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ASTR400B: Homework # 3

Galaxy Name	Halo Mass (10^{12} $M_\odot$)	Disk Mass (10^{12} $M_\odot$)	Bulge Mass (10^{12} $M_\odot$)	Total (10^{12} $M_\odot$)	$f_{bar} = \frac{total\ M_*}{total\ mass}$ (unitless)
Milky Way	1.975	0.075	0.01	2.06	0.041
M31	1.921	0.12	0.019	2.06	0.067
M33	0.187	0.009	-	0.196	0.046
Local Group				4.316	

Table: Halo Mass, Disk Mass, Bulge Mass, Total Mass, f_{bar} of Milky Way, M31, and M33

Questions

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

-- The Total Mass for both Milky Way and M31 are the same at 2.06 * 10^{12} $M_\odot$. The two galaxies dominate in Halo Mass.

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

-- Stellar Mass is computed by the sum of Disk and Bulge Mass of the galaxy. Therefore, the Milky Way has a Total Stellar Mass of 0.085*10^{12} $M_\odot$, whereas M31 has 0.139*10^{12} $M_\odot$. The galaxy M31 has a larger stellar mass than Milky Way. However, Milky Way has a larger Disk Mass than M31, which is where the luminous stars are located. M31 has a relatively larger Bulge Mass than Milky Way, which are older and exhibit a lower luminosity.

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 a larger Halo Mass than M31. However, the Baryon fraction for M31 is larger than the Milky Way.

4. What is the ratio of stellar mass to total mass for each galaxy (i.e. the Baryon fraction)? In the Universe, Ωb/Ωm ~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?

-- Baryon Fraction, f_{bar} is calculated on the table. The ratio, Ωb/Ωm is lower than the Baryon Fraction for each of the galaxies in the table. The Baryon mass value could be

underestimated due to some dim stars that are not detected. This could lead to the difference in universe baryon fractions to the corresponding galaxy baryon fractions.