

Figure 1. 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 $0.5h^{-1}\text{Mpc}$ 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).

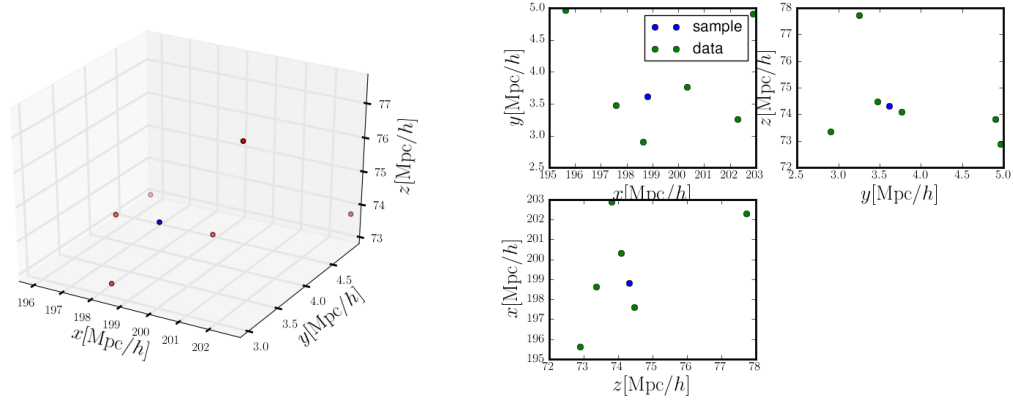


Figure 2. One of unmatched halos whose mass is above $10^{14}M_\odot$. A blue point indicates an unmatched halo from the simulation whose particle number is 256^3 and whose large stepsize is 450 steps with 5 inner steps in both plots. Red (left) and Green (right) points are halos around the unmatched 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 $z = 0.15$.

- Change the conditions for matching halos:

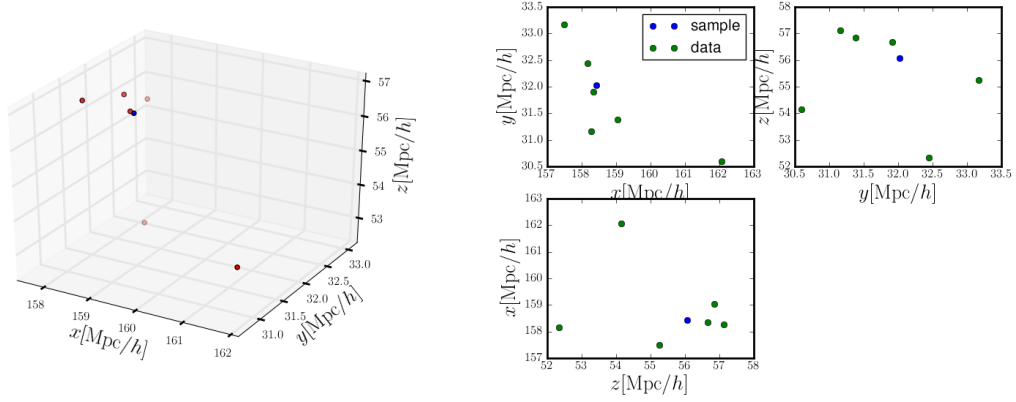


Figure 3. One of unmatched halos whose mass is above $10^{14} M_{\odot}$. A blue point indicates an unmatched halo from the simulation whose particle number is 256^3 and whose large stepsize is 450 steps with 5 inner steps in both plots. Red (left) and Green (right) points are halos around the unmatched halo from the simulation with the same number of particles but with a large stepsize of 300 and inner stepsize of 2. There is a halo which seems to be close to the halo from 450 steps, but the reason that this halo is classified as an unmatched halo is because the distance between this halo and the closest halo is $0.6 h^{-1} \text{Mpc}$. The redshift of this simulation is $z = 0.15$.