Core Compendium:

Options on Fitting Cores to Data

Dan Korytov

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Abstract

This document records the quality of fitting cores to red mapper galaxy clusters. There are too many options and iterations to keep everything in mind.

1 Overview of options

This section is broken down into two sections. The first section deals with the creating the radial galaxy distribution the cores will try to match. The second will go over the options on how to treat the cores.

1.1 Target Galaxy Distribution Options

These options are before we even use any core data. So combining all these options with the options of how the cores are treated give us the full option matrix.

- **Galaxy Luminosity**: The brightness relative to M* cut off for it to be counted in the stack. I've only looked at the two options below. Most of the new core definition has been with Mr < M*.
  - $M_r < M*$
  - $M_r < M* + 1$
- **Cluster Radial bins**: How the radial profile is stacked. Excluding the center did not change the fit significantly.
  - 15 linear out to R_{200}
  - 15 linear from $0.05/0.1/0.2R_{200}$ to R_{200}
- **Cluster Mass Stacking**: How the clusters are stacked by SO mass. Currently, it's only done by log linear bins. It might be thinking about making the bins wider in the high mass region to reduce the uncertainty. Empty bins aren't taken into consideration for the fit.
  - x log linear bins from 1e14 to 1e16 check
- **Redshift Bins**: The clusters are stacked in redshift bins. There is almost no redshift evolution, so having only one redshift bin improves the statics.
  - One bin from $0 < z < 0.35$
  - Three bins from $0 < 0.10 < 0.20 < 0.3$

1.2 Core Option

- **Infall Mass Limit**: The minimum infall mass a core must posses for it be considered a candidate to be galaxy. Varying this infall mass while keeping other variables fixed, changes the overall abundance of cores in a cluster but does not change the shape of the profile significantly.
  - On – always required
- **Core Disruption Radius**: How diffuse can a candidate core be before it's considered disrupted and removed as a candidate for a galaxy.
  - On
  - Off – current best fit
- **Core Merging Linking Length**: If two core candidates or more within are radius they are merged into one object. This uses an FoF merging algorithm for merging 3+ cores. The position is just the average position of the merged cores. Maybe weighted by infall mass so that centrals are weighted towards the center?
  - On – current best fit
  - Off
- **Disrupted Cores Merging**: Allowing the particles of disrupted cores merge into a galaxy. There was a linking length and minimum number of particles required. This option was used to solve the missing central problem which was solved by refreshing central cores.
  - Off: not needed any more
- **Infall time pass?**: Maybe cores automatically disrupt/merge after a certain amount of time. Just a thought, not implemented.
  - Off – not implement

- **Cluster Radius**: To construct the radial profile, all cores within a radius of the cluster center are used. I've tried some different radii and the parameters of the fit are pretty insensitive to the limit. Cores further out contribute a small fraction to the profile after smoothing for different angles.
  - 3 Mpc/h
  - 5 Mpc/h
  - 8 Mpc/h

1.3 Fit Option

After deciding how the data and cores are treated, there are still several options on how to calculate the likelihood function.

- **Fitting radial profile**: The main mode of fitting. Each stack of clusters try to match the radial surface density profiles of galaxies/cores.
- **Fitting Ngal**: Fitting number of galaxies within R_{200} per each stack of clusters to match. The disagreement is weighted equally as the radial bins. Each stack has 15 radial bins errors and only 1 Ngal error, so it's a bit under weighted. Maybe this can work well with global abundance? Just as a side experiment
- **Fitting Accumulated Core profile**: Error bars are highly correlated and don't get the right treatment for the correlation. This is sort of an upweighted Ngal requirement. Just of exploratory fitting.
- **Minimum Number of Clusters in Stack**: Some stacks of clusters have only a few clusters and might not representative of that stack. The Poisson error will be large, so they don't provide too strong of constraints. They could be excluded from the analysis complete or left in.
  - No Requirement
  - at least X
- **Locking the Global Abundance**: Requires that the abundance of cores per unit volume to match the expected abundance of M*+x galaxies. This is done by fitting core disruption parameter while adjusting the infall mass to match the expected abundance. **Note**: While fitting for the abundance and profiles, we can't get a good fit to the profile. Is this only a two parameter fit? Can I look at merging as well?
- **Fitting Global Abundance**: Instead of locking the parameters to follow the global abundance of galaxies, the global abundance is taking into account for the likelihood evaluation. See link_to_appendix for an example on the effect on the likelihood/ cost function. So far the fit looks pretty good. :)
- **2-point function**: Not implemented.

2 Fit Procedure

2.1 Error

The RMS of the Poisson noise and error on the mean for each stacked radial bin.

2.2 Posterior

Either through MCMC or grid search. The low dimensionality of the problem (only two or three parameters) lend

3 Fit Results

A Mstar+0, M200m

A.1 Profile fit, Disruption Only

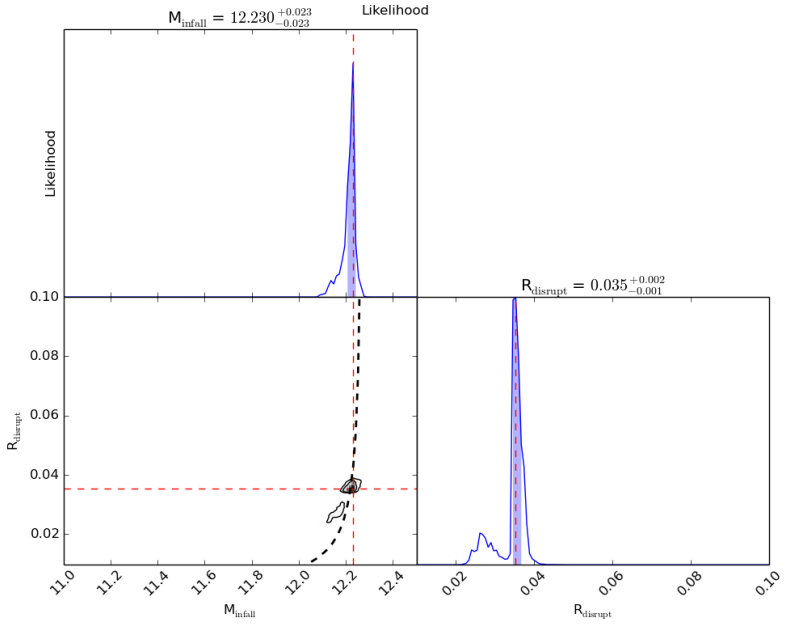


Figure 1: Likelihood on a parameter grid around the best mode. The marginalized parameter likelihood have 1 σ areas shaded in blue. The 2D likelihood distributions have 1 σ and 2 σ contours

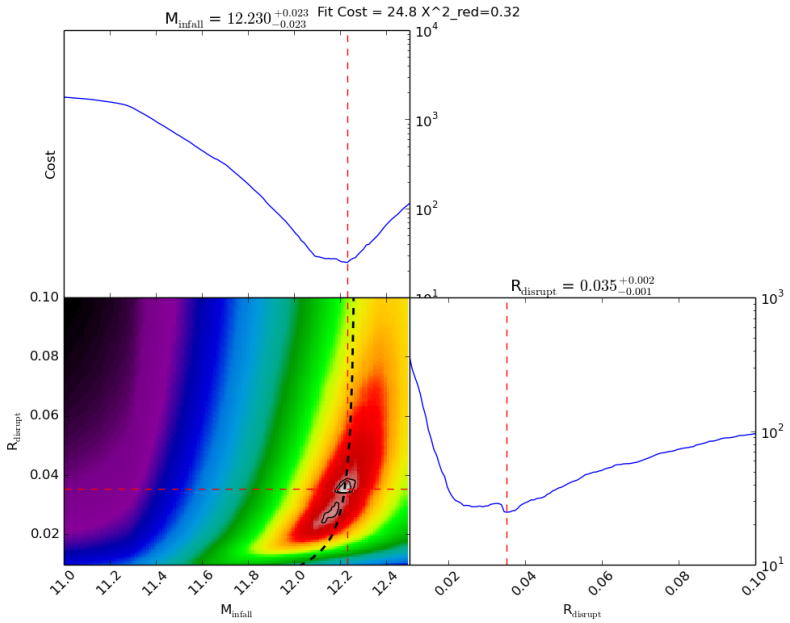
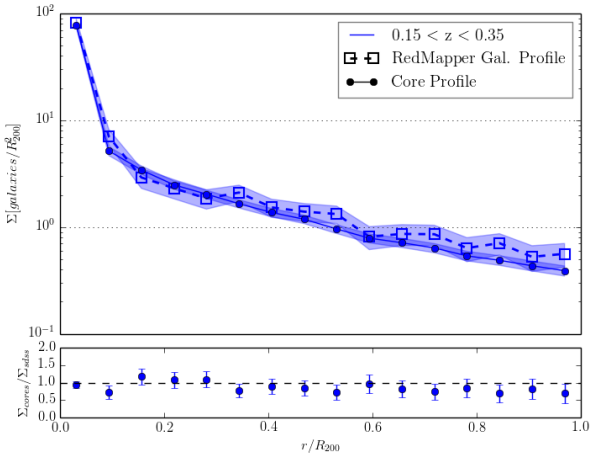


Figure 2: Likelihood on a parameter grid around the best mode. The marginalized parameter likelihood have 1 σ areas shaded in blue. The 2D likelihood distributions have 1 σ and 2 σ contours


0.15 < z < 0.35
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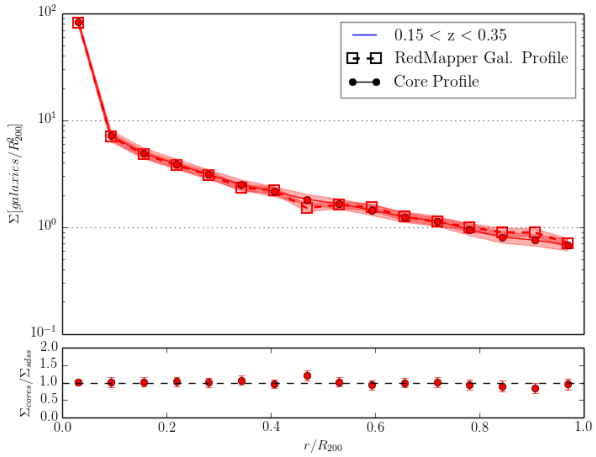
$\Sigma[galaxies/R_{200}^2]$
$\Sigma_{cores}/\Sigma_{sdss}$
r/R_{200}

(a) a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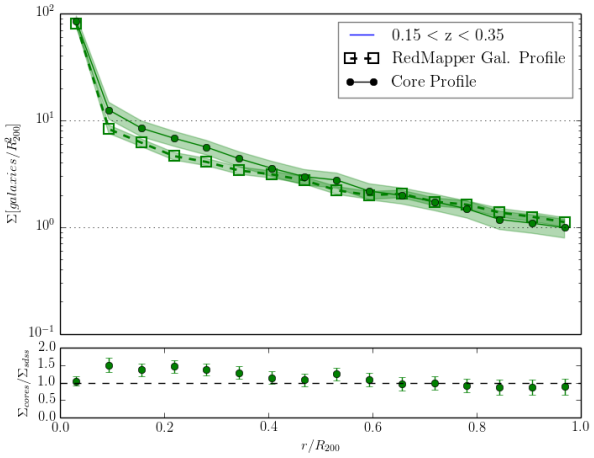
(b) a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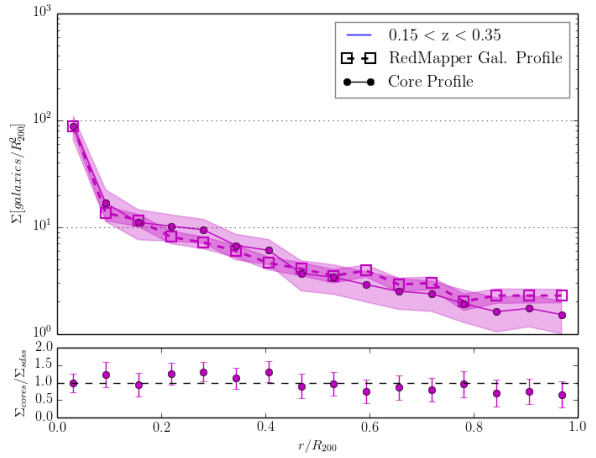
(c) a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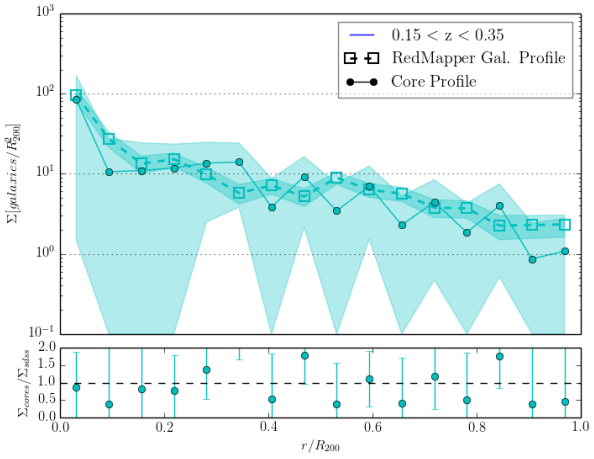
(d) a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(e) a

A.2 Profile fit, Merging Only

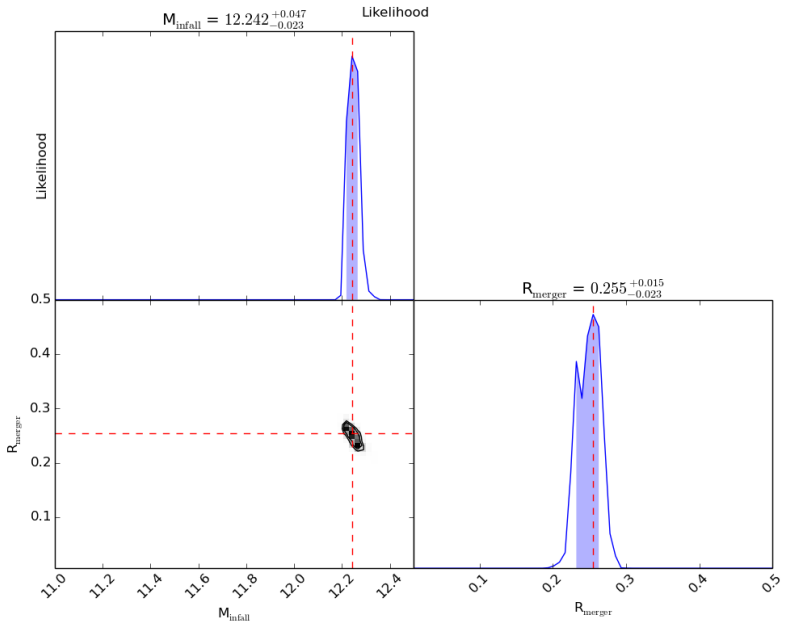


Figure 4: Likelihood on a parameter grid around the best mode. The marginalized parameter likelihood have 1 σ areas shaded in blue. The 2D likelihood distributions have 1 σ and 2 σ contours

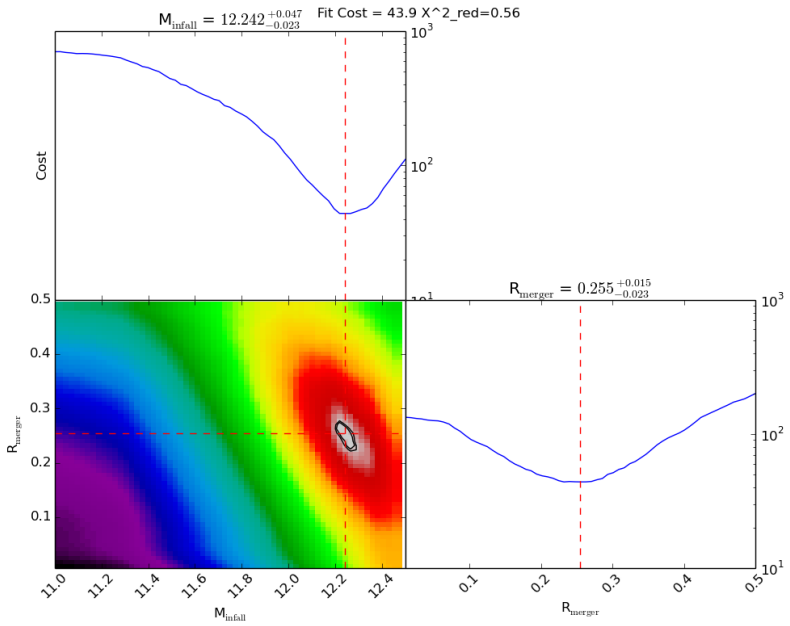
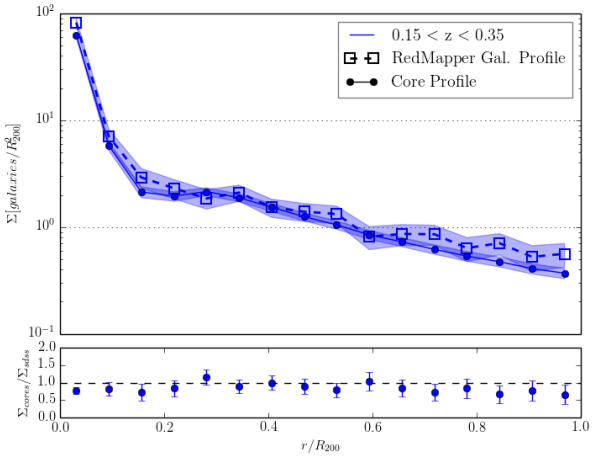


Figure 5: Likelihood on a parameter grid around the best mode. The marginalized parameter likelihood have 1 σ areas shaded in blue. The 2D likelihood distributions have 1 σ and 2 σ contours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RedMapper Gal. Profile
Core Profile
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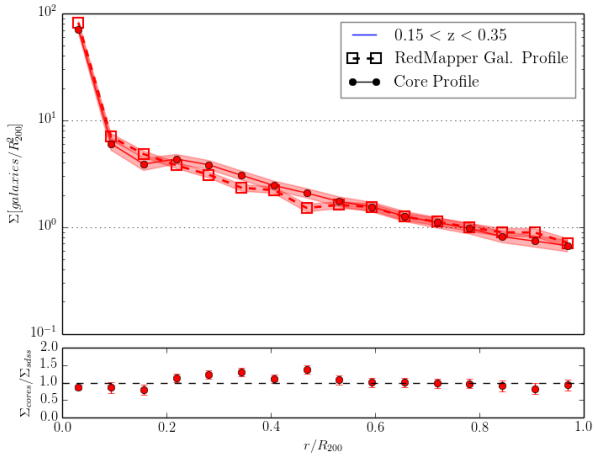
r/R_{200}

(a) a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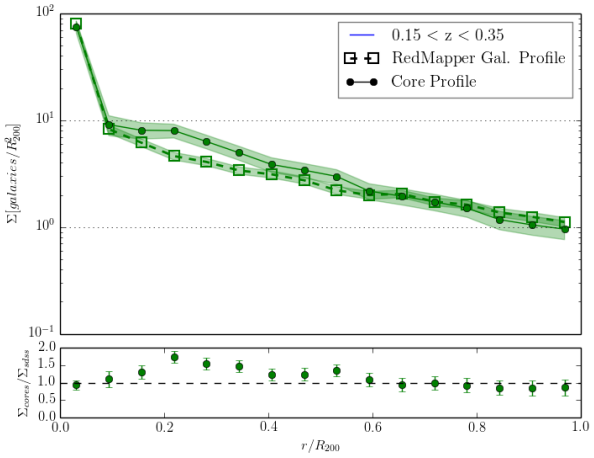
(b) a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$\Sigma[galaxies/R_{200}^2]$
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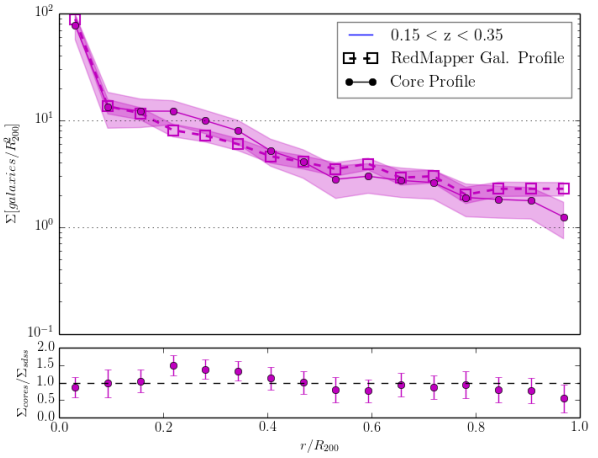
r/R_{200}

(c) a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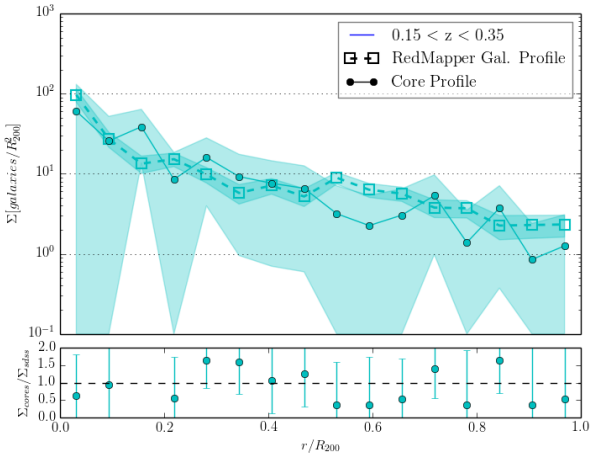
(d) a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(e) a

A.3 Profile fit, Disruption + Merging

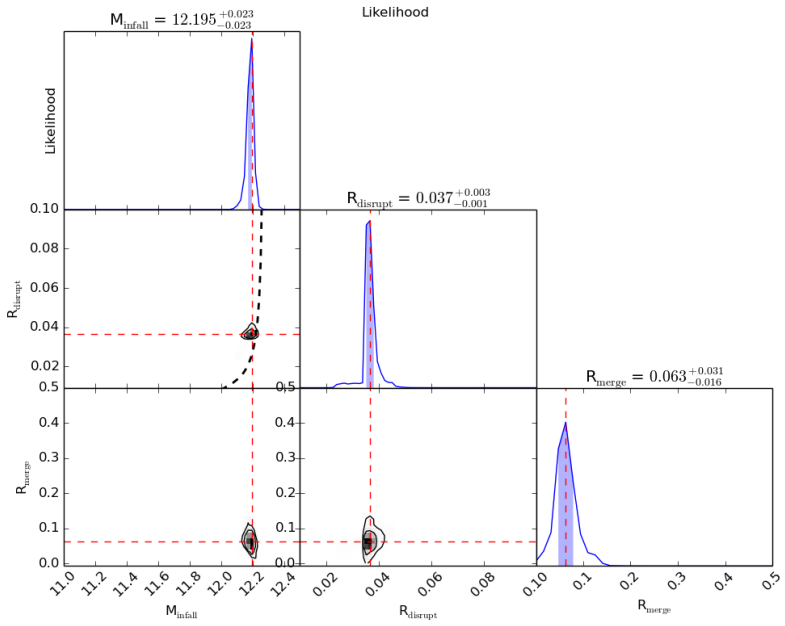


Figure 7: Likelihood on a parameter grid around the best mode. The marginalized parameter likelihood have 1 σ areas shaded in blue. The 2D likelihood distributions have 1 σ and 2 σ contours

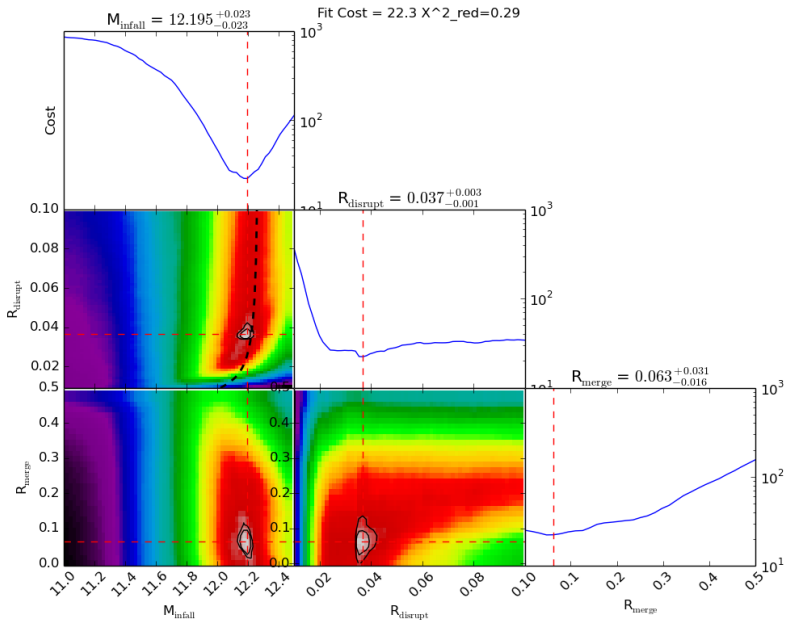
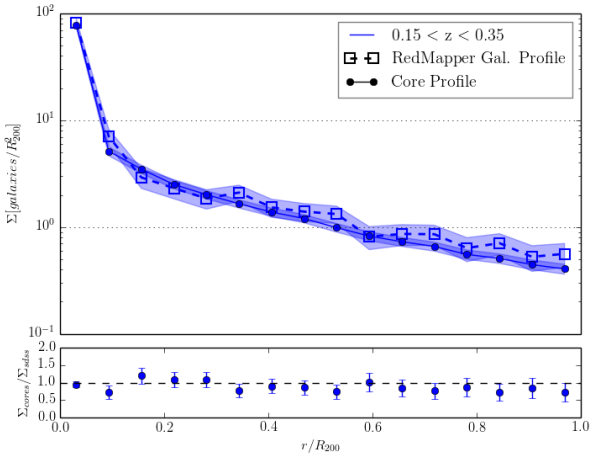


Figure 8: Likelihood on a parameter grid around the best mode. The marginalized parameter likelihood have 1 σ areas shaded in blue. The 2D likelihood distributions have 1 σ and 2 σ contours


0.15 < z < 0.35
RedMapper Gal. Profile
Core Profile
$\Sigma[galaxies/R_{200}^2]$
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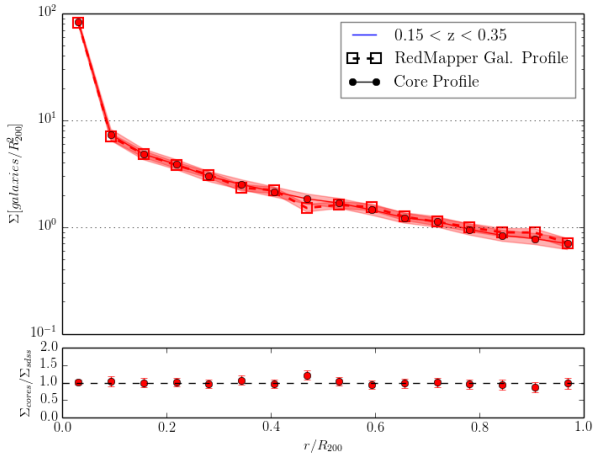
r/R_{200}

(a) a


0.15 < z < 0.35
RedMapper Gal. Profile
Core Profile
$\Sigma[galaxies/R_{200}^2]$
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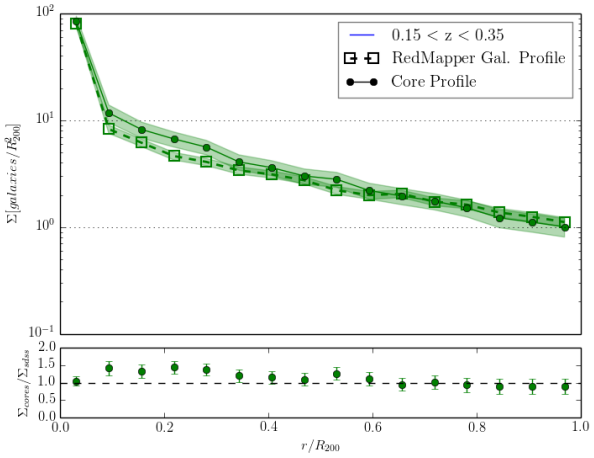
(b) a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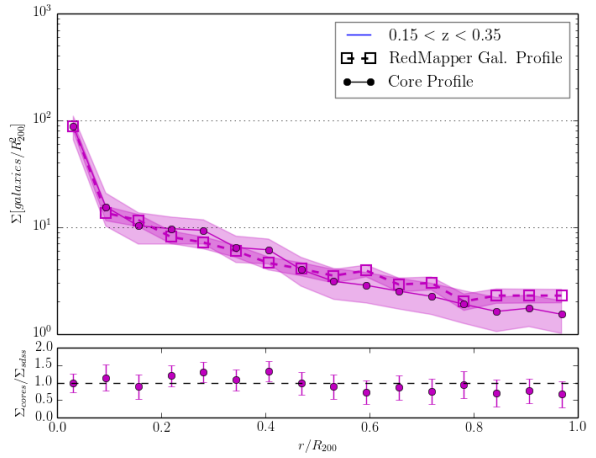
RedMapper Gal. Profile
Core Profile
$\Sigma[galaxies/R_{200}^2]$
$\Sigma_{cores}/\Sigma_{sdss}$
r/R_{200}

(c) a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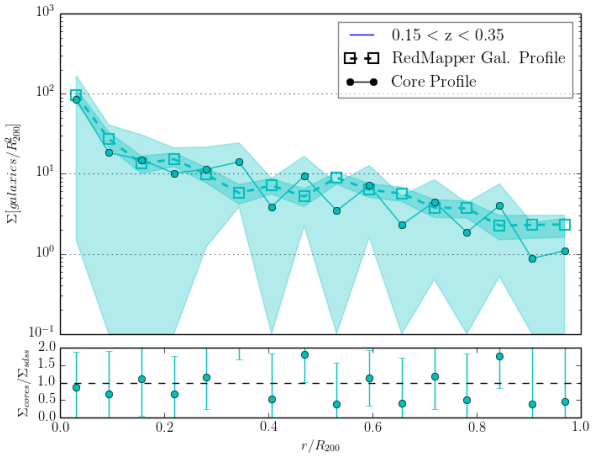
RedMapper Gal. Profile
Core Profile
$\Sigma[galaxies/R_{200}^2]$
$\Sigma_{cores}/\Sigma_{sdss}$
r/R_{200}

(d) a


0.15 < z < 0.35
RedMapper Gal. Profile
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r/R_{200}

(e) a

A.4 Profile + Abundance fit, Disruption Only

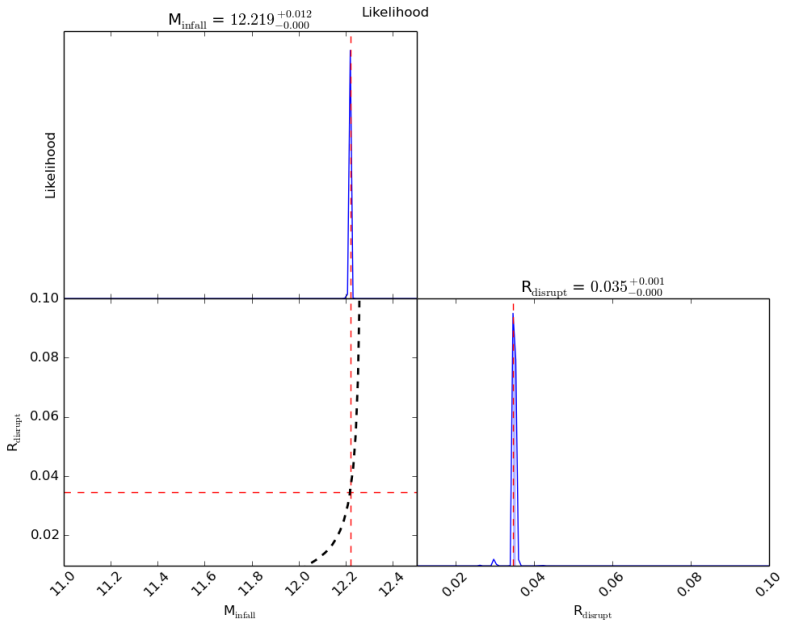


Figure 10: Likelihood on a parameter grid around the best mode. The marginalized parameter likelihood have 1 σ areas shaded in blue. The 2D likelihood distributions have 1 σ and 2 σ contours

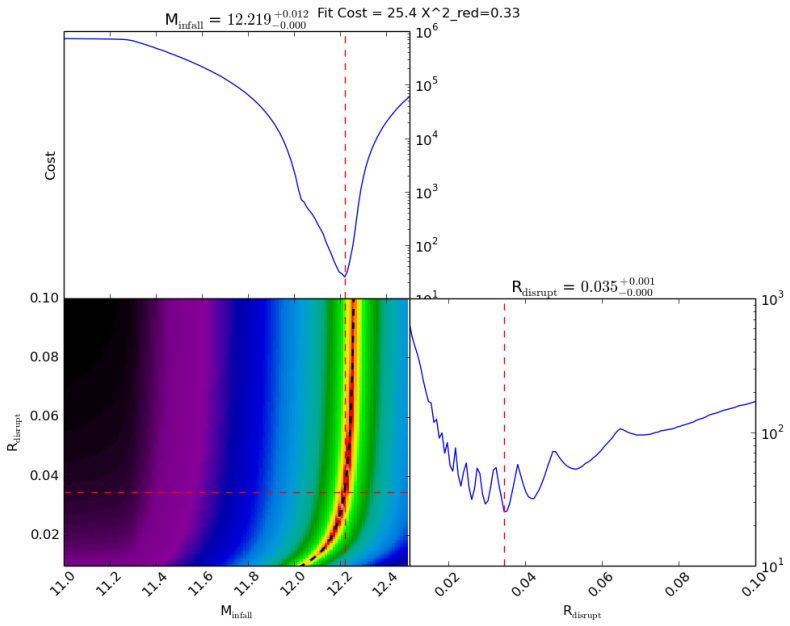
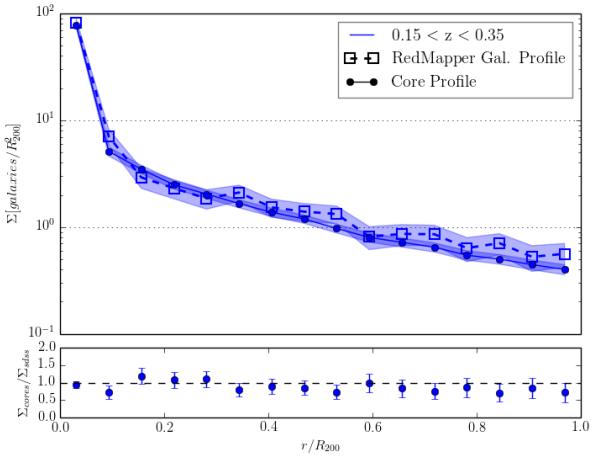


Figure 11: Likelihood on a parameter grid around the best mode. The marginalized parameter likelihood have 1 σ areas shaded in blue. The 2D likelihood distributions have 1 σ and 2 σ contours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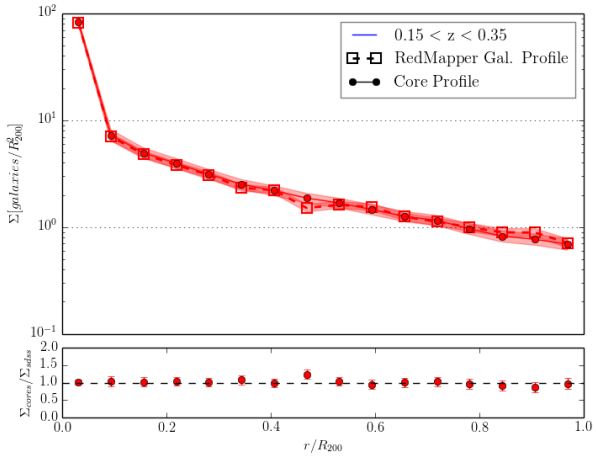
RedMapper Gal. Profile
Core Profile
$\Sigma[galaxies/R_{200}^2]$
$\Sigma_{cores}/\Sigma_{sdss}$
r/R_{200}

(a) a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$\Sigma_{cores}/\Sigma_{sdss}$
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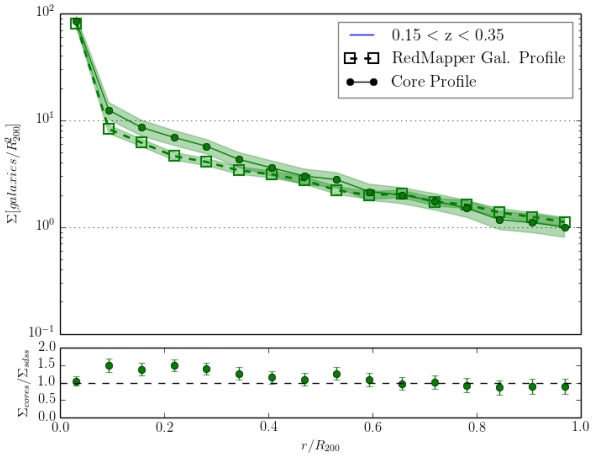
(b) a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Core Profile
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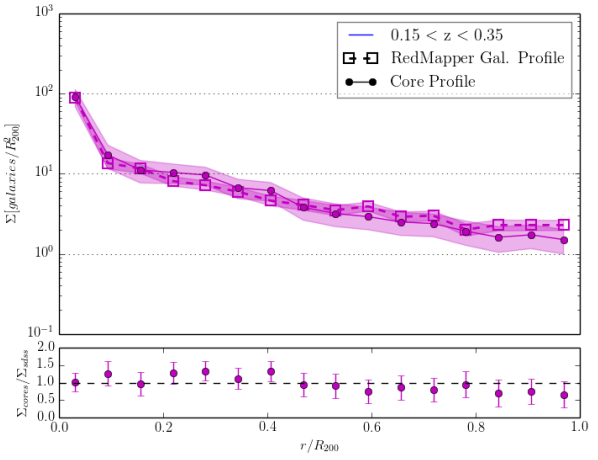
$\Sigma_{cores}/\Sigma_{sdss}$
r/R_{200}

(c) a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Core Profile
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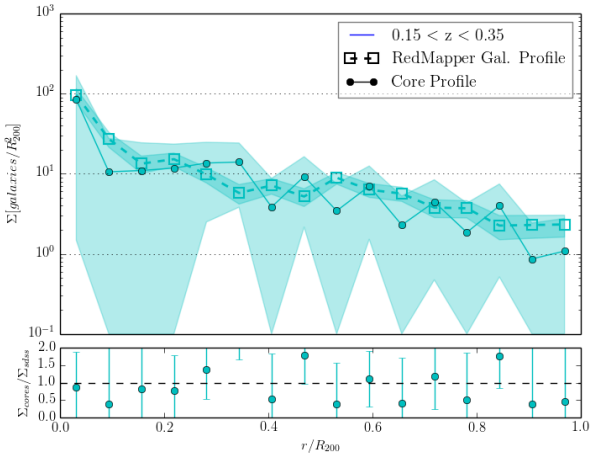
$\Sigma_{cores}/\Sigma_{sdss}$
r/R_{200}

(d) a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(e) a

A.5 Profile + Abundancefit, Merging Only

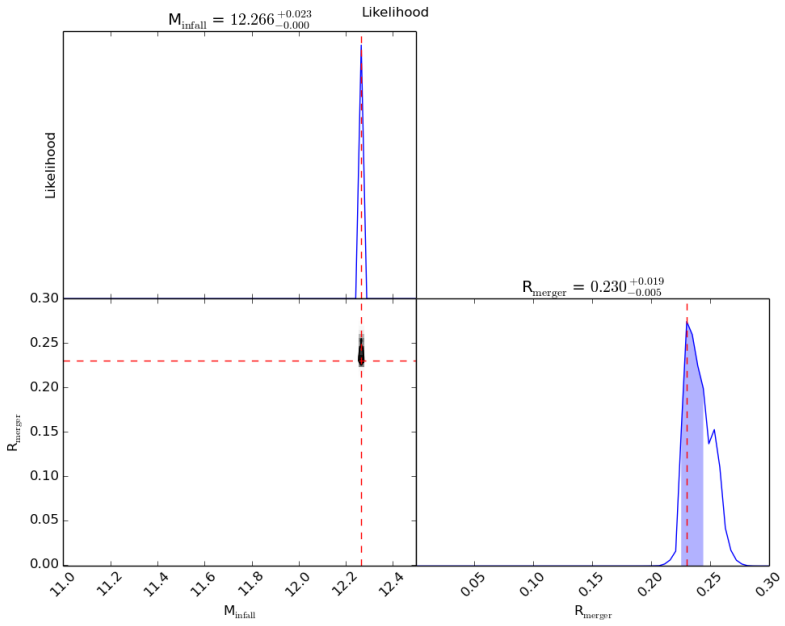


Figure 13: Likelihood on a parameter grid around the best mode. The marginalized parameter likelihood have 1 σ areas shaded in blue. The 2D likelihood distributions have 1 σ and 2 σ contours

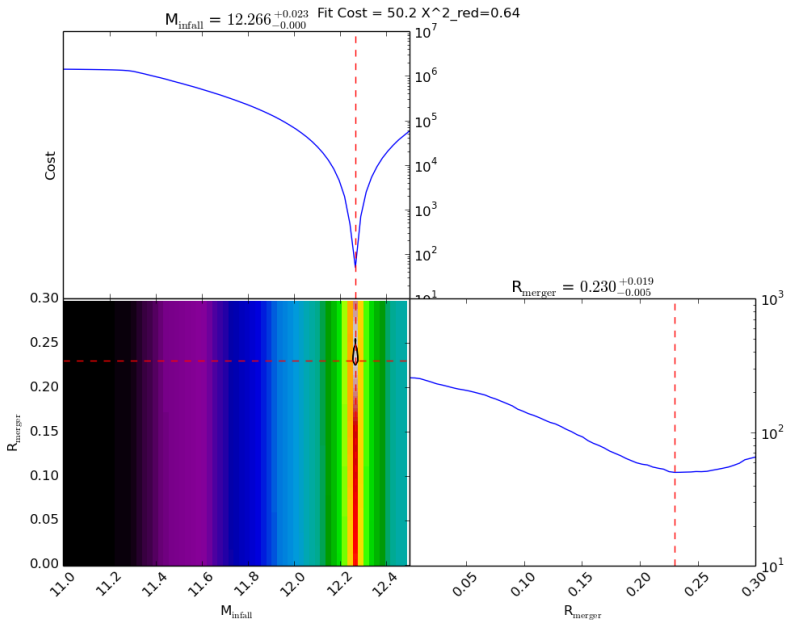
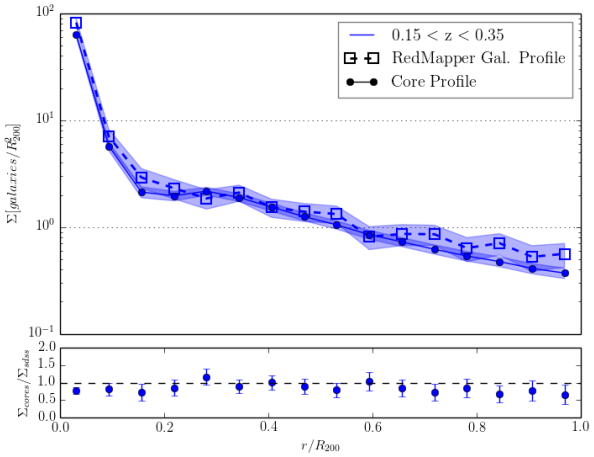


Figure 14: Likelihood on a parameter grid around the best mode. The marginalized parameter likelihood have 1 σ areas shaded in blue. The 2D likelihood distributions have 1 σ and 2 σ contours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RedMapper Gal. Profile
Core Profile
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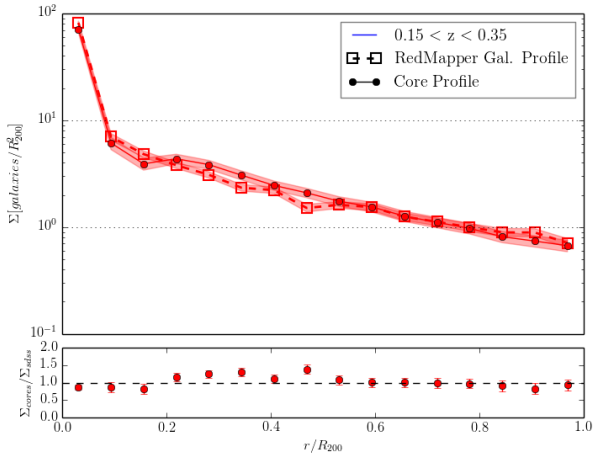
$\Sigma_{cores}/\Sigma_{sdss}$
r/R_{200}

(a) a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RedMapper Gal. Profile
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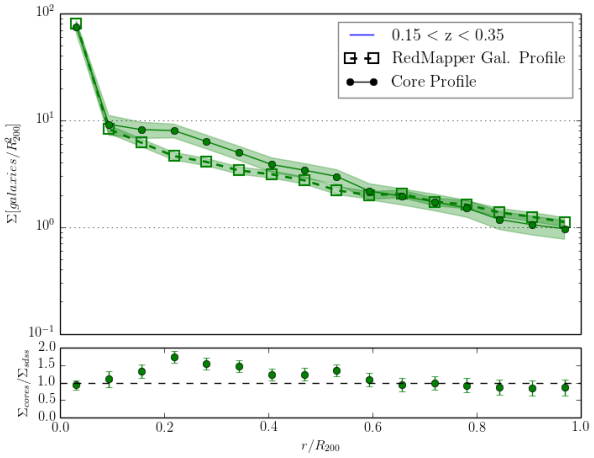
$\Sigma_{cores}/\Sigma_{sdss}$
r/R_{200}

(b) a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RedMapper Gal. Profile
Core Profile
$\Sigma[galaxies/R_{200}^2]$
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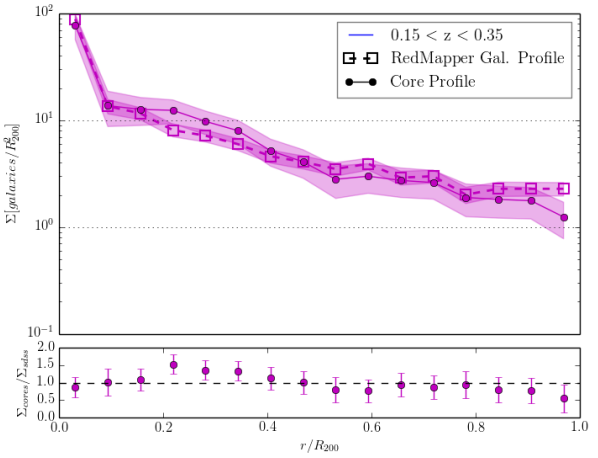
(c) a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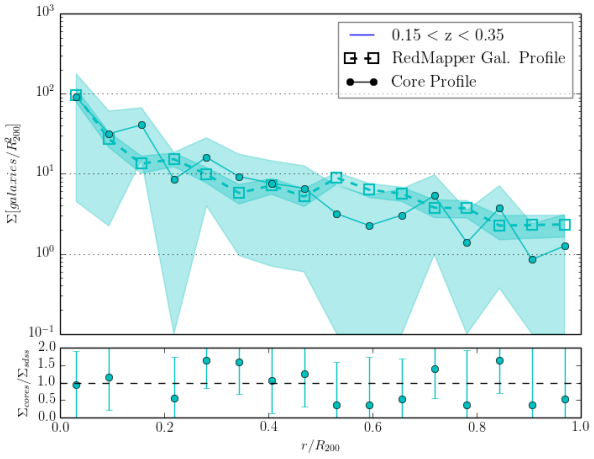
(d) a


0.15 < z < 0.35
RedMapper Gal. Profile
Core Profile
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r/R_{200}

(e) a

A.6 Profile + Abundance fit, Disruption + Merging

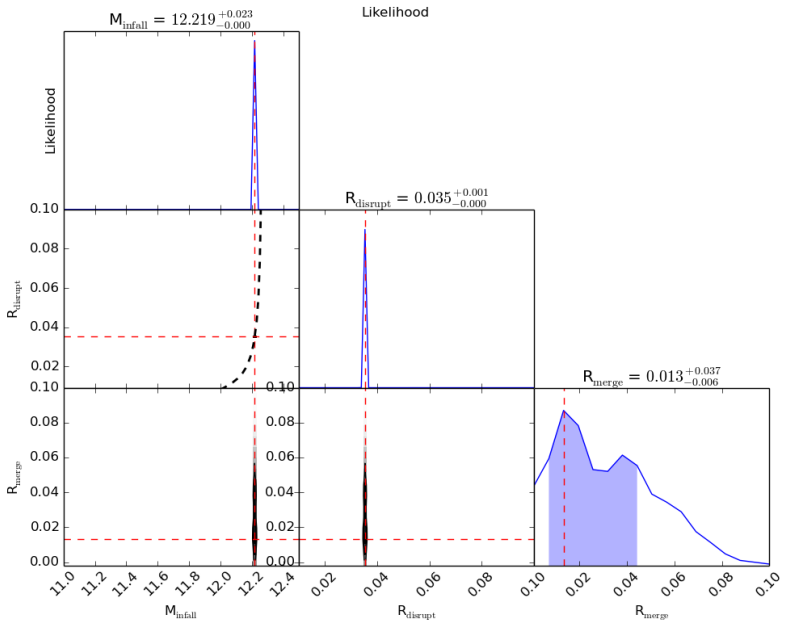


Figure 16: Likelihood on a parameter grid around the best mode. The marginalized parameter likelihood have 1 σ areas shaded in blue. The 2D likelihood distributions have 1 σ and 2 σ contours

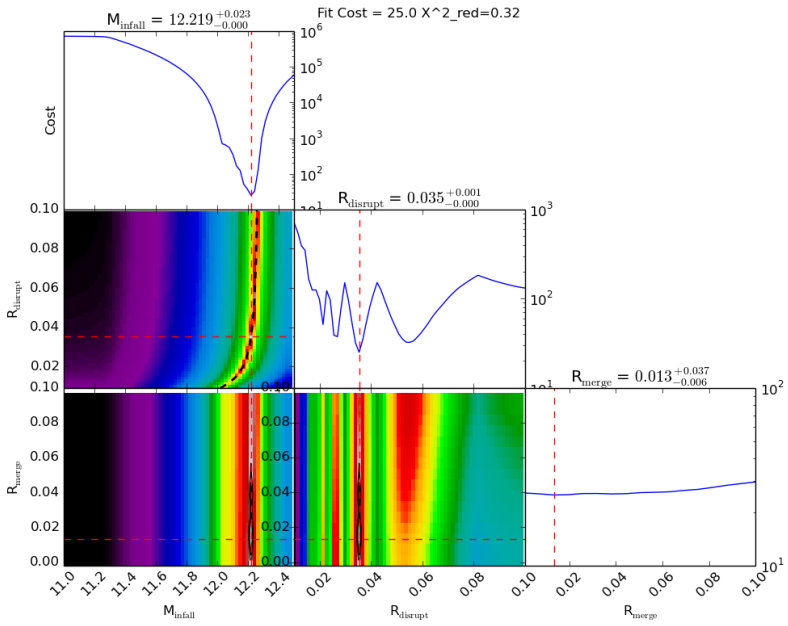
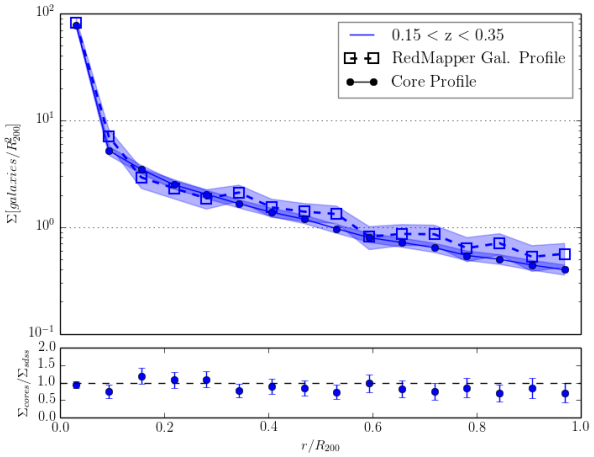
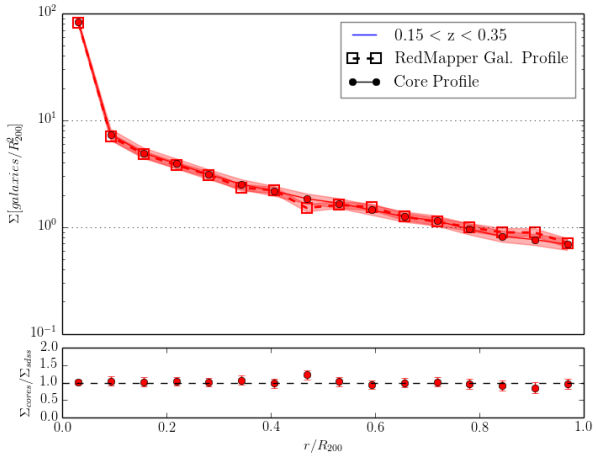


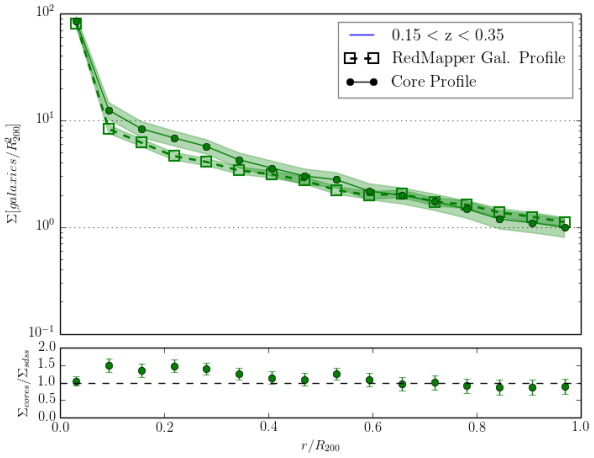
Figure 17: Likelihood on a parameter grid around the best mode. The marginalized parameter likelihood have 1 σ areas shaded in blue. The 2D likelihood distributions have 1 σ and 2 σ contours


0.15 < z < 0.35
RedMapper Gal. Profile
Core Profile
$\Sigma[galaxies/R_{200}^2]$
$\Sigma_{cores}/\Sigma_{sdss}$
r/R_{200}

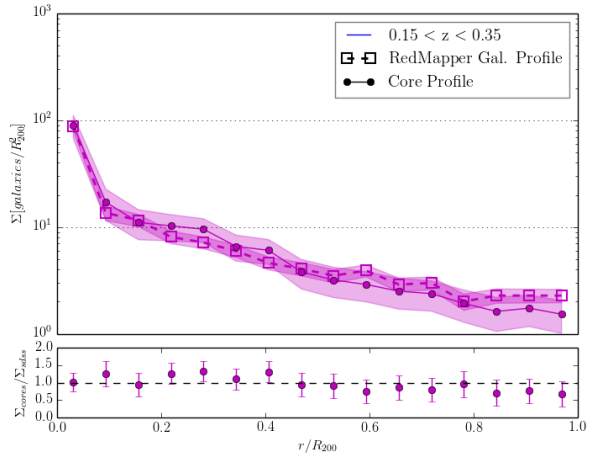
(a) a


0.15 < z < 0.35
RedMapper Gal. Profile
Core Profile
$\Sigma[galaxies/R_{200}^2]$
$\Sigma_{cores}/\Sigma_{sdss}$
r/R_{200}

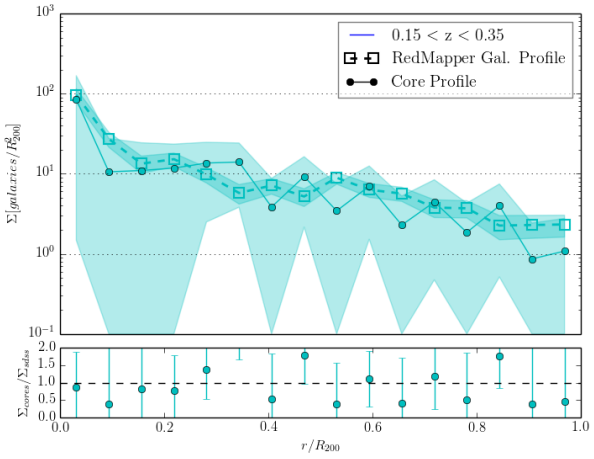
(b) a


0.15 < z < 0.35
RedMapper Gal. Profile
Core Profile
$\Sigma[galaxies/R_{200}^2]$
$\Sigma_{cores}/\Sigma_{sdss}$
r/R_{200}

(c) a


0.15 < z < 0.35
RedMapper Gal. Profile
Core Profile
$\Sigma[galaxies/R_{200}^2]$
$\Sigma_{cores}/\Sigma_{sdss}$
r/R_{200}

(d) a


0.15 < z < 0.35
RedMapper Gal. Profile
Core Profile
$\Sigma[galaxies/R_{200}^2]$
$\Sigma_{cores}/\Sigma_{sdss}$
r/R_{200}

(e) a

B M200c, Mstar+0

B.1 Profile fit, Disruption Only

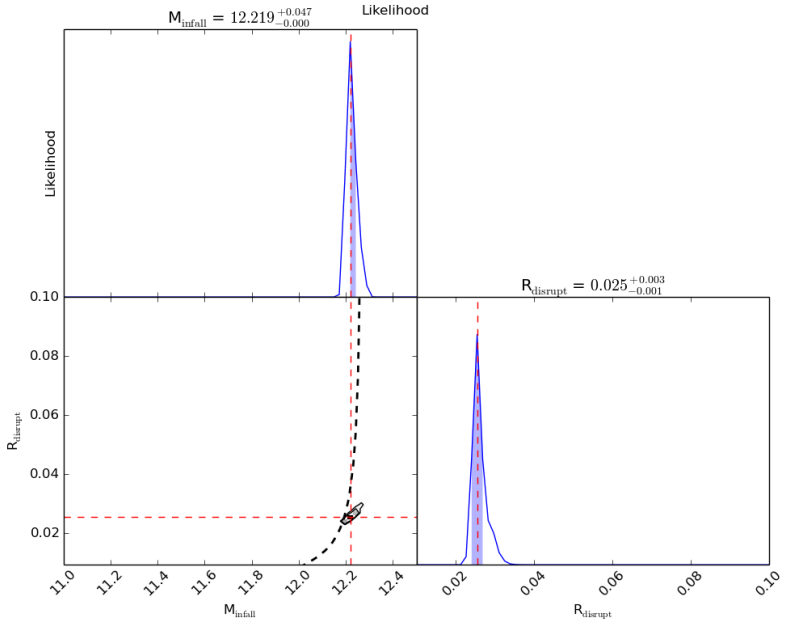


Figure 19: Likelihood on a parameter grid around the best mode. The marginalized parameter likelihood have 1 σ areas shaded in blue. The 2D likelihood distributions have 1 σ and 2 σ contours

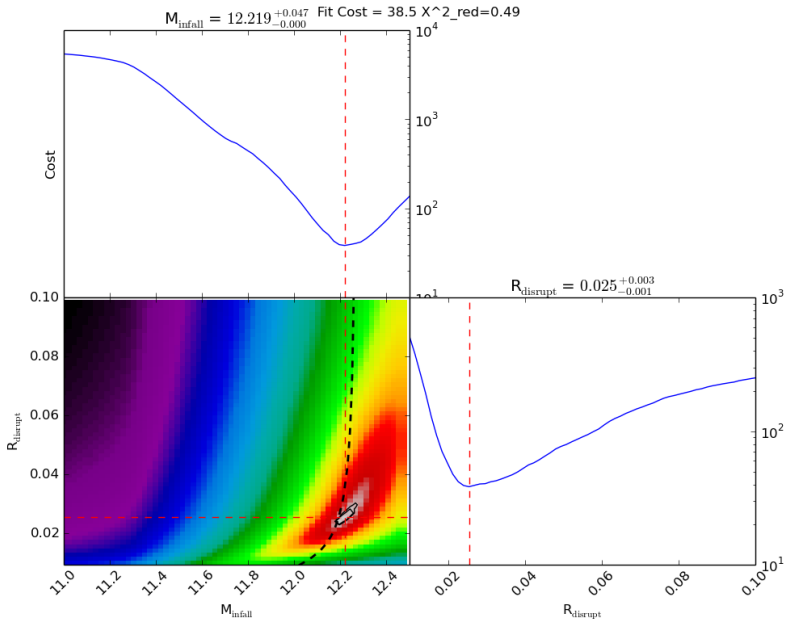
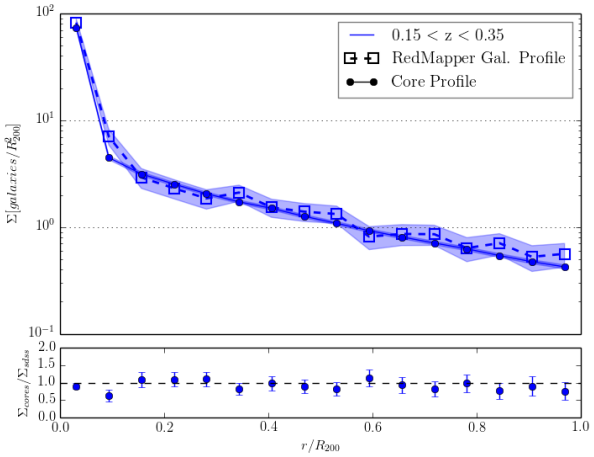
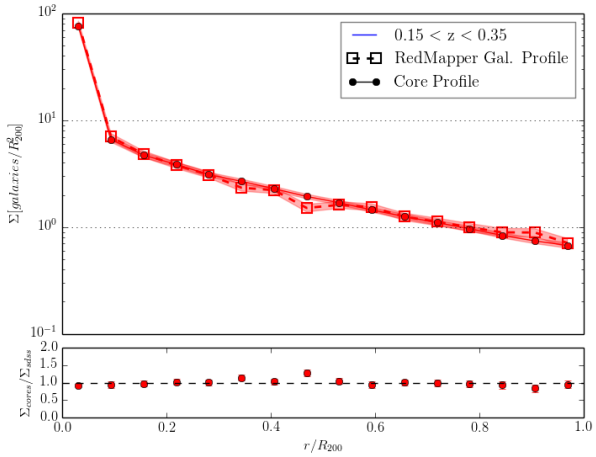


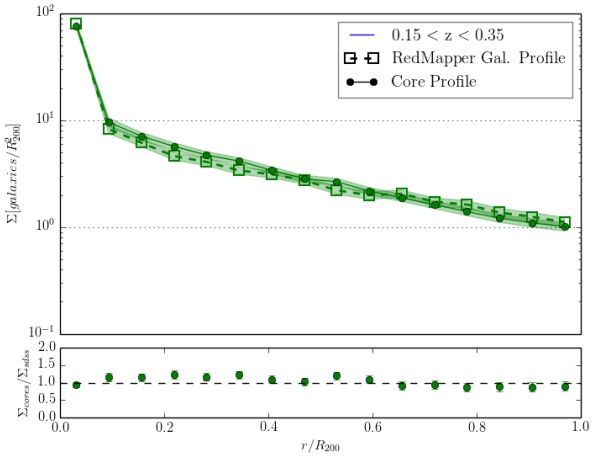
Figure 20: Likelihood on a parameter grid around the best mode. The marginalized parameter likelihood have 1 σ areas shaded in blue. The 2D likelihood distributions have 1 σ and 2 σ contours


0.15 < z < 0.35
RedMapper Gal. Profile
Core Profile
$\Sigma[galaxies/R_{200}^2]$
$\Sigma_{cores}/\Sigma_{sdss}$
r/R_{200}

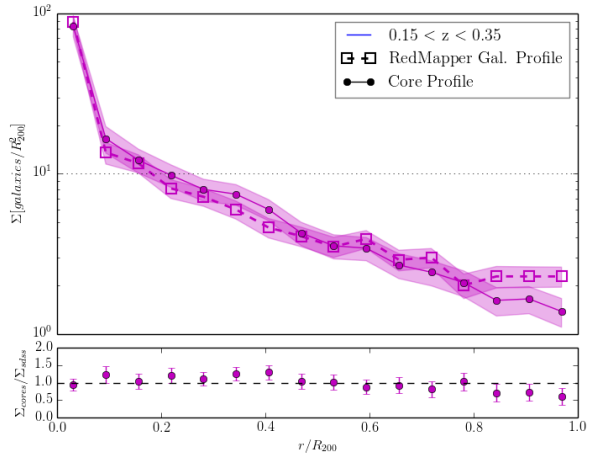
(a) a


0.15 < z < 0.35
RedMapper Gal. Profile
Core Profile
$\Sigma[galaxies/R_{200}^2]$
$\Sigma_{cores}/\Sigma_{sdss}$
r/R_{200}

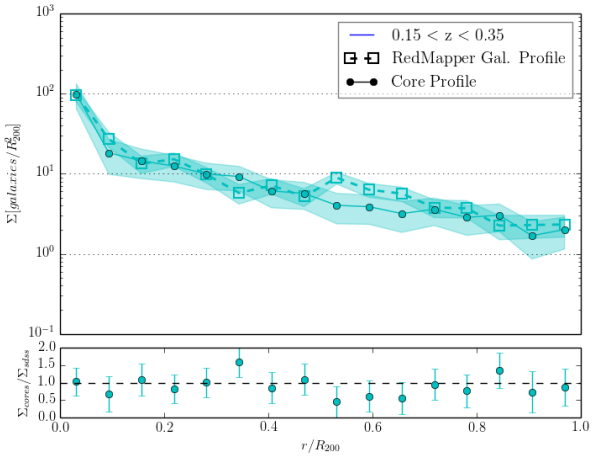
(b) a


0.15 < z < 0.35
RedMapper Gal. Profile
Core Profile
$\Sigma[galaxies/R_{200}^2]$
$\Sigma_{cores}/\Sigma_{sdss}$
r/R_{200}

(c) a


0.15 < z < 0.35
RedMapper Gal. Profile
Core Profile
$\Sigma[galaxies/R_{200}^2]$
$\Sigma_{cores}/\Sigma_{sdss}$
r/R_{200}

(d) a


0.15 < z < 0.35
RedMapper Gal. Profile
Core Profile
$\Sigma[galaxies/R_{200}^2]$
$\Sigma_{cores}/\Sigma_{sdss}$
r/R_{200}

(e) a

B.2 Profile fit, Merging Only

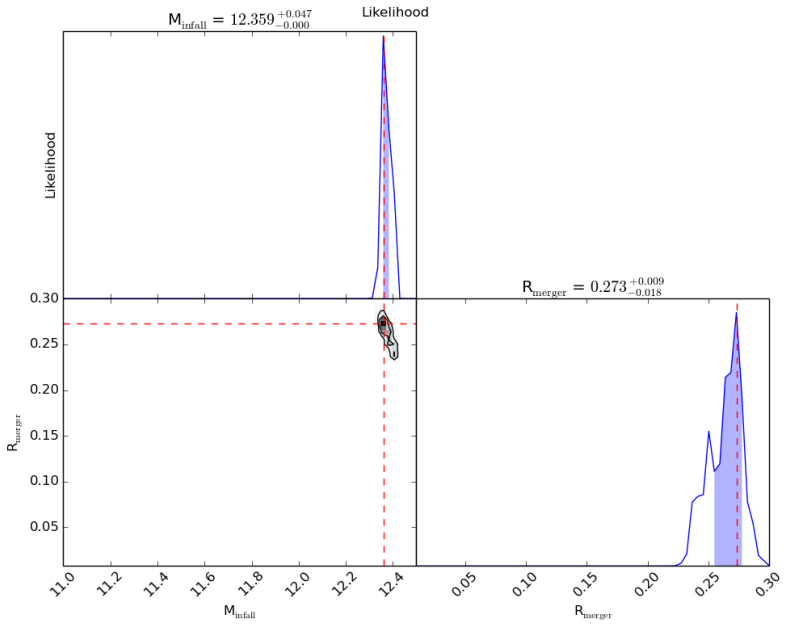


Figure 22: Likelihood on a parameter grid around the best mode. The marginalized parameter likelihood have 1 σ areas shaded in blue. The 2D likelihood distributions have 1 σ and 2 σ contours

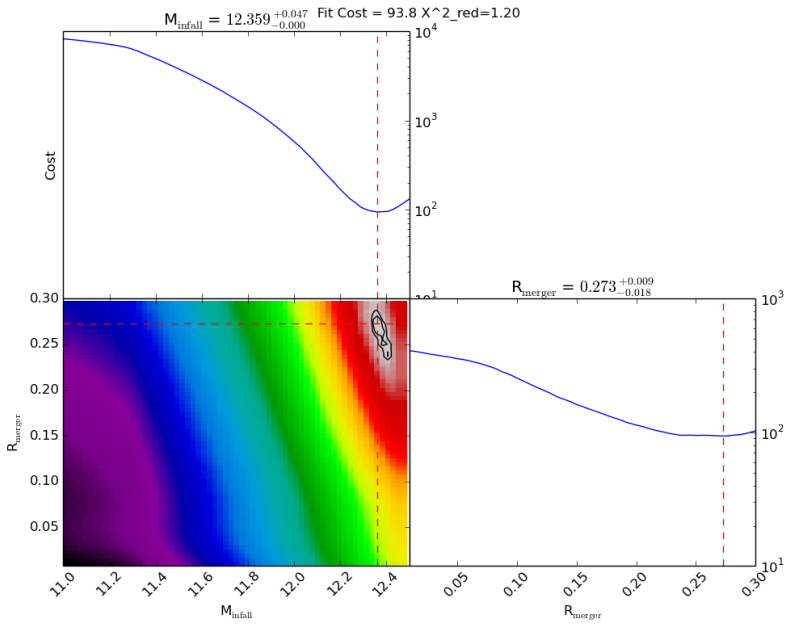
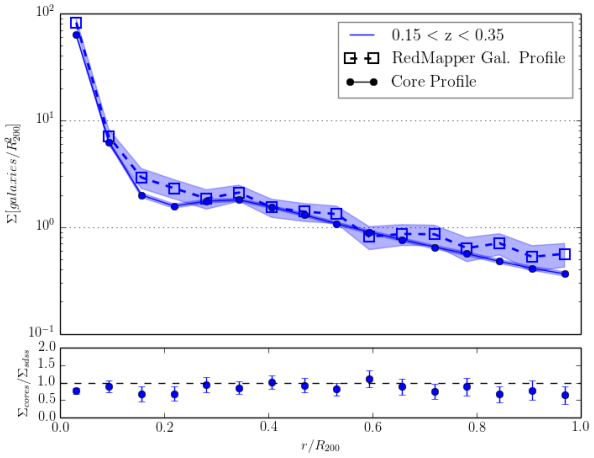
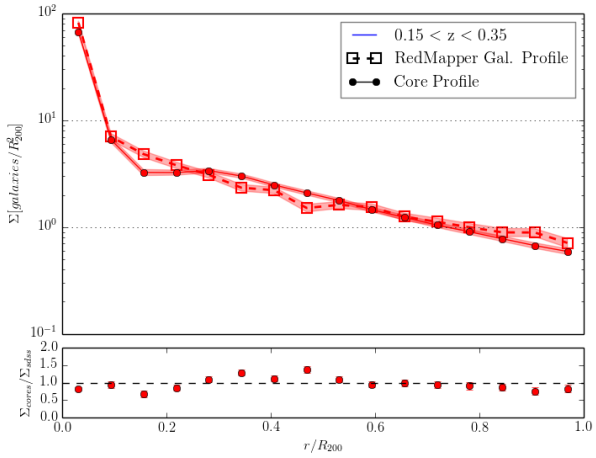


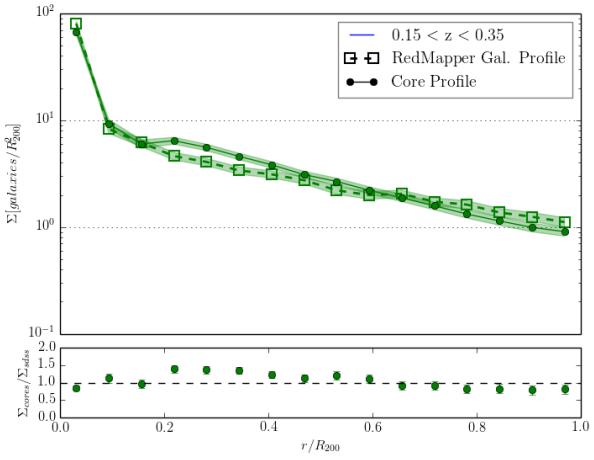
Figure 23: Likelihood on a parameter grid around the best mode. The marginalized parameter likelihood have 1 σ areas shaded in blue. The 2D likelihood distributions have 1 σ and 2 σ contours


0.15 < z < 0.35
RedMapper Gal. Profile
Core Profile
$\Sigma[galaxies/R_{200}^2]$
$\Sigma_{cores}/\Sigma_{sdss}$
r/R_{200}

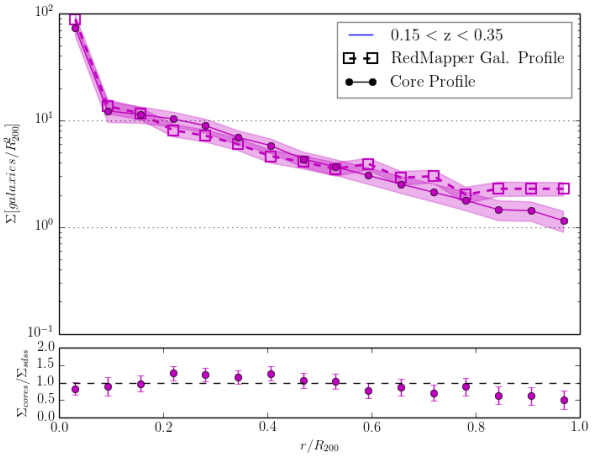
(a) a


0.15 < z < 0.35
RedMapper Gal. Profile
Core Profile
$\Sigma[galaxies/R_{200}^2]$
$\Sigma_{cores}/\Sigma_{sdss}$
r/R_{200}

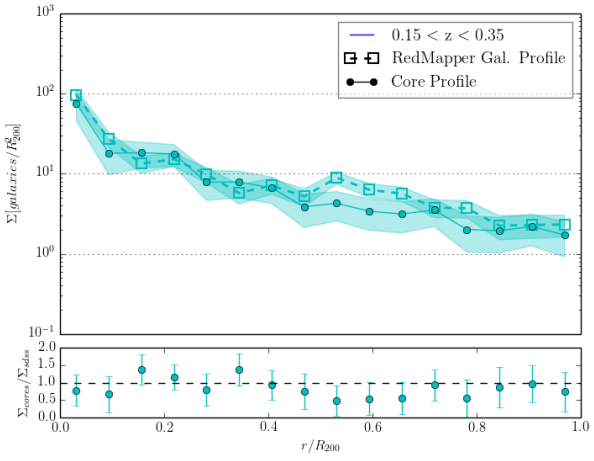
(b) a


0.15 < z < 0.35
RedMapper Gal. Profile
Core Profile
$\Sigma[galaxies/R_{200}^2]$
$\Sigma_{cores}/\Sigma_{sdss}$
r/R_{200}

(c) a


0.15 < z < 0.35
RedMapper Gal. Profile
Core Profile
$\Sigma[galaxies/R_{200}^2]$
$\Sigma_{cores}/\Sigma_{sdss}$
r/R_{200}

(d) a


0.15 < z < 0.35
RedMapper Gal. Profile
Core Profile
$\Sigma[galaxies/R_{200}^2]$
$\Sigma_{cores}/\Sigma_{sdss}$
r/R_{200}

(e) a

B.3 Profile fit, Disruption + Merging

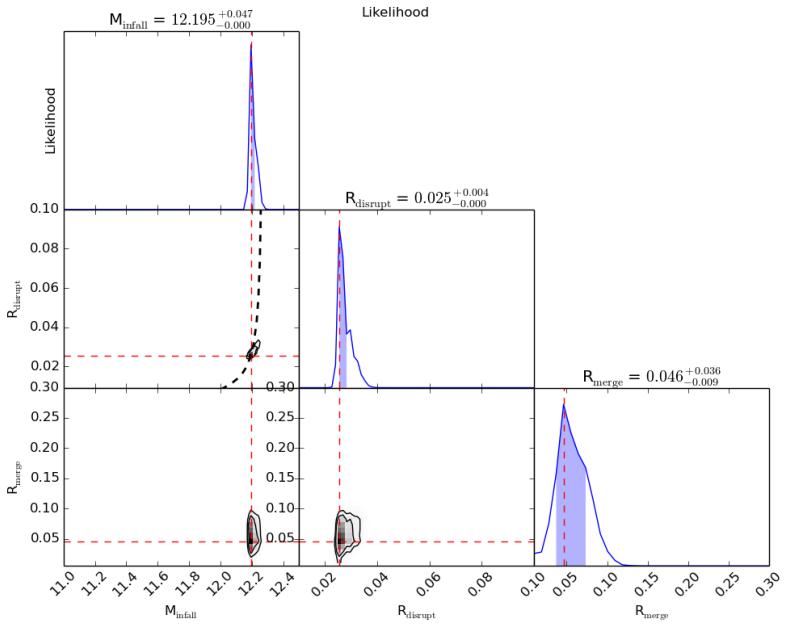


Figure 25: Likelihood on a parameter grid around the best mode. The marginalized parameter likelihood have 1 σ areas shaded in blue. The 2D likelihood distributions have 1 σ and 2 σ contours

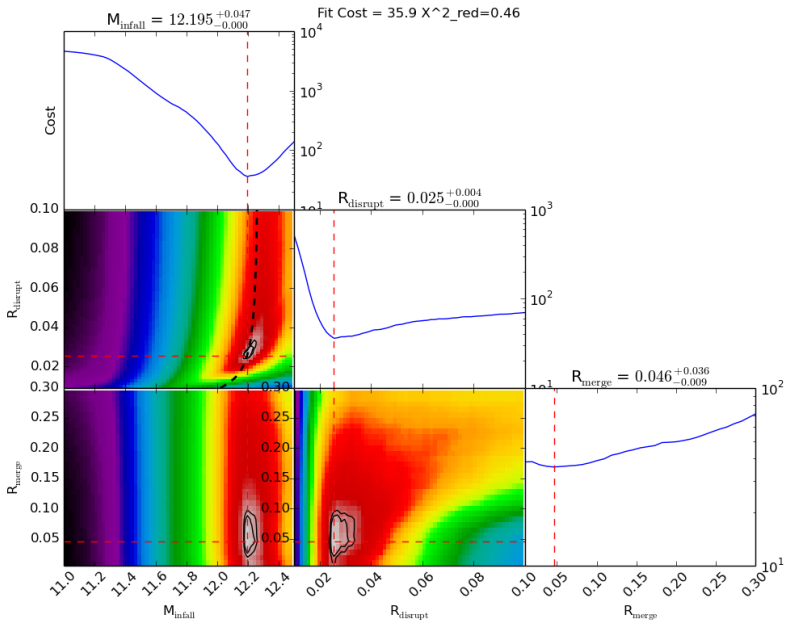
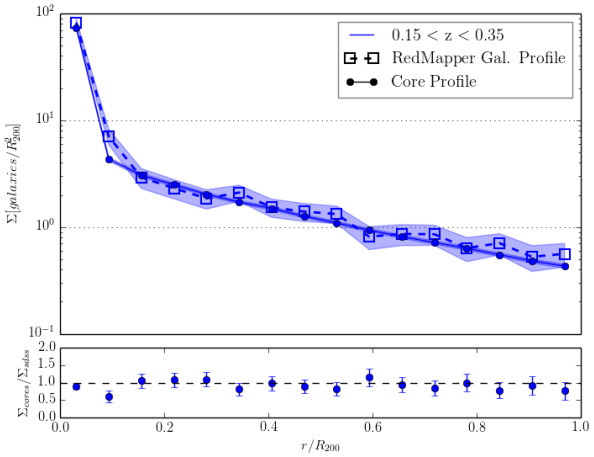
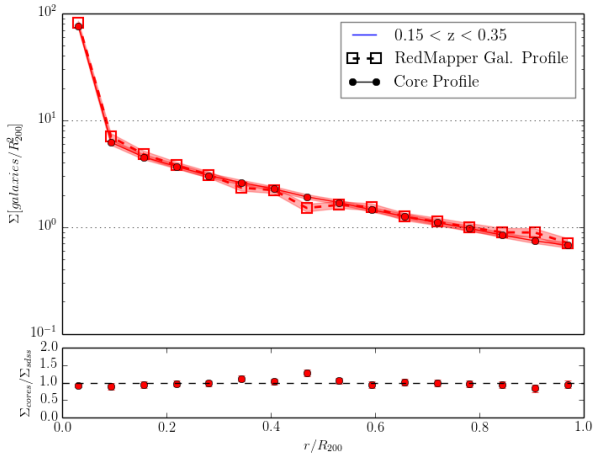


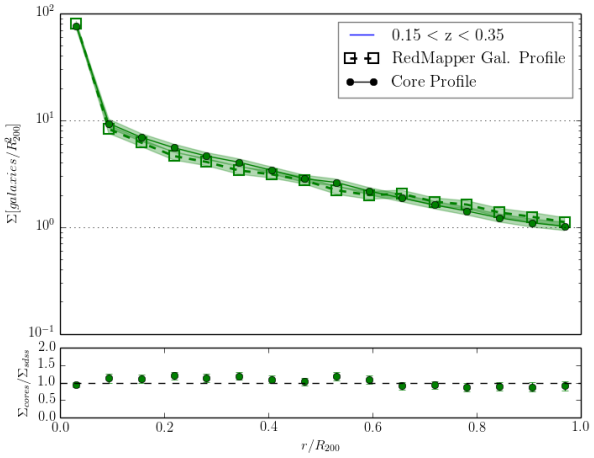
Figure 26: Likelihood on a parameter grid around the best mode. The marginalized parameter likelihood have 1 σ areas shaded in blue. The 2D likelihood distributions have 1 σ and 2 σ contours


0.15 < z < 0.35
RedMapper Gal. Profile
Core Profile
$\Sigma[galaxies/R_{200}^2]$
$\Sigma_{cores}/\Sigma_{sdss}$
r/R_{200}

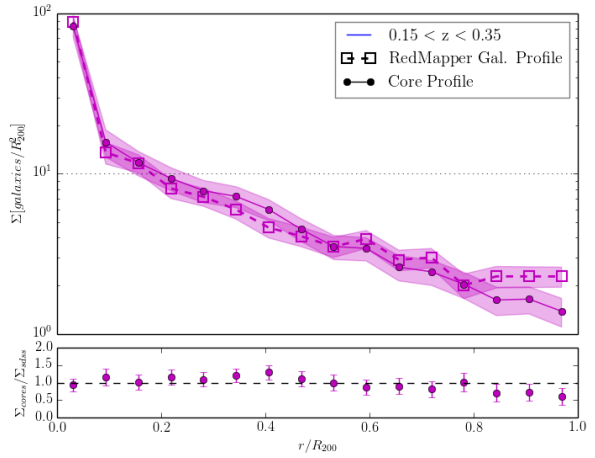
(a) a


0.15 < z < 0.35
RedMapper Gal. Profile
Core Profile
$\Sigma[galaxies/R_{200}^2]$
$\Sigma_{cores}/\Sigma_{sdss}$
r/R_{200}

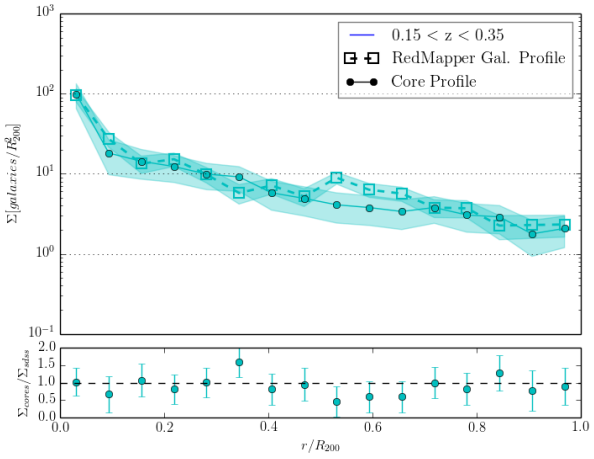
(b) a


0.15 < z < 0.35
RedMapper Gal. Profile
Core Profile
$\Sigma[galaxies/R_{200}^2]$
$\Sigma_{cores}/\Sigma_{sdss}$
r/R_{200}

(c) a


0.15 < z < 0.35
RedMapper Gal. Profile
Core Profile
$\Sigma[galaxies/R_{200}^2]$
$\Sigma_{cores}/\Sigma_{sdss}$
r/R_{200}

(d) a


0.15 < z < 0.35
RedMapper Gal. Profile
Core Profile
$\Sigma[galaxies/R_{200}^2]$
$\Sigma_{cores}/\Sigma_{sdss}$
r/R_{200}

(e) a