The Secret Plot Project !

TWO CONCRETE PAPER OUTLINES

Top to do list:

- Song + AL: supplement with photoz-s
- Song+AL: figure out what we fail to get a 1d profile, fix those issues
- Andrew+AL: compare existing UM mock to data, how far off are we?
- Andrew: mass accretion plot with Mbcg+Micl. Why do we see the halo mass split in the UM plots.
- Peter and Andrew: what is the range of scatter values in the current M*_total / Mhalo plane? Does it go low enough?
- All: decide on modeling approach (UM versus MD)
- Alexie: get new shear catalog, implement new calibration, finalize the lensing signals.
- How to deal with errors (depends on choice of simulation for the model)

PAPER I: The structure of massive galaxies depends strongly on halo mass

We have detected that the virial mass of a dark matter halo strongly influences the internal structure of the central cluster galaxy. At fixed total galaxy mass, splitting by the core mass of the galaxy yields a halo mass difference of 0.45 dex. At fixed total galaxy mass, a model based on two halo parameters is required to describe the data.

We find a model using a simulation (TBD) that can fit the lensing across the 2d plane. Do conditional abundance matching using MD or Bolshoi P.

Main plots

- NFW-lensing-mass varies across M10-M100 plane
- Show similar split in MBII and UM
- How the model fits the SMF and lensing data

Minor plots

- Profiles of galaxies in the M100 / M10 divide
- Images of galaxies in the M100 / M10 divide
- At fixed total mass, histogram distribution of 2” fiber luminosity. Or how this cuts across the M100/M10 plane

How to model the signals?

We want to build a model that can fit the lensing across the 2d M10/M100 plane. The volume of the data are similar to a simulation with L= 300 Mpc.

Options are:

- Do a conditional abundance matching scheme using 2 halo properties and M10 and M100. Possible secondary halo properties to consider could be
  - something related to the merger history (how many large/small mergers were encountered)
  - current day amount of substructure (easiest to implement)
  -Radial versus tangential orbits: borzyszkowski paper**:** assembly bias and the cosmic web
  - Wet /dry mergers? Gas content (not possible in UM at the moment)
  Also would be useful to use the existing UM mock to understand what is going on as well (modified version of Andrews accretion history figure).
- What to CAM on? HOw to do the correlated scatter?
- Fit using UM directly. Could you fit by sampling from the posteriors. Shifts the posteriors. Different constraint on parameters. This does not require walking the trees. For the good fitting models, can look at see what happens in the merger ratios for example. For this, we would need to assume that F_exsitu correlates directly with our M10 and M100 estimates. We need to see how well the existing model describes our lensing data. Will the range of posteriors be wide enough to describe the data?

Needs to be done

- Need to understanding if projection effects could play a role. Use MBII sims. Say that projections will be explored further
- Need to get accurate number densities. Figure out galaxies with missing 1d profiles and possibly supplement a little with photoz-s?
- Find a model that has two halo parameters and that fits the lensing data
- Do we need to show here that we are looking at centrals and not satellites? Do we need to reject satellites for this test? => I don't think so because we will include them in the model (forward model)
- Look at the existing UM - is it a good starting point?

Discussion points:

- Model solution may not be unique but we can show that at fixed total galaxy mass, two halo parameters are required.
- Implications for our understanding of the fundamental plane
- Galaxies selected based on inner luminosity (like BOSS selection)
- Discussion: leauthaud et al, tinker et al

- What is the resulting scatter and satellite fraction (we get this from the model)
- Implications for strong lensing? Are they biased towards galaxies with larger central density (see Alessandro)

PAPER II: A DETECTION OF CLUSTER BCG GALAXY ASSEMBLY BIAS

In this paper we explore whether or not we can see changes in the large scale clustering at fixed halo mass.

Method:

- Use the model from Paper I
- For every galaxy in the M100 M10 plane, we now have a distribution in Mhalo values
- For every halo, we can now also compute the galaxy-matter cross correlation
- Now we use Andrew's method to search for a split in the model that keeps the Mhalo distribution fixed (in the model, and using the full Mhalo distribution) but then maximizes the 3d galaxy mass correlation on large scales (exact scales TBD)

The forward model approach. And we see if we can recover the same effect using the backward modeling approach.

Plots

- Cross correlation plot to see the changes in large scale bias
- The same split is seen in the UM predictions (Andrew's plot, but based on the new model)

Questions:

- do we need to remove satellites here? => yes, we probably need to do something about this.
- Do we need to explain what type of assembly bias we are seeing? Related to the time of last major merger, merger ratios => yes, we probably need something.

PAPER III: AN AWESOME OPTICAL CLUSTER FINDER WITH LOW SCATTER AND MINIMAL PROJECTION EFFECTS

We present a series of new results that fundamentally change the way we think about how how to find massive dark matter halos. We can detect galaxy clusters with minimal projection and mis-centering effects. We show that red sequence finders are subject to projection effects which have a large impact on their lensing measurements. Using just galaxy mass alone, we can build a cluster finder down to Mhalo=10^14that has a scatter in Mhalo at fixed M* of only xx dex.

Using the shapes of galaxy profiles in addition to mass, we can further reduce this scatter in xxx dex. We show that the scatter in the galaxy-mass halo mass relation is smaller than previously thought.

In this paper, we use the mocks from Paper I to see if we can build a better estimator using M10 and M100 jointly. We write down the function Mhalo=f(M10, Mhalo)

In future work, we will explore how well one can do by combining galaxy mass with richness estimated within a small aperture (to keep projection effects minimal).

Say what kind of spectroscopic follow up campaign one would need to do to get everything which doesn't have a redshift to do an even better job.

Do we need to already reject satellites here to make this claim? Are photoz-s sufficient here?

Main plots

- Top N test with model fits overlaid
- Show how poorly cmodel does which has led to our thinking that central galaxy mass correlates poorly with halo mass. But impact of HSC cmodel isues?
- Decompose the lamba ones into a one halo and a two halo term
- Show M* versus Mhalo and “Lambda” versus Mhalo… outliers due to projection effects.
- Images of the BCGs selected by mass showing that they look like the centers of clusters

Needs to be done

- We need the mocks from Paper I for this Paper
- How to deal with galaxies for which we fail to get a fit (necessary for top N test)
- We need a model that will also fit for lambda (Andrew already has a version)
- Need to supplement with photoz-s for missing galaxies
- HSC Cmodel versus SDSS Cmodel (probably not necessary here)
- Better Mmax values?

Discussion points:
Emphasize that making mocks for red sequence finders is hard. If we want to do cosmology with clusters, really need mocks, mergers, etc …...This method makes mock making a lot easier. Also makes random catlogs easier. Just use the random catalog for the galaxies.

Paper IV: Depletion of satellites via cross correlations

Model should predict a depletion in satellites (a change in concentrations).
Does our model fit the cross correlations? Or does the model need to be re-tuned?

Other Paper in prep: scatter in M* versus Mhalo using Massive Black II simulation

Paper in prep that Song was in the process of writing.

Mass segregation

Mass segregation via cross correlation.

Do a cross-correlation? => yes would be better.
Even if tweak UM, still want to look at assembly history?
Still interesting to do a conditional abundance matching
Mass accretion plot
Titles
Modeling approach.

OLD STUFF

HSC DATA

TO DO LIST

- Do visual inspection on a few clusters to get a sense of the data. Pick L>30 and fix M100 and look at splits by M10. At the low and high z regime. What does this look like?
- Redo the signal with the 16A data.
  * apply new masks
  * try two different lambda cuts L>20 and L>30
  * try different pcen cuts
  * when split by M100 or M10, is there a difference in the Pcen distributions?

POSSIBLE SYSTEMATICS
- We remove double core BCGS and cvery close pairs. 10% of systems are removed. Do we care about this? Maybe not so much
- If you have mis-centering, it would possibly mess up lambda. But is this mitigated by the fact that richness is actually computed in a cylinder?

- What are the Pcen cuts doing?

OTHER IDEAS
- Any way to do this that does not require redmapper? Would like to have x-rays. SZ?
- Rank ordering? But what to do about satellites. Yes, there will be satellites. How sure are we of this at this super high mass regime?
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MBII SIMS

TO DO LIST
- Ask Tiziana about getting merger trees
- Get concentrations from DM
- Make a plot of M10 versus M100 and concentration on a halo by halo basis
- Jacknife the lensing to look at the difference on large scales. By hand jackknife.

Other sims:
- Would be useful to use other just DM sims to fix halo mass and split by concentration to see the maximal size of the effect?

ILLUSTRIS
- Is a smaller box .. not clear it will be useful for these tests

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Using counts in cells to constrain scatter at the high mass end

- Volume of the data?

```
define_cosmo_in, 1.0, 0.0, 0.3, 0.0457, 1.0, 0.8
=> this is with h=1
print,(cosmo(0.5, /VOL)-cosmo(0.2, /VOL))*(140.0/41254.0)*4*!pi*1.0/1e9,'Gpc^3'
0.0302525Gpc^3
print,(0.0302525)^(1.0/3.0)
0.311593

print,(cosmo(0.5, /VOL)-cosmo(0.3, /VOL))*(140.0/41254.0)*4*!pi*1.0/1e9,'Gpc^3'
0.0245891Gpc^3
print,(0.024589)^(1.0/3.0)
```

0.290791

Bolshoi Plank: 250 ...smaller than the data …
Small Multi dark Planck : 400 ….better suited.

- For the sims, the suggestion was to use multidark
- Give peter the SMF. Has to be extrapolated down to lower masses
- Peter will generate a range of mocks that fit the mean SMF (no errors) with a range of M*-Mhalo values and range of scatter
  => alexie: Peter I got confused about why it was better to generate a range of mocks beforehand as opposed to fitting this on the fly …?

In all cases: we need to implement a counts in cells in the sims ...

Question: when halo tools does a M*-Mhalo relation, does it add scatter? Yes. For SMHM-type models such as Behroozi+10, +13, Moster+10,13, log-normal scatter is assumed. For these models, Mhalo-dependent scatter is perfectly acceptable.

Note: halo tools does not do "traditional" abundance matching and deconvolve for scatter. But it does do a M*-Mhalo relation. Yes, that is correct, I do not implement this in Halotools. Since Yao did such a good job with this in his python code (which provides very nice wrapper behavior around Peter's C-kernel for the deconvolution), I saw no need to re-implement his work.

Need to know : how many things at the massive end rely on using a photoz as a function of M* and redshift? What size to use for the counts in cells? APH: The size for counts-in-cells should probably be determined by direct experimentation - see below.

In principle: I could imagine doing a joint fit to the SMF, the lensing, and the counts in cells. APH: I have a few scripts for doing MCMCs using emcee with Halotools that would be useful for this purpose.

Note: if we can constrain the scatter, then the AB mock can be used to predict fsat as a function of M*

APH: To determine an optimal set of summary statistics, it's really a straightforward exercise.
1. Start out with some reasonable choice for a "fiducial" model.
2. Generate SMF + lensing for the fiducial model
3. Estimate errors either from jackknife or otherwise
4. Use halotools+emcee to fit the SMHM parameters to the SMF+lensing (basic riff on same exact script used in Zentner+16 Decorated HOD paper)

5. From the best-fitting 10^3 models, compute counts-in-cells for a few choices of cell sizes. See which choices of cell sizes result in largest variation amongst the posteriors. That choice is the best choice to use in the subsequent MCMC.

=> yes! Also note though that the question of the size of the cylinder will depend on how many objects we have a specz. I suspect we will have a few with a photoz and will need to think about how to deal with that.