William M. Staerkel PLANETARIUM

Teacher's Guide to

"The Stargazer"

OBJECTIVES:

- To capture astronomer Jim Kaler's passion for stargazing
- To illustrate the lifespan of a star and how gravity can determine its ultimate end state
- To use the H-R Diagram to show how stars can be classified

This show conforms to the following NGSS: 1.ESS1.1, 5.PS2.1 , 5.ESS1.1, HS.ESS1.1, HS.ESS1.3

BRIEF SHOW DESCRIPTION:

Come along on a journey to the stars with University of Illinois Astronomer James B. Kaler in an exciting program written and produced by the Great Lakes Planetarium Association. Nichelle Nichols (from the original "Star Trek") and Dr. Kaler narrate this personal look at gravity, light, and the spectrum and how they help us decipher the lifestyles of the stars.

PRE-VISIT ACTIVITIES/TOPICS FOR DISCUSSION:

- What do we know about the stars? Make a list on the board. Better yet, *how* do know these things? You'll find it all comes down to light – the only thing we receive from the stars! What is light and what can we learn from light?
- Hold a prism in the sunlight and observe the spectrum. Make the connection with a rainbow where raindrops are acting like prisms.
- If you have them in your building, set up several discharge tubes (maybe hydrogen, helium, neon, etc) and then observe their spectra in a dark room with diffraction grating glasses (the planetarium has these for $1 each). How are the spectra the same (the order of the colors) and how are they different (each show a different pattern). Make a game out of trying to determine what gas is in each tube by comparing the spectra to known spectra, like these: https://practical-chemistry.com/practical-work/chemistry/atomic-structure/atomic-emission-spectra/
- What happens when you compress a gas? Trying bring in a manual bicycle pump and have a student pump it several times. What happens to the body of the pump? (Should get warm).
- Are there any stargazers in your class? Have students share their experiences watching the stars. Have any seen a planet? Meteor?

POST-VISIT ACTIVITIES/TOPICS FOR DISCUSSION:

- Simulate the H-R Diagram using this web applet: https://astro.unl.edu/naap/hr/hr.html
- Construct your own H-R Diagram in the class by first plotting two things such as height vs. weight. Height doesn't cause weight or vice versa but you'll find the taller people tend to be heavier and then you get a nice main sequence. Then use Jim Kaler's web site (see below) to make cards, each with a different star on it and its statistics. Include the star's luminosity, absolute magnitude, spectral type and temperature. Then hand one to each student and let them put a dot on the diagram for their star.
- Compare HR diagrams for the brightest stars to a similar diagram for the closest stars. What conclusions can you draw about the stars in the sky? (the stars we see are some of the brighter stars. The far greater majority are the small, red dwarf stars. We see the close ones because

they are close. The farther dwarf stars are too faint to see). See https://cseligman.com/text/stars/stellarproperties.htm

- Talk about stars on the upper right and lower left sections of the HR Diagram. How can a star be super hot but yet not bright (it must be small). How can a star be very bright yet cool (it must be large, a giant or supergiant).
- The spectral sequence (O, B, A, F, G, K, M) is based on hydrogen lines and the letters are historical. The star with the most hydrogen lines is an "A" star. But then scientists figured out that the sequence is based on temperature, but the letters stuck. Can you think of a pneumonic to remember the spectral sequence? The old way is "Oh Be A Fine Girl/Guy, Kiss Me." Can you think of another?
- Create your own spectroscope! You can use an old CD or DVD. See the directions at the end of the show's educator guide (the other link on the planetarium web page). You can also put diffraction grating classes over the camera of a smart phone and practice recording emission spectra.
- Research the scientists mentioned in the show – what were their greatest contributions? Galileo, Isaac Newton, Celia Payne-Gaposchkin, Albert Einstein. You can expand to include Annie Cannon, Henrietta Leavitt, Harlow Shapley, Edwin Hubble, Percival Lowell, Clyde Tombaugh, Leslie Peltier (famous amateur astronomer), and others.
- As stars age their position on the HR Diagram changes. Use this animation to show how the diagram can change over time for a stars cluster. Which stars evolve first? https://physics.unm.edu/Courses/Rand/applets/hr.html

VOCABULARY LIST:

Absorption lines
Black hole
Gravity
H-R Diagram
Luminosity
Main sequence
Spectra

INTERNET RESOURCES:

- Who is Jim Kaler? http://stars.astro.illinois.edu/bio.html
- A ton of resources on stars, spectra, and constellations on Jim Kaler's web page: http://stars.astro.illinois.edu/sow/sowlist.html
- Jim Kaler's Skylights page: http://stars.astro.illinois.edu/skylights.html
- Careers in astronomy: https://aas.org/learn/careers-astronomy