Decoding Starlight Exhibit Guide

Teacher Edition (C)

Introduction Panel

This panel represents the path starlight takes from a star to human understanding. The chasing lights represent the light from the star traveling through the telescope, then into an instrument like a spectrograph. The telescope in this panel is the Hobby-Eberly Telescope (HET) which is designed and optimized for producing spectra instead of pictures of celestial objects.

Contrast events before and after the light interacts with the spectrograph. After the spectrograph separates the light into its component colors according to wavelength, a transition occurs. Light changes to data. A camera records the light and digitizes the signal into binary code data. In this form, the astronomer can transfer the data from the instrument to a computer system for storage and analysis. The smiling astronomer is Dr. George Benedict, with graphical data on his computer monitor that represents the spectrum of a quasar.

Star Light, Star Bright

What are the three things you notice about the Sun's spectrum?

Responses will vary; here are some examples.

- The spectrum has the rainbow colors of ROYGBIV (red orange yellow green blue indigo violet).
- The colors are not equally spaced, e.g., there is less "yellow" area than "red".
- The colors flow into each other into a continuous pattern.
- There are vertical dark lines.
- The dark lines have different widths.

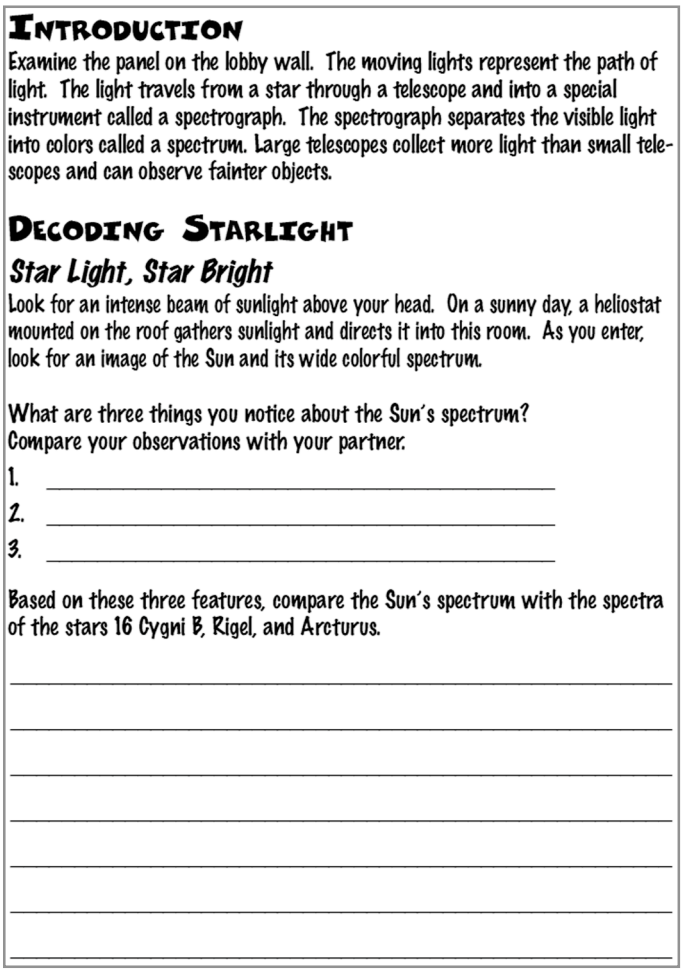
Facilitator help:

This is a real spectrum of the Sun (watch what happens when clouds go by, or when a sunspot falls on the slit!). Above the color spectrum is an image of the Sun, sliced vertically by the slit of the spectrograph. The light in the spectrum comes through this narrow slit. You can control the width of the slit. Narrowing the slit results in finer absorption lines (higher resolution), but fainter colors (less signal).

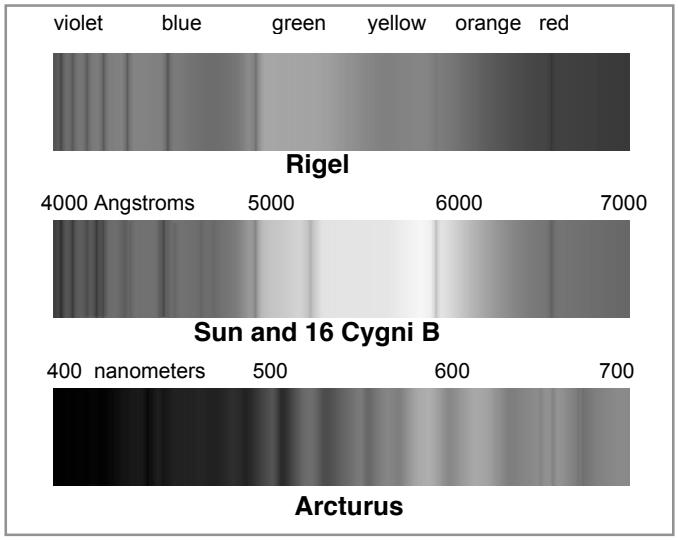
Diffraction and interference produce the color spectrum. A block of glass cut with tiny horizontal grooves is the diffraction grating. In the case of the Solar Spectrum Projector, it is a reflective diffraction grating. The exhibit's "Make Your Own Spectrum" features a transmission grating, instead of a reflective grating.

Compare and Contrast the spectra of the Sun, 16 Cygni B, Rigel and Arcturus

- 16 Cygni B has a spectrum identical to that of the Sun.
- Although 16 Cygni B is fainter than the Sun, the spectra are the same. Spectra are determined by the temperature, pressure, and chemical composition of the star. Stars of the same size, chemical composition, and temperature have identical spectra.
- Arcturus has many more dark lines than Rigel. Arcturus is brighter in the red region of the spectrum. Rigel is brighter in the blue region and has very few spectral lines.



Related TEKS: 6.13, 8.13, IPC 7, Ast 6
Related NSES: 5 - 8 Physical science: transfer of energy. 9 - 12 Physical science: interactions of energy and matter. 9 - 12 Unifying concepts and processes: constancy, change, and measurement.



Decoding Starlight Exhibit Guide

Teacher Edition (C)

Every Star has a Spectrum

What patterns do you notice as you pass the diffraction grating over the stars?

There are several answers. Your students may have other correct answers. Some examples are:

- The colors are arranged in the same direction for all stars.
- Some of the dark lines appear in about the same places in each spectrum.
- The patterns are not all the same.

Star Codes: Patterns in Starlight

What other object has this pattern?

These lines are in the Sun's spectrum, and in the spectrum of many of the stars we viewed.

If you see this pattern in a star's spectrum, what does this clue mean?

If we see this pattern, that star has hydrogen in it.

Connections to everyday life

Spectroscopy is a powerful tool in everyday life. One example is that rare elements are put into the paint used in automobiles. If a car leaves a chip of paint behind at an accident, the police can find out what type of car was involved in the accident.

Other uses of spectroscopy can be found at the web site for Spectroscopy magazine in the US
<http://www.spectroscopymag.com/spectroscopy/>
or in Europe
<http://www.spectroscopyeurope.com/>.

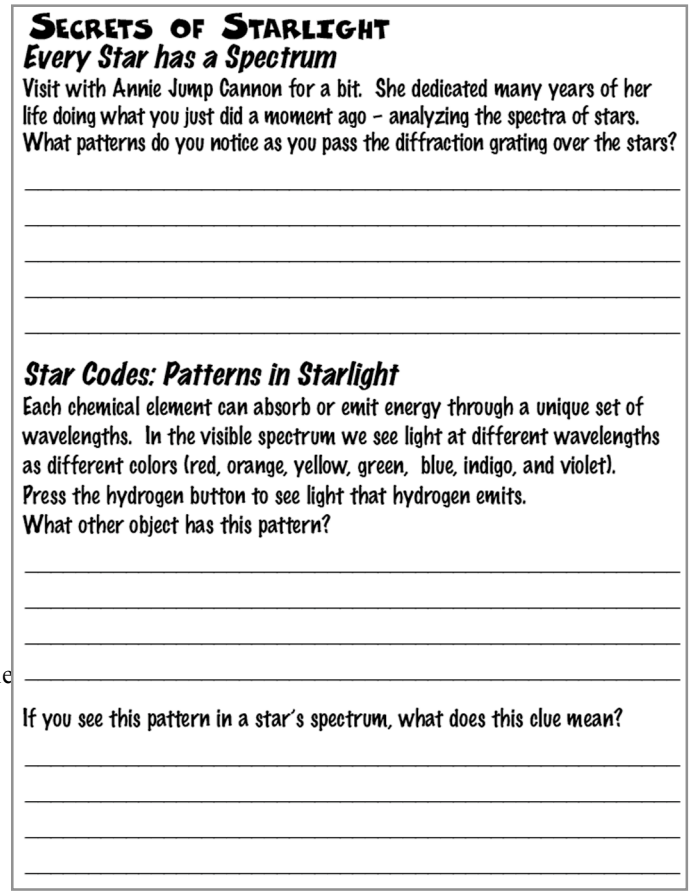
Extensions:

More information on American astronomer **Annie Jump Cannon** (1863-1941) can be found at these sites:
<http://www.wellesley.edu/Astronomy/annie/>
<http://www.sdsc.edu/ScienceWomen/cannon.html>
<http://www.netsrq.com/~dbois/cannon.html>

There is even a song about her, at:
<http://www.entersci.com/cosmic/ajump.htm>

To learn more about spectroscopy, refer to the lesson plans at **Journey into Spectroscopy** at
<http://www.mcdonaldobservatory.org/teachers/classroom/spectroscopy/sp.html>
There are four activities posted:

- Spectroscope
- Decoding Starlight: Clues for Temperature
- Decoding Starlight: Clues for Pressure
- Decoding Starlight: The H-R Diagram



Related TEKS: 8.8, 8.13, IPC 7, Ast 6
Related NSES: 9 - 12 Unifying concepts and processes: systems, order, and organization.

Decoding Starlight Exhibit Guide

Teacher Edition (C)

Different Tools Different Views

List three instruments that astronomers use.

Answers may vary, as students have a range of prior knowledge about tools and technology used in astronomy. Some sample answers include: spectrograph, CCD camera, film-camera, photometer, polarimeter, and computer.

How I Discovered a Supernova

How would you look for a supernova?
What tools would you use?

Answers may vary, as students have information from other sources about the discovery of supernovae. For each of the following examples, the observer needs a list of good places to search, for example, a list of galaxies and their locations in the sky.

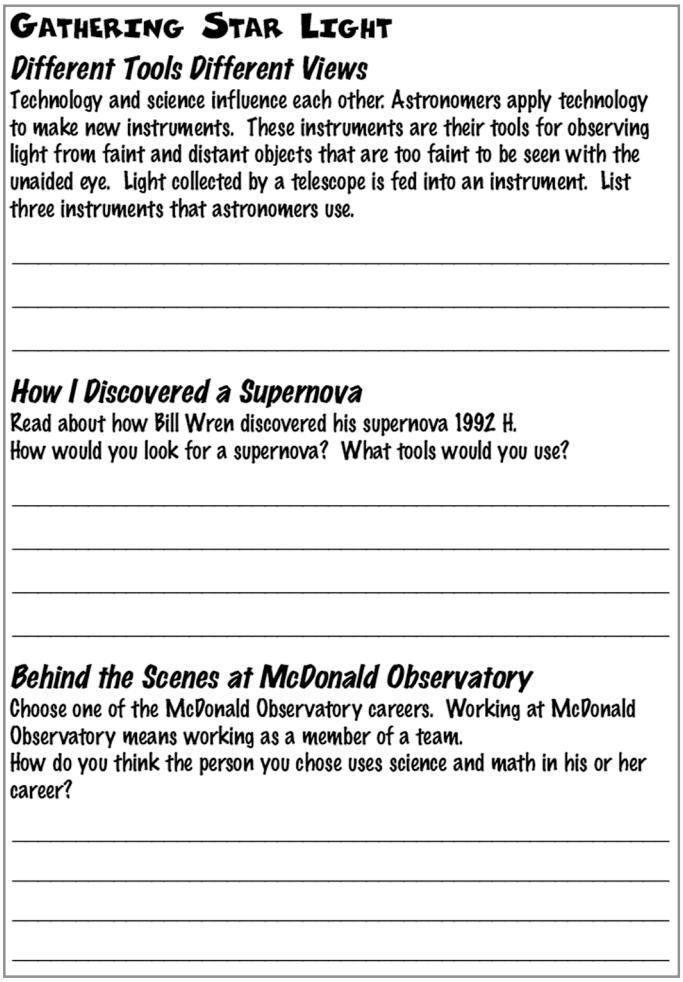
- I would use a telescope to look at the same objects every night for a long time and look for changes. I would need a telescope and pictures of the objects to compare with what I was seeing in the sky. I would need a notebook to record my observations. I would need a clock or watch to record the time.
- I would use a telescope that automatically took pictures of a series of objects in the sky. The telescope should have a large field of view so that it can make images of a large piece of the sky. I would use a CCD camera to take the images. I would use a computer to compare the images of the same part of the sky taken at different times. I would check the suspected supernovae with another telescope that can see more detail.

Behind the Scenes at McDonald Observatory

How do you think a person with the career you chose uses the science and math that you are learning in school?

These answers will vary depending both upon the career they choose and what subjects they are currently taking in school. Some examples might be:

- Telescope operator: Mathematics, Electrical Engineering, English, Physics
- Librarian: English, Foreign Language, Information Systems
- Physical Plant staff: Mathematics, Physics, Chemistry



GATHERING STAR LIGHT

Different Tools Different Views

Technology and science influence each other. Astronomers apply technology to make new instruments. These instruments are their tools for observing light from faint and distant objects that are too faint to be seen with the unaided eye. Light collected by a telescope is fed into an instrument. List three instruments that astronomers use.

_____

_____

_____

How I Discovered a Supernova

Read about how Bill Wren discovered his supernova 1992 H.
How would you look for a supernova? What tools would you use?

_____

_____

_____

_____

Behind the Scenes at McDonald Observatory

Choose one of the McDonald Observatory careers. Working at McDonald Observatory means working as a member of a team.
How do you think the person you chose uses science and math in his or her career?

_____

_____

_____

_____

Related TEKS: Ast 3
Related NSES: 9 - 12 History and nature of science: science as a human endeavor, nature of scientific knowledge.

Extension suggestions

Extend your study of the exhibits through student research into the technology used in astronomy. Some key concepts are the function of the diffraction grating (used to disperse the light into its component wavelengths), the CCD (used to record the data), computers (used to "reduce" the data by combining data taken at different times or removing the effects of Earth's atmosphere and to analyze the data).

Relationship to other McDonald activities and resources

To learn more about the telescopes at McDonald Observatory:

- View the video in the Theater.
- Take the tour of the Observatory.

To learn more about identifying objects in the sky:

- Learn to use a star map through our Enriched Student Field Experience program.
- Participate in a Star Party at the Visitors Center.

Decoding Starlight Exhibit Guide

Teacher Edition (C)

What Are Astronomers Doing?

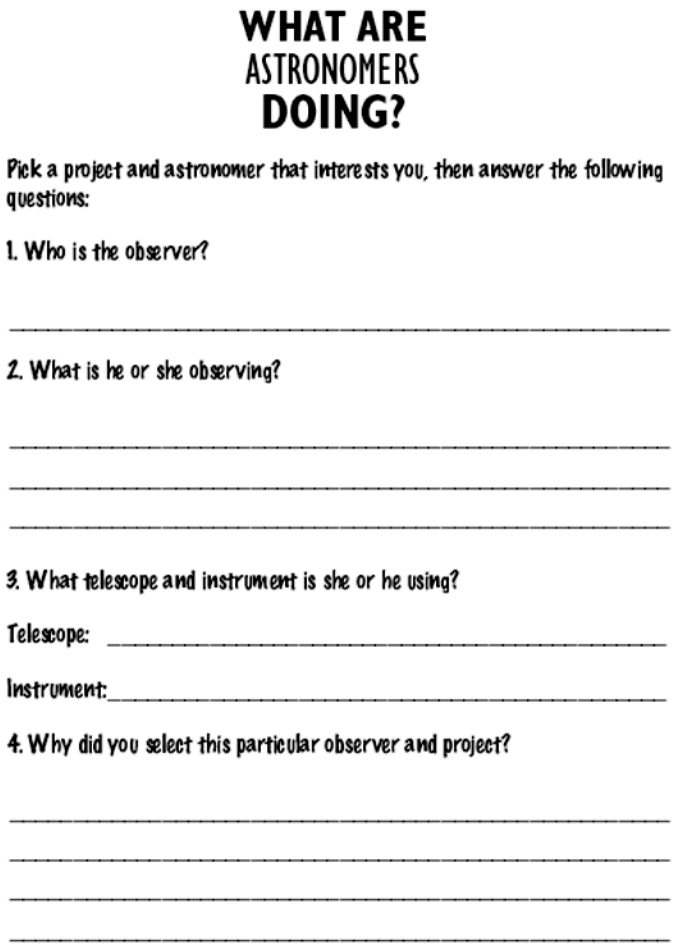
What are astronomers doing at McDonald Observatory this week?
This kiosk has an online companion, "What Are Astronomers Doing?" located at http://mcdonaldobservatory.org/research/. Every week you will find something new, research *in progress*, going on at McDonald Observatory.

The content has been chosen to be especially engaging for students. It deals with what astronomers are *doing* -- not what they have done.

There are two kiosk computers at this station that can accommodate four students (two teams). Students should pick an astronomer and a project that interests them, read and explore, then respond to the questions.

Keep an eye on how long students are working with "What Are Astronomers Doing?" It may become a "bottleneck" exhibit activity. Visitor engagement time with this exhibit ranges from 30 seconds to 10 minutes – there's a lot to explore. For instance, at the kiosk students can respond to questions 1 – 3, then reflect on question 4 while a new set of students begins.

When you return to school, students may continue to explore the web site. Over time, they may notice that their favorite astronomers return to the Observatory to follow up on past observations or begin a new project.



Related TEKS: Ast 3
Related NSES: 9 - 12 History and nature of science: science as a human endeavor, nature of scientific

Extension suggestion
See activities that use the website online at
<http://www.mcdonaldobservatory.org/research/resources/activities/>
and at
<http://stardate.org/teachers/plans/>.