UNIT 16 - THE HERTZSPRUNG-RUSSELL DIAGRAM

Introduction

If there were no common mechanism which determines the operation of the stars, then there would be no correlation between the properties of different stars. However, when plots are made of stellar properties, definite patterns become readily apparent. One such plot is the Hertzsprung-Russell diagram, or H-R diagram for short, which plots the luminosity of a star against its surface temperature. In this plot, the majority of the stars lie on a narrow band which runs from the top left of the diagram (hot, bright stars) to the bottom right (cool, dim stars). This band is known as the main sequence, and represents those stars which are functioning as stable, young to middle aged stars. All stars spend most of their life as main sequence stars, their properties varying but little over billions of years.

The relatively few stars which do not lie on the main sequence represent stars which are approaching the end of their lifetime. Such stars are classified as red giants, red supergiants, or white dwarfs, depending on their stage of development.

Experiment

In a previous Virtual Astronomy Laboratory, you used the color of the stars to determine the surface temperature. This unit extends this measurement by including the luminosity of the star, enabling you to construct the Hertzsprung-Russell diagram for the stars in the field of view.

1. Select *View the Stars* from the *Start Lab* menu. The view shows a portion of the sky containing 50 stars, with a range of surface temperatures. The stars are shown as colored, with the hottest stars being blue and the coolest stars red. By selecting *Number of Stars* from the overhead menu, you may change the number of stars appearing in the window.

2. By positioning the cursor over any one of the stars, the display at the bottom of the window will show an identification number for that star, and its luminosity. Note these values.

3. Click on the star in order to view that star's distribution of light amongst the different visible wavelengths. Measure the wavelength at which the peak light intensity occurs. To assist you in reading the plot, the display at the bottom of the screen shows the wavelength (in nm) at the position of the cursor. (Click anywhere in the window in order to be returned to the view of the stars.)

4. Use Wien's Law to calculate the surface temperature of the star:

$$\text{Surface Temperature} = 2.898 \times 10^6 / \text{Peak Wavelength}$$

   where the peak wavelength is measured in nanometers (nm), and the temperature is

measured in Kelvin (K)[1].

5. Repeat the above steps for all of the stars and make a table of the values.

6. Plot the results on a graph of luminosity (on the vertical axis) vs. temperature (on the horizontal axis). Remember that on the H-R diagram the temperature scale runs from hot to cool, and that the luminosity scale is logarithmic. A template graph is supplied to help you with this plot. (A copy of this graphics file can be found in the Virtual Astronomy Laboratory folder that was installed on your computer's hard drive - open the *HRDiagram* folder and locate the HRdiagram.jpg file. You can open this file using any suitable graphics program and print it.)

7. Select *Check Your Results* from the overhead menu. The computer will generate an H-R plot for these stars, which you can use to compare with your own plot.

[1] Kelvin is the scientific unit of temperature, defined so that the lowest possible temperature (absolute zero) corresponds to a temperature of zero.