Multiwavelength Astronomy: The Science of Optical Astronomy, by Edwin Hubble

http://ecuip.lib.uchicago.edu/multiwavelength-astronomy/optical/science/index.html

Subject(s): Earth Science, Space Science

Grade(s) Level: 9-12

Duration: Two Class Periods

Objectives: As a result of reading The Science of Optical Astronomy, students will be able to

- identify astronomers who laid the foundations of mapping the universe and name their achievements;
- describe properties of star light;
- explain techniques for measuring cosmological distances;
- articulate Hubble's Law.

Materials: Internet connection and browser for displaying the lesson, student journal.

Pre-requisites: Students should read The History of Optical Astronomy. Students should be familiar with the Electromagnetic Spectrum. Student should have knowledge of a reflecting telescope, with a basic understanding of telescope parts. Before using the lesson, students should familiarize themselves with all vocabulary terms.

Procedures: Students will read through the lesson and answer the questions below in their journals. Discuss journal responses as a group.

Introduction: Edwin Hubble made some of the most important discoveries in modern astronomy. In the 1920s, while working at the Mt. Wilson Observatory, he was able to show that some of the numerous distant, faint clouds of light in the universe were actually entire galaxies. This realization changed the way astronomers viewed our place in the Universe, because it was then understood that our Milky Way Galaxy was but one of countless other galaxies. Then, in 1929, Hubble determined what is called "Hubble's Law", which proposes that the farther a galaxy is from Earth, the faster it appears to move away. In this lesson we will learn about Edwin Hubble and other astronomers whose work built upon each others to arrive a greater understanding of the size and scale of the Universe.

Questions

1. What is the main source of optical (visible) light in the Universe? Which objects are considered secondary or indirect sources of optical light? Is it possible for all planets to reflect light from their stars?

2. Why do stars shine in the sky? What color do the hottest stars display? What does the color of a star tells us about it?
3. What is a stellar parallax and why is it important?
4. Optical light can be absorbed by gas surrounding the stars, a process that leads to re-emission. What happens to the gas cloud during the process of re-emission of the starlight? How can you tell what elements make up an object in space?
5. When was the spectroscope invented and by whom? What are atomic absorption lines? The wavelengths of specific lines in the spectrum of the Sun enable astronomers to make determinations about what?
6. The Hertzsprung-Russell diagram connects luminosity to the spectral types of stars. What does this information allow astronomers to do?
7. Hubble was able to discover a quantifiable relationship between distance and velocity. What is the basis of Hubble's Law? What is the relationship between distance and velocity?

Adaptations: Working in small groups, have students read portions (or all) of the lesson and answer questions together. The small groups will report back to the class as a whole with their responses.

Additional Discussion Question(s):

- Use student-generated questions from group discussion.

Evaluation: Formative assessment of student understanding based on answers to the questions listed above. Follow up with extensions and/or suggested readings.

Extensions: Make your own Hertzsprung-Russell Diagram using the Sloan Digital Sky Survey website http://skyserver.sdss.org/dr1/en/proj/advanced/hr/.

Suggested Readings: Lessons on the history, tools, and impact of Optical Astronomy from the Multiwavelength Astronomy website complement the Optical Science lesson.

Links: These websites are recommended for providing background and supplemental information:

Tour of the Electromagnetic Spectrum http://missionscience.nasa.gov/ems/
From Our Galaxy to Island Universes http://www.aip.org/history/cosmology/ideas/island.htm
Spectroscopy and the Birth of Astrophysics http://www.aip.org/history/cosmology/tools/tools-spectroscopy.htm
The Hubble Site http://hubblesite.org/

Vocabulary: The following terms are used and defined in the lesson. Teachers may want to review these in advance of using the lesson with students.

Albertus University
asteroid
astronomical unit
atom
Bessel, Friedrich
binary star
Boltzmann, Ludwig
Bunsen, Robert
Curtis, Heber
comet
electron
Fraunhofer, Josef
galaxy
gravity
Hale, George Ellery
Harvard University
Herschel, William
Hertzsprung, Ejnar
Huggins, William
ion
Kirchhoff, Gustav
Konigsberg Observatory
nebula
Leavitt, Henrietta
Lilienthal Observatory
Mount Wilson Observatory
Newton, Sir Isaac
Olbers, Heinrich
Oxford University
parallax
photon
Russell, Henry Norris
Shapley, Harlow
spectroscope
spectroscopy
spectrum
Stefan, Joseph
University of Chicago
wavelength
white dwarf

Standards: This lesson addresses Next Generation Science Standards HS-ESS1-2, HS-ESS1-3; and Common Core standards CCSS.ELA-Literacy.RST.9-10.1, 9-10.2, and 9-10.4.