New Outreach Activities for Stellar Astronomy

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Abstract

We have created two new activities to introduce children to concepts in stellar astronomy. The first introduces nucleosynthesis in a fashion accessible to most school-age children. The second classifies stars in the constellation of Orion on an HR diagram. Both activities focus on connecting astronomy concepts with the participants' own experiences.

• Nucleosynthesis

The idea that everything with which we interact in our daily lives (people, furniture, cats) is made in the interior of a star is one of the most captivating ideas in astronomy, but rarely is the idea dealt with except in the most cursory fashion. In this activity participants play the role of atomic nuclei in the nuclear reactions synthesizing helium from hydrogen to convey the idea of building heavy elements in a concrete way.

Materials

1) 2 "potential barriers" These can be anything compressible, from simple pillows or couch cushions to the padded "sumo wrestling suits" available from party rental outlets.

2) 6 headbands or hats marked P for proton and 2 marked N for neutron.

Procedure

1) *Introducing the elements.* Most students will have encountered the concept of elements by late elementary school or junior high. Younger children can be introduced through the analogy of building blocks or Legos. Most important to emphasize here is that the building blocks of people and planets didn't exist at the beginning of the universe.

2) *Why stars?* Equip two volunteers with P hats and "potential barriers" such that it is difficult for them to join hands when standing with the potential barriers touching. Nuclei don't like getting together, like the north poles of two magnets. Have the students then come together at a brisk pace, compressing the foam. The important point is that faster moving, higher energy particles can overcome the barrier more easily. Only in stars does material reach high enough temperatures for nuclei to join.

Figure 1. Simple diagram of the PPI chain of nuclear reactions producing helium from hydrogen. Each participant plays the role of a proton or neutron. Note that one of the protons becomes a neutron in the first reaction.

2. Classifying Stars

Participants classify stars according to temperature and brightness on an HR diagram, just as professional astronomers do. The activity introduces graphing techniques which are valuable in science, technical, and business fields, but often underused in schools. The stars are chosen from Orion, which is the most readily recognizable constellation in the night sky, so participants can see the stars they have classified.

Materials

1) Large poster of Orion.

2) Circles of paper or plastic colored and sized to represent Betelguese, Rigel, θ¹c Orionis (brightest star in the Trapezium in the Orion Nebula), a solar-type star and K and M dwarfs. This gives a good range of spectral types. Data on Temperature and luminosity can be found in *Astrophysical Data* (Lang 1992) or www.enchantedlearning.com/subjects/astronomy/stars/startypes.shtml, among other sources. θ¹c Orionis is an O star and can use generic values for such a star from these sources.

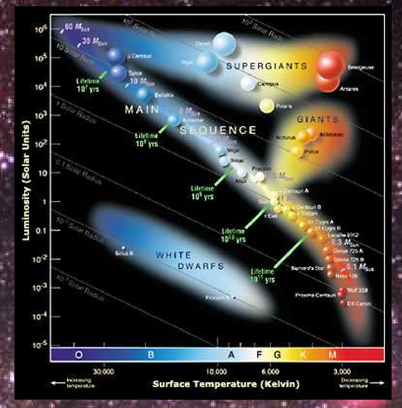
3) White/chalkboard or large graph paper for plotting.

4) Poster Tac or other reusable adhesive.

Procedure

1) *The sky full of stars.* Place the stars in their corresponding positions on the Orion poster. Low mass stars can be clustered around the Orion Nebula. Ask the participants to identify the constellation, and give instructions for finding it in the night sky. Emphasize that they are learning about stars they can see.

3. *Making helium.* Lead six volunteers through the PPI chain of nuclear burning (see Fig. 1). While the final four volunteers are still holding hands as a helium nucleus, point out that carbon and oxygen, the most common elements in people, need 12 and 16 volunteers to simulate. Iron in a car or tool needs 56. The heaviest elements would require packing more than 200 people into a room. Elements likesilver, gold, and platinum are so difficult to make that they are produced only in the most energetic events in the universe, supernova explosions which shine brighter than 100 billion stars like our sun.



HR diagram from *Cosmic Perspective*, Bennett, Donahue, Schneider, & Voit 2002, Addison - Wesley San Francisco

2. *Classifying stars.* Have volunteers place each star in its proper position on the HR diagram. Younger participants may need an introduction to graphing. Emphasize comparisons between the stars. Rigel and Betelguese started out very similar, but Betelguese is near the end of its life rather than in its prime. Comparisons of stellar lifetimes (5 million years for θ¹c, 10 billion for the sun, 1 trillion for the lowest masses) and relative brightness usually generate interest. The many types of stars around the Orion Nebula can lead into a discussion of star formation. A second constellation can be chosen for summer.

3. Testing the Activity

This activity was tested at the Astronomy Patch Day held as part of the Sahuaro Girl Scout Council's 2005 Science, Math, and Related Technologies event (see poster PR19, Astronomy Patch Day, Knierman et al.). Over 100 girls participated in the activity, ranging in age from early elementary to high school. The sessions were conducted by Patrick Young and Abigail Hedden, astronomers at Steward Observatory, and Carolyn Hollis, a Girl Scout Leader and 5th grade teacher.

We received extensive positive feedback from parents and leaders and most particularly from the girls themselves. Girls at all levels demonstrated understanding of the basic concepts of elements, building of heavy elements inside stars, stellar classification, and graphing. Carolyn Hollis has incorporated the activity into her 5th grade curriculum for the upcoming school year.

> "I thought science was just memorizing stuff, but this is about figuring things out. This is why science is *cool*."
>
> - 4th grade Girl Scout participant

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