Homework 2

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ASTP720

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https://github.com/RyanWills16/ASTP720

Problems 1, 2

I created all of the numerical calculus function using the materials discussed in the homework paper. I made sure to test the derivative method and all of the integration methods in the file *hw2.py* and then check those tests with online integral calculators. For integration, the midpoint and trapezoid rule require a high degree of resolution in the data to produce a somewhat accurate answer. Even given a high resolution, these two methods often have some deviation to the true analytical answer. Simpson's rule was by far the best and produced a very precise and accurate answer with less resolution than was required for midpoint and trapezoid.

For the second question (*rotcurv.py*), I generated points for the parameter x and then sent those through the velocity equation. To generate the model for mass enclosed, I then took those velocities and sent them through the given mass equation. To generate M(r), I use essentially used the equation $M_{enc,i+1} - M_{enc,i}$ and then calculated the radius halfway between $r_i and r_{i+1}$. I use functions to iterate through two values of c and multiple values of V_{200}. These plot are shown in Figures 1 to 8. The total mass enclosed is estimated in the descriptions of Figures 3 and 4. For some reason the calculation of $dM(r)/dr$ took a pretty long time, on the order of a minute, to run. I think the plot generally make sense, for the mass profiles, the heaviest parts of the galaxy are in the central 50 kpc of the galaxy and the profile flattens out in the halo of the galaxy. Generally speaking, it seems that the parameter c controls the width of the mass profile, where as $V_2 00$ controls the amount of mass in the galaxy.

Problems 3,4

I created the matrix class using python lists rather than numpy arrays. I was able to get addition, subtraction, multiplication, and transpose finished. I used some quick and easy unit testing using the *assert* function in my matrix methods. If I had more time to work on question 5, I would have used the given matrix with Einstein coefficients to find the coefficients of the number density equations. Then I would have tried to solve the system of equation using the form $\underline{A}\vec{n} = 0$ or something to that effect.

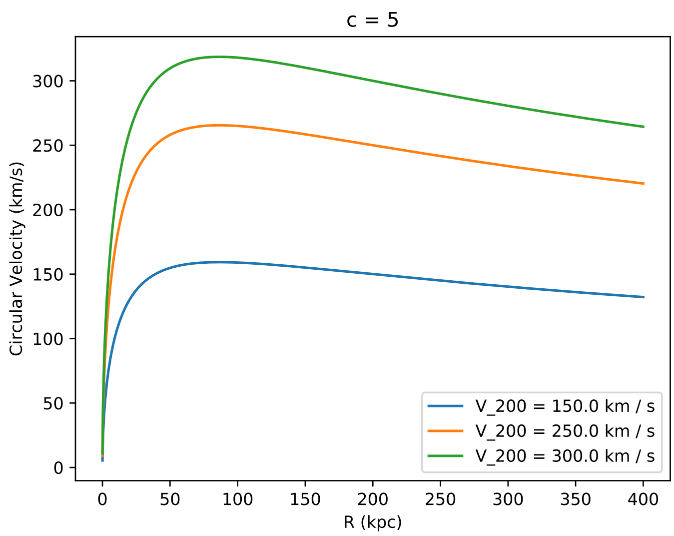

FIG. 1: The rotation curve for c = 5 and three values of V_{200} as seen in the legend.

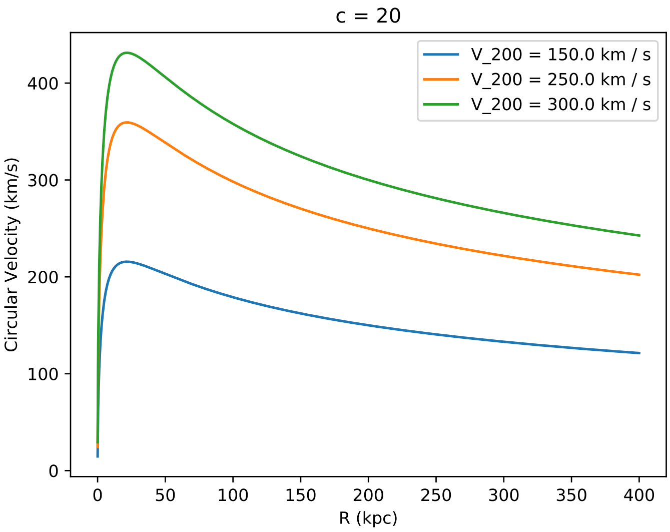

FIG. 2: The rotation curve for c = 20 and three values of V_{200} as seen in the legend.

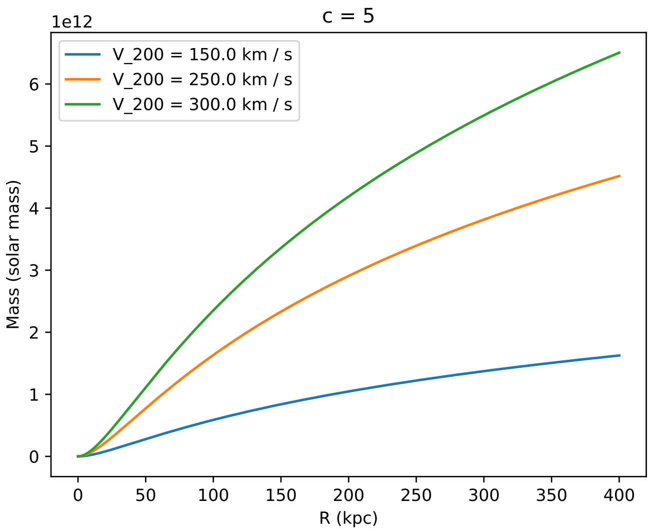

FIG. 3: The mass enclosed for c = 5. As you go to higher and higher radii, the graph should eventually plateau. The total mass is approximately 1.5×10^{12}, 4.5×10^{12}, and 7×10^{12} going down the list of V_{200} in the legend

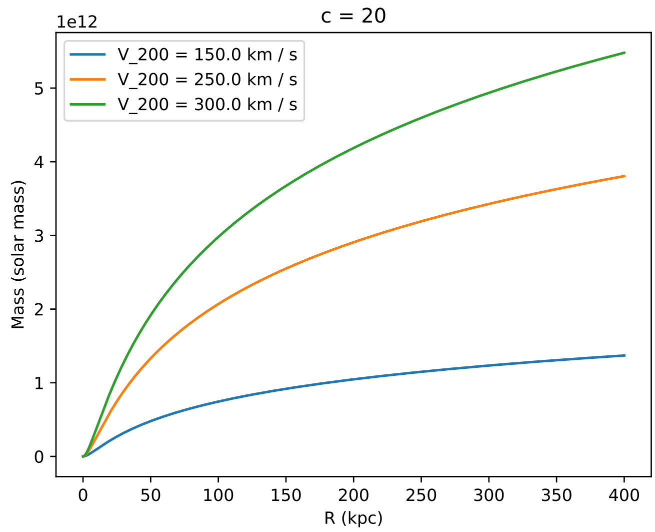

FIG. 4: The mass enclosed for c = 20. The total mass is approximately 1×10^{12}, 3.5×10^{12}, and 5.5×10^{12} going down the list of V_{200} in the legend

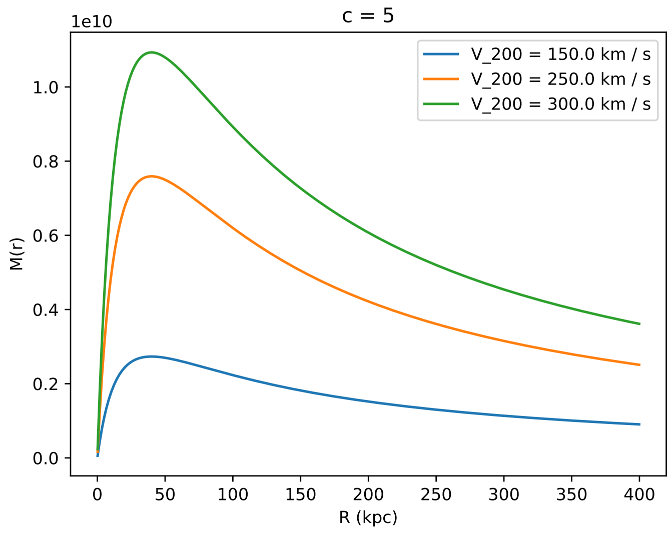

FIG. 5: The mass profile for c = 5 and subsequent values of V_{200}. The mass is distributed over a wide portion of the galaxy compared to the c = 20 case. It also reaches a peak mass of around 1.5×10^{10} solar masses.

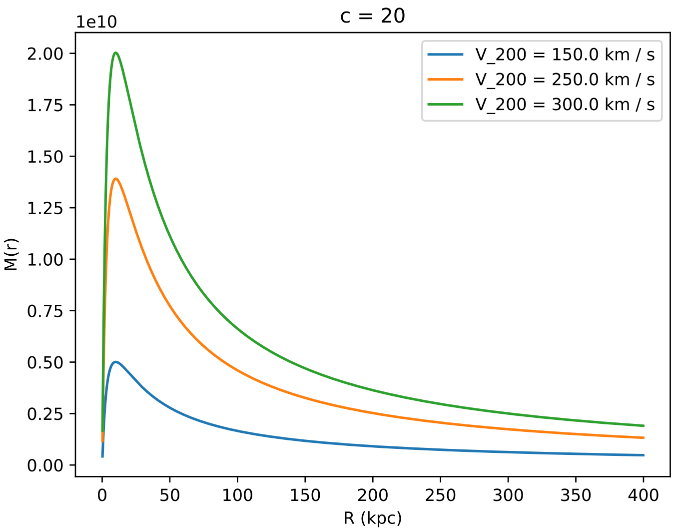

FIG. 6: The mass profile in this case it a much narrower peak than in the c = 5 case. The peak mass in this case for the 300 km/s case is 2×10^{10} solar masses. Perhaps the c = 5 case and this case have the same total mass, just a differently distributed.

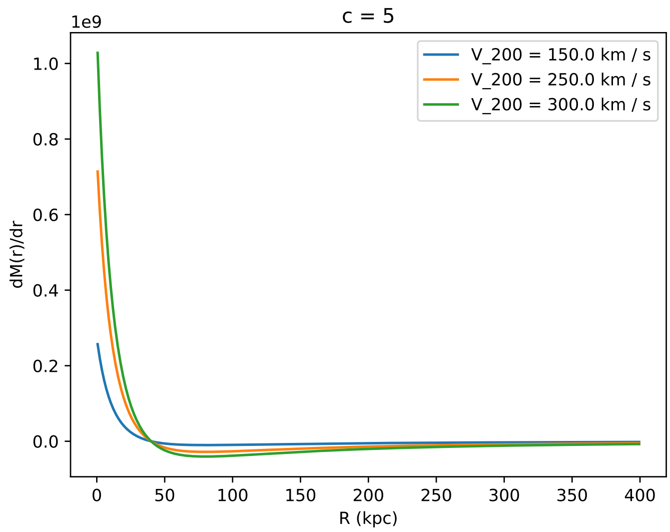

FIG. 7: Derivative of the mass profile for c = 5. This plot shows that the mass increases very quickly in the central region and then falls off at greater radii.

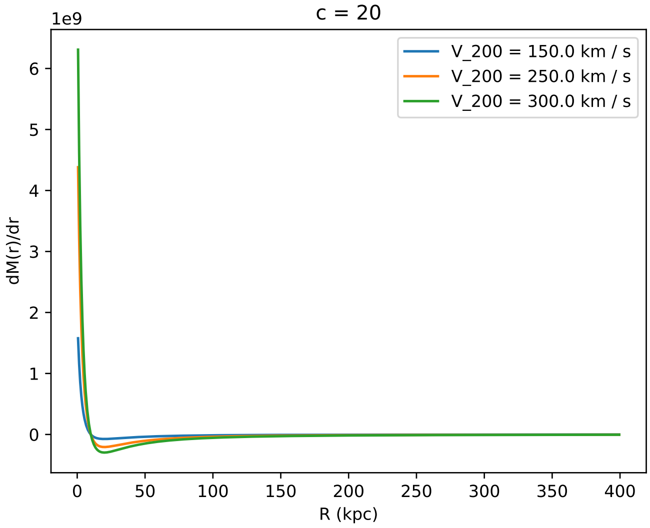

FIG. 8: Derivative of the mass profile for c = 20. Again, the plot is narrower than the c = 5 case and drops off much more quickly.