Homework 4

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1 Problems

Link `https://github.com/AasimZahoor/Comp_methods.git`

Problem 1

This function returns an array where the first element is dP/dr (non relativistic hydrostatic equation)and second one is dM/dr. The variables of the returned functions are P, M_{enc} and r. The arguments of this function are:

$k1 = G * u_e/l^{3/5}$

$k2 = 4 * pi * u_e/l^{3/5}$

G= Gravitational constant,

c= speed of light,

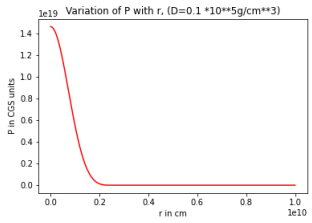
l= K(the constant multiplied to rho in the relation between P and rho)

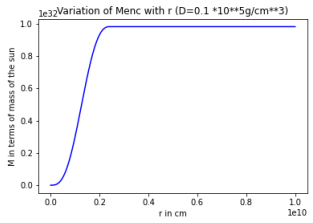
$u_e = 2.$

Note: Units given as arguments should be in CGS units.

Approach

We have been asked to solve non relativistic hydrostatic equation for given density range and plot M_{enc} V/s r. I have chosen the density values to be $[10^4, 5 * 10^4, 10^5, 5 * 10^5, 10^6]$. The max radius is 10^{10} cm and the step size is 10^6cm.





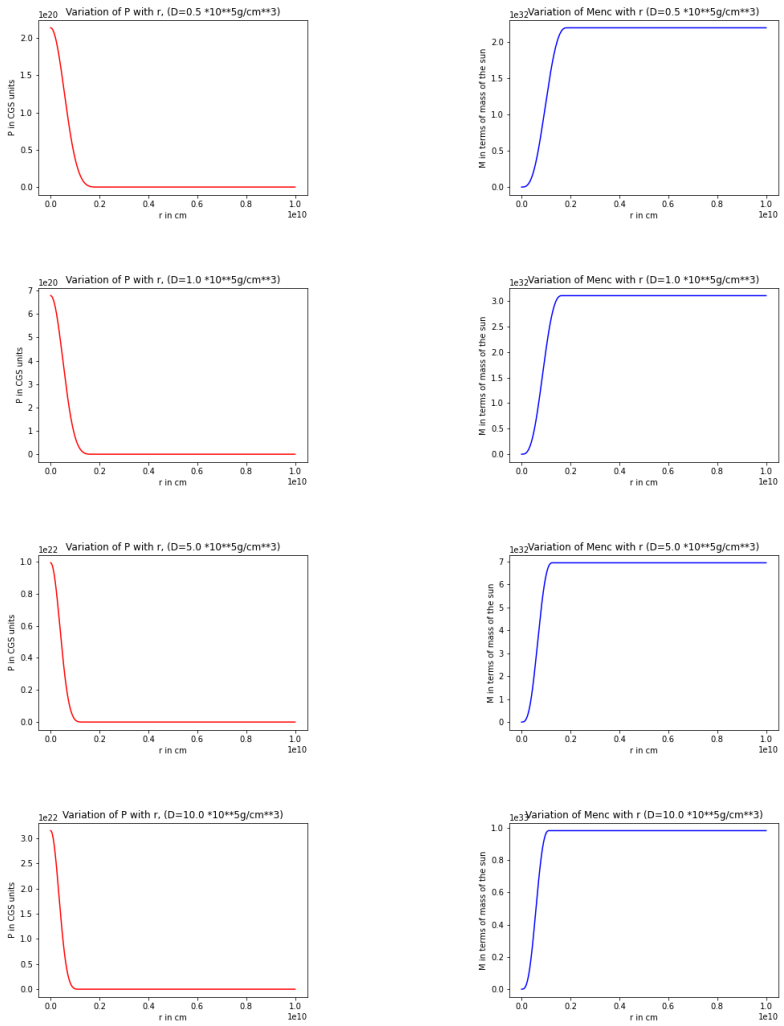


Figure 1: It is observed maximum mass in reached at lesser radius as density is increased.

Problem 2

This function returns an array where the first element is dP/dr (TOV) and second one is dM/dr. The variables of the returned functions are P, M_{enc} and r. The arguments of this function are:

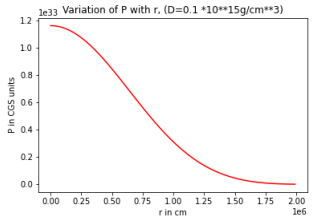
G= Gravitational constant,

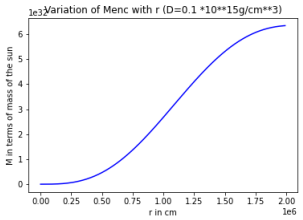
c= speed of light,

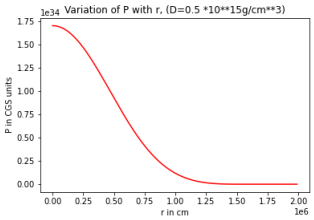
l= K(the constant multiplied to rho in the relation between P and rho).
Note: Units given as arguments should be in CGS units.

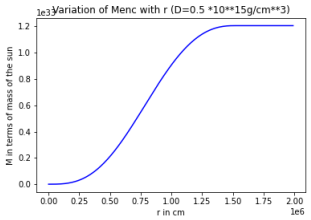
Approach

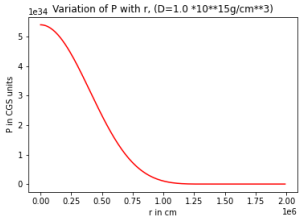
We have been asked to solve TOV equation for given density range and plot M_{enc} V/s r. I have chosen the density values to be $[10^{14}, 5*10^{14}, 10^{15}, 5*10^{15}, 10^{16}]$. The max radius is 20km and the step size is 10 m.

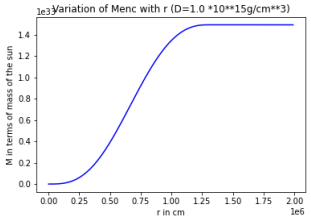


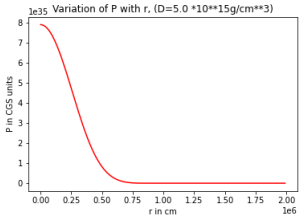


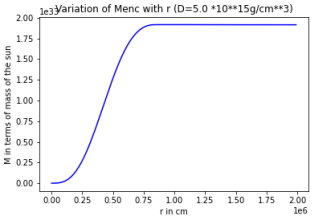


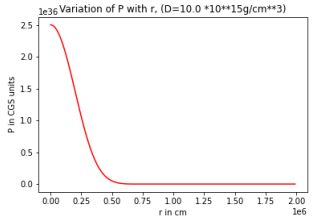












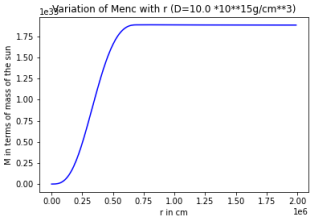


Figure 2: It is observed maximum mass in reached at lesser radius as density is increased.

Problem 3

In the code for Problem 3 I have defined one function. It is:

- **func(G,c,l)**

  This function returns an array where the first element is dP/dr (TOV) and second one is dM/dr. The variables of the returned functions are P, M_{enc} and r. The arguments of this function are:

  G= Gravitational constant,

  c= speed of light,

  l= K(the constant multiplied to rho in the relation between P and rho). *Note: Units given as arguments should be in CGS units.*

  Approach

  We have been asked to find mass of the Star given radius and using the TOV equation. I approached this problem by assuming density to be $10^(16) g/cm^3$ and then using the TOV equation and dM_{enc}/dr and RK-4 solver to find the values of M and P at different R. Then I found the maximum mass in the returned mass array. I made the code run till $r = 13.02km$ with a step size of 100 cm. Here are the graphs and output:

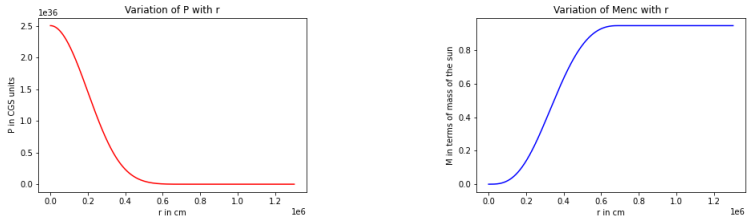


Figure : The graphs for problem 3

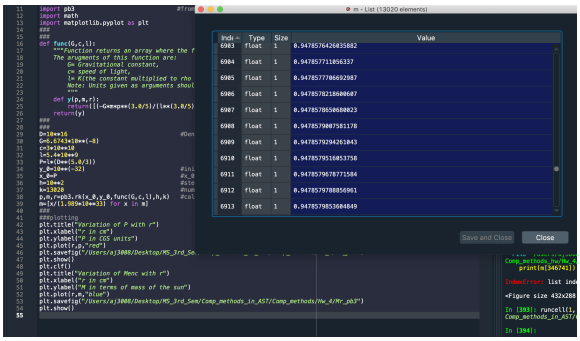


Figure 3: The output for problem 3