

Ay190 – Worksheet 12 - Solving Poisson Equation
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1 Determine Columns

In the data file, we don't know which column represents which quality of the stellar structure, right before the collapse.

	Index 0	Index 1	Index 2	Index n-2	Index n-1
Col 0	1.00000000e+00	2.00000000e+00	3.00000000e+00	1.09700000e+03	1.09800000e+03
Col 1	3.97840000e+30	8.12410807e+30	1.00864534e+31	2.17087236e+34	2.17092549e+34
Col 2	4.29601329e+06	5.46732310e+06	5.88378282e+06	4.42451097e+13	4.44331022e+13
Col 3	7.08374562e+09	7.08884898e+09	7.09205460e+09	2.61019710e+03	2.51065707e+03
Col 4	1.19790669e+10	1.17625629e+10	1.16354022e+10	2.11319957e-10	1.14387572e-10
Col 5	-4.15586982e+06	-5.28806763e+06	-5.69046445e+06	1.92404912e+03	2.21501270e+03
Col 6	0.43135654	0.43168572	0.43187965	0.83966371	0.83968791
Col 7	0.	0.	0.	0.	0.

Table 1: Showing the first three indices and the last two indices of each column to see the magnitude of values in each column.

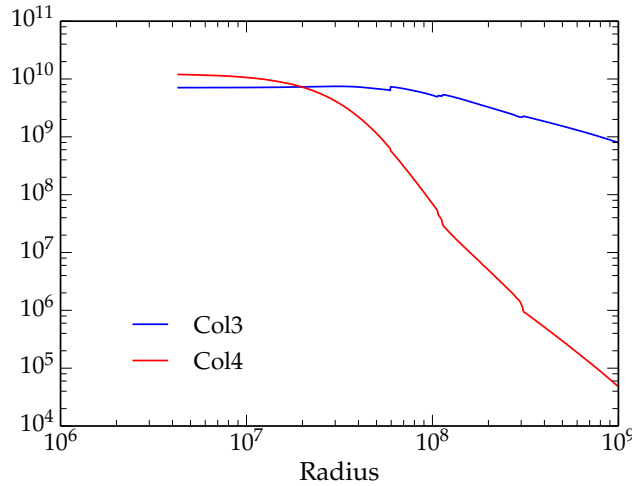


Figure 1: Compare values of column 3 and 4 vs. radius, to determine which column represents density or temperature.

Column 0 is just an index, indicating phase of the star. Column 1's dimension suggest that it represents mass. The last entry of column 2 suggests that it represents radius. Only column 3 and 4 are in the same dimension as expected density. In figure 1, we plot those columns against radius. Column 3 occasionally increases, which is impossible for density. Thus, we conclude that column 3 is temperature and column 4 is density. Column 5 has negative numbers, so we conclude that it represents radial velocity.

2 Constant Density

For a sphere with constant density, we can see that our numerical result is similar to the analytical answer. When we compare the absolute error of ϕ at $r=\text{surface}$, we can see in figure 3 the convergence rate.

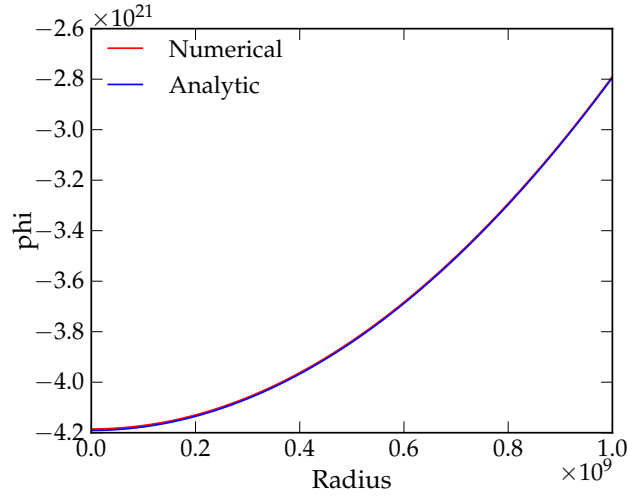


Figure 2: Comparing ϕ of constant density sphere between the numerical and analytical answer. We can see that both are similar to each other.

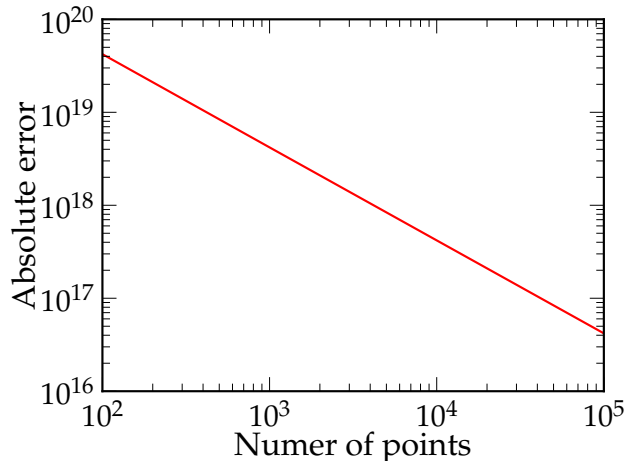


Figure 3: Convergent plot of the absolute error of ϕ at the surface.

3 Phi of a star

Interpolate the density into equilateral grid, then again perform the forward Euler integration.

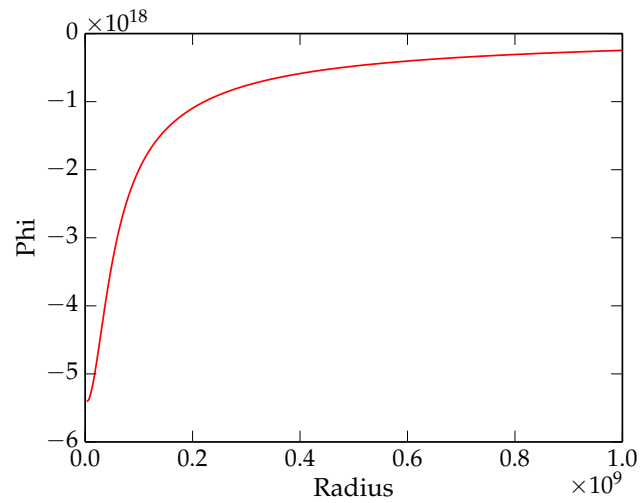


Figure 4: Phi of the star, based on density from the stellar structure data file.