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ASTR 400B
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HW #3

| Mass Break Down of the Local Group | | | | | |
|---|---|---|---|---|---|
| Galaxy Name | Dark Halo Mass [$10^{12}$ $M_\odot$] | Disk Mass [$10^{12}$ $M_\odot$] | Bulge Mass [$10^{12}$ $M_\odot$] | Total Mass [$10^{12}$ $M_\odot$] | $f_{bar}$ |
| Milky Way | 1.975 | 0.075 | 0.01 | 2.06 | 0.041 |
| Andromeda (M31) | 1.921 | 0.12 | 0.019 | 2.06 | 0.067 |
| Triangulum (M33) | 0.187 | 0.009 | 0.0 | 0.196 | 0.046 |

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 of the MW and M31 seem to be approximately the same! Their mass is distributed differently across their different components, but their dark matter halos are by far their most massive component.

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

   M31 has a higher stellar mass than the MW, therefore it is likely more luminous because massive stars dominate a galaxy's 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 MW has a lower stellar mass but a higher dark matter mass than M31; we can assume that a galaxy with higher stellar mass will also have a higher dark matter mass but that is not the case. This goes to show that there is not a one to one correlation between stellar mass and dark matter mass, but both galaxies still have about the same total mass and very similar rotation curves.

4. What is the ratio of stellar mass to total mass for each galaxy (i.e. the Baryon fraction)? In the Universe, $\Omega_b/\Omega_m$ ~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 fractions computed for MW, M31, and M33 all fall between 4.1%-6.7%. The universe's baryon fraction is much higher than those of galaxies, a situation known as the "missing baryon problem" because the whereabouts of these expected extra baryons were a complete mystery for a long time. We now know that these missing baryons that are present in the universe –as indicated by the CMB– are located in the intergalactic medium. Therefore, it makes sense that galaxy baryon fractions are lower, because the universe's baryon fraction accounts for all the gas and particles in the medium between those galaxies.