Matching Halos (2013.02.14)

The conditions to find a matched pair of halos in different samples (i.e., different stepsizes) are

1) the closest distance which is smaller than $0.5h^{-1}$Mpc,

2) mass ratio is smaller than $10^{0.5}\mathrm{M}_{\odot}$.

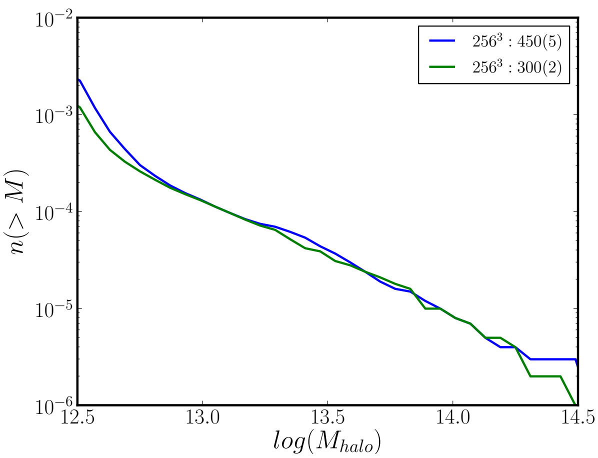

Figure 1: Unmatched halo number density for the simulation of 300 large steps and 2 inner steps matching with 450 large steps and 5 inner steps at redshift $z = 0.15$.

Figure 1 shows that there are unmatched halos whose masses are above $10^{14}\mathrm{M}_{\odot}$. So, I checked how the unmatched number density is changed by changing the conditions for matching halos.

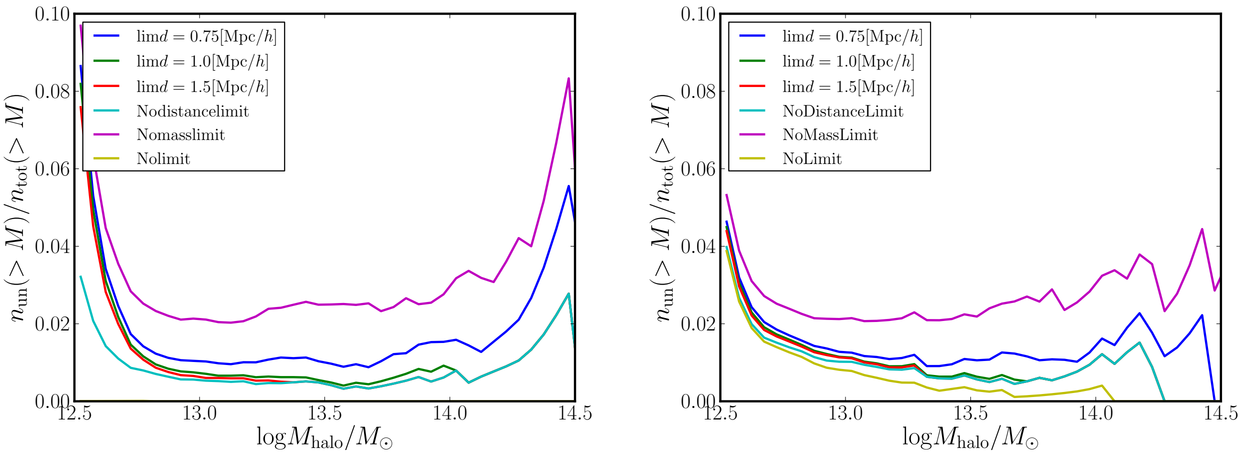

Figure 2: Left: Ratio of unmatched halo number densities for sample halos with respect to the corresponding total number densities. The sample simulation has 256^3 particles with 450 large steps and 5 inner steps. We compare this sample file to the simulation with the same particle number but different stepsizes, which is 300 large steps and 2 inner steps. The right plot shows the same ratios of this simulation. Both plots are at redshift $z = 0.15$. To find matched halos among different stepsize simulations (with the same initial condition), we have two criteria that 1) distance limit: two halos should not be separate more than $0.5h^{-1}$Mpc and 2) mass limit: mass ratio of two halos should not be differ more than $10^{0.5}$M$_\odot$. Those plots indicate that distance limits are more sensitive as a criterion for matching halos (compared to halo mass limit).

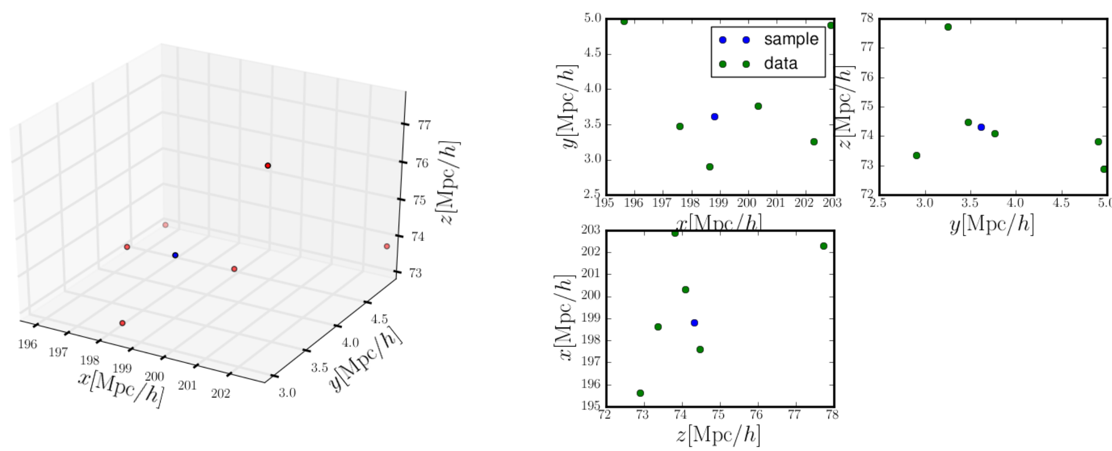

Figure 3: One of unmatched halos whose mass is above 10^{14}M$_\odot$. A blue point indicates an unmacthed halo from the simulation whose particle number is 256^3 and whose large stepsize is 450 steps with 5 inner steps in both plots. Red (left) and Green (right) points are halos around the unmatched halo from the simulation with the same number of particles but with a large stepsize of 300 and inner stepsize of 2. Clearly, there is no close halos from the simulation of 300 steps around the halo from 450 steps. The redshift of this simulation is $z = 0.15$.

The problem was that there are two ways to define halo positions: mean and center, and I used only mean coordinates as halo positions. But, mean coordinates and center coordinates differ by $1h^{-1}$Mpc and sometimes center coordinates agree better. By including center coordinates into the halo matching code, the problem of having high mass unmatched halos was resolved (shown in Figure 4). Right now, in the matching halo code, I am calculating two distances which are distance between mean coordinates and center coordinate, but should I also include the mixing cases which are distances between mean coordinates and center coordinates?

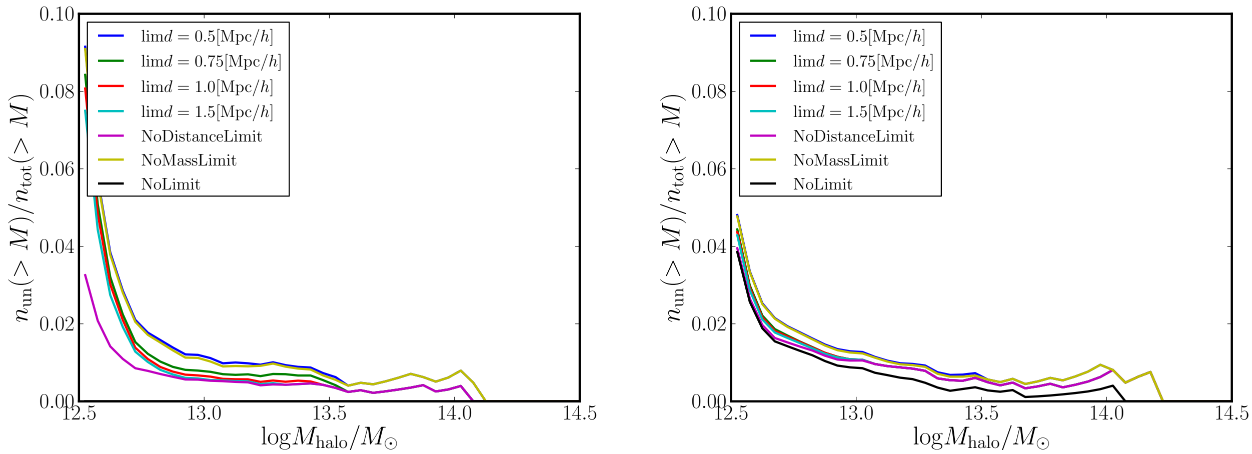

Figure 4: Left: Ratio of unmatched halo number densities for sample halos with respect to the corresponding total number densities. The sample simulation has 256^3 particles with 450 large steps and 5 inner steps. We compare this sample file to the simulation with the same particle number but different stepsizes, which is 300 large steps and 2 inner steps. The right plot shows the same ratios of this simulation. Both plots are at redshift $z = 0.15$. To find matched halos among different stepsize simulations (with the same initial condition), we have two criteria that 1)distance limit: two halos should not be separate more than $0.5h^{-1}$Mpc and 2)mass limit: mass ratio of two halos should not be differ more than $10^{0.5}$M$_\odot$. Those plots indicate that distance limits are more sensitive as a criterion for matching halos (compared to halo mass limit).

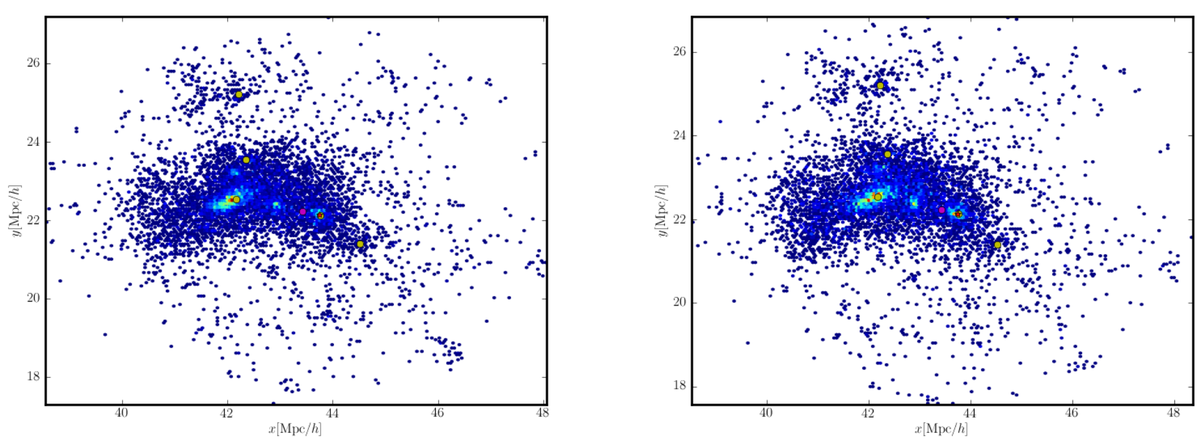

Figure 5: Contour plots of DM particles around previously unmatched halos within $5h^{-1}$Mpc. DM particles from "sample" (right: which is the simulation of 256^3 particles with 450 large steps and 5 inner steps) and from "data" (left: which is the simulation of 256^3 particles with 300 large steps and 2 inner steps). A purple point indicates an unmacthed halo's mean coordinates and a red star is the unmatched halo's center coordinates from "sample". Yellow points are halos from "data" around the unmacthed halo. Those plots indicate that sometimes halo's mean and center coordinates are not identical.

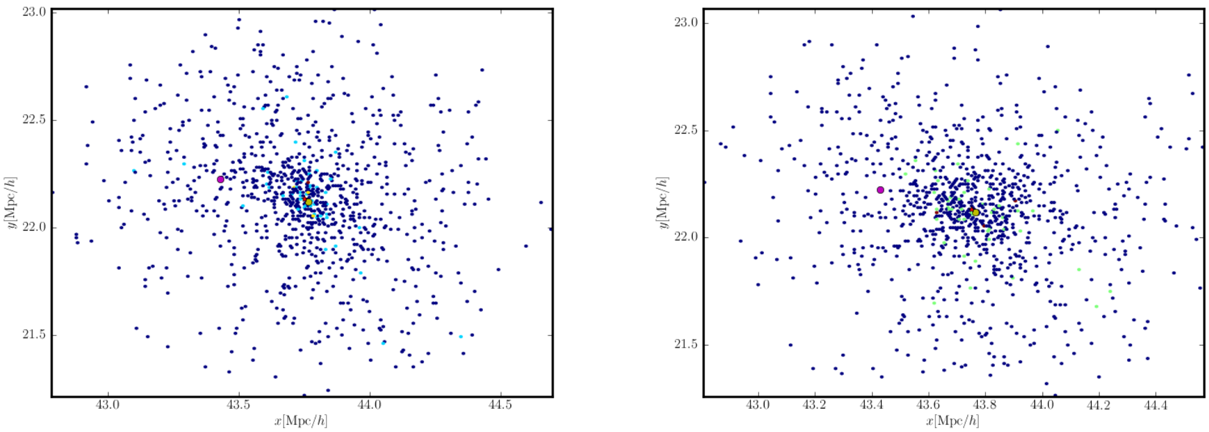

Figure 6: Contour plots of DM particles around previously unmatched halos within $1h^{-1}$Mpc. DM particles from "sample" (right: which is the simulation of 256^3 particles with 450 large steps and 5 inner steps) and from "data" (left: which is the simulation of 256^3 particles with 300 large steps and 2 inner steps). A purple point indicates an unmacthed halo's mean coordinates and a red star is the unmatched halo's center coordinates from "sample". Yellow points are halos from "data" around the unmacthed halo. Those plots indicate that sometimes halo's mean and center coordinates are not identical.

- Question: Comparison of cross-power coeeficients for mass-selected halos and "matched" halos:

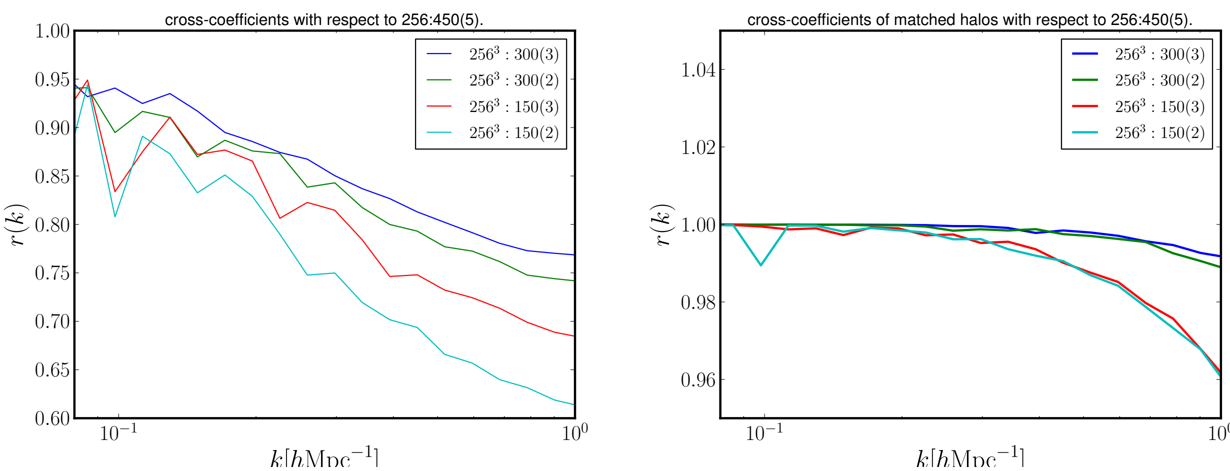

Figure 7: Those are the cross-correlation coefficients of different stepsizes in 256^3 particle simulations. Halos in the left plot are selected based on mass, while halos in the right plot are chosen so that they match with halos with 450 large steps and 5 inner steps. Those plots tell us that mass-selected halo samples from different stepsizes are not well correlated compared to the "matched" samples. The question is when we only have samples from the simulation with 300 large steps and 2 inner steps, how should we select mass samples which corresponds to the simulations with larger steps (i.e., finer stepsizes)? Although if we only care about galaxy samples, HOD may compensate this difference...As shown in Figure4, linear biases calculated from mass-selected samples and matched-halo samples are almost the same...which I don't understand why the deviation of smaller steps is bigger for matched halos (instead of mass-selected halos).

What those plots tell us is that halos which are selected based on their masses in different samples are not well correlated, but what does this mean? Because we can't do halo matching for all the mocks and there is no way to select halo samples except mass-selection, anyway. At least, measured linear biases from mass-selected samples and matched halo samples agree well enough on large scales.

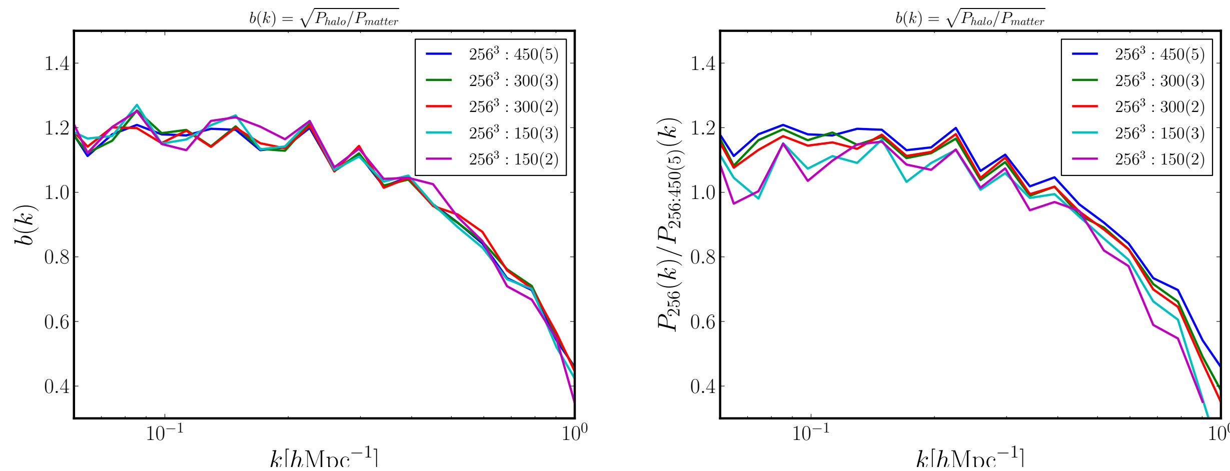

Figure 8: Halo Biases for different stepsizes with 256^3 particles at redshift $z = 0.15$. Left panel is halo biases for samples which are selected based on mass, and right panel is for samples which are corresponding to halos of 450 large steps and 5 inner steps. Different colors indicate different stepsizes and mass range for halo samples is from $10^{12.5}\mathrm{M}_\odot$ to $10^{13.0}\mathrm{M}_\odot$.