ASTR 400B Homework 3 PDF

Madison Walder

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1 Mass Breakdown of the Local Group Table

Galaxy Name	Halo Mass ($10^{12} M_\odot$)	Disk Mass ($10^{12} M_\odot$)	Bulge Mass ($10^{12} M_\odot$)	Total Mass ($10^{12} M_\odot$)	$f_{bar}(M_{stellar}/M_{total})$
Milky Way	1.975	0.075	0.01	2.06	0.041
M31	1.921	0.12	0.019	2.114	0.066
M33	0.187	0.009	0.0	0.196	0.047
Local Group	4.136	0.204	0.029	4.37	0.053

Table 1: Total and component masses, and baryon fractions for Local Group

2 Homework 3 Questions and Answers

2.1 Question 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 quite similar, but M31 is slightly more massive. The mass from the dark matter halo dominates the total mass for both of these galaxies.

2.2 Question 2

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

The Milky Way has a stellar mass of about 0.085 * $10^{12} M_\odot$, whereas Andromeda has a stellar mass of about 0.139 * $10^{12} M_\odot$. Andromeda has a slightly larger stellar mass, therefore you would expect it to be more luminous.

2.3 Question 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?

$$\frac{M_{DMMW}}{M_{DMM31}} = \frac{1.975 \cdot 10^{12} M_{\odot}}{1.921 \cdot 10^{12} M_{\odot}} = 1.028$$

The dark matter masses of M31 and the Milky Way are pretty close, but our galaxy has a slightly larger halo mass. This is surprising because Andromeda has a larger stellar mass which lead me to believe that it would also have a larger halo mass, but this is not the case.

2.4 Question 4

What is the ratio of stellar mass to total mass for each galaxy (i.e. the Baryon fraction)? In the Universe, $\Omega_b/\Omega_m \sim$*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 Milky Way is 0.041, that of M31 is 0.066, and that of M33 is 0.047. This ratio implies that there is more baryonic matter than is evident in the baryon fractions calculated before. The fractions calculated for each member of the Local Group are all less than half of that ratio. Although gas is negligible in these galaxies, there are large nebulae and molecular clouds that contribute much more gas mass to the universe as a whole. This could be a reason why the universal baryon fraction differs from those calculated in the table.