Project:
Galaxy dynamics & galaxy-based mass estimates

Participants so far: Lyndsay Old
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Galaxy-based cluster mass estimation

These methods use properties of galaxies to estimate mass:

- Positions
- Velocities
- Colours
- Luminosities

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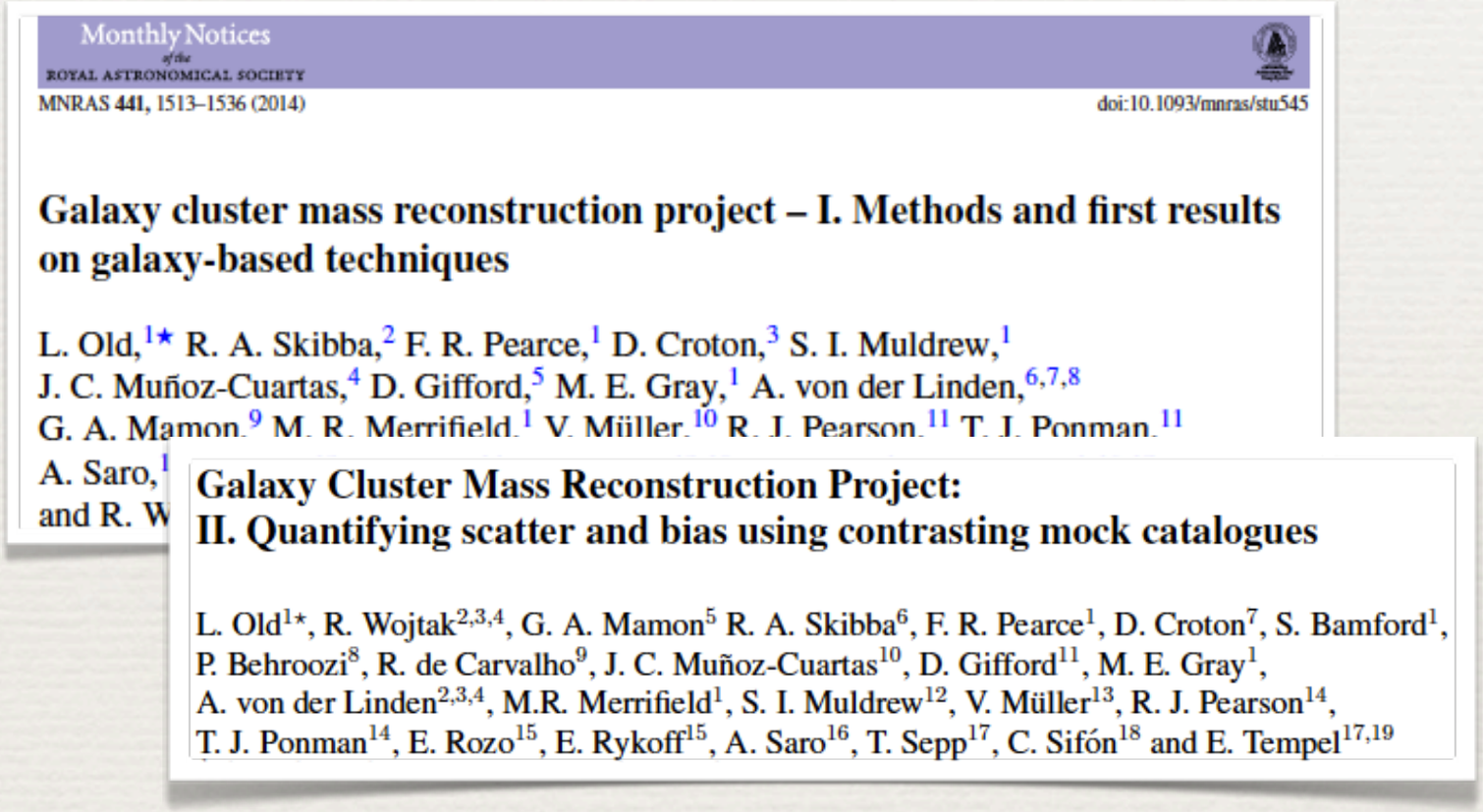
Apply these to the nIFTy/Perth clusters!



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Galaxy cluster mass reconstruction project – I. Methods and first results on galaxy-based techniques

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Galaxy Cluster Mass Reconstruction Project: II. Quantifying scatter and bias using contrasting mock catalogues

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Extensive, homogenous study of galaxy-based cluster mass estimation techniques

Why galaxy dynamics?

• Dynamical analysis of galaxy velocities exposes substructure: asymmetrical velocity distributions, dynamically distinct subgroups.

• Presence of dynamical substructure is a strong indicator that clusters have recently undergone a merger and, hence, are most likely unrelaxed.

• Most cluster mass estimation techniques rely on assumption that clusters are relaxed... is this valid for a particular cluster?

Specific questions

- Can the most commonly used (& the most successful according to Hou et al. 2012) dynamical substructure test, the Dressler-Shectman (DS) test, detect dynamical substructure before, during and after major mergers occur in the DM?

- How does the galaxy substructure correlate with other cluster properties? E.g., is galaxy dynamical substructure detected in the 3 X-ray unrelaxed and 3 X-ray relaxed clusters?

- How do the galaxy-based mass estimates compare to those from WL, X-ray estimates?

Very preliminary results for cluster 00019 Galform galaxies

Very preliminary results for cluster 00019 Galform galaxies

1) Selected galaxies in an observational-like manner according to the following criteria:
- their X and Y locations are within the halo R_{200c} aperture 'on the sky'
- their z peculiar velocity is ±1000 km/s
- they are not orphans
- they have a stellar mass ≥ 1 x 10^9 M_{solar}

2) Applied the Dressler-Shectman (DS) test at each snapshot so we can see DS detection as a function of redshift/scale factor

↓

DS test: compares local mean velocity and velocity dispersion for each individual galaxy and its nearest neighbours to the global cluster values.

DS `bubble' plot

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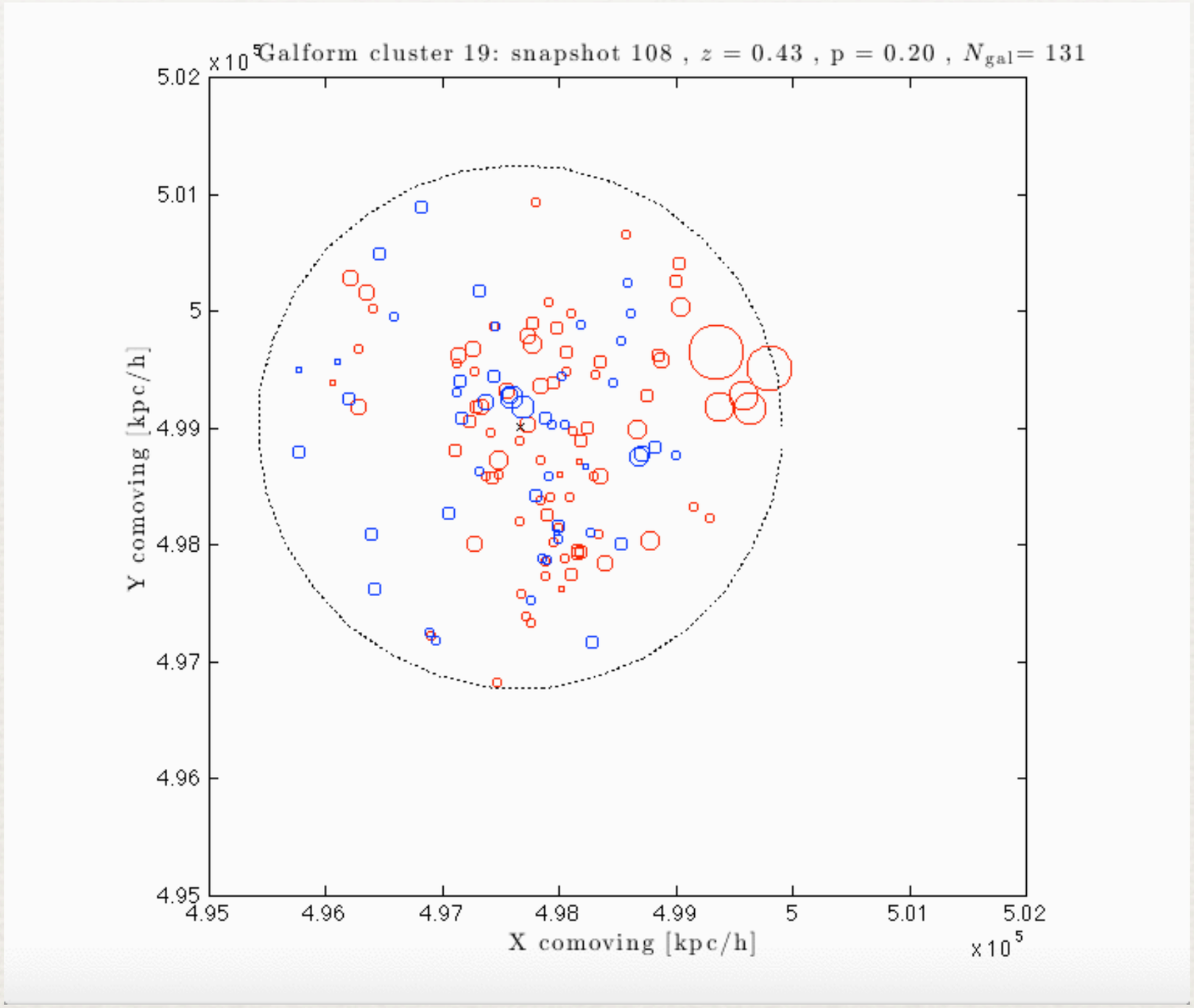
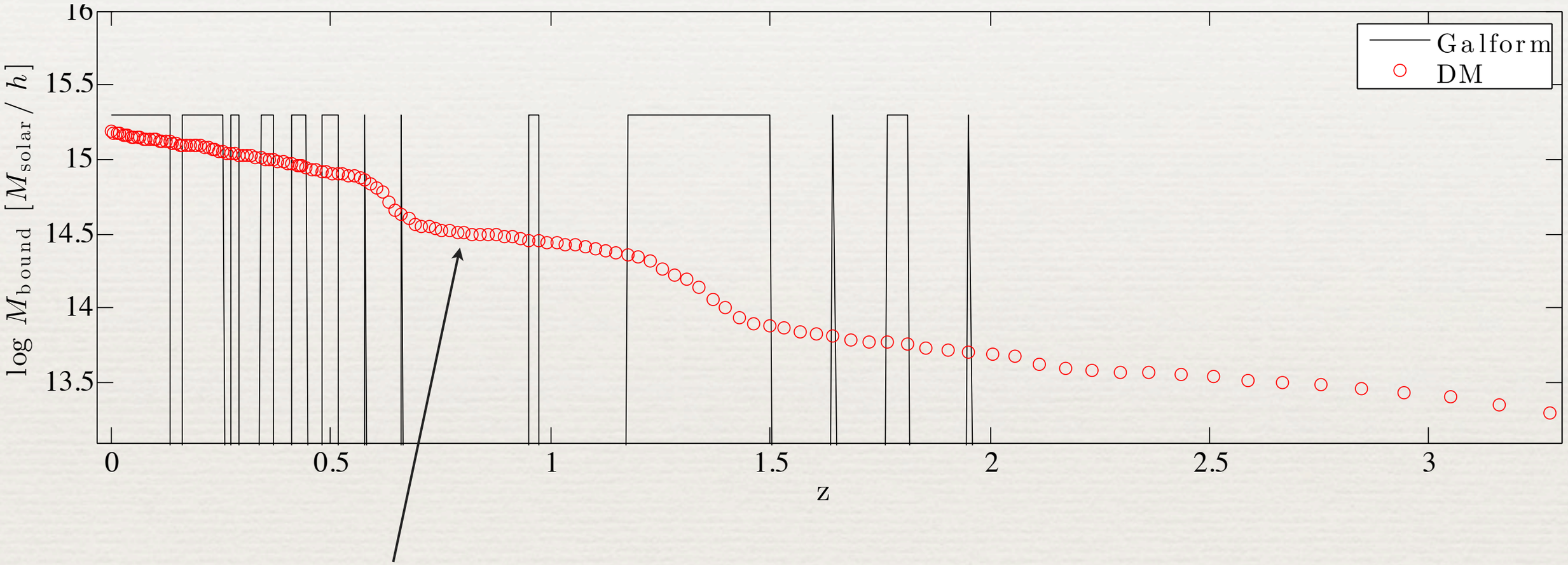


Dynamical substructure & DM M_{bound} vs. z

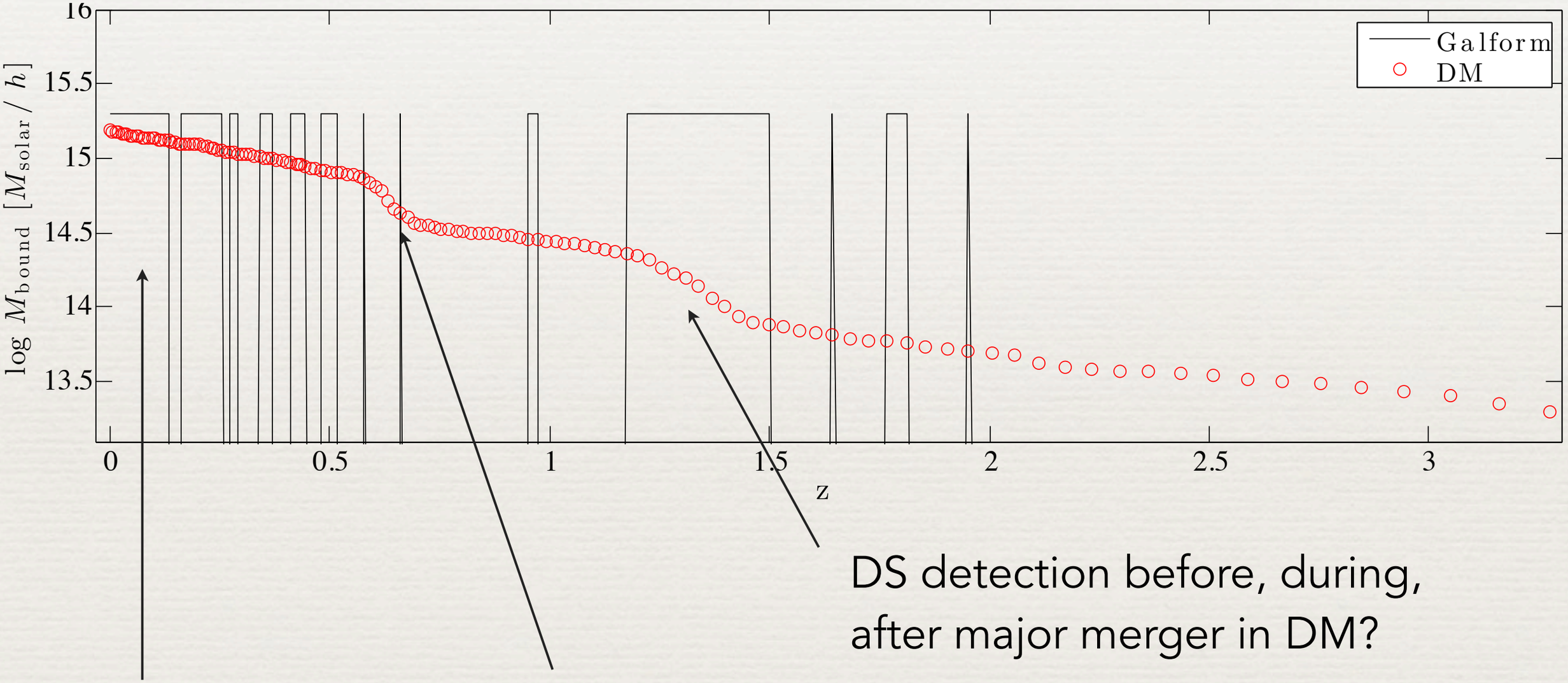


Rockstar log M_{bound}

1 = DS p-value < 0.05, likely substructure

0 = DS p-value ≥ 0.05, unlikely substructure

Dynamical substructure & DM M_{bound} vs. z

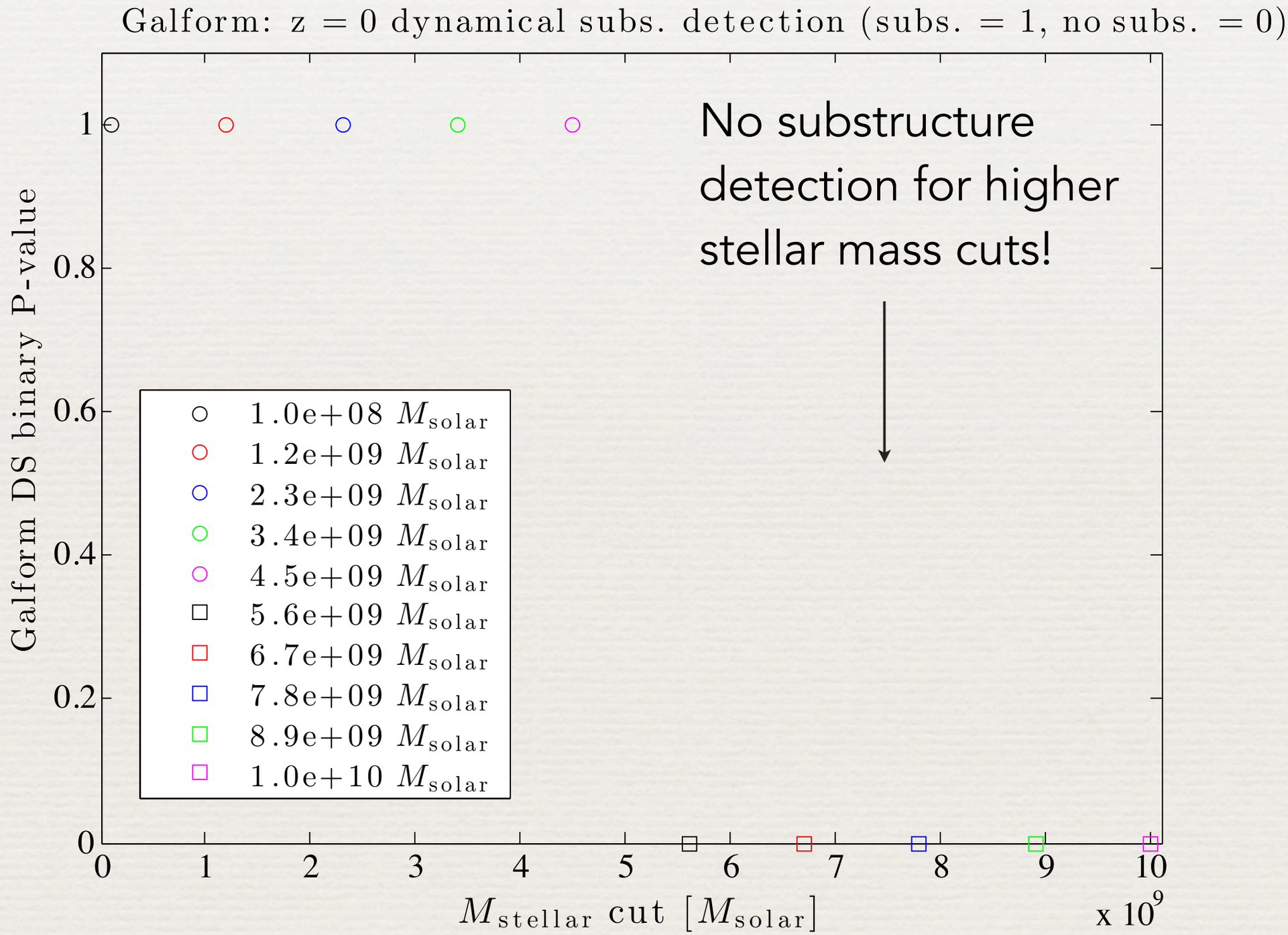


DS detection before, during, after major merger in DM?

Short DS detection

Continuous substructure until z=0

But what about galaxy selection?



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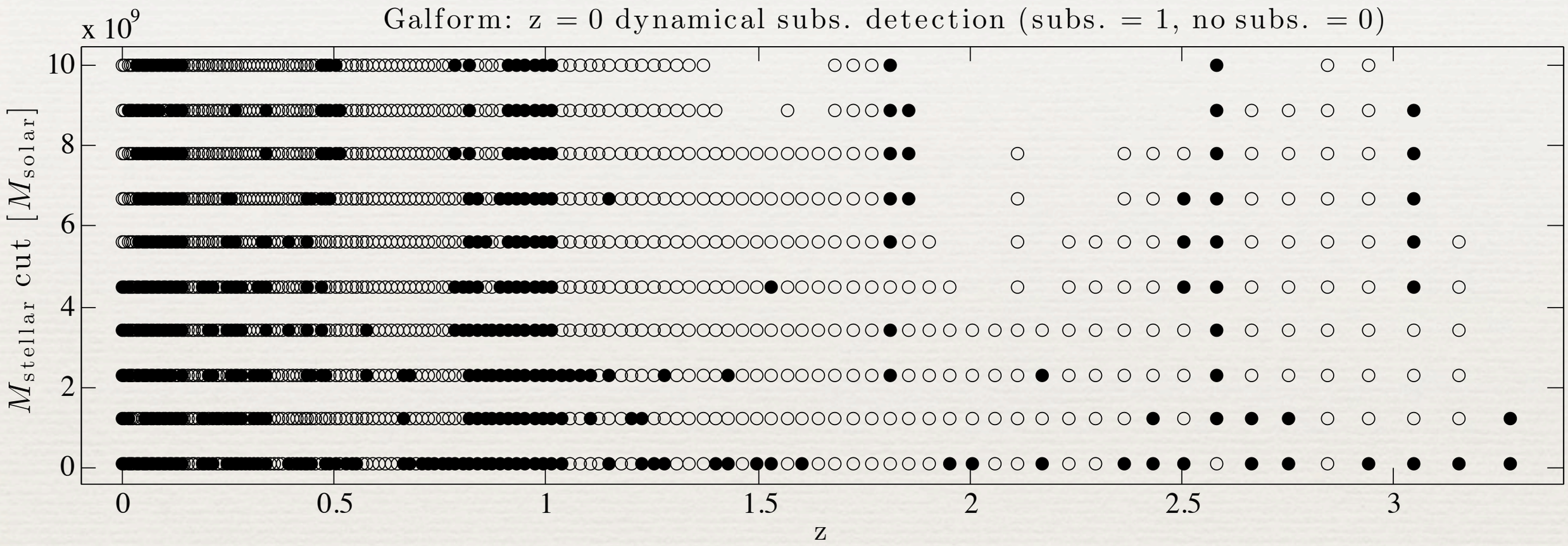


DS test is very sensitive to stellar mass cut!

Project: Galaxy dynamics & galaxy-based mass estimates

- Perform the DS test as a function of z for other SAMs, full physics clusters (X-ray unrelaxed & relaxed)
- Apply additional tests for dynamical substructure & subsampling
- Run all available galaxy-based mass estimation techniques on the mock clusters
- Compare both mass and substructure to WL, X-ray, DM!

Any ideas? If interested, please get involved!

Galaxy dynamics update

DS substructure catalogues have been made *but* take these with a pinch of salt as:

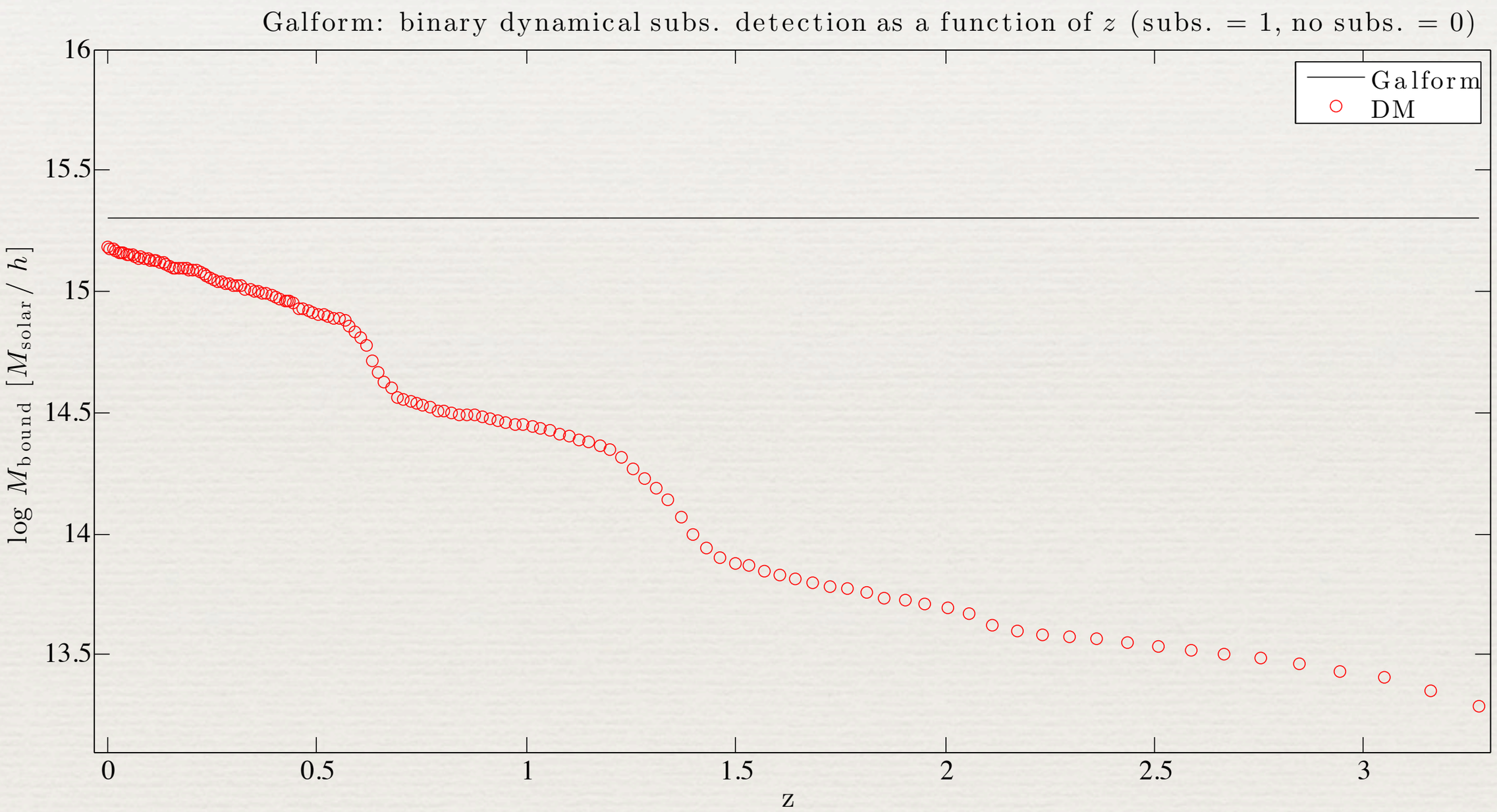
- Galaxy population in SAMs & hydro is not what we think it should be
- Though we can perform dynamical substructure detection testing (e.g., magnitude limits, stellar mass limit, Ngal subsampling, membership selection) we will not be able to properly infer what is going on

DS test update

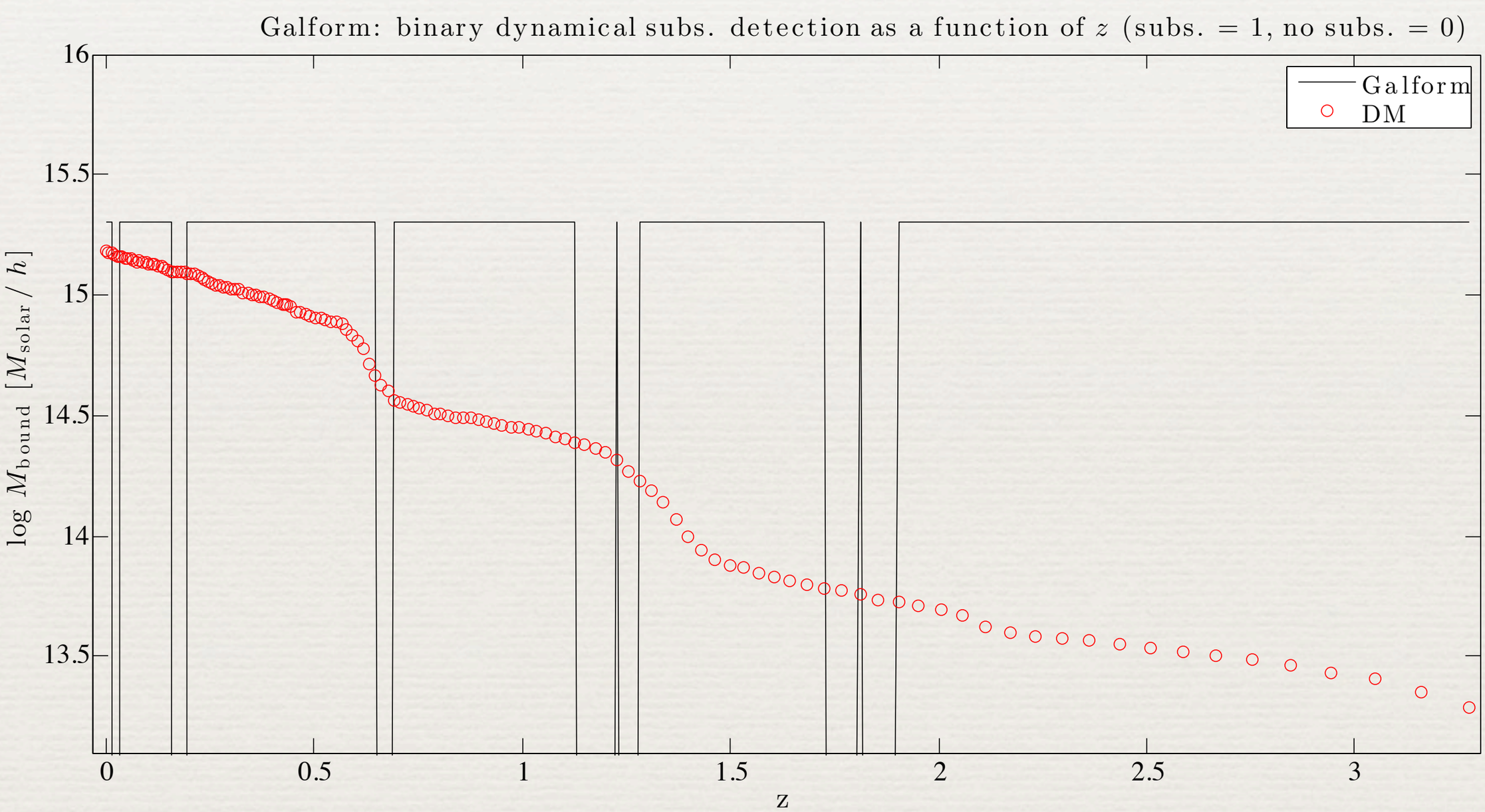
For Galform cluster 00019, select galaxies according to the following criteria:
- their X and Y locations are within 3 Mpc of the halo centre
- their z peculiar velocity is ±5000 km/s
- they are not orphans
- they have an r_ext < -19, -20, -21

Nb. this is just *one* way to do this observationally, results will most likely change with different membership selection technique. Will be updating this with Matt's selection for consistency!

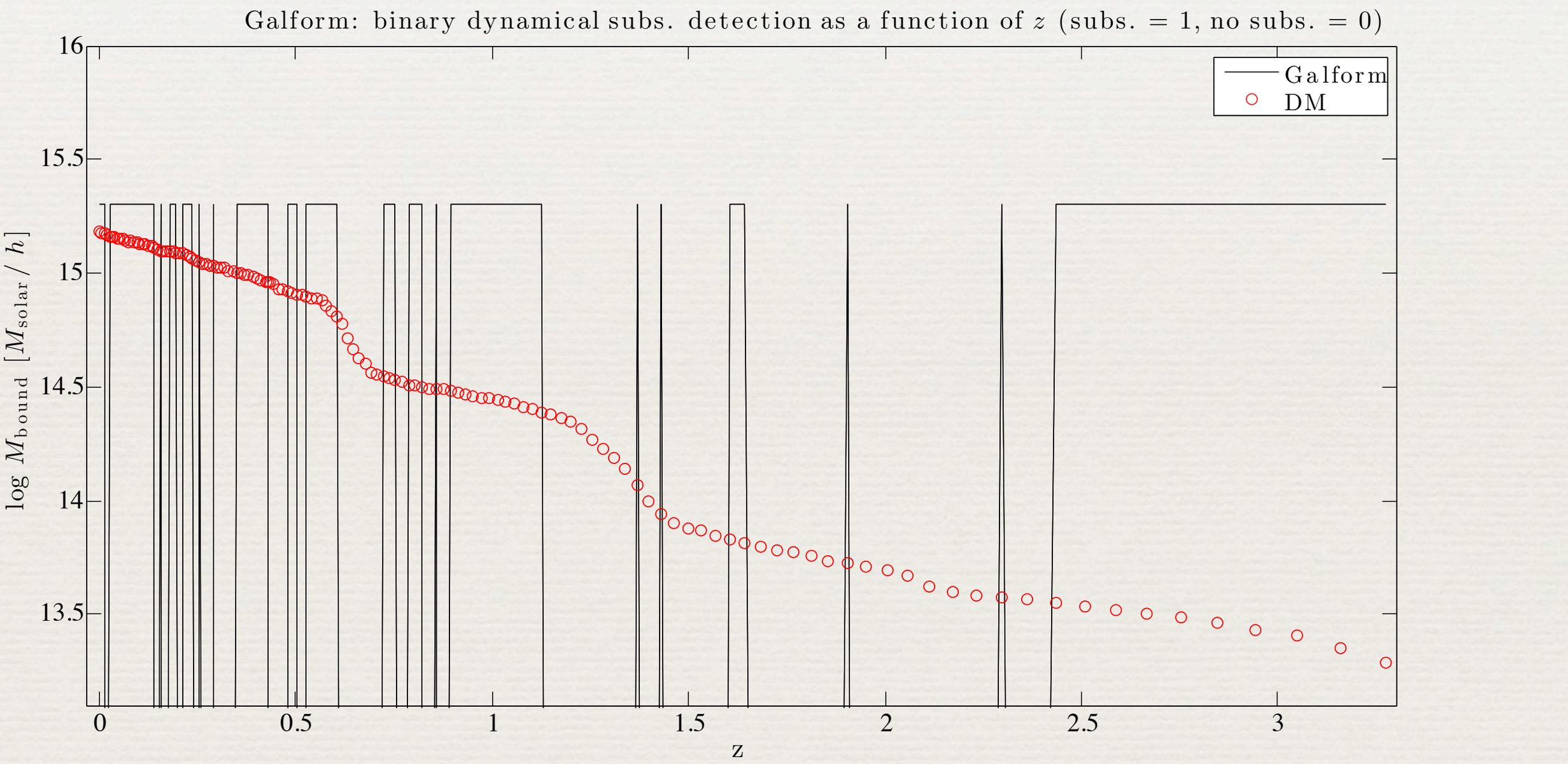
DS detection vs. z for r_ext -19



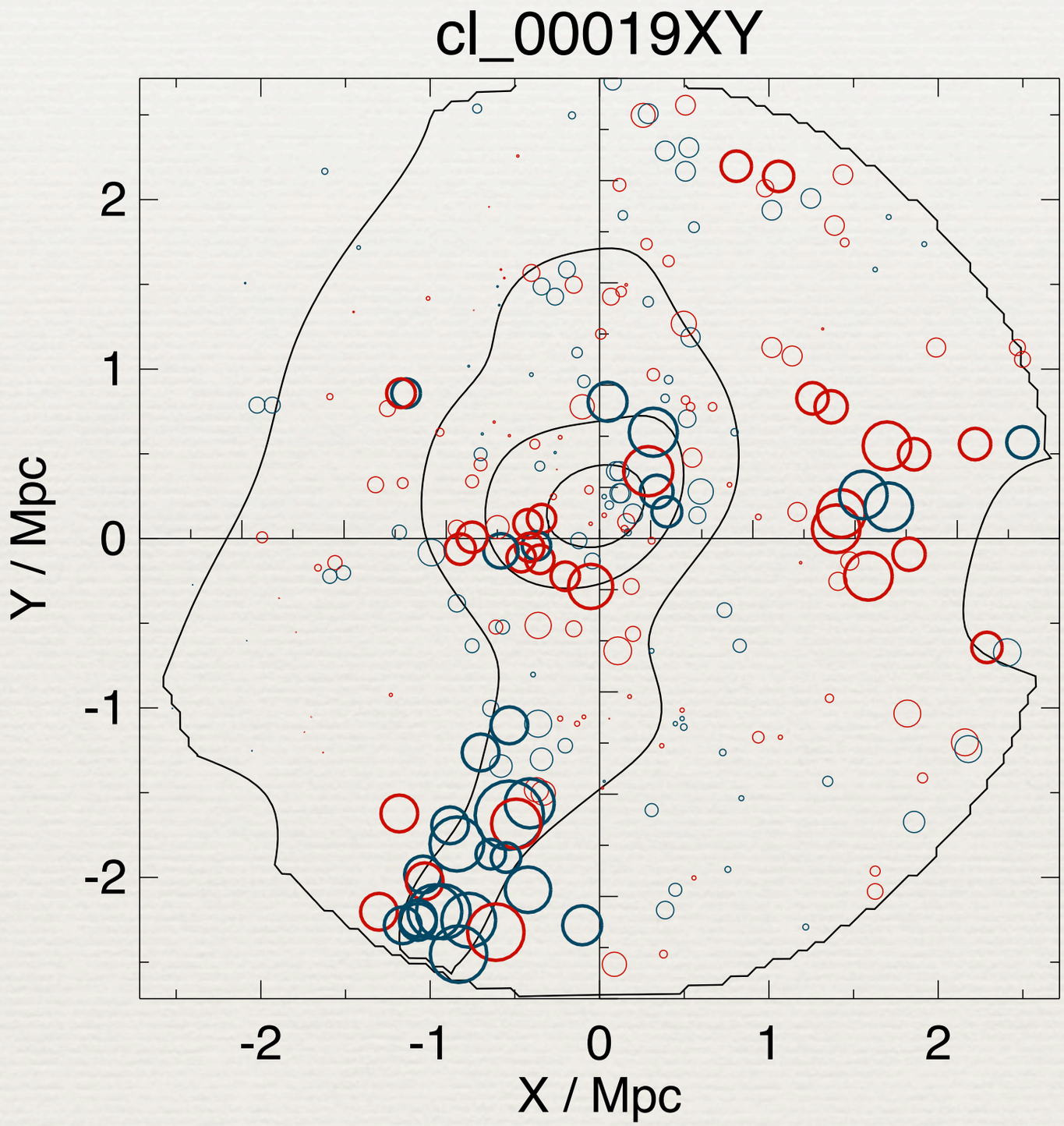
DS detection vs. z for r_ext -20



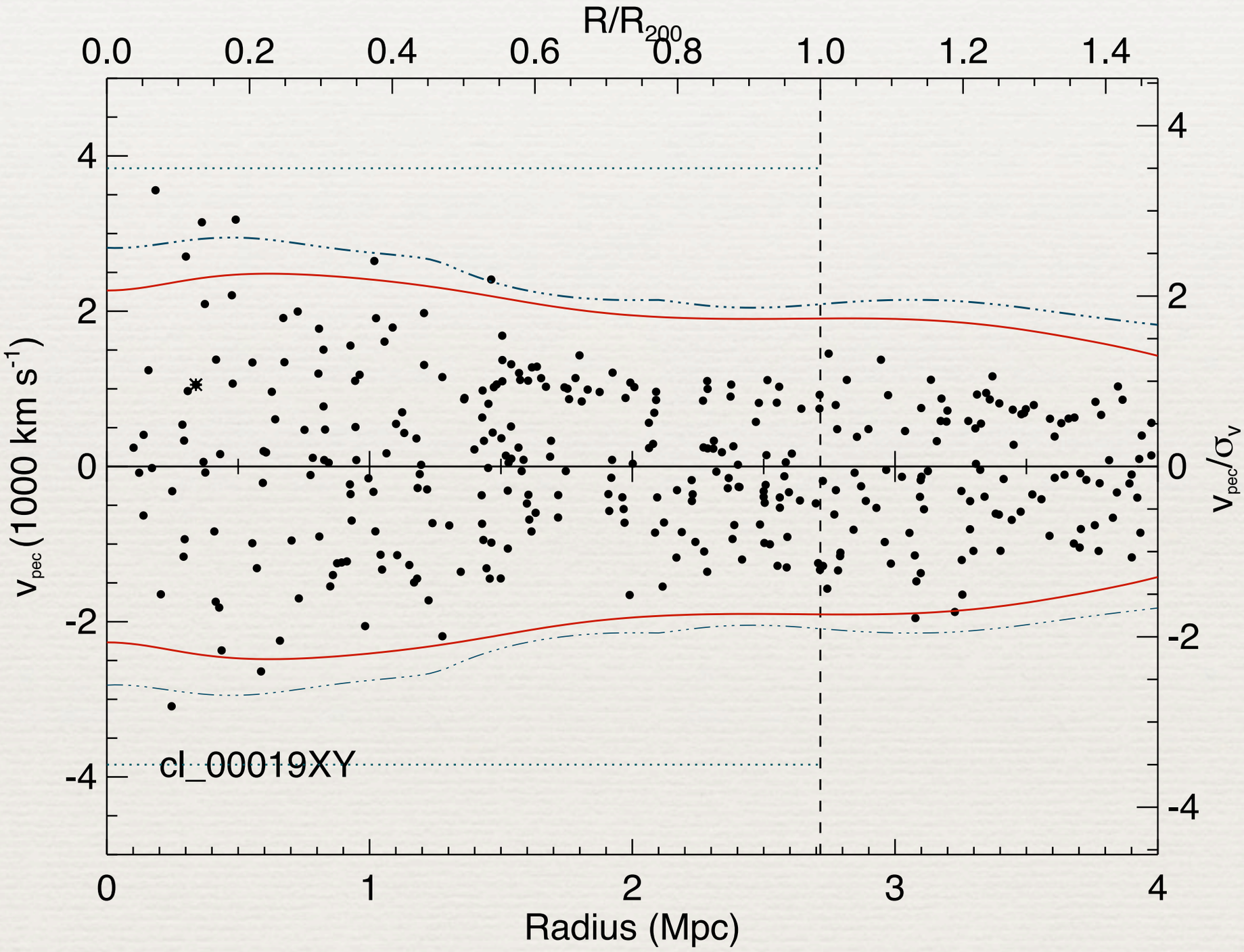
DS detection vs. z for r_ext -21



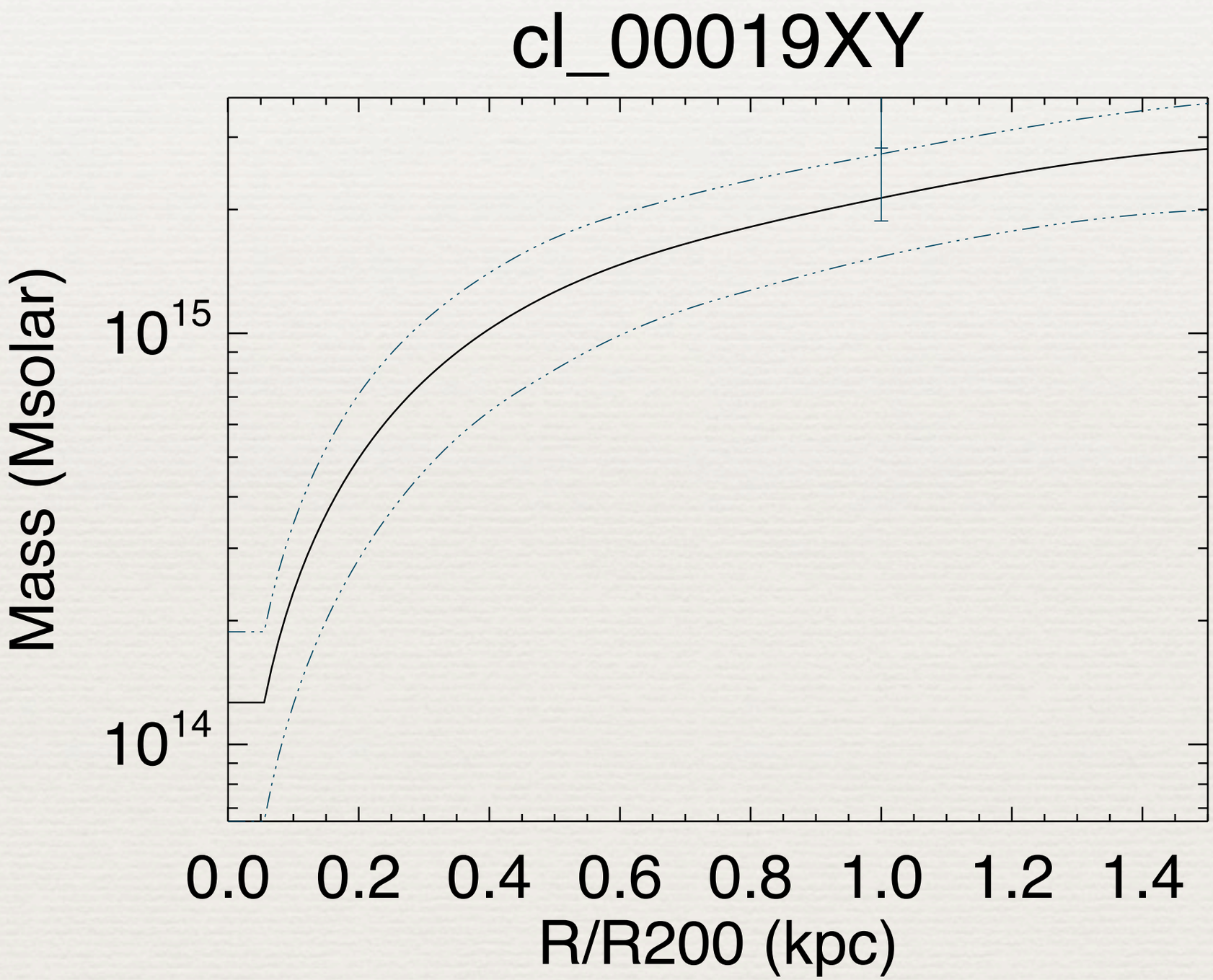
κ-test z=0 - XY projection



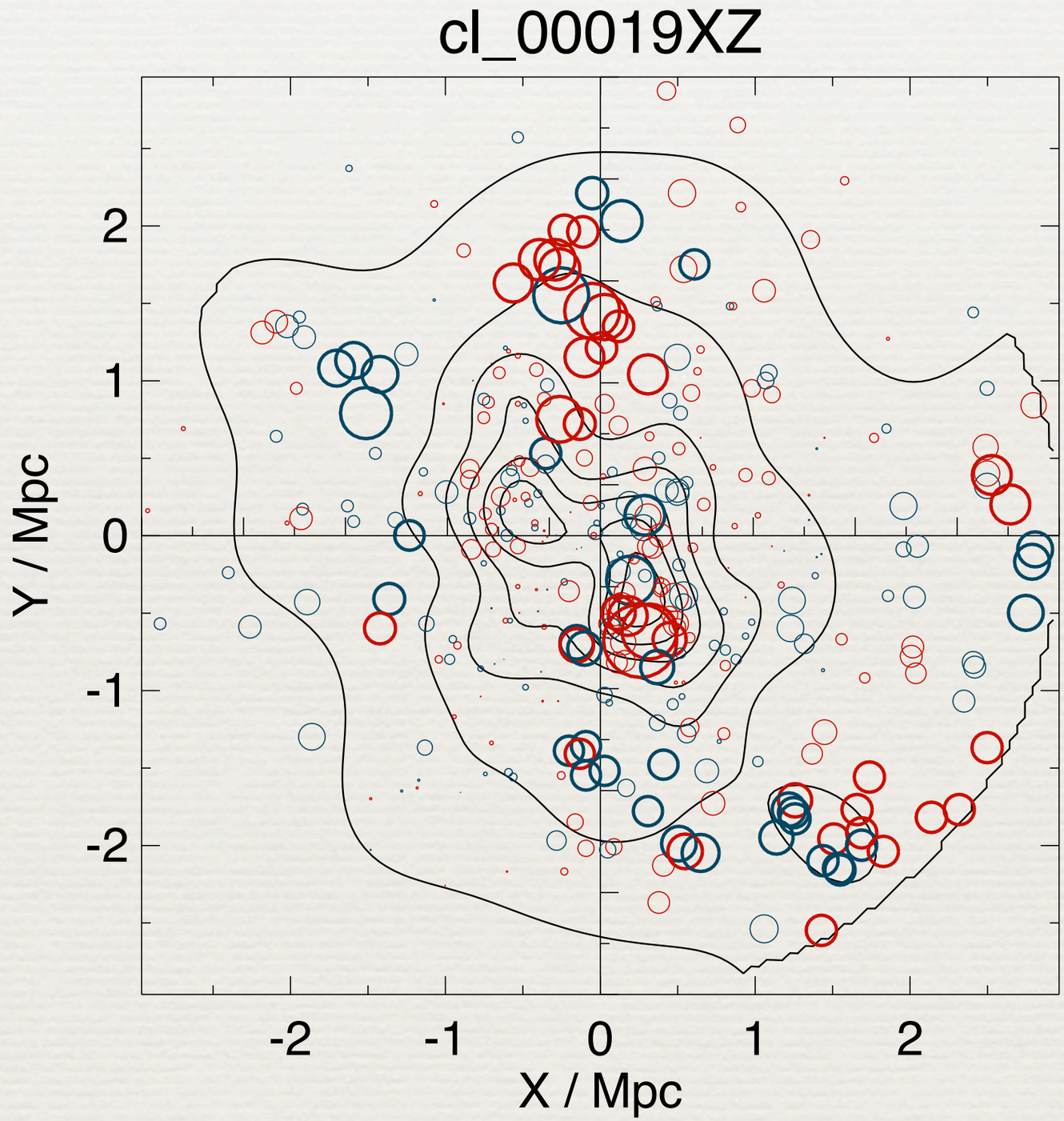
Members in phase-space - XY projection



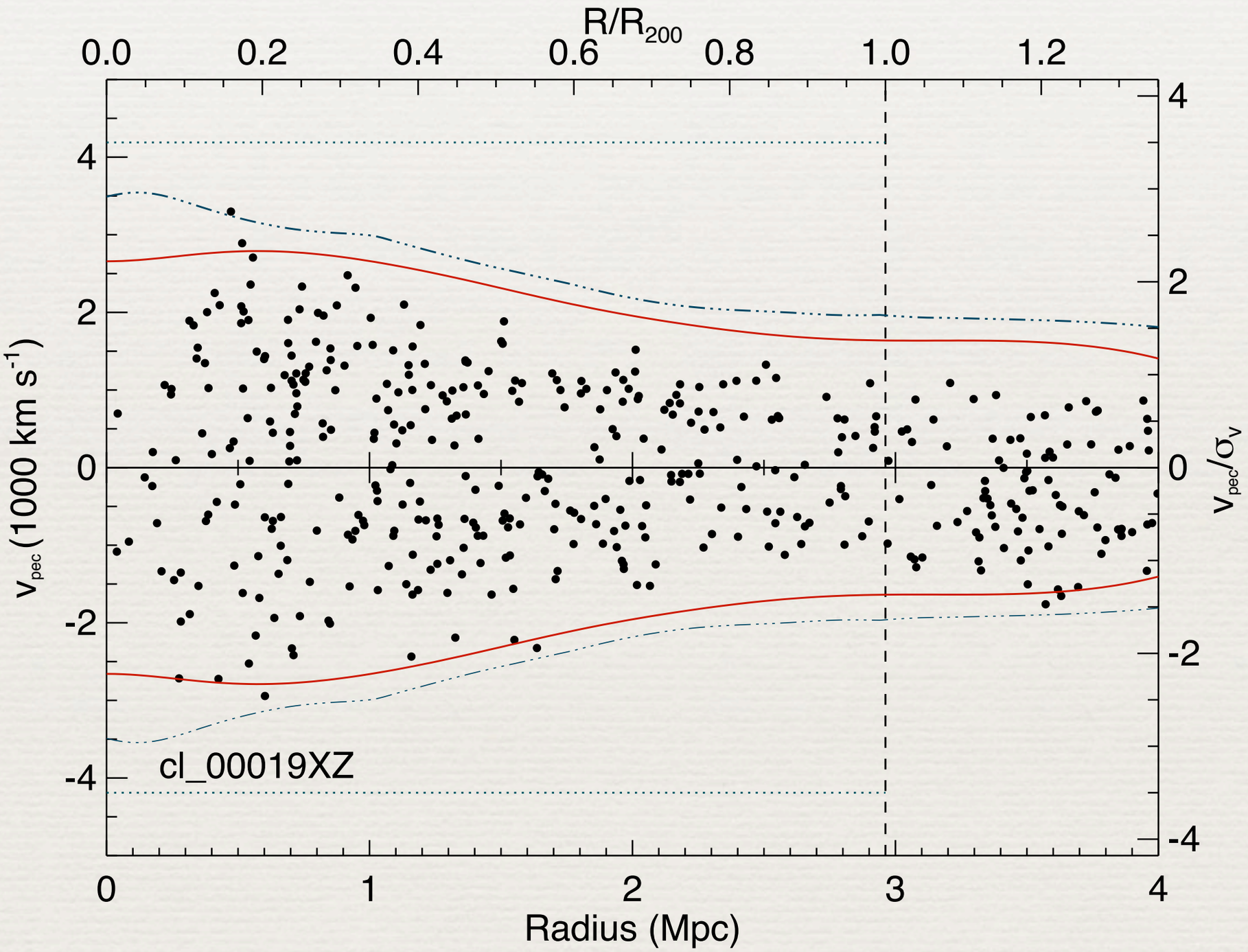
Mass profiles - XY projection



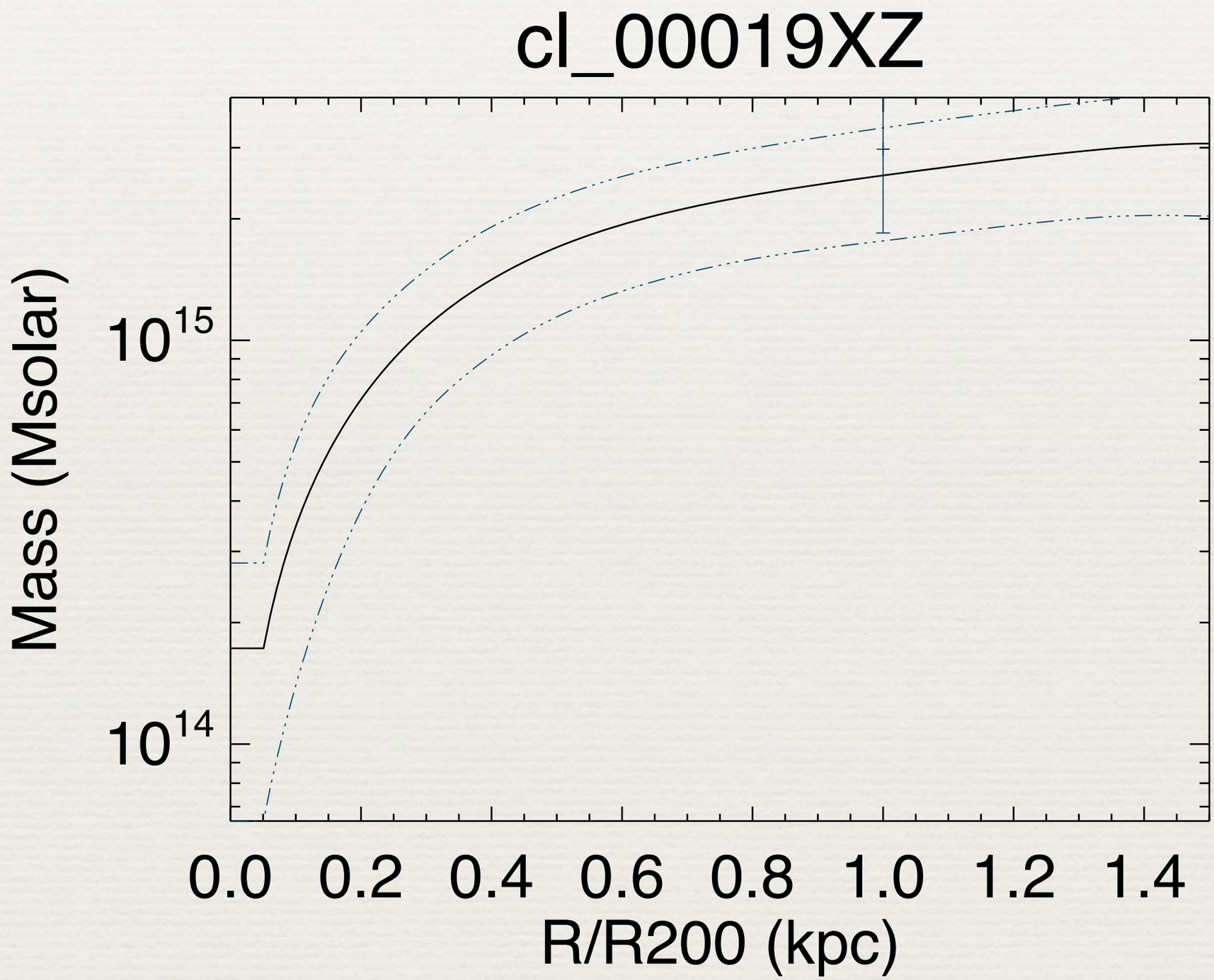
κ-test z=0 - XZ projection



Members in phase-space - XZ projection



Mass profiles - XZ projection



DS substructure catalogues

Will be located in /ClustersOfGalaxies/PerthClusters2015/users/lold/

Ascii file for each snapshot & stellar mass limit with filename format:

Galaxy id (row #)	Xi	Yi	VZi	δi	Δobs	p-value
791	500560	498300	-192.41	1.91933	166.882	0
1147	498990	498680	481.42	2.97955	166.882	0

What next?

- DS test will be run using galaxies found by Matt which means both the κ-test and DS test have the same input
- DS test with different projections
- Mass estimates from caustics and dynamics as a function of z
- κ-test as a function of z & catalogues
- Can still compare these & DS test results with other proxies but do not necessarily trust substructure test results with this data...
- Run on full physics