

ASTP-720 Homework 2

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Github Link: <https://github.com/zrd7527/ASTP720.git>

1 Problem 1

For this problem I implemented the equations derived in class. Each function in my code takes a function and a step size, h . The derivative uses a starting x value Then finds the input functions value at that x then at the x one step later. The integral functions all take 2 bounds and sum the function between the bounds. The number of iterations that the integral sums over is determined by dividing the difference between the bounds by the step size.

2 Problem 2

The Navarro-Frenk-White density profile uses dark matter to describe how galaxies can have such a large rotational velocity at large radii. Using this density profile, the mass enclosed, $M_{enc}(r)$, is determined by Equation 1 with $V_c(r)$ defined by Equation 2. The plots of $M_{enc}(r)$ with varying V_c and C are shown in figures 1 and 2 respectively. The total masses all came out to between 110^8 and 510^8 for velocities between 150 and 250 km/s and concentration factors between 10 and 25. The mass in a small shell is the same as dM/dr for my code because I used a step size of one parsec. This made the shells small enough to approximate the derivative. Plots for the shell/derivative are shown in figures 3 and 4.

$$M_{enc}(r) = \frac{rv_c^2(r)}{G} \quad (1)$$

$$v_c(r) = v_{200} \sqrt{\frac{1}{x} \frac{\ln(1+cx) - \frac{cx}{1+cx}}{\ln(1+c) - \frac{c}{1+c}}} \quad (2)$$

3 Problem 3

Using online sources, I created a matrix class which can do everything asked in the problem description. The matrices can be added, multiplied, and transposed. The trace, determinant, and inverse of any size matrix can also be found. The determinant and inverse have helper functions for 2 by 2 matrices. An LU decomposition function is also implemented.

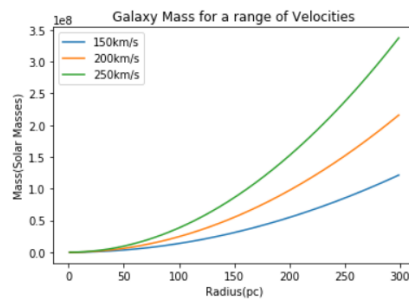


Figure 1

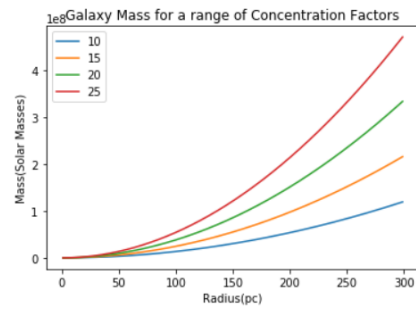


Figure 2

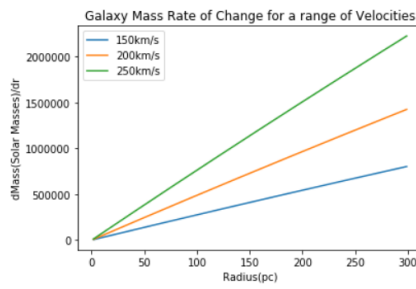


Figure 3

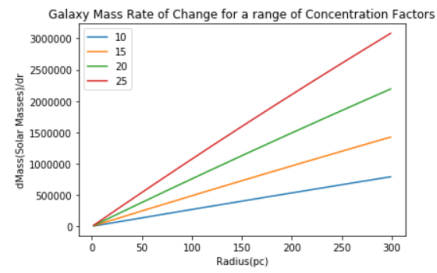


Figure 4