Nicolas Mazziotti
ASTR 400B
Homework 3

1. How does the total mass of the MW and M31 compare in this simulation? What galaxy component dominates this total mass?

Both galaxies have a total mass of 2.06 x 10^{12} M_{sun}. The halo mass dominates this total for both galaxies, representing over 90% of the total mass.

2. How does the stellar mass of the MW and M31 compare? Which galaxy do you expect to be more luminous?

The MW has a stellar mass of 8.5 x 10^{10} M_{sun} (disk plus bulge) while M31 has a mass of 1.39 x 10^{11} M_{sun}. Since M31 has nearly twice the stellar mass of the MW, I would expect it to be more luminous due to the presence of more stars.

3. How does the total dark matter mass of MW and M31 compare in this simulation (ratio)? Is this surprising, given their difference in stellar mass?

The MW has a halo mass of 1.975 x 10^{12} M_{sun} while M31 has a halo mass of 1.921 x 10^{12} M_{sun}, yielding a ratio of approximately 1.03. This ratio is close enough to one to treat both galaxies as having the same halo mass. This is a little surprising because you expect more dark matter to be associated with the higher stellar mass in M31.

4. What is the ratio of stellar mass to total mass for each galaxy (i.e. the Baryon fraction)? In the Universe, Ω_b/Ω_m ~16% of all mass is locked up in baryons (gas & stars) vs. dark matter. How does this ratio compare to the baryon fraction you computed for each galaxy? Given that the total gas mass in the disks of these galaxies is negligible compared to the stellar mass, any ideas for why the universal baryon fraction might differ from that in these galaxies?

The baryon fraction for the MW and M31 is 4.1% and 6.7%, respectively, which is about 10% lower than the 16% baryon fraction of the Universe. I think the baryon fraction is lower in these galaxies because they are not truly isolated systems. There are various astrophysical processes, such as tidal stripping from other galaxies, supernovae ejections, and AGN feedback that relocate the baryon content from stars over time to the circumgalactic medium. This would then make the baryon content of a galaxy lower than that of the Universe.