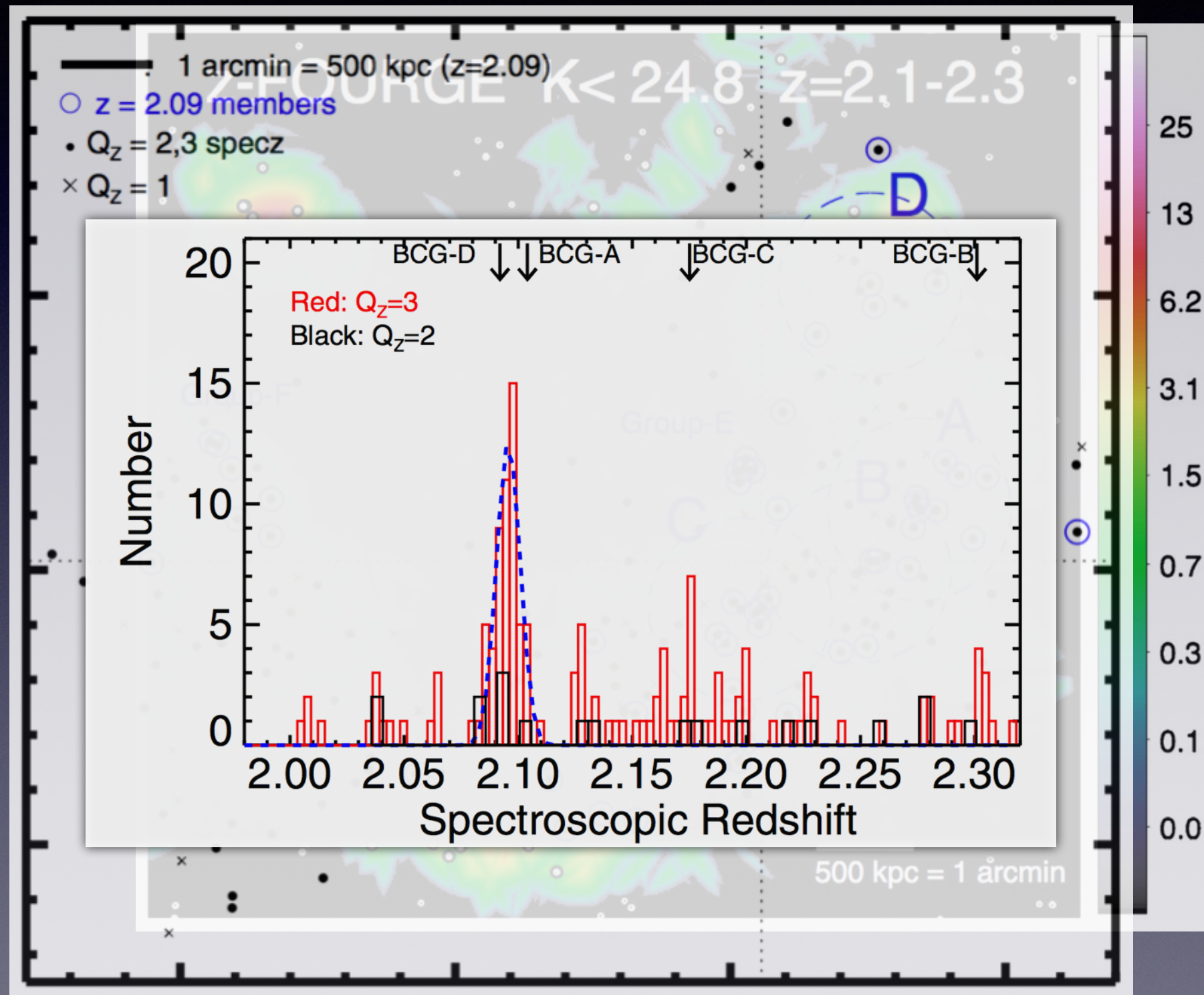
Spitler et al. (2012); Yuan et al. (2014); also see Chiang et al. (2014)

A spectroscopically confirmed cluster at $z=2.1$



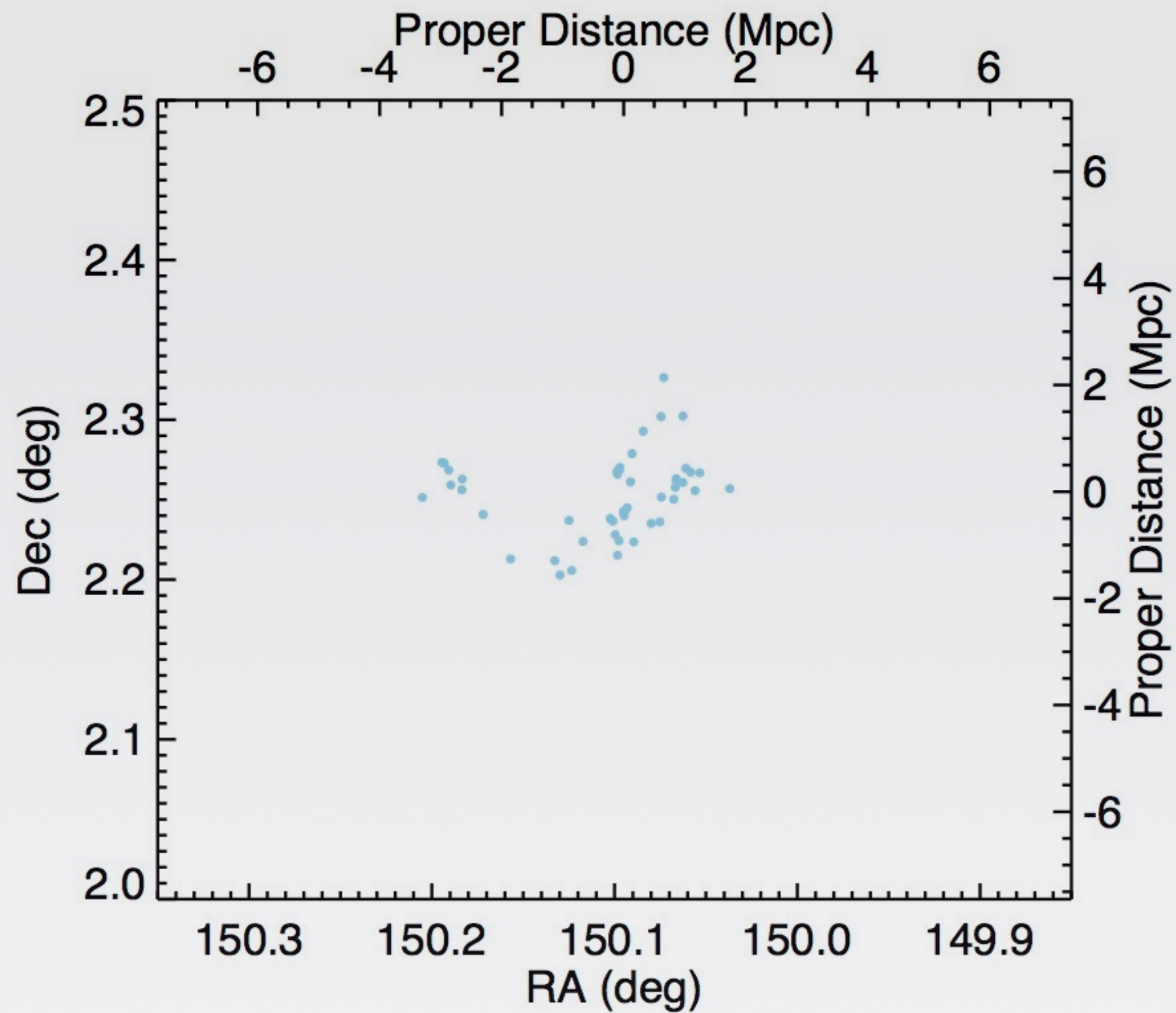
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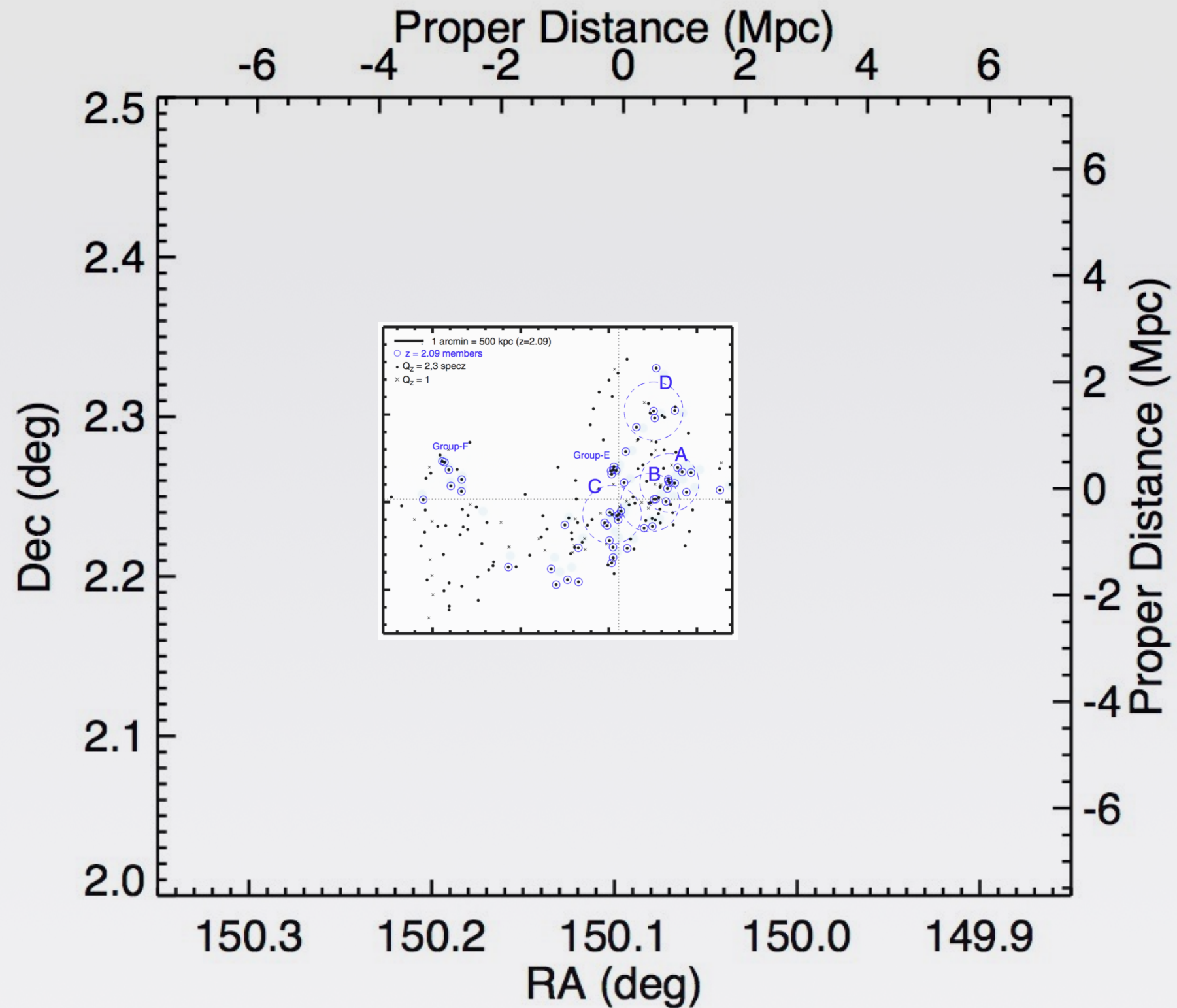


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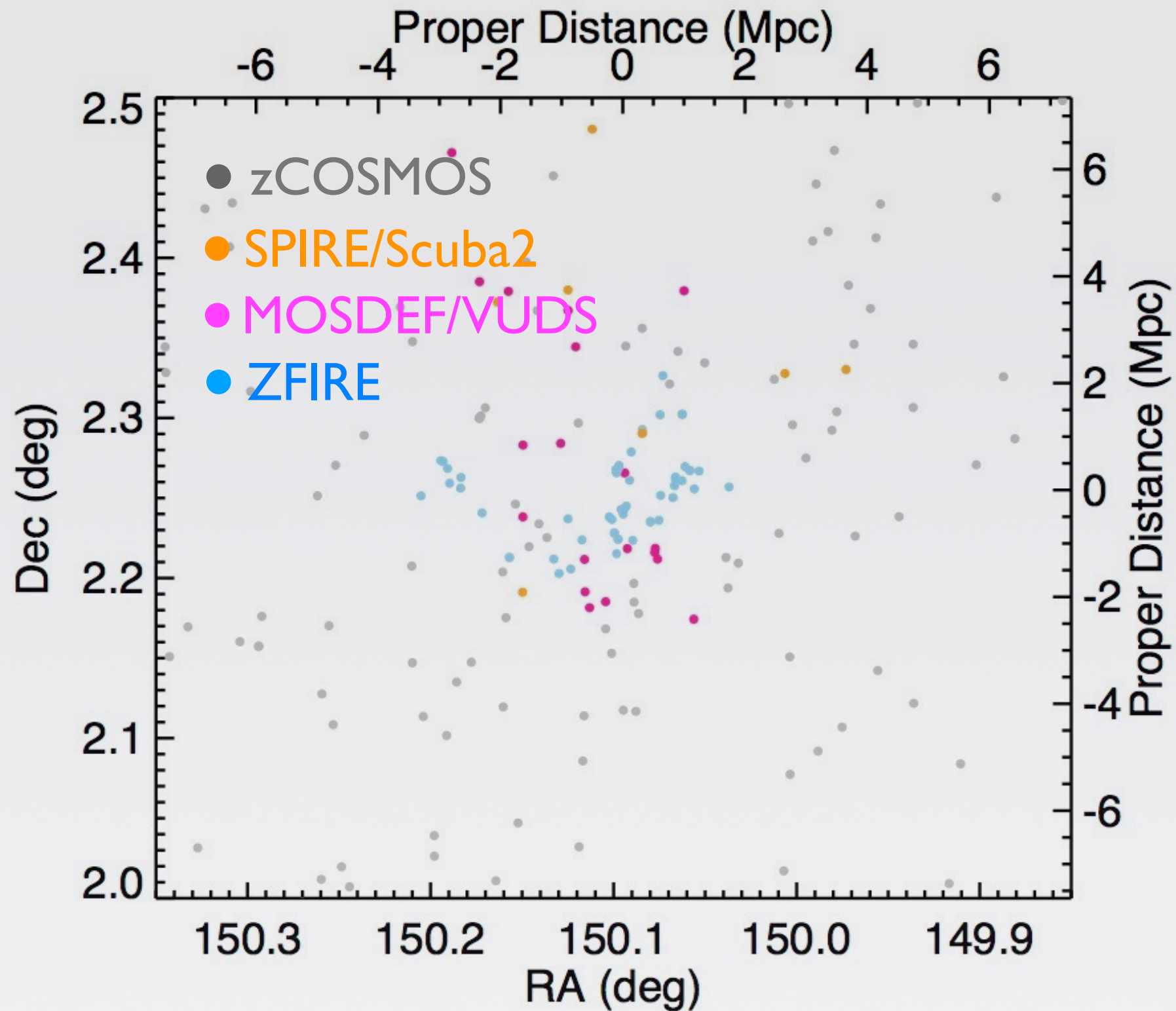
SFGs $2.07 < z < 2.12$



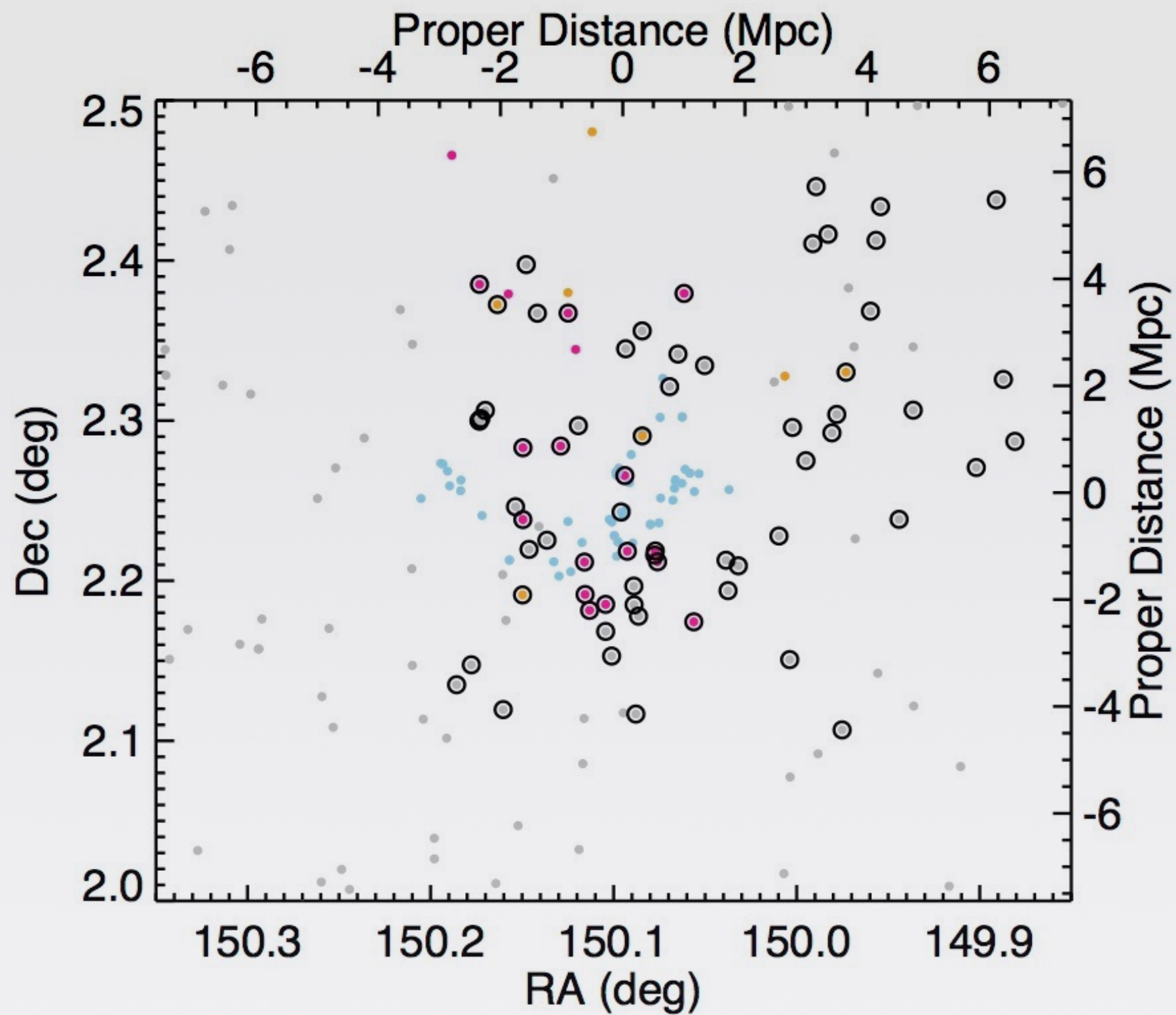
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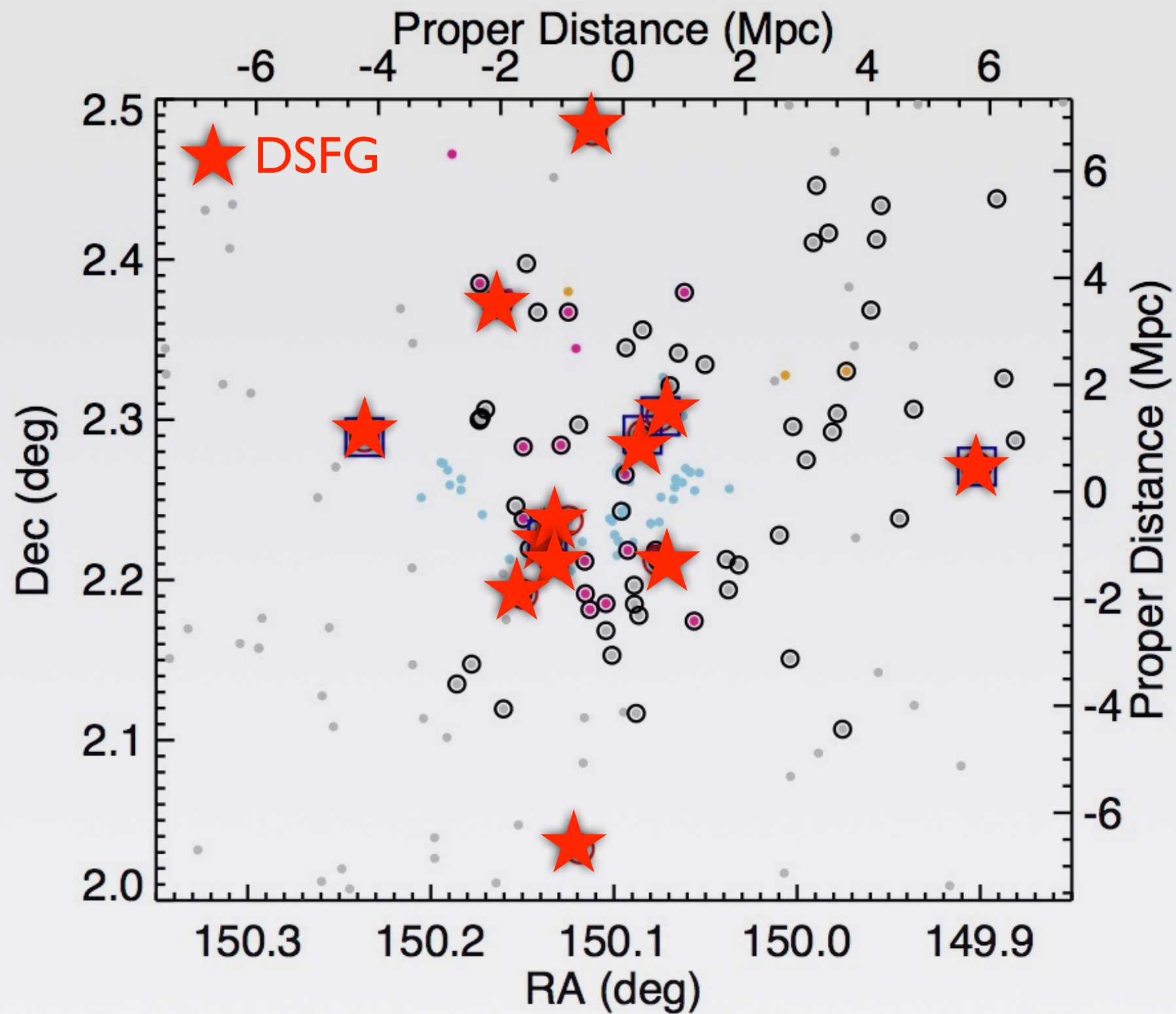
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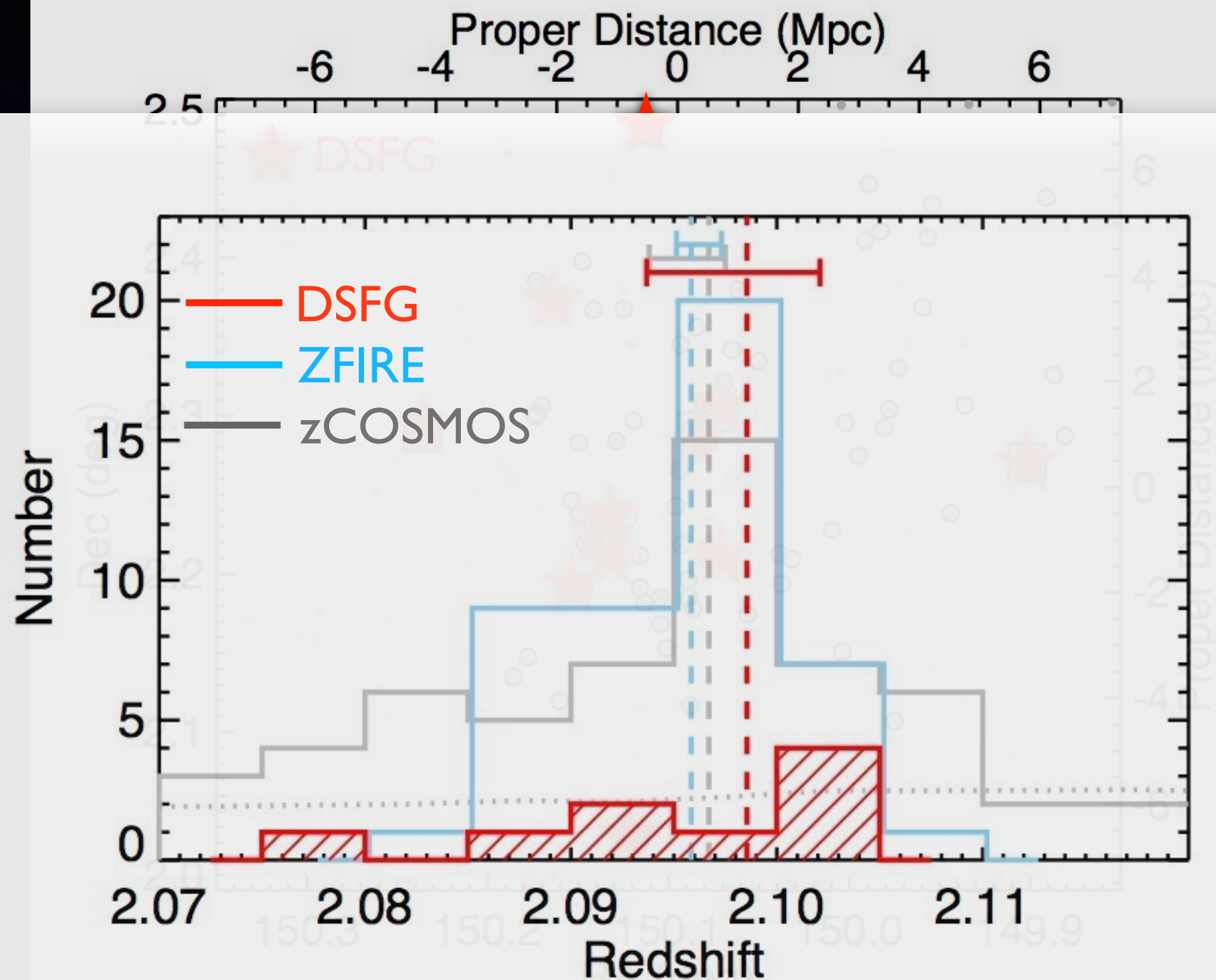
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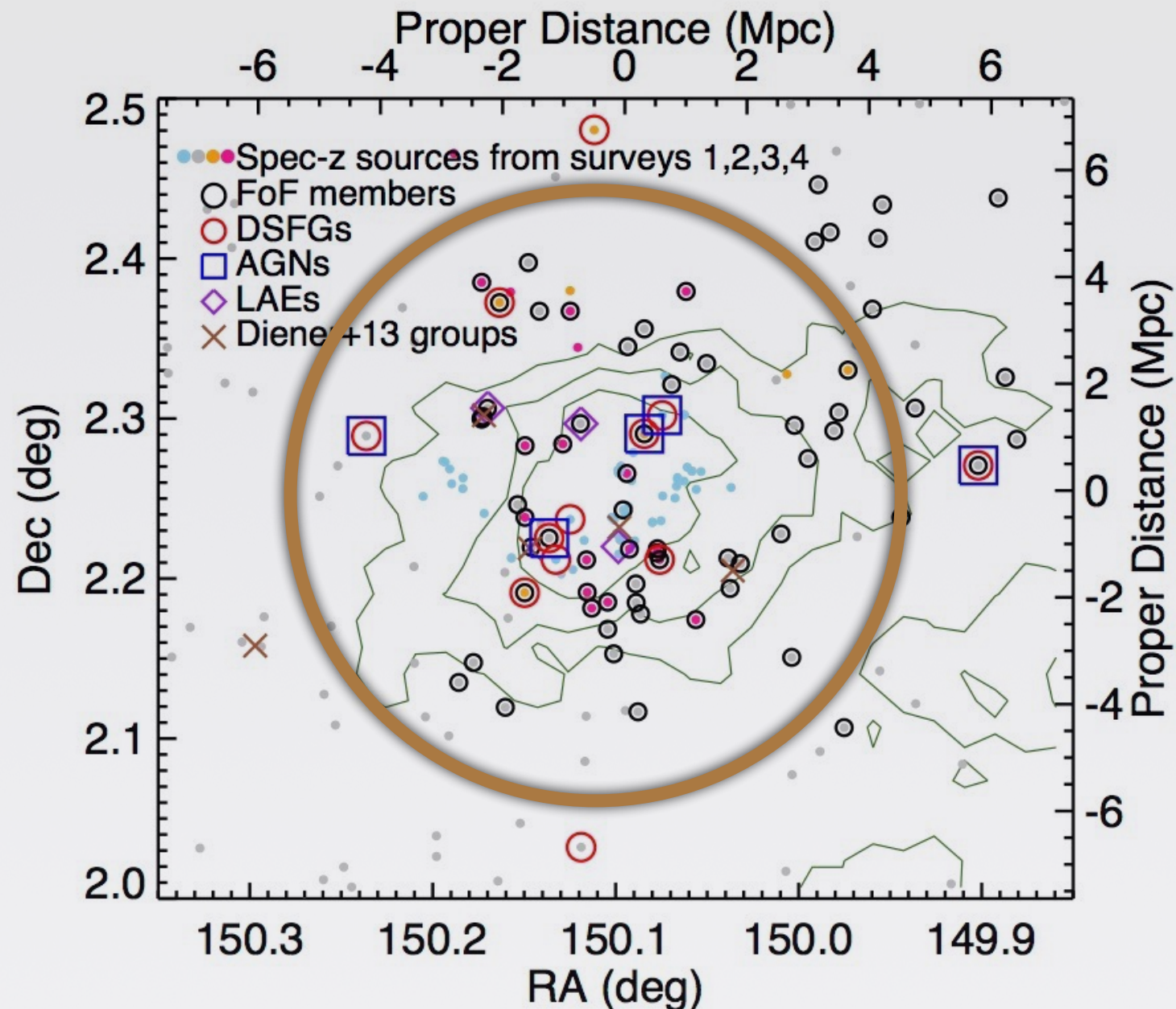
SFGs $2.07 < z < 2.12$



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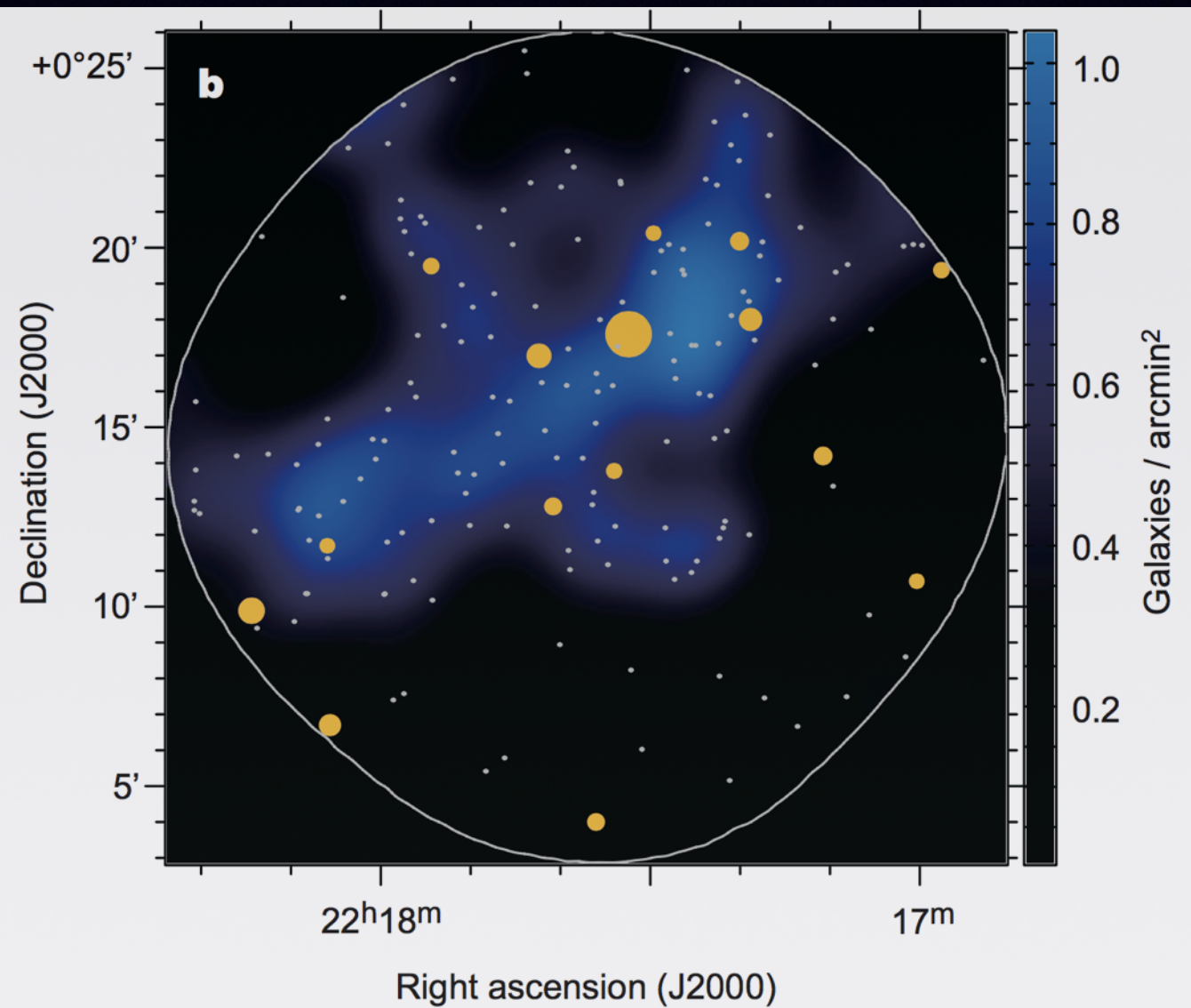
$z=2.1$ cluster and extended LSS



- 34 additional color-selected SFGs from zCOSMOS: $\delta_{\text{SFG}}=2.8$
- 9 DSFGs in the structure: $\delta_{\text{DSFG}}=12.3$

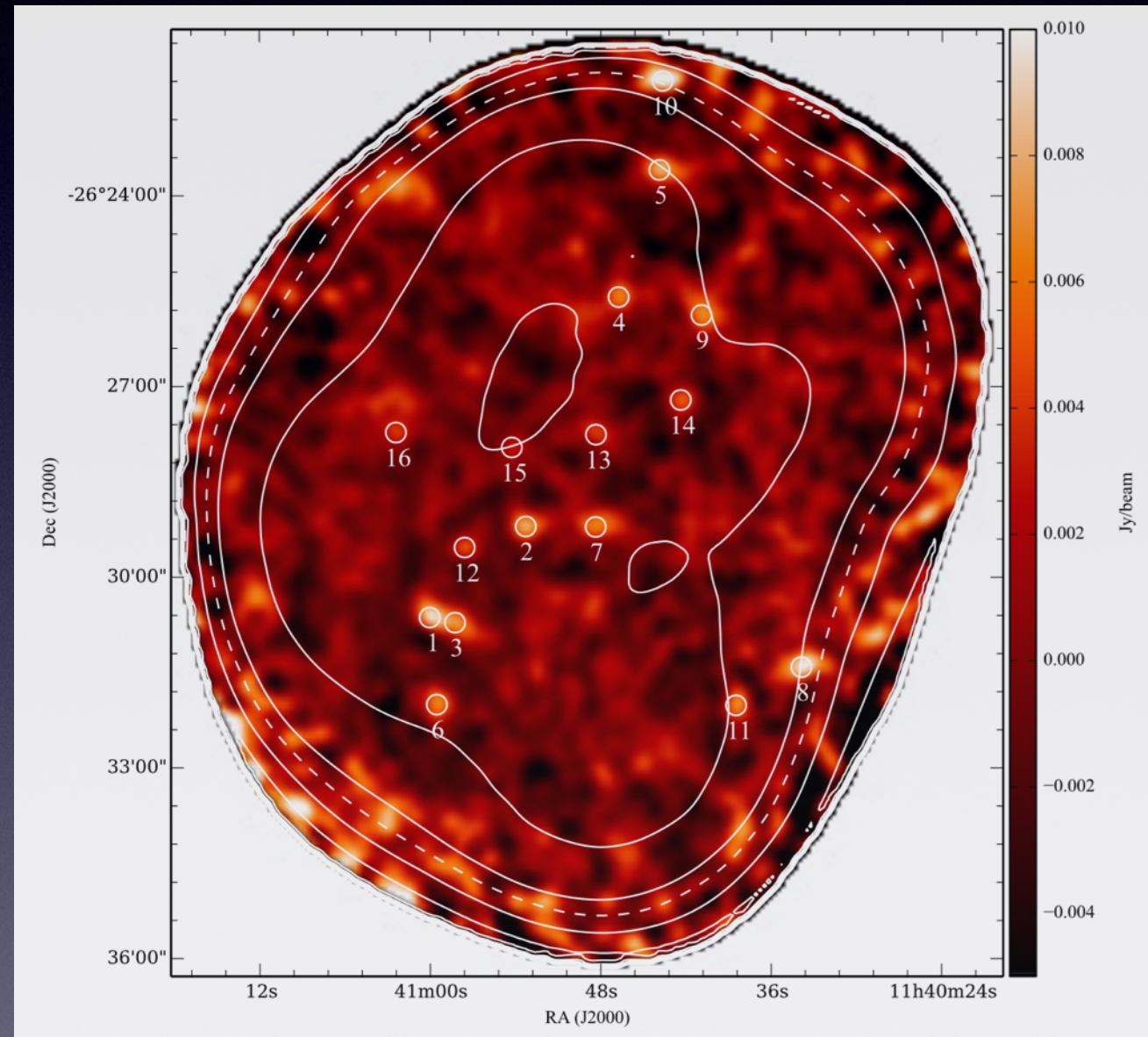
Overdensity of SMGs/DSFGs in *known* protoclusters

SSA 22 at $z=3.09$



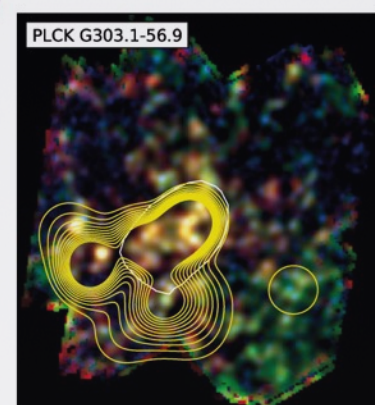
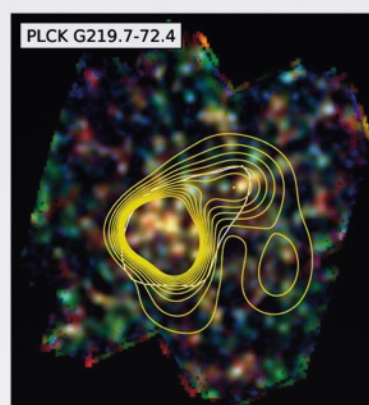
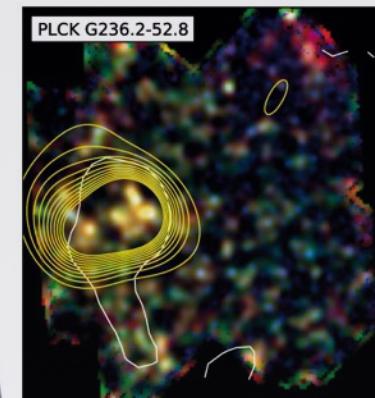
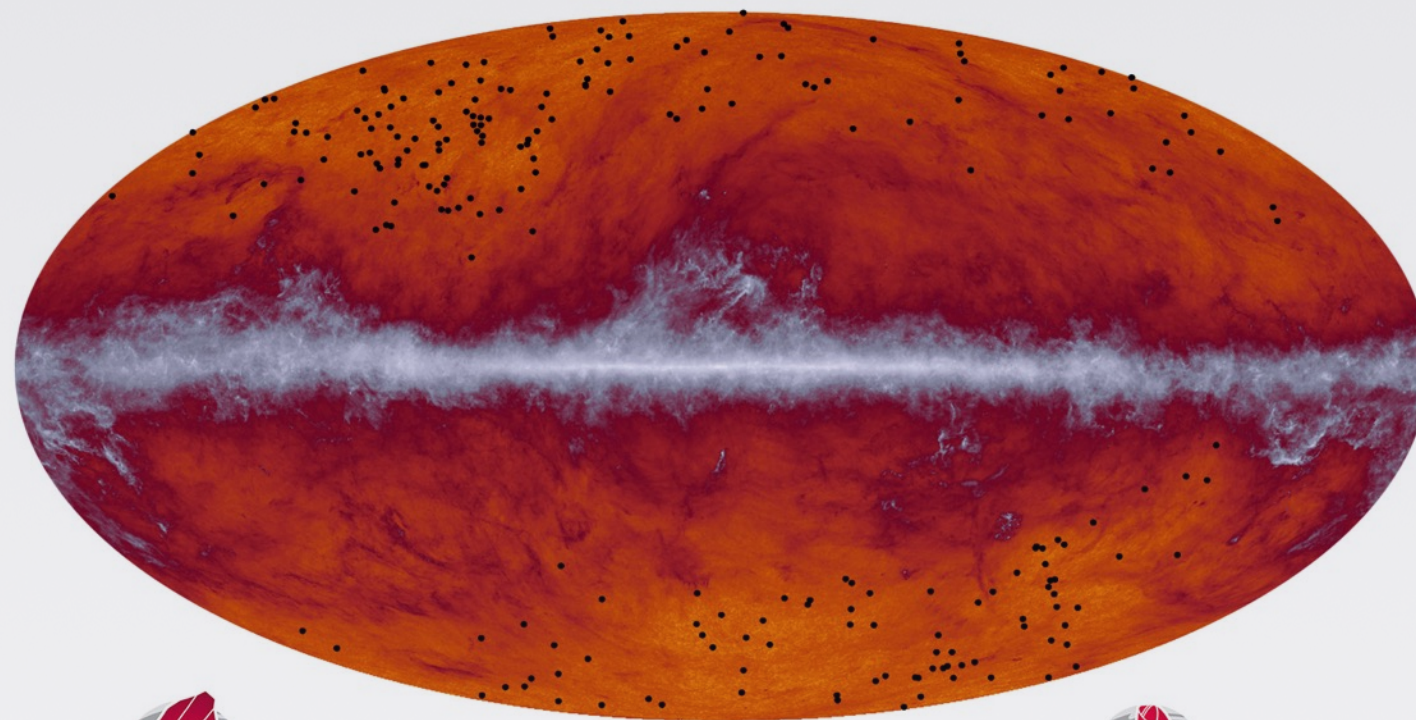
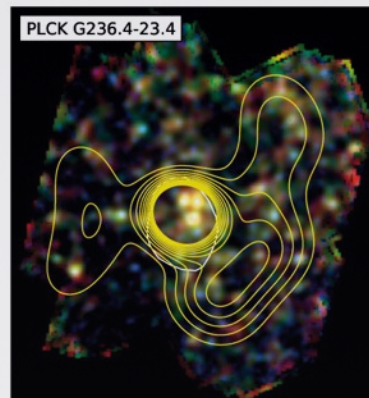
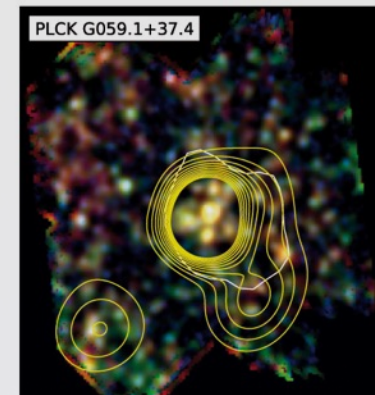
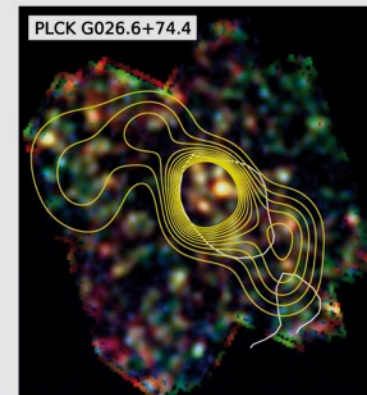
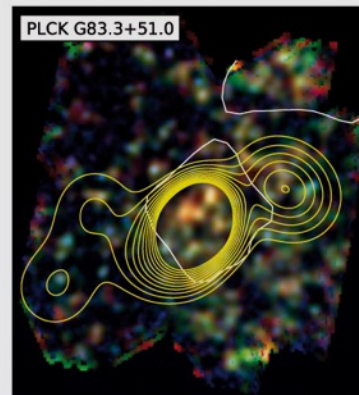
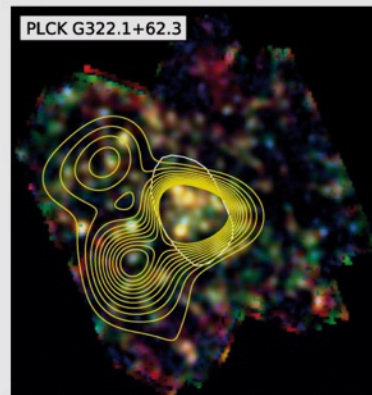
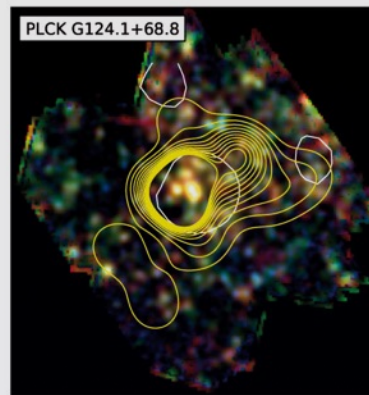
Tamura et al. (2009)

MRC 1138-262 at $z=2.16$



Dannerbauer et al. (2014)

→ Herschel and Planck proto-cluster candidates



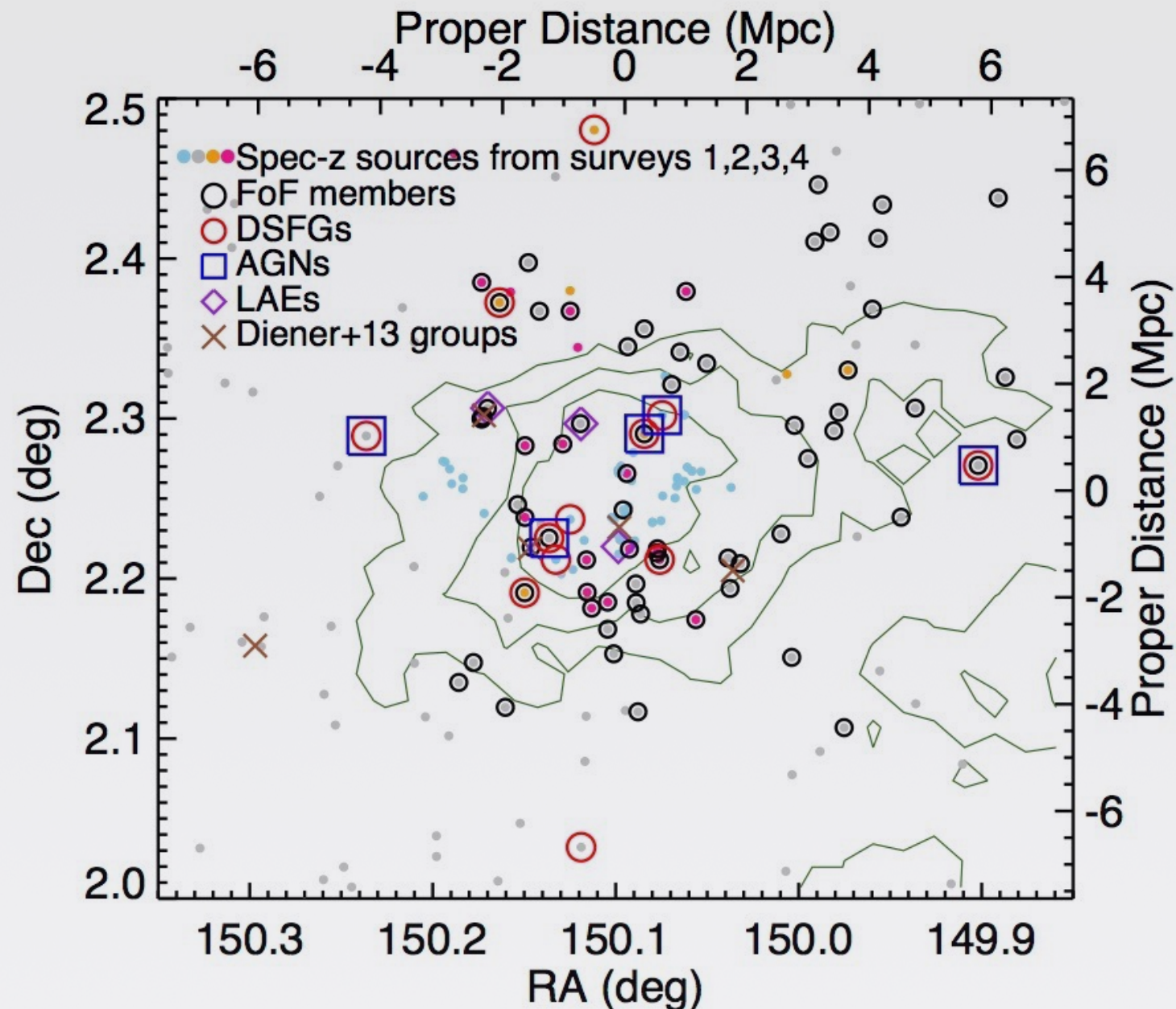
herschel



planck

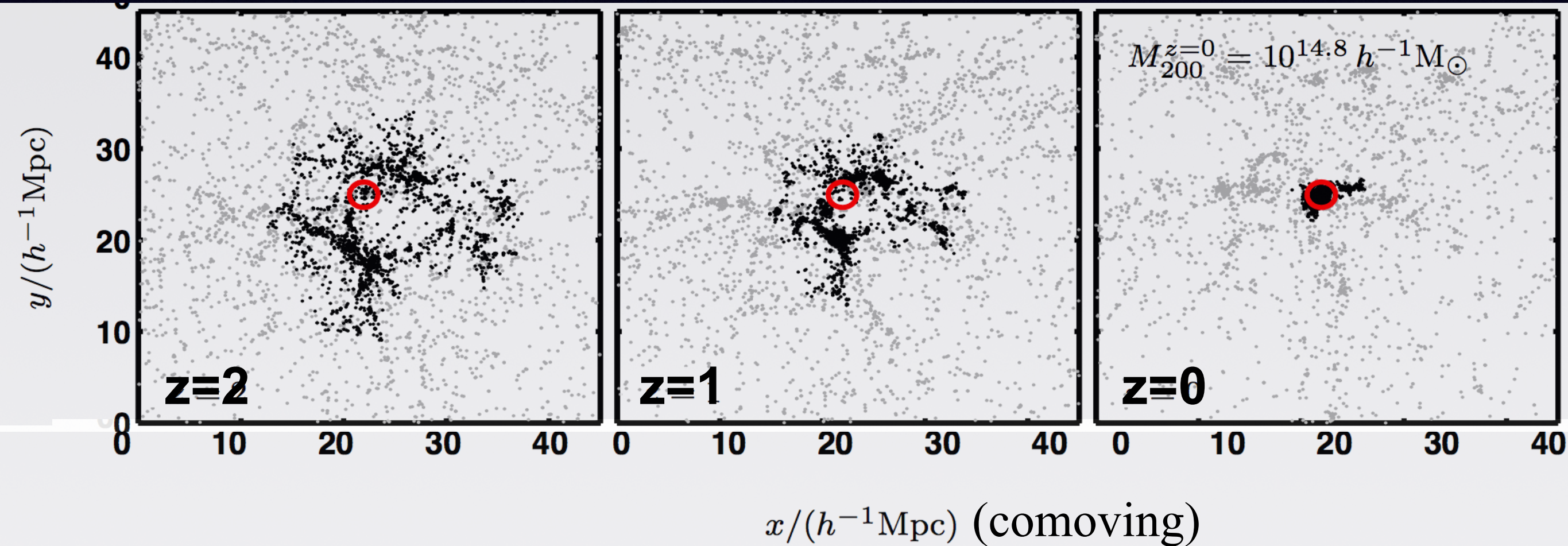
Planck Collaboration (2015), Clements et al. (2014, 2016)

$z=2.1$ cluster and extended LSS

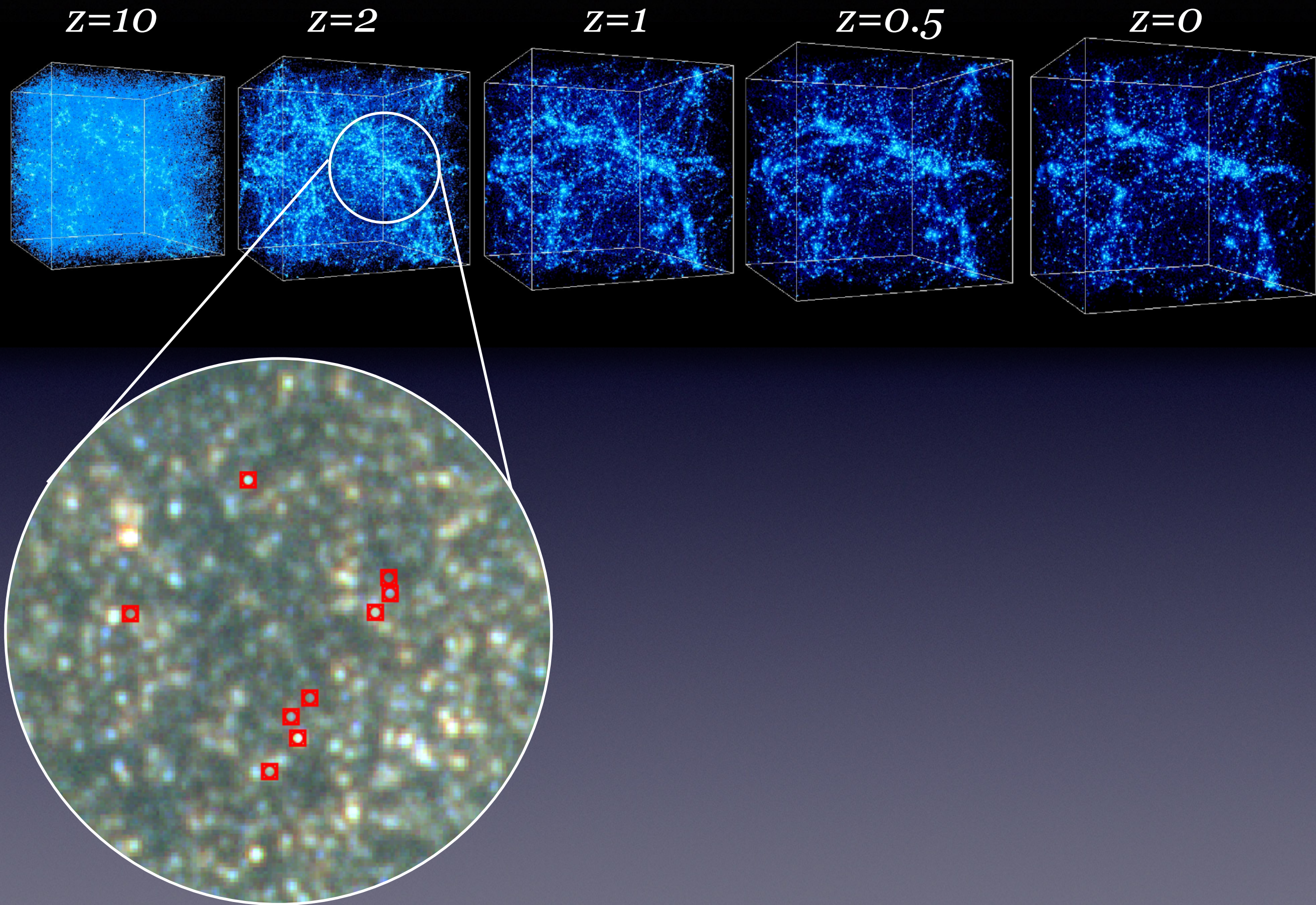


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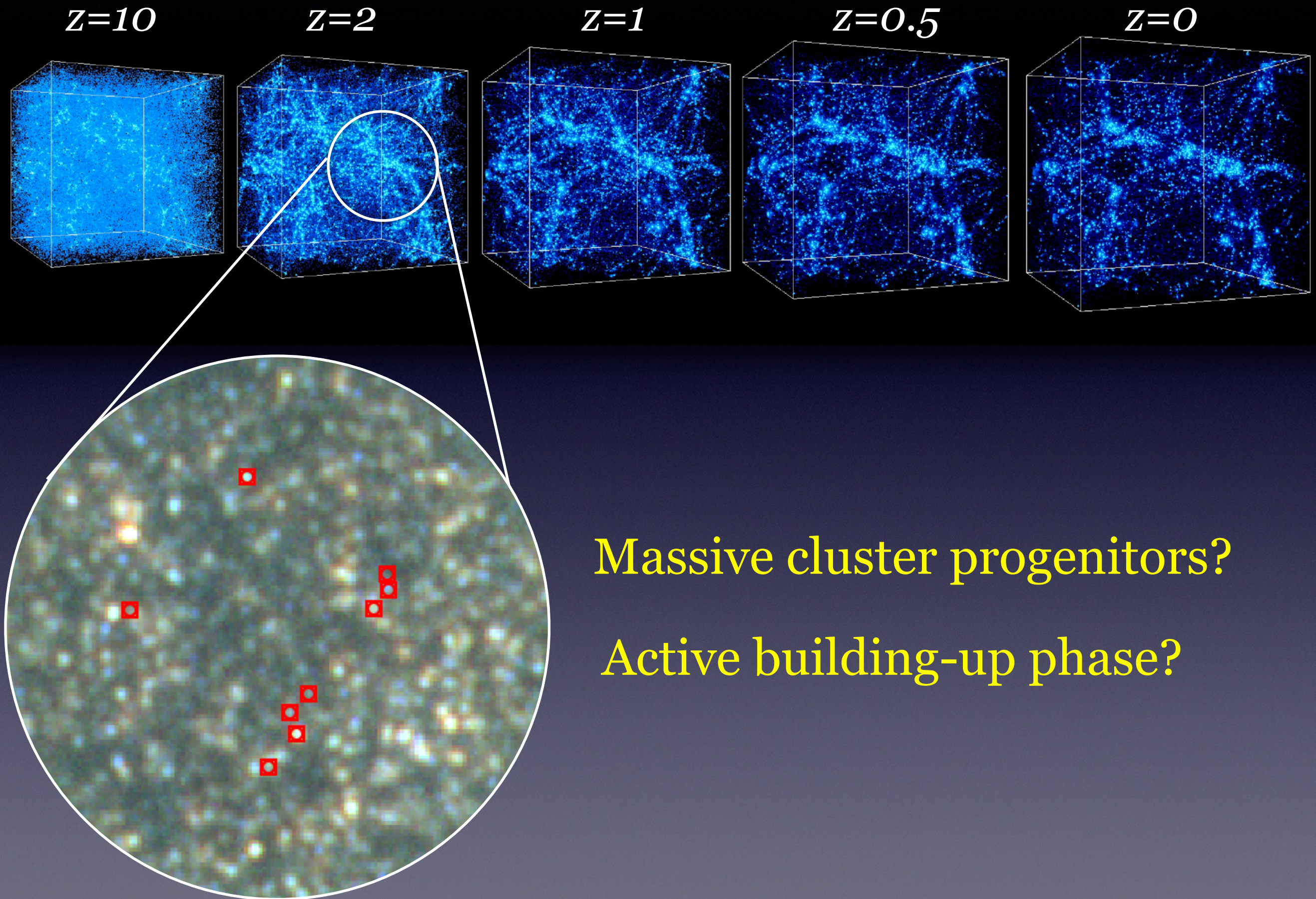
Large spatial extent of $z \sim 2$ protoclusters seen in simulations



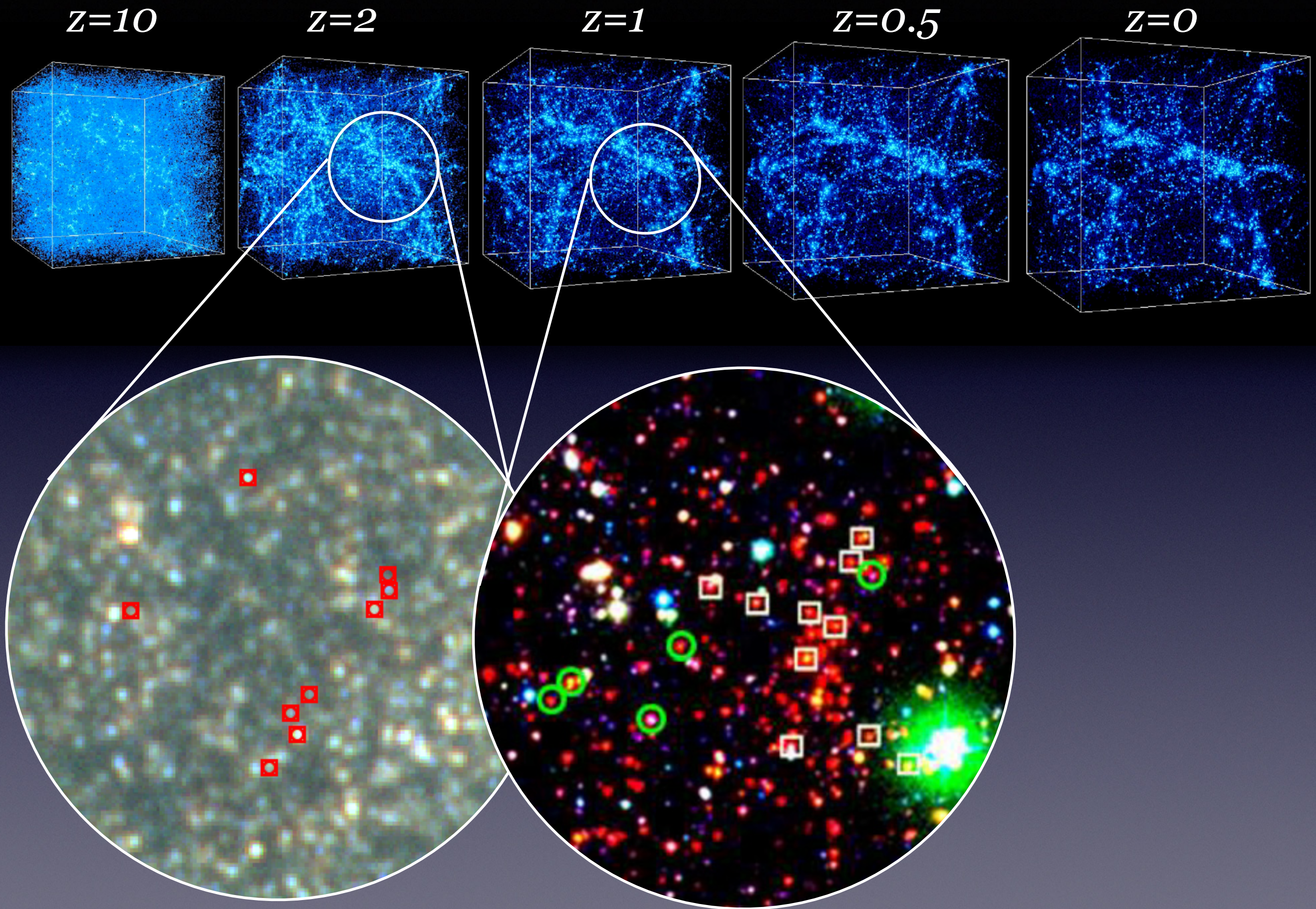
Muldrew et al. (2015)



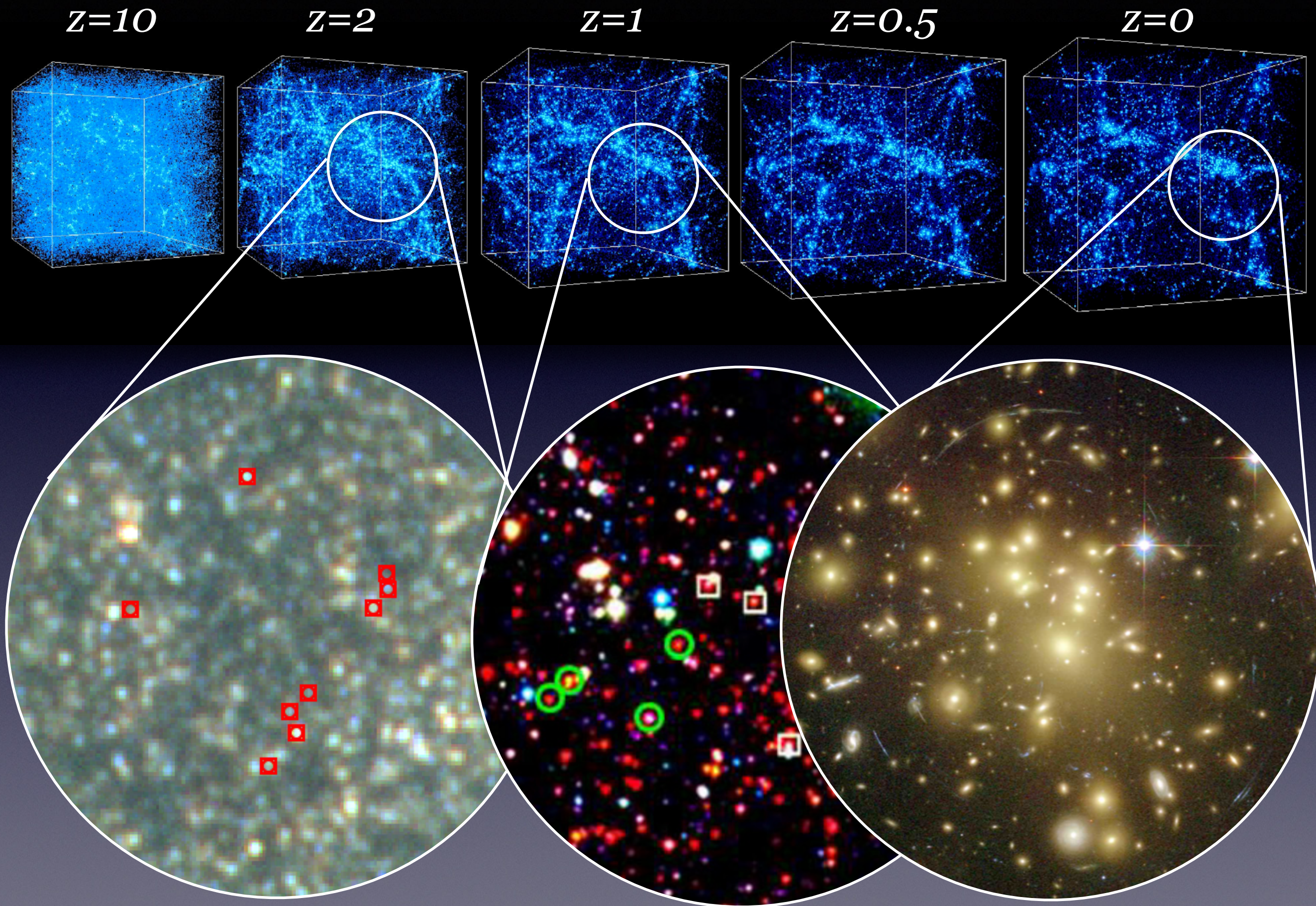
NASA, JHU; Center for Cosmological Physics; HerMEs-COSMOS; Wilson+09



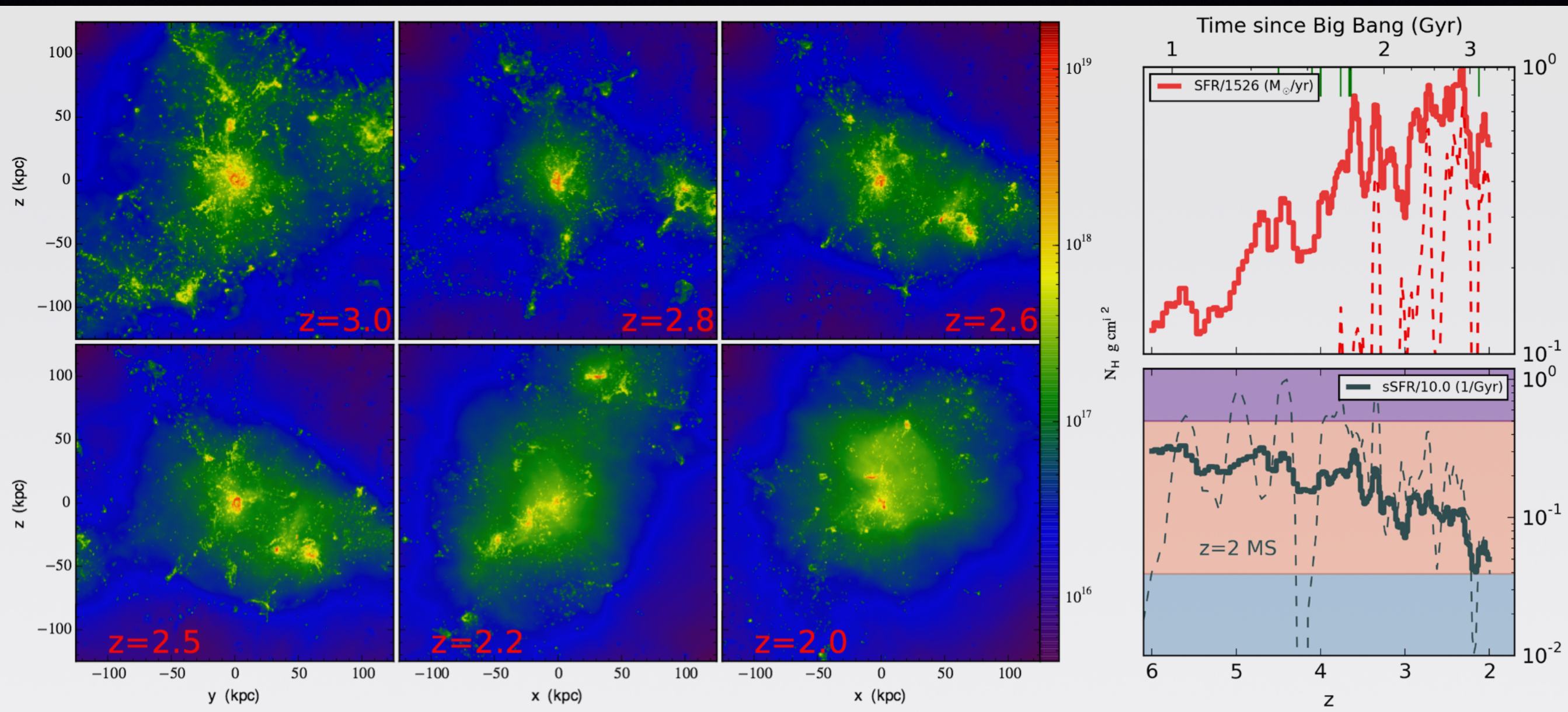
Massive cluster progenitors?
Active building-up phase?



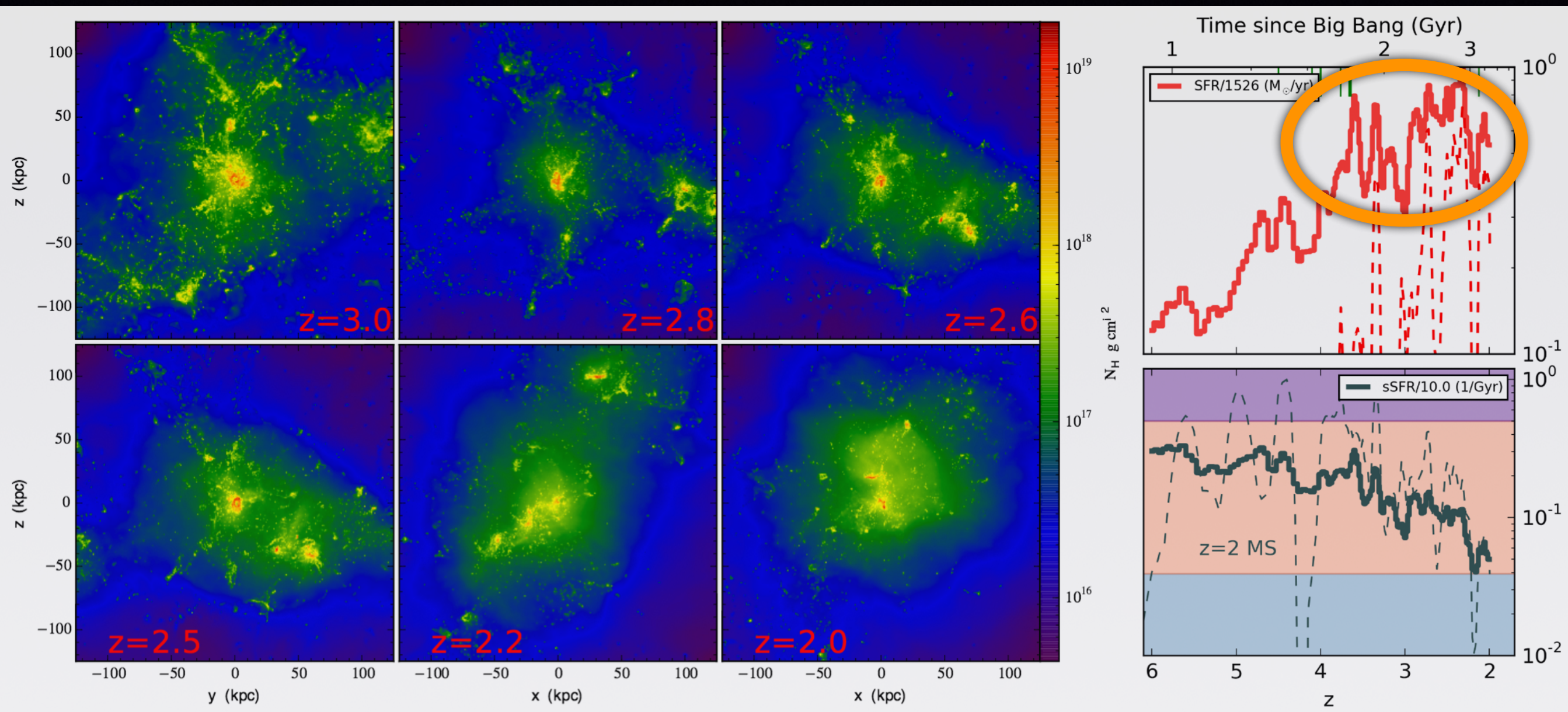
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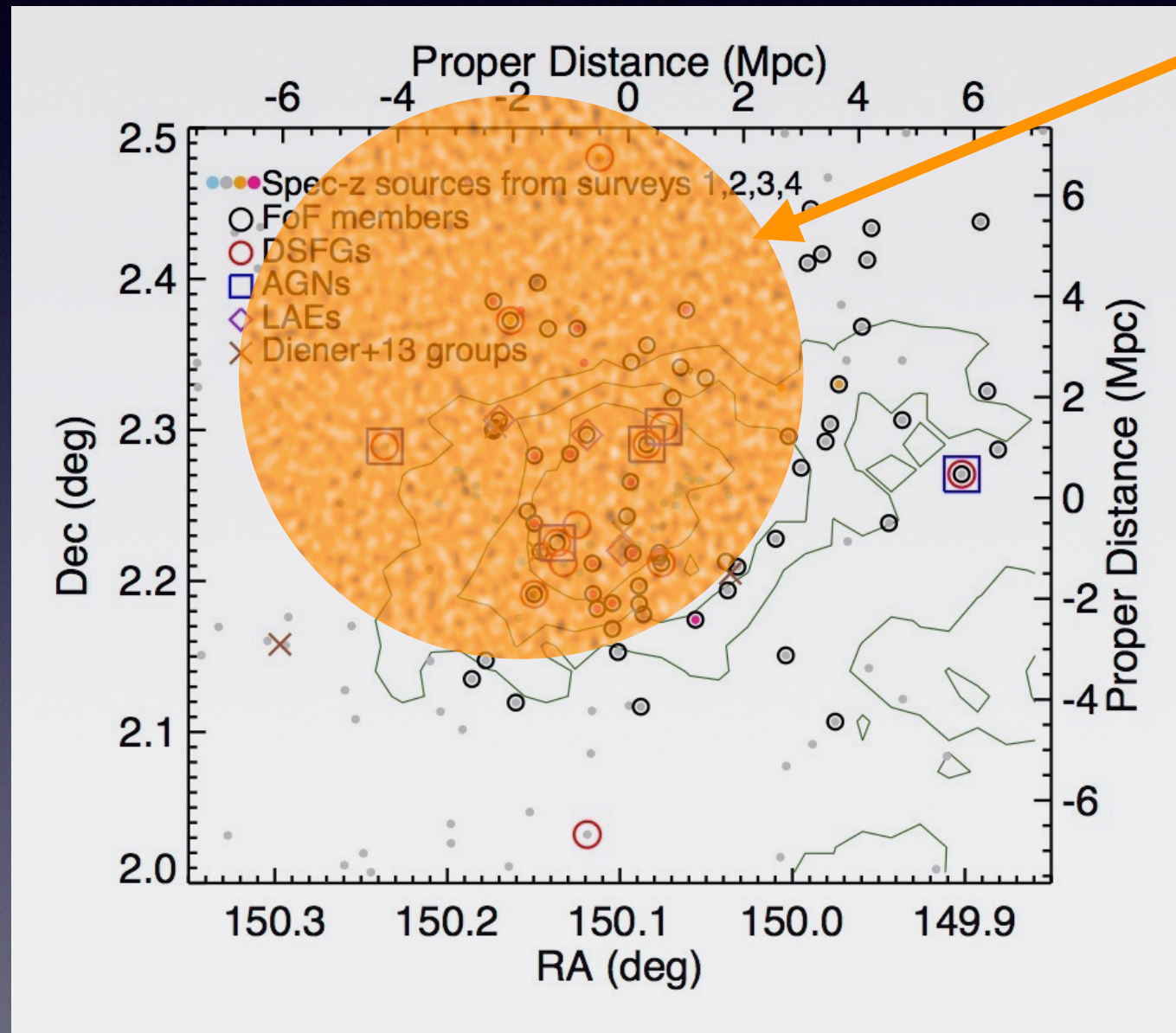


Narayanan et al. (2015)



Narayanan et al. (2015)

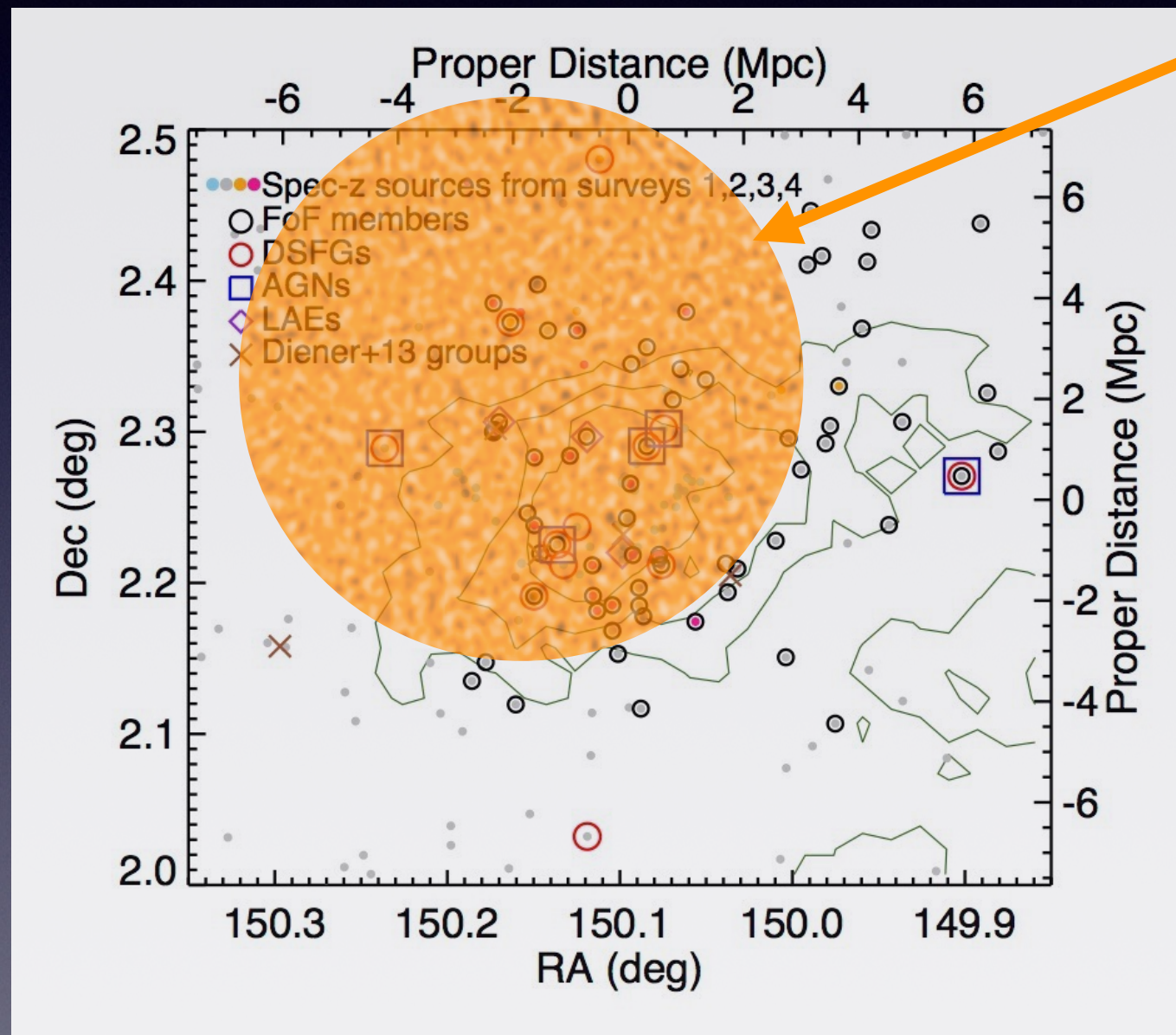
Gas Content in Protocluster



Casey et al. (2013)
Scuba-2 850 micron coverage

molecular gas conversion from Scoville et al. (2014, 2016)

Gas Content in Protocluster



Casey et al. (2013)

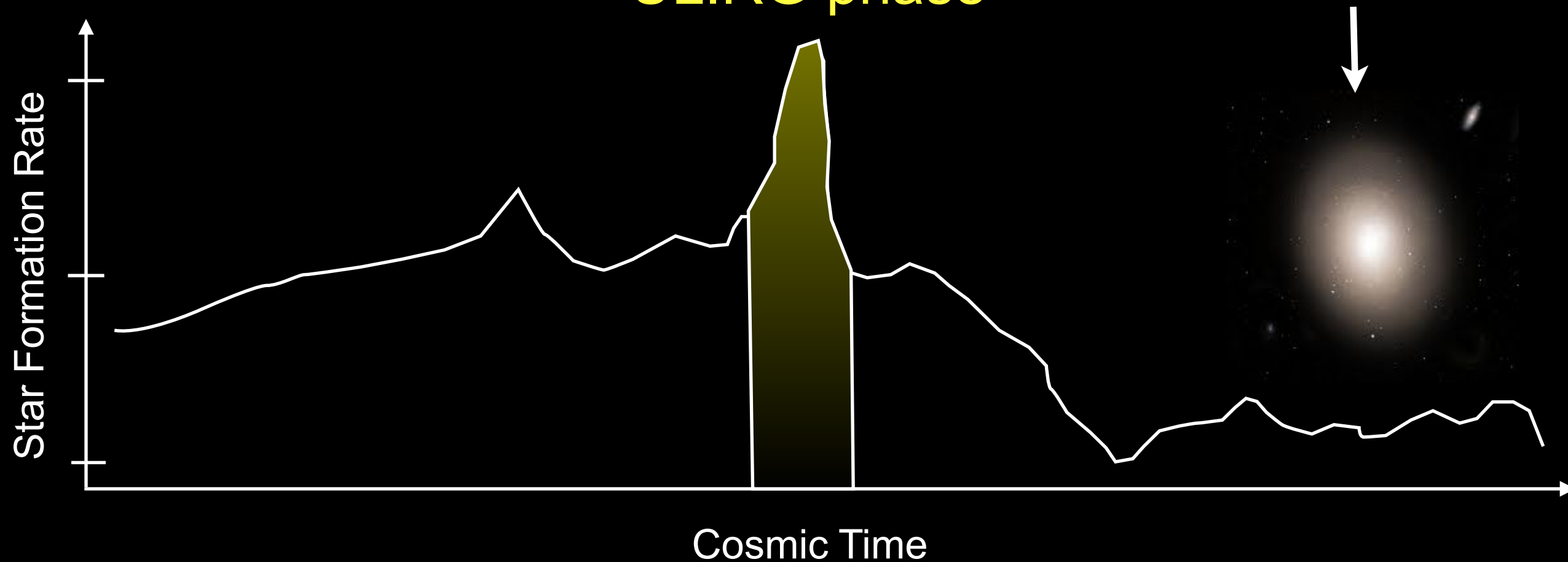
Scuba-2 850 micron coverage

- No detection SFGs in protocluster
- ~ 0.3 mJy (2σ) SFGs outside protocluster
- Sensitive to gas mass of $\sim 10^{10}$ Msun

molecular gas conversion from Scoville et al. (2014, 2016)

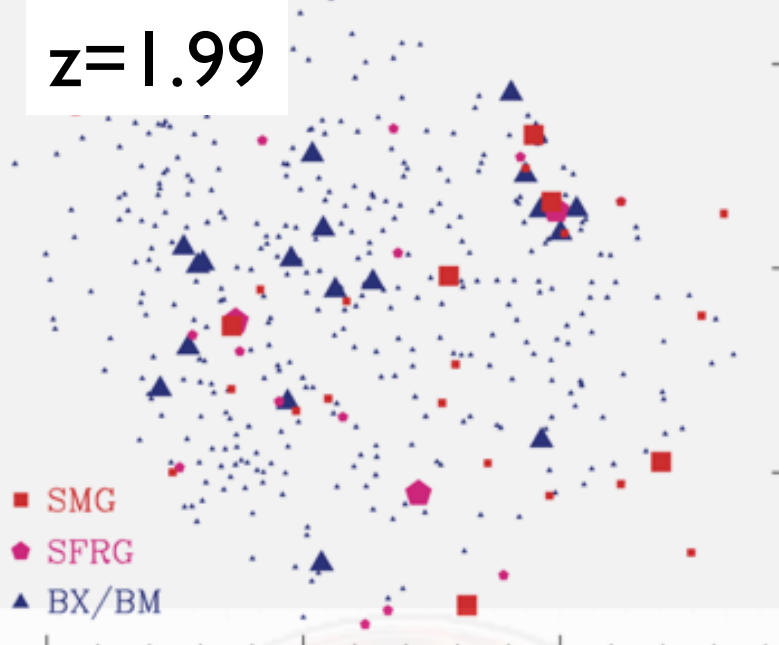


ULIRG phase

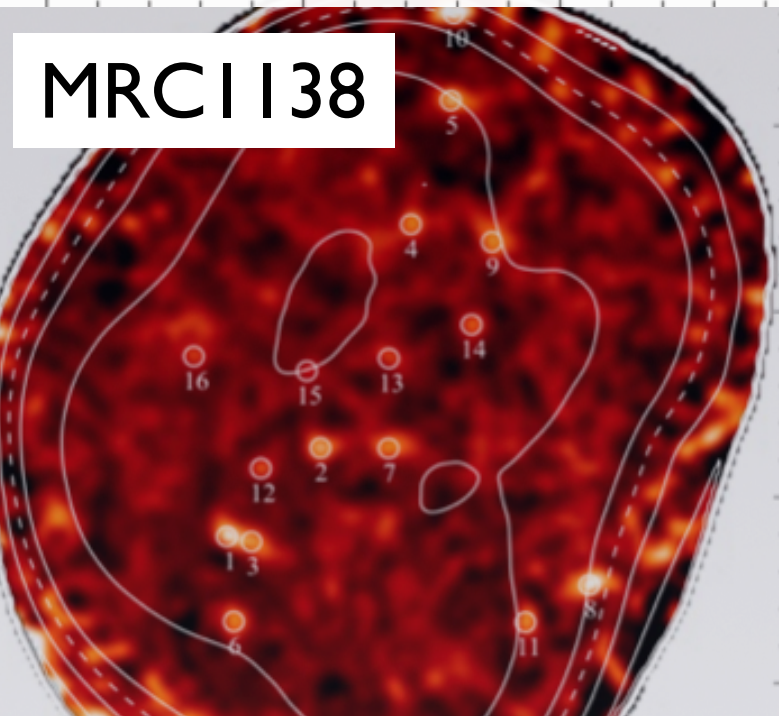


adopted from Sanders 1988; Hopkins 2006, 2009

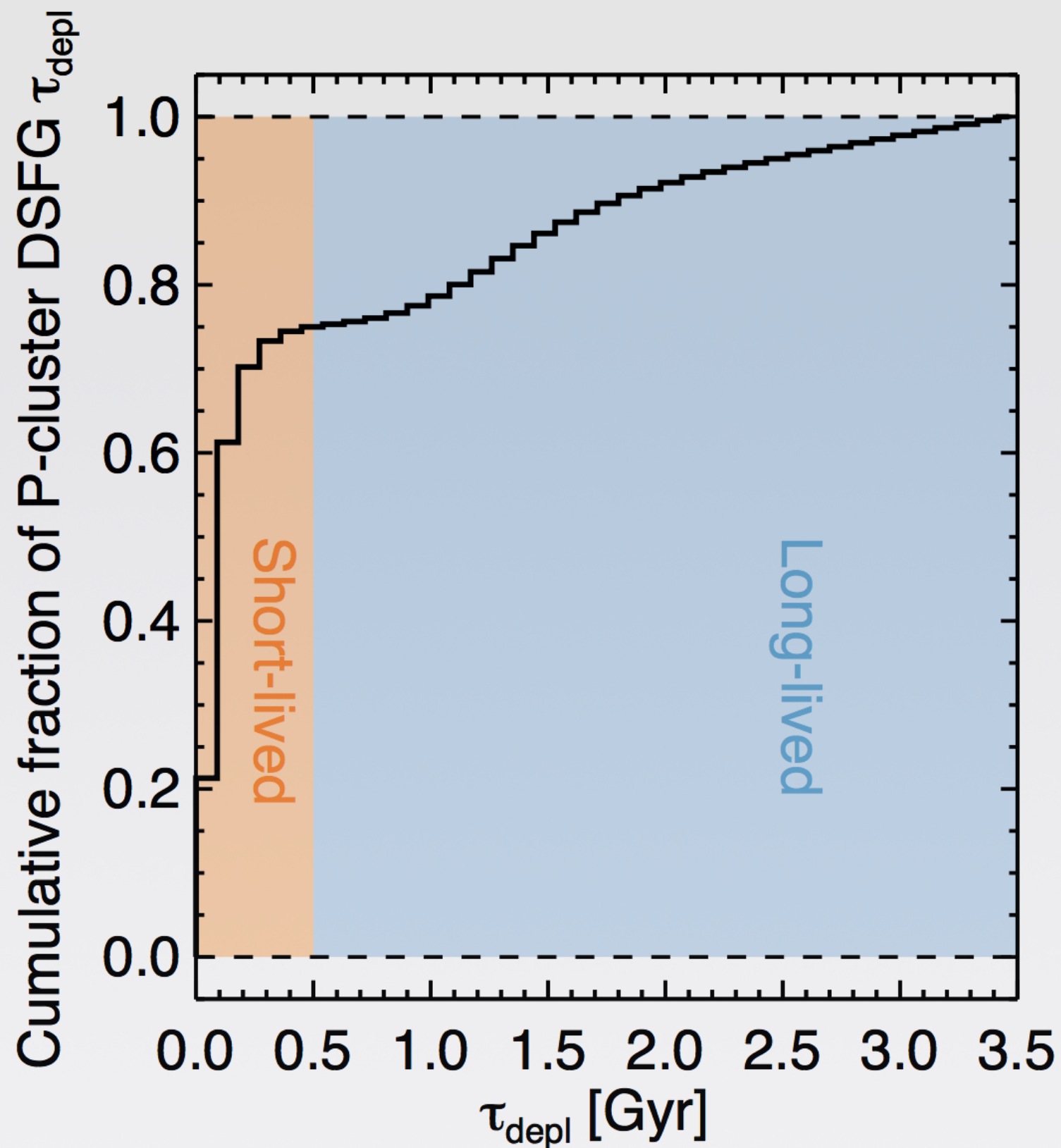
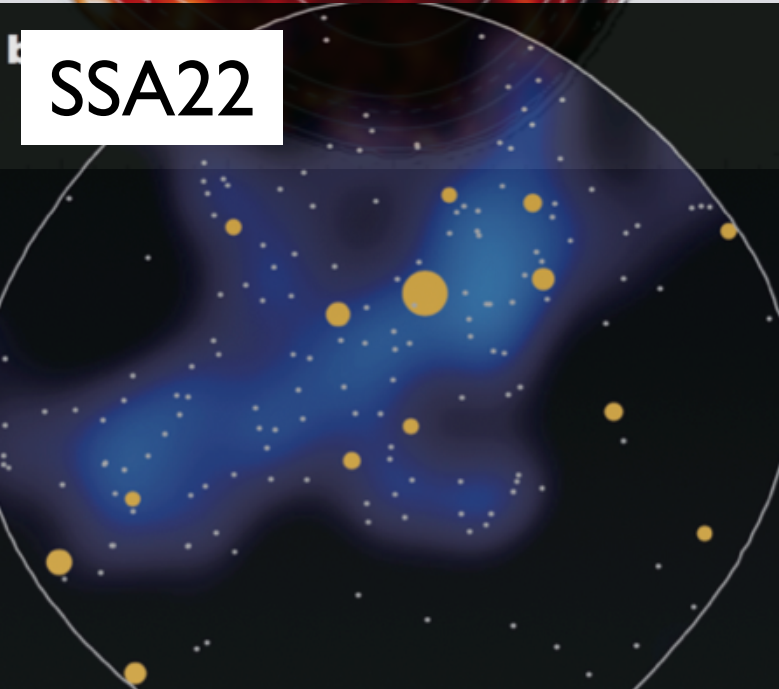
$z=1.99$



MRC1138

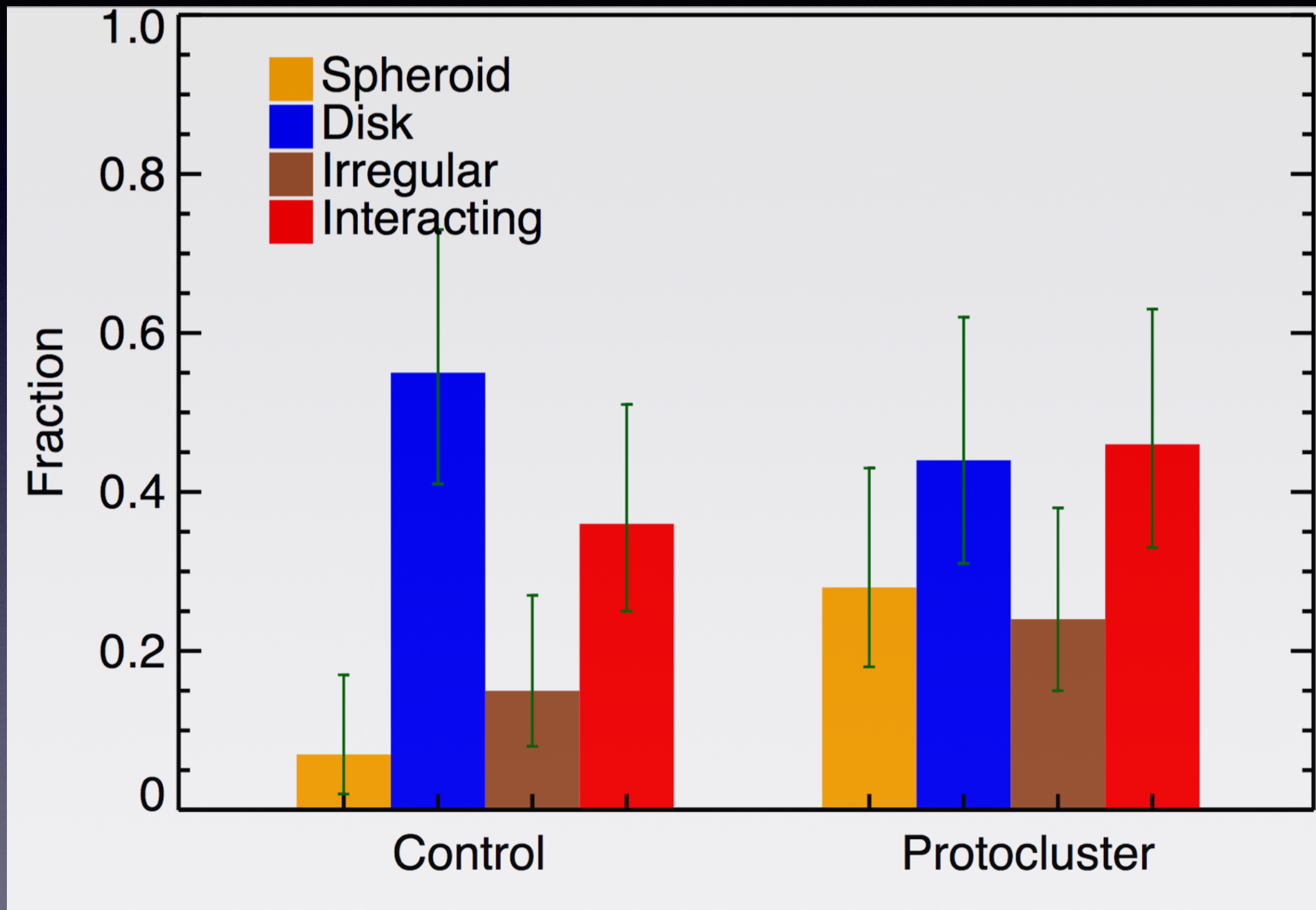


SSA22

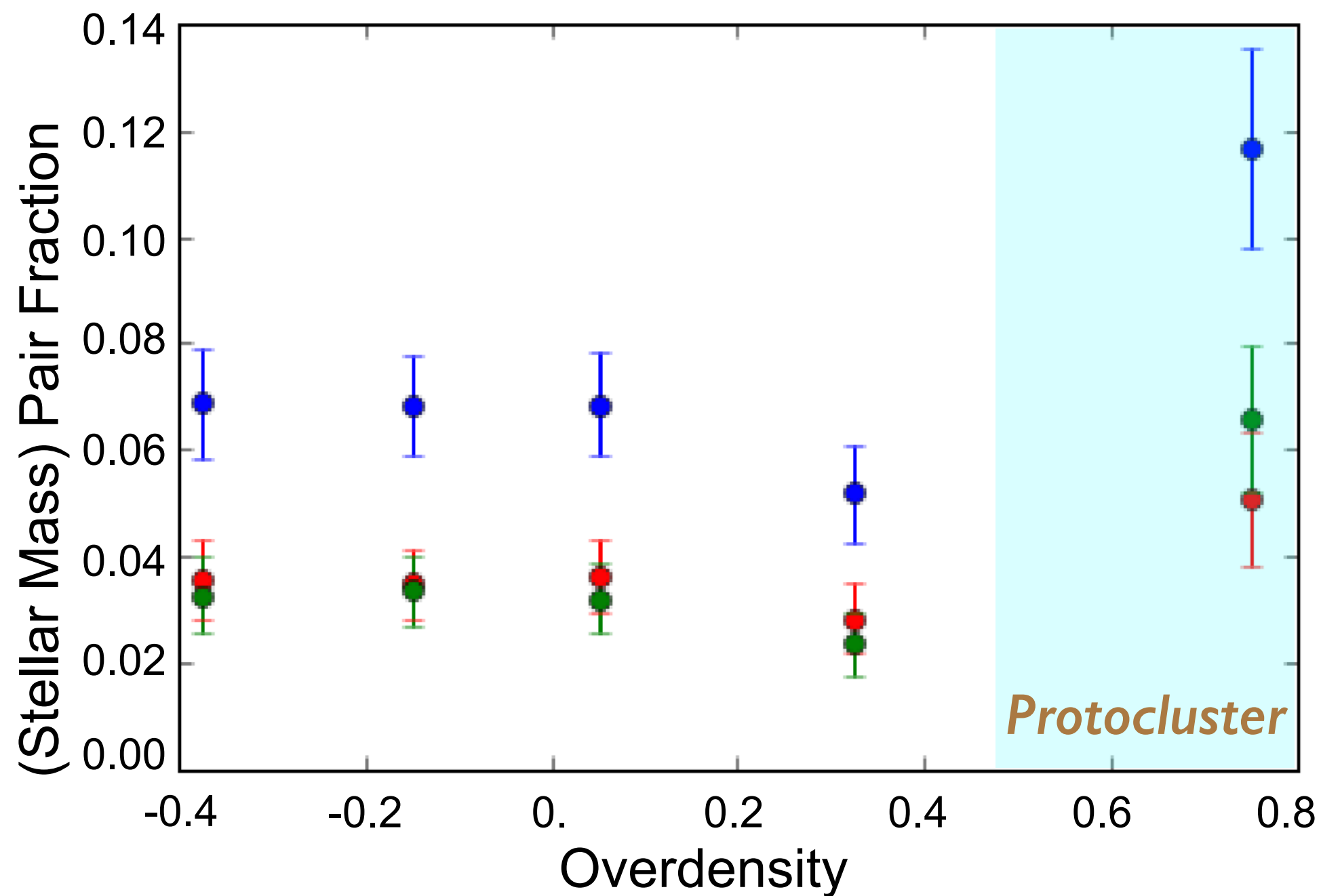


Casey (2016)

Galaxy morphology of SFGs in protocluster

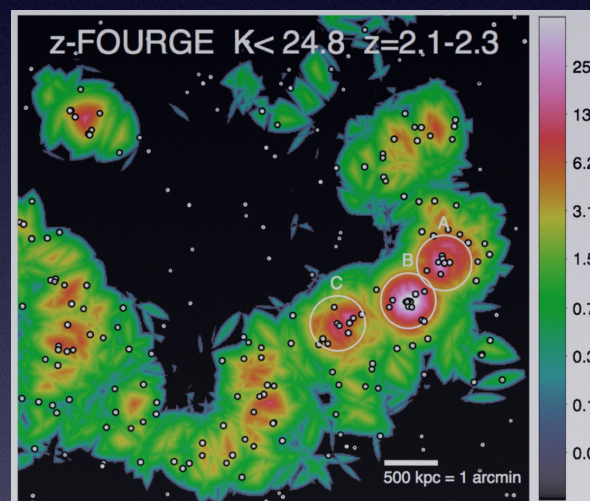


Galaxy morphology in protocluster



**TAURUS
Scholar
Derek Holman**

Summary



Summary

