ASTR400B Homework 3 Questions

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Galaxy Name	Dark Matter Mass ($10^{12} M_\odot$)	Disk Star Mass ($10^{12} M_\odot$)	Bulge Star Mass ($10^{12} M_\odot$)
Milky Way	1.975	0.075	0.01
M31	1.921	0.12	0.019
M33	0.187	0.009	0.0
	Total Mass ($10^{12} M_\odot$)	Baryon Fraction	
Milky Way	2.06	0.041	
M31	2.06	0.067	
M33	0.196	0.046	
Local Group	4.316	0.054	

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

The Milky Way and M31 have equal masses in this simulation. In both galaxies, dark matter completely dominates the total mass with a contribution of approximately 95%.

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

M31 has about 60% more stellar mass than the Milky Way. Since baryonic matter is the only contributor to luminosity, we should expect M31 to be significantly more luminous than the Milky Way.

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 Milky Way has approximately 3% more mass due to dark matter than M31. These two galaxies have the same total mass, but M31 has significantly more stellar mass, so it makes sense that the Milky Way would make up for this difference in dark matter. However, the fractional difference between the two is very small because stars do not account for much of the total mass.

4.What is the ratio of stellar mass to total mass for each galaxy (i.e. the Baryon fraction)? In the Universe, 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 all galaxies in this simulation is much, much smaller than the estimated 16% for the universe. There could be several reasons for this. First, the galaxies in the local group could be composed of an unusually high percentage of dark matter compared to other galaxies. Since the local group has only two massive galaxies and a collection of minor satellites, it is reasonable that the Local Group could be an outlier. Secondly, galaxy groups might not be characteristic of the overall makeup of the universe. This means that outside galaxy groups we might find a very dark matter poor environment. Third, there might be sources of baryonic matter within the local group that we haven't accounted for in this simulation. This could include satellite galaxies, globular clusters, or the intergalactic medium.