# Student Instructions - How Old Are the Jewels?

In this exercise, you will plot the color and brightness of a sample of stars from the Jewelbox Cluster to determine its approximate age. For this activity you will need:

- these instructions,
- print of the Jewelbox Cluster,
- StarGauge,
- graph sheet,
- student answer sheet,
- washable marker,
- ruler.

Examine the print of the Jewelbox Cluster provided by your teacher.

1. Do all the stars appear to be the same color?
2. Can you tell where the edge of the cluster lies?

Outline where you think the boundaries of the cluster are with the marker.

Place an "X" where you estimate the center of the cluster of stars to be and use a ruler to draw a 4 cm square about this center point. Measure the brightness of the star closest to the upper left hand corner of your square from its size in the image in comparison to the dots on the StarGauge. Have your lab partner estimate the star's color using the color portion of the StarGauge and place a filled-in dot on the graph provided in the box that corresponds to the brightness and color you have measured for your first star.

Place a dot with your marker on the star you have just measured and then proceed in some systematic fashion to measure the brightness and color of every star within your 4 cm square.

3. Do the Jewelbox stars on your graph appear to be randomly scattered or do they fall in any kind of pattern?

Stars in front of or behind the Jewelbox which are not part of the cluster also appear in the image. Astronomers call these "field stars." If time allows, estimate how many of these stars are included in your measurements by drawing a 4 cm

square near the edge of the print and measure the color and brightness of the stars within this square. Mark these stars on your brightness-color diagram using an "x" instead of a dot.

4. Do the field stars appear to fall randomly on your diagram or do they appear to fall in any kind of pattern?

5. Compare your answer to Q3 and Q4. Why do you think the similarities or differences between the two star patterns exist?

## *Estimating the Age of the Jewelbox Cluster*

Newly formed stars occupy a band in your graph from the upper left corner to the lower right corner. The most massive stars are hot (blue) and bright. The least massive stars are cooler (red) and dim. This band of stars is called the "main sequence."

When stars live out their lives and become old, the gravitational forces which tend to collapse the star and internal heat forces which tend to expand a star get out of balance. This imbalance leads to the "death" of the star.

Part of the cycle of stellar life and death is the stage of old age called "red giant." Red giants are bright because they have 10 to 20 times the diameter of our Sun, and they appear red because they are cool. They are classified as either K or M stars on your StarGauge, but they are also very bright. The most massive stars burn their fuel quickly and are the first stars in a cluster to leave the main sequence to become red giants. They expand and cool, to become brighter and redder, and move to the upper right corner of the graph. As the cluster ages, less and less massive stars leave the main sequence to become red giants. Astronomers can tell a cluster's age by determining the color of the brightest, most massive stars still on the main sequence.

Many stars in old clusters have progressed beyond red giant to another stage of extreme age: white dwarf. But white dwarfs are so small (equal to the size of our Earth, 12,600 km in diameter) and faint that they cannot be seen in this image of the Jewelbox Cluster.

Using the sample graphs on the graph worksheet, estimate the age of the Jewelbox Cluster.

Extension Questions:

6. If you have studied the H-R diagram, explain what the three cluster-age graphs above say about the relative lifetimes of O/B stars compared to A/F/G stars compared to K/M stars?

7. Where would our star, the Sun, be plotted on your diagram?

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