PYU33A03 Stellar Structure Assignment 1

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Objective: The aim of this assignment is to familiarise you with some of the basic properties of stars, as well as provide a recap of the use of cgs units. It will also remind you how to make plots using a computer programme of your choice; I recommend Python but its use is not compulsory.
Marking: The assignment is worth 5% of the PYU33A03 module.
Submission and deadline: Your submission should be uploaded to Blackboard by the deadline of 23.59 on Wednesday 4 October 2023.
Format: Your submission should be a **single** PDF document and include your name and student number at the top of the first page. Your upload should include the answers to the questions (handwritten or typed) as well as your workings, e.g. computer code and any other handwritten/typed workings. Your code can be converted to PDF format using 'print' or 'save as' options depending on what you are using.
Plagiarism reminder: You are welcome to discuss the assignment but you must complete the question and coding yourself.

Question:

1. Create 'your star' by taking the last four digits of your student number and add 3000 to this value to get a stellar temperature in Kelvin of your star, e.g., if your student number ends 1234, it would be 1234 + 3500 = 4734 K.

2. Under the assumption that your star emits as a blackbody, determine the peak wavelength in angstroms of its emission using Wien's Law.

3. The equation for the energy radiated per unit time per unit area per unit wavelength of a blackbody, e.g., the flux per wavelength, λ, F_λ is given by:

$$F_\lambda(T) = \frac{2\pi hc^2}{\lambda^5}\frac{1}{e^{hc/\lambda k_B T} - 1} \tag{1}$$

   where h is Planck's constant, c is the speed of light, k_B is the Boltzmann constant, and T is the temperature. Using a computer programme of your choice, plot this flux in units of ergs s^{-1} cm^{-2} Å^{-1} at wavelengths between 200 and 20000 Å using the temperature of your star. Make sure to label the axes and include units.

4. Estimate using the plot data the peak wavelength of your star's emission and compare it *quantitatively* to the value found in part 2. Describe your method.

5. Plot and label on the same graph as your star, the blackbody spectrum of the nearest star to our Solar System, Proxima Centauri, assuming a surface temperature of 3100 K. What are the main differences between the spectra?

6. Assuming your star is on the main-sequence, what is its approximate radius in cm?

Tip: You're free to use any package you like to make the plot. However, I highly recommend using Python as it is a good refresher for your labs/other modules and because it makes nice plots. You can find an example Python notebook (.ipynb) for manipulating and plotting data here. There is also a .pdf ('PythonIntro_StephenPower.pdf') with instructions on various ways to access Python on Blackboard.