ASTR 400B Lab 5

1 First Step

Make sure to have a cloned copy of your own repository on your computer (or nimoy if you are using nimoy for Jupyter). Create a directory Labs/Lab5.

From the command line git clone the class repository. If you have already done this, git pull to update the repository. There is a directory Labs/Lab5/ with a file Lab5.ipynb, which is the template for this exercise.

Copy this template to your own repository directory Labs/Lab5

2 Part A: Mass to Light Ratios

Wolf et al. 2010 :

$$M(< R_{half}) = \frac{4}{G}\sigma^2 R_e \tag{1}$$

Where R_{half} = 3D half mass radius and R_e is the 2D half mass radius of stars (observed)

Determine which of the following two systems are galaxies:

The system 47 Tuc is observed with: $\sigma = 17.3$ km/s, $R_e = 0.5$ pc, $L_v \sim 10^5 L_\odot$

The system Willman I is observed with: $\sigma = 4.3$ km/s, $R_e = 25$ pc, $L_v = 10^3 L_\odot$

3 Part B: Abundance Matching Relation

Following the work of Moster et al. 2013 :

Equation 2: $\frac{m}{M} = 2N \left[\left(\frac{M}{M_1} \right)^{-\beta} + \left(\frac{M}{M_1} \right)^{\gamma} \right]$

m = stellar mass, M = halo mass

Equation 11: $\log M_1(z) = M_{10} + M_{11} \frac{z}{z+1}$

Equation 12: $N(z) = N_{10} + N_{11} \frac{z}{z+1}$

Equation 13: $\beta(z) = \beta_{10} + \beta_{11} \frac{z}{z+1}$

Equation 14: $\gamma(z) = \gamma_{10} + \gamma_{11} \frac{z}{z+1}$

These equations are written up in the Lab template file (.ipynb, .py) as part of a class called *AbundanceMatching*.

Create a new function called *StellarMass* that uses the function *SHMRatio* and returns the stellar mass.

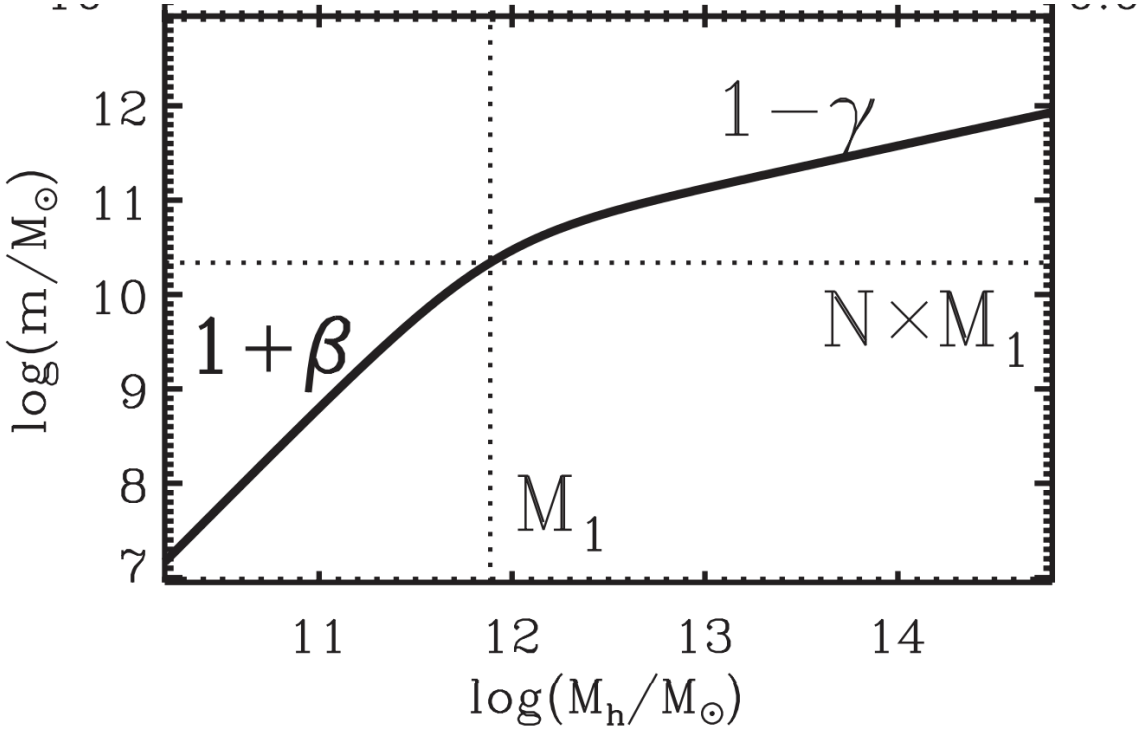

Figure 1: From Moster+2013. Plotted for z=0.

4 Part C

Plot StellarMass as a function of halo mass for redshifts 0, 0.5, 1 and 2, as in Figure 1.

5 Part D

5.1 Question 1

In traditional models of the Magellanic Clouds (prior to 2010), the LMC is thought to have a halo mass of order 3×10^{10} $M_\odot$. According to LCDM theory, what should be the stellar mass of such a halo?

How does this compare against the actual observed stellar mass of the LMC at the present day of 3×10^9 $M_\odot$?

What is the ΛCDM expected halo mass? What is the origin of any discrepancy?

5.2 Question 2

What is the expected stellar mass of an L∗ galaxy at z = 0?

What is the expected stellar mass of an L∗ galaxy at z = 2?