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 are the same at 2.060x10^12 solar masses. They are the same because the MW dominates due to its size.

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

The stellar mass of the MW = 0.075x10^12 +0.010x10^12 = 0.085x10^12 solar masses. The stellar mass of M31 = 0.120x10^12 +0.019x10^12 = 0.139x10^12 solar masses. Even though the MilkyWay dominates in terms of mass the M31 galaxy will be much more luminous because it contains more stellar matter and less dark matter than the MW.

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 dark matter mass of MW is 1.028x (2.8%) larger than the dark matter mass of M31. It is not surprising that the dark matter component dominates in both cases as galaxies typically contain more dark matter anyway. The very small fraction of stellar matter in each case can be very different from each other because they are both still small components of the total.

```
dark_matter_ratio = 1.975 / 1.921
print(dark_matter_ratio)
#Answer = 1.028
```

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?

The baryon fractions calculated in the table were as follows: f_bar_MW = 0.041262 (4.1%); f_bar_M31 = 0.067476 (6.7%); f_bar_M33 = 0.045918 (4.6%). This fraction ~16% is not represented in galaxies because there is still a significant amount of baryon matter outside of the galaxies, such as in nebulae/gas/dust... Galaxies also include less of a stellar mass ratio (lower f_bar) compared to the rest of the universe due to the way they form. Dark matter constitutes more of a galaxy compared to the rest of the universe.