Computational Methods in Astrophysics- HW2

Anjali Yelikar

10 September 2020

1. The codes are in the Q1 folder of HW2 in the Git repository. Each of them can be imported as a module to perform the specific task. I ran them in a Jupyter notebook and following is the image of the results.

```
In [ ]: # Demonstration of numerical derivative and integration packages

In [1]: import Numerical_derivative

        f = lambda x: (x**3) - 8.

        Numerical_derivative.Num_derivative(f,4.,0.0001)

Out[1]: 48.000000010013366

In [2]: import Numerical_integration_midpoint

        f = lambda x: (x**3)

        Numerical_integration_midpoint.Midpoint_integration(f,2.,3.,100)

Out[2]: 16.249937499999994

In [3]: import Numerical_integration_trapezoidal

        f = lambda x: (x**3)

        Numerical_integration_trapezoidal.Trapezoidal_integration(f,2.,3.,100)

Out[3]: 16.250125000000004

In [4]: import Numerical_integration_Simpson

        f = lambda x: (x**3)

        Numerical_integration_Simpson.Simpson_integration(f,2.,3.,100)

Out[4]: 15.715376040000002
```

Figure 1: Numerical integration and derivation packages example

The midpoint method and Trapezoidal rule are giving a good approximation of the actual integral, but not the Simpson's rule.

2. The total mass of the dark matter halo is $\sim 10^8 M_\odot$ Parameters c, v_{200} and r_{200} for the analysis are given in the caption of each figure.

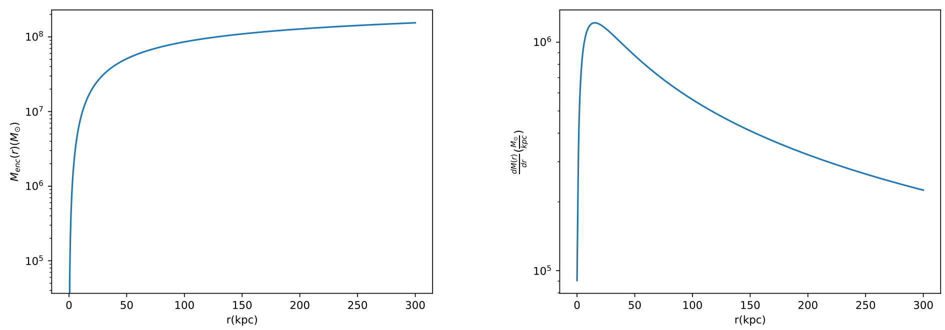

Figure 2: c=15, $v_{200} = 160$ km/s, $r_{200} = 230$ kpc

When c is kept same and v_{200} is doubled, the $\frac{dM}{dr}$ v/s r plot does not change much, but the mass enclosed by the halo increases.

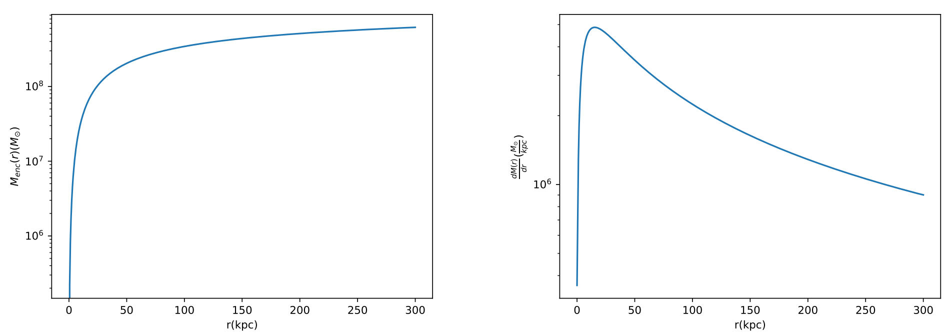

Figure 3: c=15, $v_{200} = 320$ km/s, $r_{200} = 230$ kpc

When c is doubled and v_{200} kept the same, the $\frac{dM}{dr}$ v/s r plot changes quite a lot.

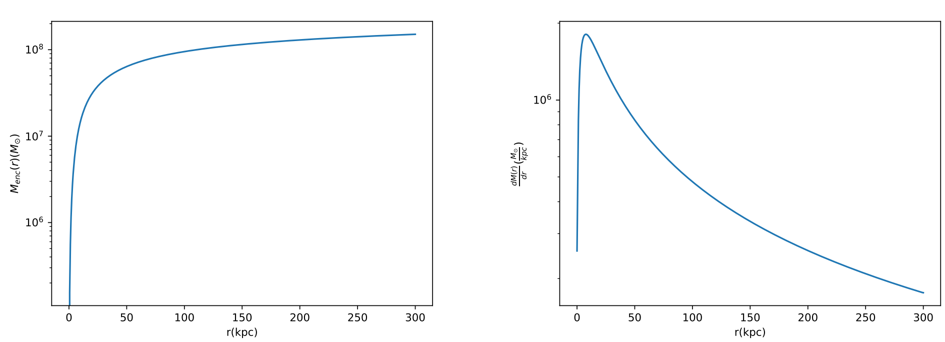

Figure 4: c=30, $v_{200} = 160$ km/s, $r_{200} = 230$ kpc

3.