Problem 1

My numerical calculus library is contained in numerical_calculus.py.

Problem 2

$M(r)$, $\frac{dM(r)}{dr}$, and $M_{enc}(r)$ are all shown below (Fig. 1-3) for varying values of c and v_{200}. One obvious thing worth noting is that higher c values have a drastic impact on the mass at larger radii. In the case of $c = 15$, the mass at large radii falls off much quicker than it does for $c = 8$. I don't notice any drastic effects of changing v_{200} over the range that I chose.

I also used my code to calculate the mass of the dark matter halo, assuming the radial extent of the Milky Way's luminous matter is 15 kpc and the radius of the dark matter halo is 100 kpc, to be $1.68110^{12} M_{\odot}$.

Problem 3

The library of matrix functions can be found in matrix.py.

Problem 4

The unittest features are stored in matrix_test.py. Running the script will automatically test matrix.py.

Problem 5

In this problem, I have done everything up to and including calculating B_{ul}. I do not understand how to proceed in making the $d \times d$ matrix that can be used to calculate the densities.

The part that is so troublesome is the existence of both B_{ul} and B_{lu}. So I'm trying to ask myself, what transitions can happen at each energy level? And I'm using the 3×3 example matrix as a guide to do so. I encounter a lot of confusion when it comes to a value like B_{12} - does this represent absorption (lower = 1, upper = 2) or does this represent emission (lower = 2, upper = 1)? With no way to differentiate, I found myself just getting very confused.

I'm still going to try to figure it out!

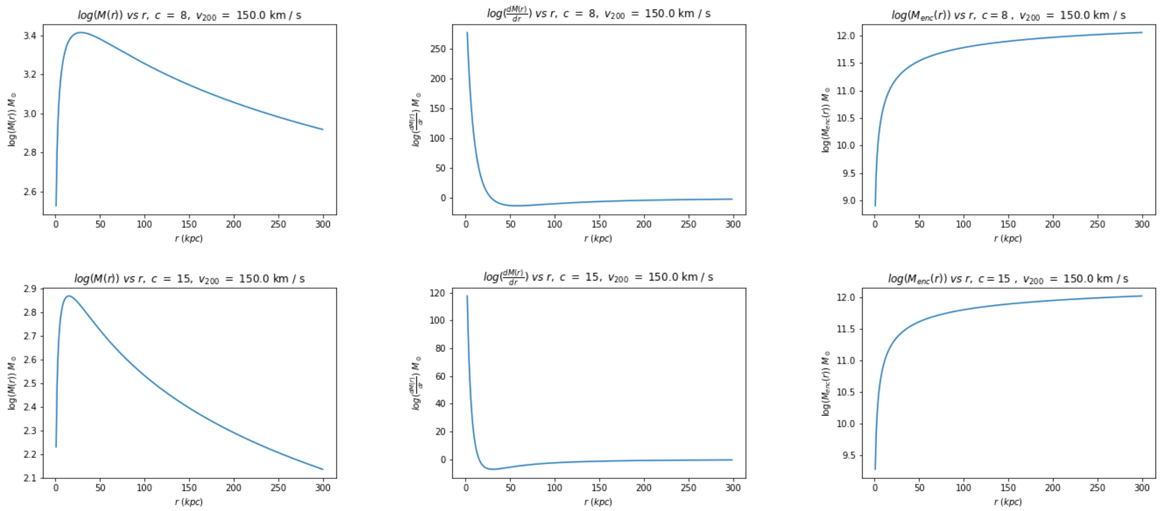

Figure 1: $M(r)$, $\frac{dM(r)}{dr}$, and $M_{enc}(r)$ for $c = 8, 15$ and $v_{200} = 150km/s$

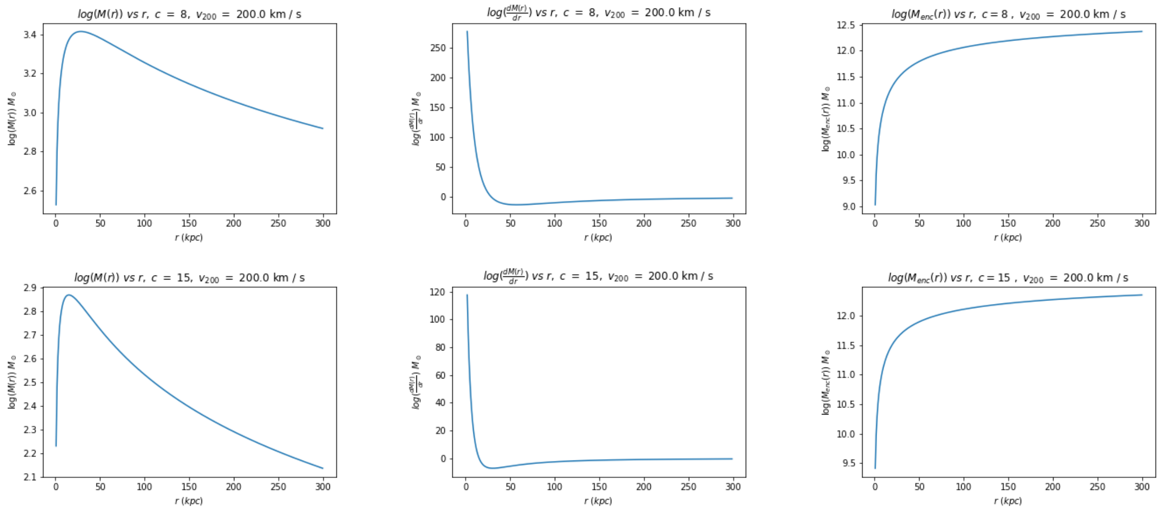

Figure 2: $M(r)$, $\frac{dM(r)}{dr}$, and $M_{enc}(r)$ for $c = 8, 15$ and $v_{200} = 200km/s$

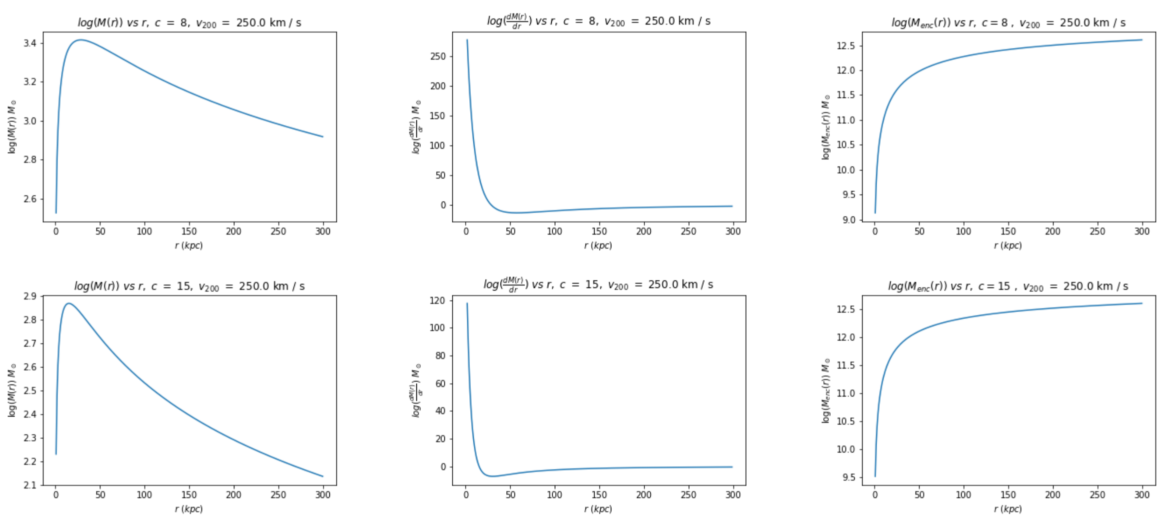

Figure 3: $M(r)$, $\frac{dM(r)}{dr}$, and $M_{enc}(r)$ for $c = 8, 15$ and $v_{200} = 250km/s$