Planetarium Programs

The Colors of Stars: Presenter Script
(25 Minutes)

Set-Up:
- Latitude: Home
- Precession: Current
- Set Sun and sky for today's date
- Time: About 9:00 pm
- Turn off Sun, Moon, and planets
- Select constellations that are in tonight's sky from the cards
- Select enough constellation cards so that each student (or team) has his/her own "star"
- Select cards so that a wide range of stellar temperatures is represented

Materials:
- Constellation cards
- Laser pointer
- Rainbow glasses or Slide-mounted diffraction grating
- Light bulb with dimmer switch (on low so as to not blind later on!)

Dialog is in normal type; actions/audience parts are in bold italics and indented.

Classifying Stars

> ***The first part of the planetarium program ended with the students finding their constellations. The students should still have their cards and should be asked to put them down directly in front of them as we take a few moments to* observe *the stars.***

Now, we look at the stars, we may want to consider them from a different perspective: how much can we learn about the stars from their constantly twinkling lights? First, who remembers what a star really is?

> ***The common misconception is that a star is a burning ball of gas. This leads to incorrect images of gasoline fires or oil burns. Stars are better described as huge balls of hydrogen and helium gas that produce their own energy through nuclear reactions (billions of hydrogen bombs in their cores)!***

As I turn the lights in the planetarium down again, I want each of you to observe the stars quietly. All we have ever received from stars is their light, and it is up to us to discover their secrets and the nature of the Universe by unraveling the information contained in that light.

Astronomers learn more about our universe by observing and classifying the objects in it. After you take a hard look at the night sky in here, I want you to give me some ideas of how you would classify these stars.

> ***Allow just a few moments as the students settle down to observe. Accept any classifications: patterns, sizes, groupings, distances, place in the sky, brightness, etc. The goal is to get* color *as one of the classification schemes.***

All of those classification schemes are really good and will help us learn more about the stars. The one important classification that we want to work with now is the color of the stars. What color or colors would you say stars are?

Accept additional colors: white, yellow, gray, silver, clear, orange, red.

Although most stars may look white or yellow to us, there are quite a few stars that shine with a different color: some red or reddish, some bluish. It takes a certain level of brightness for the eye to recognize color.

Colors and Temperatures of Stars

Let's find some stars that have a different color than usual. Can you find any stars that have an unusual color, different from white, yellow, and silver? If you would like to point one out to the rest of us, raise your hand so that I can give you a light pointer.

Demonstrate pointer if needed. Have a couple of volunteers point out stars of different colors. For each volunteer...

What color does that star seem to you? There are stars of many different colors. Why do you think stars shine with different colors? (***Accept a few answers***.)

Turn up the planetarium lights bright enough so that the students can read their cards.

Let's find our constellation cards and investigate why stars might be different colors. Now that you have your card and your star again, look to see what the temperature of your star is. Can everyone find the temperature of your star? Look around at your neighbor's stars. Are they hotter or cooler than your star?

Allow a few moments for the students to read the temperature of their star and to compare that temperature with those of their neighbors.

Which stars do you think are hotter: red stars or yellow stars? Raise your hand if you think yellow stars are hotter. Raise your hand if you think the red stars are hotter. Which stars do you think are hotter: blue-white stars or yellow stars? Raise your hand if you think blue-white stars are hotter. Raise your hand if you think yellow stars are hotter.

Now, I have a special request for each of you. Everyone hold up your constellation card so that we can all see what color your star is.

Students hold their cards so that the colors are facing out. Ask students in turn: purple, blue, white, green, yellow, orange, red what the temperatures of their stars are.

What color(s) are the hottest stars? ***(purple, blue, white)*** What color(s) are the medium-hot stars? ***(green, yellow)*** What color(s) are the coolest stars? ***(orange, red)*** The hottest stars in the Universe have surface temperatures of 40,000 Kelvin; the coolest stars have surface temperatures of about 2,000 Kelvin. The centers of stars, though, are millions and millions of degrees Kelvin!

The stars that we can see are huge enormously hot balls of hydrogen and helium. Just as fires here on Earth burn with different temperatures, not all stars are the same temperature. Some are producing much, much more energy than other stars and thus are hotter. Most people use either the Celsius or Fahrenheit scales to measure temperature in daily life. The Celsius scale is set up so that 0 corresponds to the temperature at which water freezes and 100 degrees corresponds to the boiling point of water. Astronomers measure temperature according to the Kelvin scale. The Kelvin scale is set up so that 0 degrees is the coldest temperature possible in the universe, absolute zero. A body at absolute zero has no energy and emits no light. On the Celsius scale, absolute zero corresponds to -273 degrees.

Please put your constellation cards on the floor in front of you. Let's all pretend that the Universe is at absolute zero as we ***s-l-o-w-l-y*** pass out our special diffraction glasses. Please make sure you don't touch the special lenses.

> ***Have an adult volunteer pass out the diffraction glasses. Encourage students to "start to freeze" -- they are so cold that they can't move, or talk, or even shiver! "3-2-1 absolute zero"!***

You may all now slowly thaw out. You each have a special pair of glasses that will make light spread out in a rainbow. How many of you have a CD and have held it up to light? What did you see? ***(Hold up a CD to demonstrate.)*** These glasses work on the same principle as the CD's that turn light into rainbows.

How many think that a white light bulb can be made into a pretend star?

> ***Show of hands as you position the dimmer light box into view. Turn on the white bulb in the center and brighten and dim a few times -- end with the bulb as bright as it will go. Make sure that everyone can see the light bulb directly. There may need to be minor seating adjustments so all have a direct line.***

You may need to move a little so that you can see the wire inside the light bulb. Right now, it is the hottest I can make it. What color is it? ***(white)*** Now put on your rainbow glasses and tell me what colors you see?

> ***Spend a few moments as the students work with viewing the rainbow properly. If they turn their heads slightly away from the light, they can see the spectrum better than if they face the light directly. Ask how many rainbows they see. Are all the rainbows the same size and brightness?***
>
> ***Turn off the planetarium light so that only the light bulb is on. Start dimming the light bulb very slowly.***

I'm now going to start "cooling off" my "star" and I want each of you to observe very, very closely what colors you see. What color do you see disappear first? ***(purple/blue)*** As I continue to turn the bulb down, I want you to tell me when you stop seeing any light at all, and what color the light was when it disappeared.

> ***Continue to turn down the bulb slowly....what color is it now?....and as I cool it off more....what color is it now?....and just about when it's going to die out.....***
>
> ***Students will argue about the last color, so brighten the star slowly and repeat the dimming.***

What conclusions can we make about the colors of stars versus their temperatures? If we were to make a graph, and we had one of the hottest stars, we would say its color is: ***(purple/blue/white)*** If we had a medium hot star, we would say its color is: ***(green/yellow)*** If we had the coolest stars, we would say their colors were: ***(orange/red)***

What can we also say about how much light hot stars are producing versus cool stars? When this bulb was the hottest (bluest), it was also the: (***brightest -- technically, the most luminous)*** When this bulb was the coolest (reddest), it was the: ***(dimmest -- technically, the least luminous)***

Stars radiate their light just like light bulbs: in watts. Here, we have a 200-watt light bulb, but the Sun is equal to a 1-followed-by-26-zeros watt light bulb! If I could make the light bulb hotter, it would turn bluish and then maybe even purplish. Has anyone ever seen a blue fire? Why do welders need

to wear those special helmets with the thick black glass over their eyes? ***(ultraviolet light rays and very intense light)*** On the other hand, who has been camping and watched the coals glow deep red as the fire goes out? ***(Show of hands)***

Similarly with the stars, the blue stars are very hot, and the red stars are the coolest, even though by our standards, they are still very hot!

What color is the closest star to us? ***(Yellow)*** What is the name of that star? ***(The Sun)***.

> ***Dim the light bulb and set aside as the stars are turned back on. Planetarium lights should be on dim as well.***

Patterns to take with you

I'm going to turn the stars back on as we end our program for today. I want you to take one last look and find your own pattern of stars to take with you. Memorize that pattern and give it a name. It can be a name that only you know, and it can be an animal, a person, a place, or a thing. Does your pattern of stars, your new constellation, have a story that goes with it? Think about your story (in your head).

> ***Give the students time to find their own pattern. This works best if the planetarium lights are completely dimmed, but not turned off. If time, have the students point out their pattern with the laser pointer. An excellent motivator is to give the pointer only to those who are cooperating.***

IF TIME: I need some questions about constellations, the night sky, colors, light, or space!

> ***Wait for many seconds looking around the planetarium for any raised hands.***

Thank you all for visiting with us today and for being such attentive astronomers. You may keep your starmaps and use them to find your stars and patterns. On your way out, please deposit your constellation cards, rainbow glasses, or extra starmaps in the box. May all your skies be clear and happy!