The Life Cycle of the Stars

Teacher Background

The star-filled sky is in many ways like a large crowd of people. Within that group you may find babies, children, teenagers, adults and even senior citizens. Like humans, stars pass through different stages in their lives. They are born, they mature and, eventually, they die. However, unlike humans, the typical star may last for millions or billions of years. While we cannot witness the complete life cycle of any one star, the night sky does reveal stars in various stages of stellar development. In some ways we've got a time machine that enables us to look back and out into the future. In so doing we can glimpse aspects of our own star's past and destiny.

Like all stars, our Sun was formed from a cloud of hydrogen gas and dust that almost certainly included the ashes from an earlier star gone supernova. In its death throes, it created elements heavier than iron that our solar system inherited. Gravity pulled the cloud together into a giant ball. When enough gas and dust had gathered, enormous pressures at the center forced hydrogen atoms to begin fusing into helium, thereby releasing energy and raising the temperature at the core to over 15 million degrees. Another star was born, and the Sun began to glow.

The birth of all stars is much like that of the Sun, but the mass of the gas and dust comprising the star will determine its precise destiny. Medium-sized stars like our Sun eventually use up their hydrogen fuel, cool and expand into red giants. Later they shed their outer layers and appear as a diffuse cloud called a *planetary nebula* (which, confusingly, has nothing to do with planets!), lose more gas, shrink down to become *white dwarf* stars, and eventually even smaller stellar corpses called *black dwarfs*. At this stage they may be only a few thousand miles in diameter.

In general, the smaller the mass of a star, the longer its life. Our Sun is now near the mid-point of its estimated 10 billion year life. Stars that are many times more massive than our Sun experience dramatic and sometimes explosive endings. Following the *red giant* stage they may continue to expand into *supergiants*. The core then shrinks and grows hotter and denser. Eventually internal forces erupt to cause the star to explode as a *supernova*. The stellar remnants become either extremely dense *neutron stars* or mysterious *black holes*, objects with such a strong gravitational pull that not even light can escape. Matter ejected from a supernova is blown out into interstellar space and may enter a kind of cosmic recycling program, seeding new solar systems of stars, planets, and moons with the gold and iron of the earlier generation of stars.

Stars come in several colors—red, orange, yellow, white and blue. The color of a star offers us a clue to its surface temperature. Red stars are the coolest and blue stars are the hottest. Our Sun is classified as a medium-sized, yellow dwarf star. Astronomers use star color and actual brightness to determine the stage in a star's life cycle.

Objectives

Students will compare and contrast features (temperature, brightness, color) of stars including our Sun.
Students will use the surface temperatures of various stars to construct a continuum of star color from coolest to hottest.

Vocabulary

magnitude, supernova, nebula

Materials

set of star cards

Note: teacher preparation required.

Photocopy each star card on appropriately colored paper (red, orange, yellow, white and blue) or mount on appropriately colored construction paper. Laminate the cards to preserve them for future classes: this is likely to become a favorite activity!

Engage

Ask students to describe characteristics of a star. Accept all answers. Have students suggest ways in which stars can differ.

Explain/Explore

Procedure

This activity is best conducted either outdoors or in a large indoor area.

Distribute one star card to each student. Ask students to study the information on the cards. Give them time to compare information between with their classmates.

Ask students to arrange themselves in order of star surface temperature, from coolest to warmest. Ask them to indicate any patterns they can see in how they've lined up. Students should discover that they have also arranged themselves according to star color, in the same order as colors in the spectrum of visible light.

Expand/Adapt/Connect

Have students create graphs showing how our Sun's surface temperature compares to that of the other stars used in this Activity.

Ask students to group themselves into stars found in the same constellations. Have them align themselves in order of relative distance from Earth. Are all stars in the same constellation equal distance from Earth?

Research the significance of the Hertzsprung-Russell (H-R) Diagram to determining the stage a star in its own life cycle. Where would our Sun be located on the H-R Diagram?

Have the students use the star cards to model the H-R Diagram on either a gymnasium floor or an outdoor field. Use signs to label the temperature and luminosity axes.

Go online to view images taken by the Hubble Space Telescope of M16, the Eagle Nebula. This is a stunning image of an area where new stars are forming.

Plan an evening Star Party and have students locate stars of various colors. Check magazines such as "Astronomy" or "Sky & Telescope" for monthly sky charts.

Have students research online or via a computer program such as "Starry Night" or "Voyager," stars at significant light years (e.g. stars at a number of light years away from Earth corresponding to parents' or other relatives' birth years).

Suggested URLs

http://www.skypub.com/sights/northern/northern.html
Sky and Telescope: excellent monthly star maps for the northern and southern hemispheres.

http://amazing-space.stsci.edu/light/stellarEncounters-frames.html
Amazing Space: this section of the amazing space web site has an interactive activity on indentify the temperature of stars based on color.

http://oposite.stsci.edu/pubinfo/gif/M16Full.gif
M-16, the Eagle Nebula