ASTR 401 Midterm Assignment
Due Friday Oct 16, 2020, 11:59pm

(1) Using a numerical algorithm of your choosing, solve the Lane-Emden equation and plot solutions for $n = 0, 1, 2, 3, 4, 5$. In addition, plot the case in which n gets very large (Recall that the Lane-Emden equation is derived assuming $P = \rho^\gamma$ with $\gamma = 1 + 1/n$). In each case, identify the first zero of the solution (ξ_1). Use the boundary conditions that are discussed in the lecture notes.

In a one-page write-up (11pt, single-spaced font), discuss the nature of the solutions. In your write-up, include:

1. Motivation on why the Lane-Emden equation is used to model the structure of stars
2. The difference between the solutions in the radiative and convective regimes
3. Comparison of the solutions that you obtain for each n
4. Discussion of the algorithm that you used to obtain your solution (you don't have to turn in your code)

(2) The hyades star cluster is approximately 40 pc from the Earth. Its coordinates may be obtained from:

http://simbad.u-strasbg.fr/simbad/sim-basic?Ident=hyades+cluster&submit=SIMBAD+search.

Using data from Gaia DR2, identify stars that are associated with the hyades. Similar to the first assignment, write a short query to extract stars from the direction of the hyades. By finding stars with parallax and proper motion close to that of the hyades, identify stars associated with it. Plot the associated stars on a color magnitude diagram, and use this to find the luminosity of the brightest star in your sample. Show that this luminosity agrees with the luminosity of the main-sequence turn-off point as discussed in the lecture.

Write-up one page (11pt, single-spaced font) discussing your methodology and the results you obtain. Your writeup should also include a brief introduction on the hyades cluster.