

Homework Set 3

Due: May 14, 2013, *before class*

1. Simple Stellar Models

Write a program to solve the Lane-Emden Equation.

Suggested steps are:

- Convert Lane-Emden Equation into a system of 1st order linear differential equations.
- find inner boundary condition as needed for integration; formally the term is $0/0$, so you have to find the right limit by taylor expansion or other method.

$$\lim_{\xi \rightarrow 0} \frac{d^2\theta(\xi)}{d\xi^2} = \dots$$

- Write intergartion program using finate steps. Don't just use pre-compiled solver package. It is reasonable possible to do this just with a spreadsheet linke Goolge Documnts.
- Find value of ξ where θ crosses 0. In thge lecture we called this value ξ_1 . If you use finate steps you could use interpolation to refine estimate. Also obtain

$$\left. \frac{d\theta(\xi)}{d\xi} \right|_{\xi_1}$$

Show and document you solution steps and program (submit program or formulae used in spreadsheed).

Tasks:

- Compute mode for $n = 1.5$, $M = 1 M_{\odot}$, central density $\rho_c = 10 \text{ g cm}^{-3}$. Use ideal gas with $\mu = 1.3$.
What is the radius of the star, what are central pressure, P_c and central temperature, T_c , of the star?
- Compute a model for $n = 1.5$, $M = 10 M_{\odot}$, $\rho_c = 1 \text{ g cm}^{-3}$, and a mixture of 70% hydrogen (^1H), 28% helium (^4He) and 2% of nirogen (^{14}N), all percnetages by mass fraction. Use ideal gas *with radiation*. Assume the gas is fully ionized.
What is the radius of the star, what are central pressure, P_c and central temperature, T_c , of the star? What is fraction of gas to total pressure,

$$\beta = \frac{P_{\text{gas}}}{P}$$

at the center of the star?