Online Modules from The University of Chicago

Multiwavelength Astronomy: Gamma Ray Science, by Dieter Hartmann (Clemson University)
http://ecuip.lib.uchicago.edu/multiwavelength-astronomy/gamma-ray/science/index.html

Subject(s): Physics and Astronomy/Space Science

Grade(s) Level: 9-12

Duration: Two Class Periods

Objectives:

Students will

- Learn about gamma radiation and gamma-ray bursts (GRBs), their sources and types;
- Find out how GRBs are used for spectroscopy, and what that tells us;
- Learn about how space scientists use the electromagnetic spectrum to answer particular questions;
- Understand the collaborative nature of doing science;
- Consider the role of science in society.

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

Pre-requisites: This lesson could be used at the end of a unit on the electromagnetic spectrum. Before using the lesson, students should have the following:

- Understanding of photons
- Understanding of the Electromagnetic Spectrum
- Some knowledge of optics
- Knowledge of the relationship between frequency and wavelength
- Understanding of astronomical terms (see vocabulary)

Procedures: Students will read through the Gamma-Ray Science lesson and complete the reading guide at the end of this lesson plan.

Introduction:

Professor Dieter Hartmann is a high energy physicist who studies supernovae and gamma-ray bursts (GRBs) to make sense of the physical processes that cause them. He also studies GRBs to learn about the origins of the elements, using spectroscopy. Professor Hartmann did not always expect to be a scientist, but the nature of scientific work was something he found he enjoyed. Astrophysics may seem exotic, but all space science research has an impact on our everyday lives.

Adaptations:

Have students read portions (or all) of the lesson in small groups and answer questions together. The small groups report back to the class as a whole with their responses. Or, the teacher can lead the whole class in reading through the lesson and use the questions from the reading guide as discussion prompts.

Additional Discussion Questions:

- What do you think scientists do? What is your idea of a scientist?
- Why is it important to study space?
- Do we need to send people into space to do this work? Should we?

Evaluation: Formative assessment of student understanding based on answers to questions in the reading guide and additional discussion questions. Follow up with extensions and/or suggested readings.

Extensions: Additional activities can be found on the Swift Site for educators at http://swift.sonoma.edu/education/index.html.

Suggested Readings: The lessons on the history, tools, and impact of Gamma Ray Astronomy from the Multiwavelength Astronomy website.

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

Tour of the Electromagnetic Spectrum http://missionscience.nasa.gov/ems/
The Swift Education and Public Outreach Website http://swift.sonoma.edu/
Swift Gamma-Ray Burst Mission https://heasarc.gsfc.nasa.gov/docs/swift/swiftsc.html
Fermi Gamma-ray Space Telescope http://fermi.gsfc.nasa.gov/

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.

afterglow
alpha radiation
astrophysics
BeppoSax
beta radiation
Big Bang
binary star
black hole
Braunschweig
Clemson University
collapsar
collimate
compact star
Compton Gamma Ray Observatory
cosmological
electromagnetic spectrum
energy
Ernest Rutherford
eV
Fermi Gamma-Ray Space Telescope
flux
frequency
Galaxy
gamma radiation
gamma-ray bursts
Hermann Oberth
HETE-2
interstellar
intergalactic medium
ion
ionization
light years
magnetic field
Marie and Paul Curie
MeV
nuclei
nucleosynthesis
photons
spectrum
spectroscopy
Stan Woosley
Stirling Colgate
supernovae
Swift Gamma-Ray Burst Explorer
University of California at Santa Cruz
wavelength

Standards: This lesson addresses NSES **Content Standard B**: Physical Science – Interactions of Energy and Matter (Electromagnetic waves result when a charged object is accelerated or decelerated. Electromagnetic waves include radio waves (the longest wavelength), microwaves, infrared radiation (radiant heat), visible light, ultraviolet radiation, x-rays, and gamma rays. The energy of electromagnetic waves is carried in packets whose magnitude is inversely proportional to the wavelength.); and Science and Technology and **Content Standard F**: Science in Personal and Social Perspectives; AAAS Project 2061 Benchmark **1A/H1**. The Nature of Science/The Scientific Worldview; and Common Core Common Core standards **RST.11-12.2.** Determine the central ideas or conclusions of a text; summarize complex concepts, processes, or information presented in a text by paraphrasing them in simpler but still accurate terms, and **WHST.11-12.2.** Write informative/explanatory texts, including the narration of historical events, scientific procedures/experiments, or technical processes.