Hi everyone, I’m Jiaxi. My master project is the Halo abundance matching for eboss galaxies. I’m going to introduce the Halo abundance matching method and the progress of my thesis in my following talk. If you have any question, please let me know at once.

There are three perspectives to study the universe: theories give us the framework of the cosmology - the LCDM model; observations collect the detectable information and N-body simulations can realise all kinds of universe given its framework and parameters. Come back to the halo abundance matching. Why do we need it in the cosmology research?

DM particles interact through the gravitational force, their behaviour could be modeled by the N-body simulation. Simulation results can validate the DM theories that describe those behaviours, ensuring the framework is self-consistent.

The observation constrains the parameters under the LCDM framework, such as H0, the dark energy equation of state. But before the constraining, we should confirm the reliability of the galaxy theory. However, there is something missing in between the DM and galaxy theories.

The missing link is the galaxy bias theory that describe how galaxies reside in the DM field. Once we confirm it is a reliable link under the LCDM framework, then the galaxy theory is also reliable and the observation constraints are meaningful.

The HAM is used to test the galaxy bias theory that we presume. So what is the halo abundance matching?

As we mentioned, it’s a method to test the galaxy bias model. To be specific, HAM study the galaxy distribution in DM halos. Those formula are reminders for the linear relation between the galaxy bias and the correlation function which is used to describe the galaxy/DM clustering. For small scales that we’re interested in, the relation is more complicated, but the take-home message is the galaxy correlation function amplitude is a function of galaxy bias.

So how indeed does the HAM work? The core of this method is the selection of DM halos. Those selected halos can host a galaxy in its centre and have the same peculiar velocity as them. The galaxies should follow the empirical distribution function in halos and match the observations. For very massive halos, they always have a passive, red galaxy inside, but no star-forming, blue galaxies because they will quench the SF process. For light halos, they are unable to hold any galaxies. For the halos in between, the galaxy distribution has a certain degree of randomness. The randomness is the reason that we need a scattering step.

Let’s see how the scattering works. If we simply cut the halo with mass less than a threshold, their distribution would be like this. If we apply a Gaussian random scattering, the acute turning at the threshold would be smoothed. And we get the LRG distribution. For ELG, there are two edges, so we need 1 scattering and two cuts in both massive end and light end. That’s all for the principle of my work.

So just to conclude, my thesis topic is to test the galaxy bias theories, guaranteeing the observation constraints are meaningful. In order to test our empirical models, we need to apply HAM and fit the so called galaxies’ correlation functions to the observations. Next, I’ll introduce my progress by now.

My first task is to move the haloes from the real space to the redshift space where we should consider the RSD. The diagram is a reminder of the RSD effect caused by the objects’ peculiar velocities. In small scales, the velocity results in the finger-of-god effects that elongated the observation along the line of sight, while for large scales, the observations are suppressed along the line of sight.

In the correlation multipoles, the RSD is embodied by the shape of quadrupole that measures the ellipse shape of the correlation function. For small scales, its values are positive, while for larger scales, the

The second task is to play with models to see the parameters’ effects. The monopole and quadrupole are affected by the scattering sigma because they are functions of the galaxy bias. but hexadecapole is not the case, so it’s not sensitive to the scattering parameter.

Let’s see how the scattering affect the galaxy distribution in DM halos. As we expect, the larger the scattering parameter, the broader the transition range is. Additionally, for the ELG, since we have another cut for massive halos, this value will also affect the position of the distribution peak.

The most important and time-consuming part is the chi2 fitting. I’ve completed the scripts primary tests and been removing the statistical instability caused by the random numbers. As the plot illustrate, different random seeds for the same Gaussian distribution dispersion produces different correlation function, which will affect the precision of our best-fits. So we average over 30 results of different random seeds to produce a single correlation function for the chi2 calculation. The chi2-parameter relation also shows that more random seeds averaging together can give a more stable chi2 relation. But we can still see the small tip, which prevent the minimiser from converging and geting the error of the parameter. I’m solving this problem using another tool now.

After I get the reliable LRG and ELG galaxy bias models, I’ll continue to multi-tracer HAM. It will

Enable us to have different kinds of galaxies within one HAM. The difficulty here would be assign galaxies in the mass range where there are more than one kind of galaxies. The following step will be the cross-correlation study and error analysis. That’s all for my work.