Multiwavelength Astronomy

Tools – Neils Gehrels

These lessons could be used after units on telescopes and image processing. It should come at the end of a unit on the Electromagnetic Spectrum.

These lessons will become part of a unit on the Electromagnetic Spectrum. I have materials from GEMS Invisible Universe & SOFIA that explore Optical, Infrared, Microwave, and Radio wavelengths. This will add Gamma-Ray light to our explorations.

Lesson 1 – Gamma-Ray Tools Online Reading Guide

Pre-requisites

1. Knowledge of a reflecting telescope and how it focuses light.
2. Knowledge of a CCD camera and its job as a detector.
3. Understanding that a telescope has 2 basic parts – the focusing system and the detector.
4. Basic understanding of the Electromagnetic Spectrum – different wavelengths (wavebands) with different energy.

Teaching Objectives

Students will become familiar with an astronomer's path from childhood to adult as regards his interest in astronomy. Students will compare optical telescopes with gamma-ray telescopes. Students will become familiar with the Swift's telescope three instruments, BAT, XRT and UVOT.

Standards

HS.PS-IF Interactions of Forces

Obtain, evaluate, and communicate information to show how scientists and engineers take advantage of the effects of electrical and magnetic forces in materials to design new devices and materials through a process of research and development.

HS-ETS-ETSS Links Among Engineering, Technology, Science, and Society

Gather evidence to evaluate different explanations for the widespread adoption of a modern technology, including the role of societal demands, market forces, evaluations by scientists and engineers, and possible government regulation.

Common Core

W.9-10.7 Conduct short as well as more sustained research projects to answer a question (including a self-generated question) or solve a problem; narrow or broaden the inquiry when appropriate; synthesize multiple sources on the subject, demonstrating understanding of the subject under investigation.

RI.9-10.1 Cite strong and thorough textual evidence to support analysis of what the text says explicitly as well as inferences drawn from the text.

W.9-10.9(b) Draw evidence from literary or informational texts to support analysis, reflection, and research.

Supports

Computers; Reading guide printed out or place to upload digital questions/answers

Activity

Students will read through the Multiwavelength Astronomy webpages Gamma-Ray Tools, using the online reading guide [http://jbcbarge.cuipblogs.net/gamma-ray-tools-neil-gehrels]

Assessment – Formative: Answers to questions on reading guide

Lesson 2 – Exploring Swift

Pre-requisites

1. Knowledge of a reflecting telescope and how it focuses light.
2. Basic understanding of the Electromagnetic Spectrum – different wavelengths (wavebands) with different energy.

Teaching Objectives

Students will develop an understanding of an aspect of the Swift mission of their choice (location of Swift, location of GRBs, the science of Swift & GRB, scientist's life as a Swift astronomer, the physical design of Swift telescope)

Standards

L **HS.PS-IF Interactions of Forces**

Obtain, evaluate, and communicate information to show how scientists and engineers take advantage of the effects of electrical and magnetic forces in materials to design new devices and materials through a process of research and development.

HS-ETS-ETSS Links Among Engineering, Technology, Science, and Society

Gather evidence to evaluate different explanations for the widespread adoption of a modern technology, including the role of societal demands, market forces, evaluations by scientists and engineers, and possible government regulation.

Common Core

SL.11-12.2 Integrate multiple sources of information presented in diverse formats and media (e.g., visually, quantitatively, orally) in order to make informed decisions and solve problems, evaluating the credibility and accuracy of each source and noting any discrepancies among the data.

W.11-12.9(b) Draw evidence from literary or informational texts to support analysis, reflection, and research.

RST.11-12.9 Synthesize information from a range of sources (e.g., texts, experiments, simulations) into a coherent understanding of a process, phenomenon, or concept, resolving conflicting information when possible.

MP.5 Use appropriate tools strategically

S.IC Make inferences and justify conclusions from sample surveys, experiment, and observational studies.

Supports

Computers, at least one class period, possibly more; Check-in sheets printed out

Activity

1. Students will choose two of the activities listed on the Exploring Swift web page to explore. [http://jbcbarge.cuipblogs.net/exploring-the-swift-gamma-ray-burst-explorer-mission]
2. After one week has passed, students will check in and complete a check-in sheet. Students that have created a product will share it with the class.

Assessment – Formative: Answers to check-in

Lesson 3 – GRB Imaging

Pre-requisites

1. Knowledge of a reflecting telescope and how it focuses light.
2. Knowledge of a CCD camera and its job as a detector.
3. Understanding that a telescope has 2 basic parts – the focusing system and the detector.
4. Basic understanding of the Electromagnetic Spectrum – different wavelengths (wavebands) with different energy.
5. Understanding of Right Ascension and Declination
6. Understanding of how to request images from SkyNet – ability to name image correctly, choose telescope, choose filters, choose exposure time, download fits file.
7. Ability to image process a fits file.

Teaching Objectives

Students will become familiar with one GRB using the Gamma-Ray Burst Real-Time Sky Map. Students will obtain an image from SkyNet of their GRB location. They will create an image and an explanation page about their GRB.

Standards

HS.PS-IF Interactions of Forces

Obtain, evaluate, and communicate information to show how scientists and engineers take advantage of the effects of electrical and magnetic forces in materials to design new devices and materials through a process of research and development.

HS-ETS-ETSS Links Among Engineering, Technology, Science, and Society

Gather evidence to evaluate different explanations for the widespread adoption of a modern technology, including the role of societal demands, market forces, evaluations by scientists and engineers, and possible government regulation.

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RST.11-12.9 Synthesize information from a range of sources (e.g., texts, experiments, simulations) into a coherent understanding of a process, phenomenon, or concept, resolving conflicting information when possible.

MP.5 Use appropriate tools strategically

S.IC Make inferences and justify conclusions from sample surveys, experiment, and observational studies.

Supports

Computers for several class periods; Printer, preferably color, Display area

Activity

1. Students use the Gamma-Ray Real-Time Sky Map to find and learn details about a GRB.
2. Students use Nasa's SkyView to compare images of their GRB's location across different wavebands.
3. Students use SkyNet to request an image of their GRB location. It may or may not be visible.
4. Students use image processing to adjust their image from SkyNet.
5. Students print their image and create an explanation describing their GRB (ID, location, date identified, details including other light seen from it)

Assessment – Summative: Communication Piece Rubric

Gamma Ray Tools Reading Guide

Neil Gehrels has been working with gamma-rays for a long time and has been instrumental in the development of new tools to explore this part of the electromagnetic spectrum. He is the Principal Investigator (PI) for the Swift Gamm-Ray Burst Explorer Mission that is currently in space. As you read through Neil's story think about the questions listed below. Write out an answer or reflection for each section. Each section includes several webpages. Your answers will be uploaded to Moodle.

Growing Up with Stars – From Music to Physics

1. As you read about Neil's life as a child, what did you feel about his exposure to astronomy? Did that exposure have a cost to it at all? What do you think about his foray into music?

Watching the Detectors – Counting Photons with Well-Detectors

2. What kind of things caused problems for the early detectors?
3. Several different early instruments were talked about in these pages. Which one do you find interesting or surprising? Explain why. To learn more about the instruments, visit the sites below.

    Voyager
    The Gamma-Ray Imaging Spectrometer (GRIS) balloon instrument
    Messenger

Imaging with CCD's – Focusing with Optics

4. We have been using CCD images, and have even seen one a CCD. A CZT is a CCD on steroids!! But they are still hard to use with gamma-rays. Getting the gamma-ray light to the CZT, or the detector plane, is tough. There is so much energy in a gamma-ray photon, it can go right through the mirrors we use to focus visible light. How does Neil and other gamma-ray astronomers get around this problem?

Swift Gamma-Ray Burst Explorer Mission – How Swift Works

5. Neil explains why he thinks it is important to study GRBs. What do you think? Do you agree with him? GRBs are the most powerful things in the Universe. These explosions equal the energy of a billion billion (10^18) Suns!
6. How does Swift help with detecting and locating sources of gamma-ray bursts?
7. Swift has three instruments on it. Which one actually detects the gamma-ray light? What do the other two do? Why do you think they are even on the spacecraft? You can learn more about them at the links below.

    BAT
    XRT
    UVOT

13 Billion Light Years and Counting…

8. As you read Neil's last words, what are the big ideas he has left with you about gamma-ray astronomy?

If you want to hear Neil in person, listen to this audio clip of an interview with him.

When you are finished reading and reflecting on Neil's story, upload your answers/thoughts to Moodle – Gamma-Ray Tools Reading Reflections

Exploring Swift Check-in Name _____

Activity #1

1. Circle the activity you did

Swift Explorer iPhone App Swift Song Gamma Ray Burst Lottery Swift at Twitter

Paper Model of Swift Swift movies/animations

2. What did you do and/or what happened in this activity?

3. What did you learn from this activity?

4. Do you have something you made to share? If so, explain.

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Activity #2

1. Circle the activity you did

Swift Explorer iPhone App Swift Song Gamma Ray Burst Lottery Swift at Twitter

Paper Model of Swift Swift movies/animations

2. What did you do and/or what happened in this activity?

3. What did you learn from this activity?

4. Do you have something you made to share? If so, explain.

GRB Image & Explanation Rubric

Name _____ GRB ID # _____

Image Processing

Criteria	Points Possible	Points Earned	Comments
Field visible – stars/nebulosity	3 - 2 - 1 - 0		
Color / Black on White	3 - 2 - 1 - 0		
Details brought out	2 - 1 - 0		

Explanation

Criteria	Points Possible	Points Earned	Comments
Location identified	2 - 0		
Length of burst described	2 - 0		
Afterglow in different wavebands described	3 - 2 - 1 - 0		
Other details described	3 - 2 - 1 - 0		
Images in other wavebands described/shown	2 - 1 - 0		

Total points: /20

GRB Image & Explanation Rubric

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